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# The Broadway Bridge, Saskatoon

## A Multiple Concrete Arch Highway Bridge Over the South Saskatchewan River

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**Paper to be presented at the General Professional Meeting of The Engineering Institute of Canada, Montreal, Que. February 8th and 9th, 1934.**

SUMMARY.—This reinforced concrete highway bridge is nearly 800 feet long, exclusive of the approaches, and consists of five arches of varying span. The roadway carries four lines of traffic and has a grade of 4 per cent. Much of the construction was carried on under very severe climatic conditions with air temperatures ranging from −36 degrees to over 100 degrees in the shade. After dealing with design and construction, the author discusses the observations made on the temperatures of the concrete in different portions of the structure during and after construction, extending over a period of more than twelve months.

The city of Saskatoon is cut diagonally by the South Saskatchewan river. Up until 1907 when the population was about four thousand, a primitive ferry was the only means of cross river communication. In that year the 19th street traffic bridge, a steel truss type, was formally opened. Its clear roadway of eighteen feet nine inches, ample for the ox carts and horse vehicles of 1907, was overcrowded in 1913 by the demands of a city of twenty-five thousand with a double line of street-car tracks and the advent of motor cars. The University bridge at 25th street, a concrete arch, was finished during the early war years and provides ample facilities for the northern section of the city. In 1928, when the city had a population of over forty thousand, a Town Planning Commission was formed to study and prepare a comprehensive plan for the Saskatoon of 1960. A careful study of traffic flow, population growth and a major street system indicated, among other things, that in the near future a third bridge at the approximate site of the old ferry crossing of 1907 would be necessary to relieve a badly overcrowded condition at the 19th street bridge. When in 1931 it was proposed to undertake, under the auspices of federal, provincial and municipal authorities, a programme of public works for relief purposes, the Broadway bridge was selected by Saskatoon.

The conditions set down by the authorities handling relief added greatly to the natural difficulties of such an undertaking. In the first place only a month was available between the time the project was authorized and the letting of the contract on December 12th, 1931. The year allowed for completion was further restricted owing to climatic and fluvial conditions which made it necessary to build the cofferdams and construct six piers, involving 9,000 cubic yards of concrete, within a period of eleven of the most severe winter weeks in which the average daily temperature was below zero most of the time and minimum temperatures of 40 degrees below zero prevailed for several days; further the flood conditions of the river in June make it impossible to construct falsework in the river until early in July, and as sub-freezing temperatures are common after the middle of October, it will be seen that the summer construction period for such work is also limited. Moreover all labour had to be obtained on requisition from the Relief Office and the use of machinery was restricted; the effect of these restrictions on construction methods and costs will be mentioned later.

The project will be dealt with in this paper under the following three general headings:

I. Design.
II. Construction and costs.
III. Technical data and records i.e. temperature records, expansions, arch and pier movements.

### I. Design

#### General and Aesthetic

At the site selected for the bridge the elevation of the existing street intersection on the south bank was approximately 63 feet higher than that on the north bank. The river at high water is over 800 feet wide and the distance between streets on the banks about 1,300 feet, an indicated grade between existing streets of nearly 5 per cent. It was decided to limit the grade of the proposed bridge to 4 per cent and eliminate a potentially dangerous grade crossing on the north bank by raising the bridge level at this point and diverting the existing river road underneath the approach spans. Building a bridge between two points of widely different elevation presents serious difficulties both in general proportioning and detailing as the use in elevation of horizontal lines must be studiously avoided. The concrete arch type for the main bridge was selected as being best suited aesthetically and also because it would provide the greatest amount of local employment. In deciding upon the general outlines, arrangement and dimensions of spans, both economic and aesthetic studies were made.

The south river bank presented a problem calling for serious study as it rises steeply to 100 feet above the river bed, and at several locations in the city serious slippage of banks has occurred; at the site of the bridge there was evidence of slippage and extensive borings had shown the presence of a deep stratum of impervious, slippery, blue clay overlaid with layers of sandy clay, quicksand and water, which combination indicates probable slides; remedial drains to relieve this condition had been proposed and were subsequently built. It was decided however to so design the south approaches that protection against slipping would be obtained even if the proposed drain did not give the results anticipated. Figure 1, a general elevation of the bridge, shows the layout of the approaches; the broken line above the footings indicates the elevation of the glacial drift, a very dense clay which is an excellent foundation stratum as will be described later. The south approach consists of four girder spans from 40 to 48 feet in length, supported on bents of four columns which rest on pedestals in the solid glacial drift. Each bent was braced laterally and, as is shown, a continuous line of struts was constructed, about 8 feet below ground surface, from the shore pier to each column in succession; the design was made on the basis that if the four columns at the refuge bay (chainage 12+22) acted as a solid retaining wall of a length equal to that of the entire width of the bridge, the pressure of the pedestals against the glacial drift on the bottom would prevent the base from moving and the struts would carry the thrust at the top of the columns to the abutment shore pier. At the location where the bridge floor met the original surface of the grade (chainage 12+67) the glacial drift was overlaid with quicksand layers of 10 to 15 feet, which made it difficult to put caissons down, and as it was felt some settlement of the ground in the vicinity might be experienced it was decided to build a floating span resting on a cap supported by piles; the continuity of this span was completely broken at the last column bent and any settlement of the floating end will not affect the main structure.

The north approach consists of three 45-foot girder spans and a retaining wall to harmonize with the south approach and arch spans.

In determining the number and size of multiple arch spans on a grade it seems that as the springing lines of all arches must be at the same elevation, either the arches must be of equal span and widely varying rise or of varying span with approximately constant rise-span ratio. Sketches indicated that the latter with a slightly increasing ratio gave the most pleasing elevation. Accordingly tentative designs were made for the river spans with arches varying in number from four to seven and computations indicated that a five-arch arrangement as shown in Fig. 1 was the most economical and moreover seemed to harmonize best with the shore connections.

From the architectural standpoint it was decided that no pretentious ornamentation, portals or pylons would be suitable on a relief project, that the design should be bold and simple emphasizing the structural functions of the various members and an attempt made to obtain the beauty inherent in a structure, well proportioned and suitable to its use. Figure 2 will indicate the measure of success obtained in this respect. It was decided to emphasize the straight line of the deck, making it continuous and well defined; this was obtained by using a simple poured railing, a well defined sidewalk fascia beam and a simple curtain wall to fill in the space between the top of the arch crowns and the floor system; this gave a line of about 11 feet depth, suitably relieved for close observation but from a distance giving a feeling of unity. The arch

Fig. 2—Broadway Bridge Completed.

rings and piers are plain and show their function naturally. The floor system was carried to the arch rings by simple columns.

At the ends of the girder approach spans, simple refuge bays with concrete lighting standards cast in place were constructed so as to make a suitable transition between the retaining wall sections and the bridge proper.

The features over the piers were complicated, due to two facts; first, the grade of the bridge made it essential to avoid horizontal lines or panels of ordinary design; further, as expansion joints in the floor system were used only over piers, provision had to be made for an actual movement of well over an inch between the two halves of the railing panel. The motif selected for the railing panel was used also in the refuge bays and railing terminal blocks.

### Structural

The roadway was designed for live loads due to four lines of 20-ton trucks, or to two lines of 50-ton street-cars with two lines of trucks. Allowances for impact were 40 per cent for slabs and stringers and 30 per cent for floor beams. A live load of 80 pounds per square foot plus 50 per cent impact was used for sidewalk design. For the arch rings live loads of 190 pounds and 100 pounds per square foot for the street railway area and balance of floor area respectively, were used without additional impact allowance. A temperature range of 120 degrees F. was used for arch design.

Stresses of 20,000 pounds per square inch in steel and 1,000 pounds per square inch for bending compression in

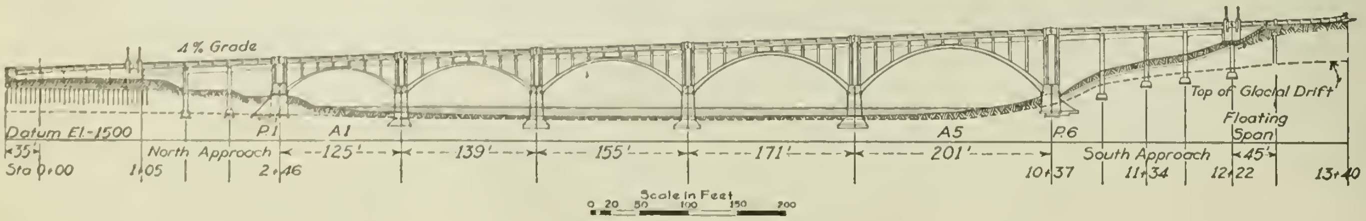


Fig. 1—Upstream Elevation of Bridge.

concrete were used. Canadian Engineering Standards Association specifications for reinforced concrete were used throughout.

*Foundations:*

At Saskatoon, as in most of the localities in the central prairies, bed rock cannot be reached at practicable depths and foundations must be placed on clay.

The glacial drift or till, often called boulder clay, which underlies the Saskatoon district is an excellent bearing soil and at the bridge site was found to lie, in the river bed, only about four feet below a blanket of silt, gravel and clay, while at the approach footings the covering varied in depth up to 25 feet. This glacial drift is a dense fine grained clay interspersed with small pebbles and sand grains and at the upper horizon usually carries large boulders. Information obtained concerning several bridges across the Saskatchewan river built on similar clay indicated that bearing pressures up to 5 tons per square foot normal dead load have been used successfully, that dead loads up to 3 tons per square foot were considered conservative and that the clay was safe for maximum pressures up to 8 tons per square foot. Bearing tests at the site gave similar indications and during excavation it was found that the clay had to be loosened with air chisels as it could not be readily picked and at the dry river piers blasting was necessary. The excavations for river piers were carried approximately ten feet into the glacial drift.

It was decided to adopt bearing pressures of 3.5 tons per square foot for normal dead load with 5.5 tons for maximum due to combined dead, unbalanced live load, wind and traction and an outside limit of 8 tons for possible extreme unbalanced conditions during construction. It will be seen below that the pressures during construction due to unbalanced loading will probably never be equalled again. Figure 3 shows the actual pressures realized at pier 5 which are typical.

The data on pier rotation presented later emphasize the need to study carefully the pressure conditions that may arise during the construction of elastic arches.

Foundation Pressures in Tons per Square Foot at Pier 5

| | |
|---|---|
| *After Completion* | |
| Dead load | 3.1 |
| Dead plus live on one span only | 5.2 |
| Probable max.—dead plus live on both spans | 3.6 |
| *During Construction* | |
| Arch ring 5 only | 4.2 |
| Arch rings 4 and 5 plus deck of 5 | 4.0 |
| Arch ring and deck of 5 only; condition never realized | 7.5 |

**Fig. 3.**

*Floor system:*

Figures 4 and 5 show the arrangement and dimensions of the floor system on the arches. As the arches are of varying spans the column and floor beam spacing had to be varied from 16 feet to 19 feet both for aesthetic and mathematical reasons. In fact a bridge built on a grade with increasing spans greatly multiplies the labour of detailing, as not only do the different arches with their floor systems have to be designed separately but the two halves of one arch differ in detail. The section of the slab carrying the street railway tracks was depressed 8 inches below the finished grade, this surface was waterproofed and the rails set on 4-inch by 3-inch by ⅜-inch angles as ties after which an 8-inch reinforced concrete slab was poured to grade; anchor rods run through the steel ties and the rails and ties become an integral part of the reinforced slab. The roadway section was paved with 2 inches of asphalt with a specially roughened surface suitable to steep grades. Under the roadway slab on the upstream side a conduit approximately 6 feet by 4 feet in the clear was constructed to carry telephone and electrical lines as well as provide space for future water and gas mains. This conduit, which has 4-inch floor and walls, was suspended from the curb stringer on one side and the floor slab on the other by ⅜-inch reinforcing rods bent U shaped so that they ran continuously from the curb stringer down one side wall across the floor and up the other side wall to anchorage in the floor slab. The handrail was poured monolithically with the sidewalk fascia beam which was carried by the cantilevers. The railing was designed to stand a horizontal thrust acting at the coping line of 400 pounds per lineal foot or a concentrated load of 2,700 pounds. At each cantilevered floor beam the railing consisted of a solid vertical panel which in turn was designed as a cantilever supporting the coping which as a beam could support the loads above mentioned; the dado was not assumed to take load.

Each floor beam was carried on four columns, two on each arch ring at 12-foot 8-inch centres with the two inner columns at 18 foot 4-inch centres. A careful analysis was made using influence lines and moment distribution at the joints of columns and floor beams.

The calculated reactions of inner and outer columns were as follows:

| *Max. Reactions* | Outer Col. on Arch | Inner Col. on Arch |
|---|---|---|
| Dead load | 79,500 | 65,200 |
| Live load plus impact | 33,400 | 120,600 |
| Total | 112,900 pounds | 185,800 pounds |

This indicates that the spacing of columns is reasonably satisfactory and that the column reactions on the arch ring

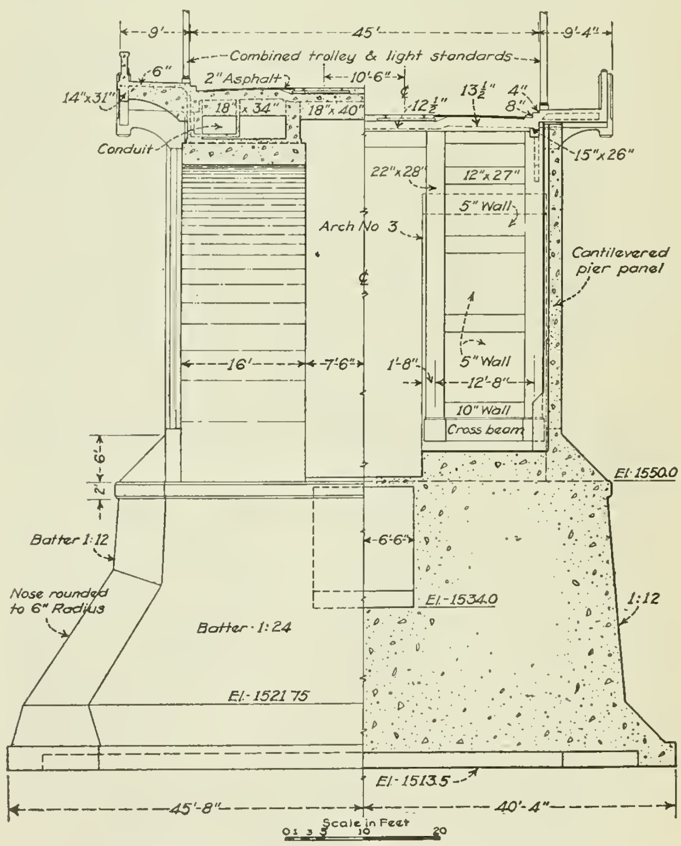


**Fig. 4— Section through Crown of Arch and Centre Line of Pier.**

will be so nearly equal that in designing the arch rings the weight may be considered as equally distributed. For dead load only the outer column carries 55 per cent of the load and the inner 45 per cent. The maximum live load condition will rarely if ever be realized and normal conditions will probably be dead plus one half maximum live, under which condition the outer column will carry about 45 per cent of load and the inner 55 per cent.

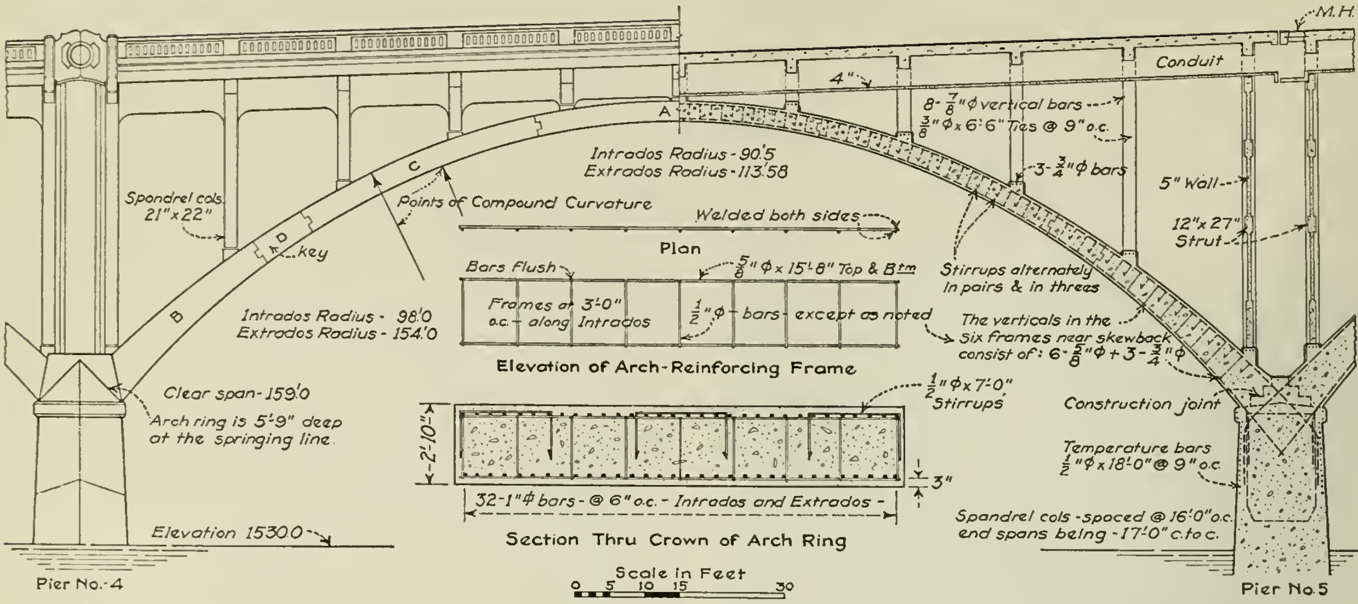


**Fig. 5—Half Elevation and Sections of Arch 4.**

Over the approaches a slab-stringer-floor beam system was found most economical. On the north approach there are one 45-foot simple span and two 45-foot continuous spans, the expansion being taken care of by flexible split columns as indicated in Fig. 1; on the south approach there are two 45-foot continuous spans and two adjacent continuous spans of 40 and 48 feet, these also are separated by flexible split columns. The floor slab is 8 inches, on top of which is placed the track and necessary fill. The four stringers under the rails are 24 inches by 48 inches and two under the centre of the roadway 24 by 46, the curb stringer 24 by 48 and the fascia beam on the sidewalk 24 by 31 inches. The floor beams are 33 inches by 52 inches under the tracks and 28 inches by 52 inches elsewhere. The interior columns are 40 inches by 42 inches and at the expansion joints are split to 20 inches by 42 inches. In calculating stresses in stringers and floor beams, which were considered continuous,

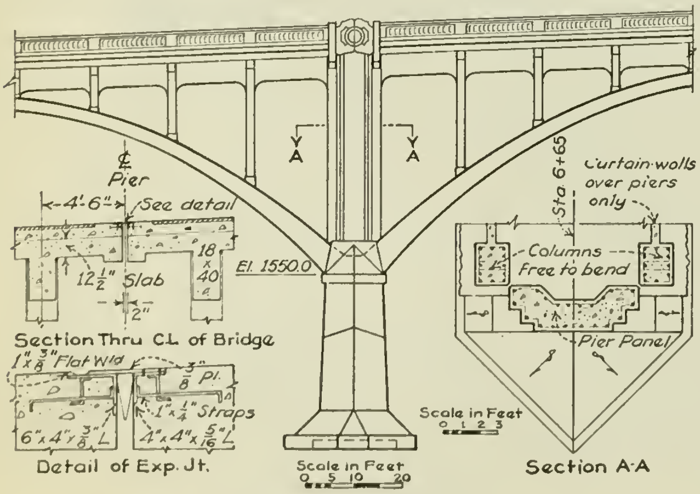


**Fig. 6—Elevation of Typical Pier.**

influence lines and tables for reactions, moments and shears were used. Expansion joints for the deck were located over the piers only on the arch spans and at the split columns on the approach spans: Fig. 6 shows the construction of the joints and the arrangement and details for the panel or pilaster over the pier. This latter unit had to be built as a vertical cantilever resting on the pier, and absolutely separated from the columns and deck which move freely under changes in temperature; it was designed to resist a horizontal wind pressure of 30 pounds per square foot.

*Columns:*

The design of the columns at the expansion joints, both on the approach girder spans and at the piers for the arch spans, was interesting as there was a range from very short columns over the shortest arch, which had to be hinged in order to avoid excessive stresses, to long columns on the south side with an $h/D$ ratio over 20, and all were subjected to moments of magnitude as compared to the axial loads. Further the moments due to bending of columns with deck expansion and those due to fixed end condition of columns at floor-beams, vary with the stiffness of the column, while those due to wind and traction, except for the portion due to end restraint, do not. Unlike the conditions normally found in building work the bridge columns have a stiffness factor much less than the other members at the joint; in the case of long columns at pier 5 the column had a stiffness factor of 50 as compared with values of 260 and 802 for the connected members. The deck columns and arch rings were considered as a frame and moment distribution at the joints was made by the Hardy Cross method of analysis. The following table will indicate the relative magnitudes of the forces in one of the shortest and one of the longest columns.

Stresses in Columns

| | (a) Long Column Size 24 inches by 30 inches Length 41.5 feet | (b) Short Col. without hinge Size 16 inches by 30 inches Length 22.5 feet | (c) Short Col. with hinge Size 14 inches by 28 inches Length 22.5 feet |
|---|---|---|---|
| Maximum moment at top.... | 1,705,000 | 1,600,000 | 1,048,000 |
| Corresponding axial load..... | 135,700 | 124,000 | 124,000 |
| Maximum moment at bottom. | 1,698,000 | 1,345,000 | zero |
| Corresponding axial load..... | 162,000 | 135,000 | |

**Fig. 7.**

The maximum moments in the above represent the greatest combinations of either maximum or minimum fixed end moment due to dead and live loads combined with moments due to either the greatest elongation or contraction of the deck under temperature changes together with wind and traction effects.

In case (*b*) a trial column of 16 inches by 30 inches 22.5 feet long gave moments as shown which in turn gave excessive unit stresses in the concrete of 1,300 pounds per square inch. If the column is increased in width the stiffness factor increases directly and as the principal moments due to dead and live loads and temperature changes in deck also increase with the stiffness of the column, and as the increased strength of the column in bending also increases directly as the width, there is little value in widening the column where the stresses due to moments are large as compared to axial stresses. On the other hand if the depth be increased the stiffness factor of the column increases as the cube of the depth, the moment increases in a different ratio according to the relative stiffness coefficients at the joint but, in such cases as are being dealt with, at a rate only a little less than the cube of the column depth. The strength of the column in bending increases however only as the square of the depth so that increasing the size of the column actually weakens it. A hinge at the bottom relieves the stresses as indicated by (*c*) and permits the use of a smaller column in which stresses in the concrete are below 1,000 pounds per square inch. The columns as in (*a*) presented no such difficulties, calculations indicated that decreasing the $h/D$ ratio, as was possible in many cases, tended to weaken the column but notwithstanding these theoretical calculations it was not considered wise to use ratios much above 20. In designing columns checks were made by using both the normal methods for direct stress plus bending and the tentative method suggested by Hardy Cross.*

When hinges were required a type of reinforced concrete hinge, similar in design to those used in Europe for arch rings, was made up on the job at a very small cost, and observations made throughout the past year indicate that these hinges are functioning well.

There is some uncertainty as to the forces acting on columns resting directly on the arch ribs; if the arch rib remained unchanged under temperature changes undoubtedly great bending stresses would be set up in these columns as the deck expanded or contracted under such influences but the arch ring where the column joins the rib undoubtedly rotates in a direction tending to relieve any stresses so set up. In designing such columns only the rigid frame moments due to dead load, live load, wind and traction were considered.

*Arch rings:*

In designing elastic arch rings the magnitude of the yearly temperature variations is an important factor, especially if the ratio of rise to span of arch is not great. At Saskatoon, temperatures ranging from 110 to minus 60 degrees F. may be experienced over a long period and yearly variations of 150 degrees can be expected frequently. Under such conditions arch rings wider and thinner are more advisable than would be the case in more temperate climates. A width of 16 feet was selected as most suitable, studies showed that for the longest arch with a rise-span ratio of 0.245, a 12-foot width containing less concrete would be more economical, but for the shortest arch with a ratio of only 0.201, the 16-foot width proved the more economical.

When the deck has expansion joints only at the piers the arch ring, columns and deck unquestionably act together structurally to an appreciable extent. While this problem of deck participation has been studied experimentally by many investigators** one hesitates to accept the results of such studies for design purposes except as qualitative indications, for the reason that constructional methods seriously influence the premises. The rings on the bridge under review were poured and the false work removed, the deck was then poured and before the concrete was set and the deck in a position to participate structurally, the arches were carrying, with consequent deformations of over one inch, the full dead load; this is a condition different from a model which has the deck attached before the arch rings are placed under any stress. No allowance was made for any possible strengthening of the arch rings due to deck participation, but the temperature moments and thrusts as calculated for the arch rings were increased about 75 and 150 per cent respectively at the springing section and extra steel provided to take care of this.

Figure 5 shows clearly the profile, dimensions and reinforcement of one arch. As shown, frames, made on the job by bars welded together, were used to support and tie together the longitudinal reinforcement, these frames were set on small precast concrete blocks which rested on the forming, and proved both economical and convenient. Concrete arch rings are usually poured in sections in order to relieve shrinkage stresses. Arch 4 as shown was poured in sections in the following order $A$, $B$ and $C$. The key $D$ which was left for several days was so located that all reinforcing bars were discontinuous between $B$ and $C$, the overlapping splice occurring in the keyway. As the rings were poured and settlement of falsework occurred, there was a slipping movement between the bars as follows:

At completion of pour except key way..... Ave. total slip 0.5 inches
Two days after completion of pour........ Ave. total slip 0.75 inches

At the end of two days the slipping had practically ceased and the keyways were poured. It occurs to one that the shortening of the arch ring due to settlement of the forms and falsework, which continues for some time, may be a more valid reason for pouring arch rings in sections and with keyways than the commonly accepted one of relief of shrinkage stresses.

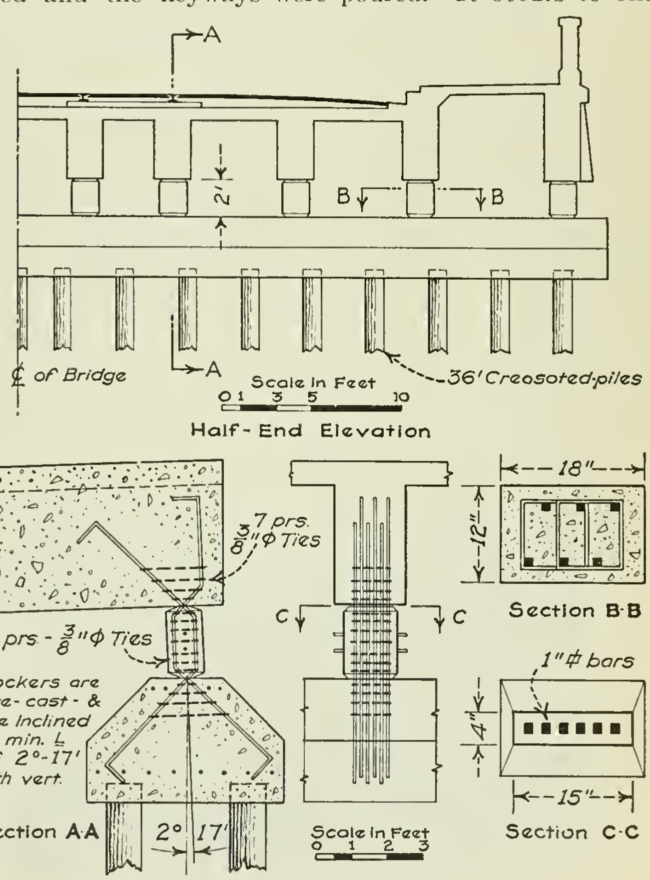


Fig. 8—Details of Hinged Rockers.

*Floating span:*

The design of the floating span involved some interesting details. As will be noted from Fig. 1 the girder spans are

* Journal American Concrete Institute, December 1929.

** Bulletin No. 226 University of Illinois; Civil Engineering, November 1932.

flanked on the shore ends by retaining walls, with refuge bays. On the north end a common gravity retaining wall on pile foundations was used, but on the south end foundation difficulties made it impracticable to build an ordinary retaining wall and aesthetic considerations demanded the appearance of one, accordingly the walls shown were suspended from the floor system and suitably braced at the bottom to prevent movement. A novel feature was introduced by using hinged rockers to carry the stringer reaction to the floating pedestal as detailed in Fig. 8. It was felt that due to the potentially unstable condition of the ground at this point, if an ordinary expansion joint were used there might be the danger that during the cold weather the pedestal supported by the piles would move riverwards if the expansion joint failed to function, that the sliding hill would then settle firmly behind and during the summer expansion period the earth resistance would make the expansion joint function, such an action if repeated yearly might produce serious results. Accordingly reinforced rockers were designed and so placed that the axis will always be off the vertical and in summer or winter whether the bridge is expanding or contracting there will always be a small component of the reaction acting up hill against the earth pressure.

The reinforcement was bent on the job and the complete rockers constructed and placed at the small cost of $15. each. These rockers, weighing 700 pounds apiece, were used under each of the ten stringers.

## II. Construction and Cost Data

The construction period was divided naturally into three parts.

First, the winter—From letting of contract December 12th, 1931, to middle of March 1933, during which time the river piers had to be constructed.

Second, the spring—From middle of March to first of July; from the time the ice started to go out until after the recession of the June floods little work could be done on the river and in this interval the shore approach spans were built.

Lastly, the summer—From the first of July to the middle of October the arch rings and floor system of the river spans had to be built.

The winter weeks were the most trying, during which a fight against time and the elements was waged continuously

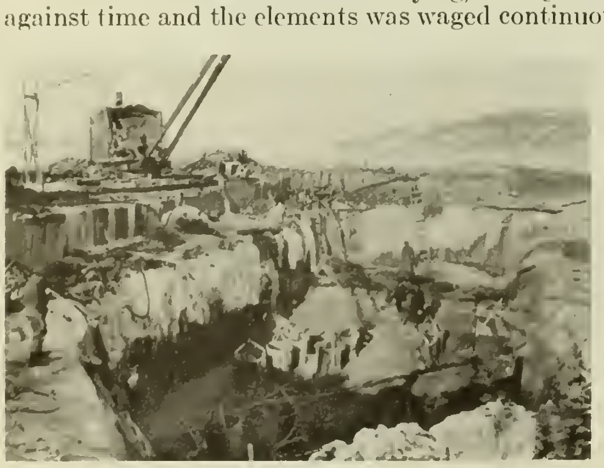

Fig. 9—Excavation for Pier 5, March 10th, 1932.

for nearly three months, twenty-four hours a day, seven days a week.

The excavations for piers 1 and 6 on the shores were made in the dry. For the other piers cofferdams made of two rows of 6-inch by 12-inch tongued and grooved sheet piling, were used. The cofferdams were designed so that no interior bracing would be necessary; a distinct advantage during excavation and forming. The inner row of piling was driven on a line 10 feet outside the edge of the footing, the two rows were driven 5 feet apart and the intervening space filled with clay puddle. The piles were supposed to be driven at least two feet into the glacial drift. When this was done comparatively little trouble was experienced, but on pier 3 there was a layer of gravel deeper than usual above the clay and the piles when first driven did not penetrate the clay. The result was that this dam broke in thirteen

Fig. 10—Work in Progress, February 19th, 1932.

times between the date it was started early in January and the time of completion late in February; eventually all the piles had to be redriven into the drift. All excavation work was, under "relief regulations," to be done by hand, the glacial drift was, however, so hard that air chisels were permitted. The soil was raised in buckets by a hoist. Figure 9 shows the excavation for pier 5, where a troublesome stratum of large boulders made driving difficult and in which leaks had to be fought constantly during a period of extremely cold weather. The ice in the river rose rapidly before this pier was finished and this illustration shows the ice close to the top of the cofferdam. Before completion the water level was within an inch of overtopping the dam.

The specially built combination pile driver and hoist, weighing about 12 tons, was for the most part moved directly on the ice, and was carried on timbers which spread the weight over 280 square feet. When first put into operation however, the ice, then only 10 inches thick, failed, and supporting piles had to be driven, but when the ice thickened to about 18 inches the load was carried safely. An incident showing the great adhesive force of ice happened in February. In building the cofferdams a channel about seven inches wide was cut with ice saws around the outline of the cofferdams, the piles were first set in place by hand around the entire site with a small opening left for the pile driver to enter the enclosure and drive the piles. (Figure 10 shows the piles so set for one cofferdam.) The weight of the pile driver was apparently supported by a small area of ice 106 by 45 feet, which had been cut almost completely around the periphery, no trouble was experienced until one night the firemen on the pile driver cleaned the boiler and allowed the hot water to flow out on the top of the ice. Almost immediately the ice and driver sank, fortunately only a few feet, as the hot water broke the bond between the ice and piles. The pile driver had been carried almost entirely by the adhesion between the piles just recently placed and the ice against which they rested.

During the winter all concrete was mixed and placed under cold weather conditions. Great difficulty was experienced in obtaining aggregates as there was no opportunity to stock material during the fall weeks. Due to relief considerations, tenders were called for gravel "loaded in trucks at the pit," the trucks to be supplied by the relief department of the city; the only bid that could be considered from the cost standpoint was from a pit 10 miles from the city on a local road, used little in summer time and never before in winter time; the pit was not equipped for winter operation and was badly equipped at best. During a very cold winter on the wind-swept open prairie, without shelter, stripping and excavating had to be done continuously under very strenuous conditions. In addition the roads became blocked with snow and a motor-driven snow plough had to be made quickly and operated at times night and day in biting and blinding blizzards. It soon became apparent that the screening apparatus would not operate under such conditions and delivery of pit run gravel was accepted during the winter months. This aggregate was deficient in both the finer sand grains and in the coarse sizes over ¼ inch, consequently it was necessary to obtain crushed rock and a very fine sand locally and to mix these three materials at the site. Fortunately it was possible to have the services of a competent concrete technician and three assistants, all engineers of experience, and by analysing the pit run material from hour to hour and changing the mixes as often if necessary, a satisfactory and economical concrete was obtained. Test cylinders of concrete from the buggies were taken every two hours, the average strength of which was 2,460 pounds per square inch, the specified strength being 2,250 pounds per square inch.

The aggregates were thoroughly studied in the Materials Testing Laboratory of the University of Saskatchewan and charts worked out so that the proportions could be easily changed according to the composition of the pit run samples. The consistency was checked regularly by the slump test. The specified strength was obtained by using 4.75 bags of cement to the yard with a maximum slump of 2 inches. The aggregate was delivered by trucks directly on top of the aggregate shed which was built into the side hill. Perforated 1½-inch steam pipes were laid at 6-foot centres across the floor of the shed and the aggregate, piled on top, was heated to a temperature varying from 70 to 100 degrees F. depending on outside conditions, the mixing water was also heated.

Relief restrictions also demanded that the concrete be wheeled by labourers from the mixers to the piers. For this purpose a trestle runway was built at the level of the springing line of the arches and all wheeling done at that level. (Figure 10 shows the trestle and also the aggregate shed located on the north bank.) Generally speaking, concrete had to be poured when the excavation was ready, regardless of weather conditions, as there was always the danger that the cofferdams would spring a leak. The common procedure was as follows: the mat for a depth of 2 feet was poured in the open directly against the clay, there being no side forms, the portion from that elevation to about river ice level was also poured in the open without protection but the forms were built as the concrete was being poured. The portion from the ice level to springing line level, about 25 feet, was usually housed in and heated by steam and stoves, but this housing was built as the pouring proceeded. A description of the procedure on one pier will be given as an indication of the cold weather methods used. Pier 6 on the south shore was located about 1,000 feet from the mixing shed; the excavation was finished and pouring started at 9 o'clock p.m. Thursday night. The outside temperature was then about 10 above zero but the weather changed suddenly and by 4 o'clock the following morning the thermometer had dropped to 25 degrees below zero and a stiff north west wind of about 20 miles per hour was blowing. The men wheeling the concrete in buggies on a platform high above the river had to make a round trip of 2,000 feet exposed to these unusually severe conditions, and it is a testimonial to relief labour that for two days and three nights under such conditions the work went on uninterruptedly. As concrete was being placed in the open, work could not be stopped, because the heat generated by the chemical reaction of setting in the mass concrete was the only protection available. The concrete left the mixers at an average temperature of 90 degrees and during the 1,000-foot haul only 2 degrees were lost; as the concrete was dumped into the footings the top exposed surface would freeze quickly but frost did not penetrate far

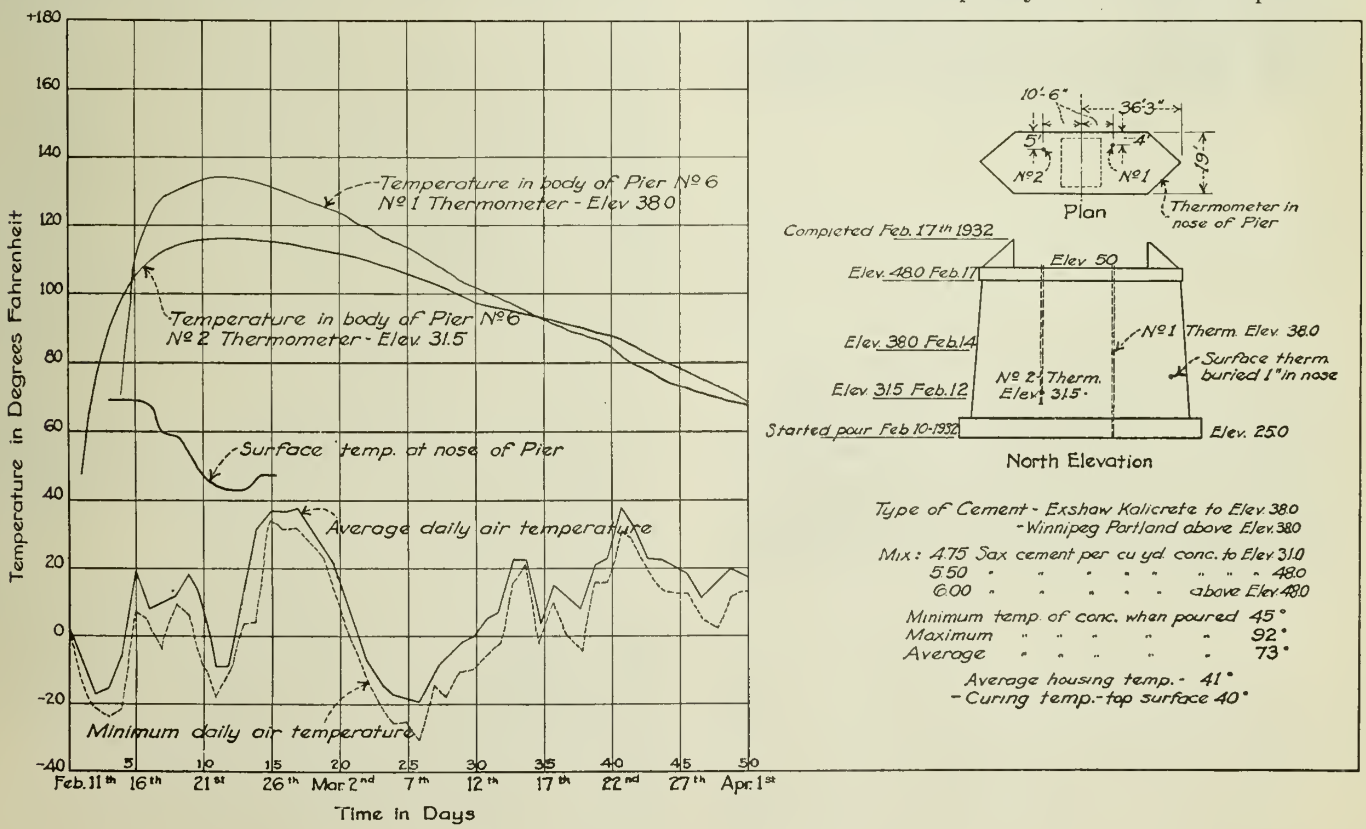


**Fig. 11—Temperatures of Concrete, Pier 6.**

as each layer was soon covered over with a heated mass and the frozen surface quickly thawed and there was no alternate freezing and thawing. When forming was started tarpaulins were used to cover the surface of one end while pouring was concentrated at the other, thermometers were buried in the mass and also on the inside of the forms. In the interior of the pier the temperature of the concrete rose rapidly and within a few hours stood at 100 degrees. The

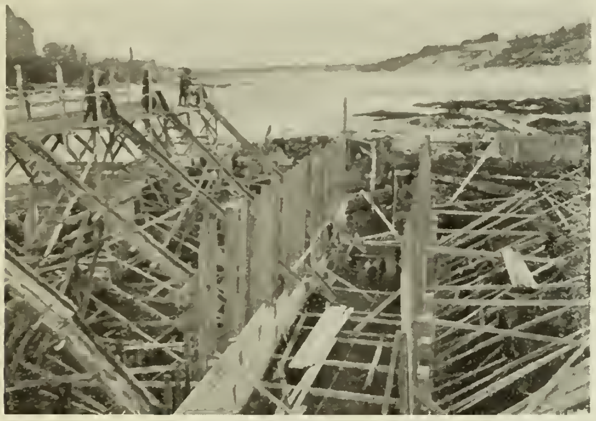

**Fig. 12—Forming and Pouring, Pier 3, February 26th, 1932.**

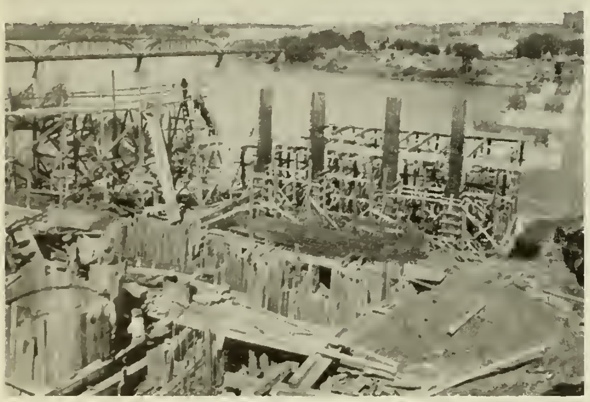

**Fig. 13—Spring Work, South Bank, May 23rd, 1932.**

forms alone gave such protection that the thermometer against the forms never read below 50 degrees. Altogether about 9,000 cubic yards of concrete were poured under sub-freezing conditions with satisfactory results. In the centre of all piers tubes were installed at different levels and temperatures were read daily for several months. Figure 11 shows the temperature rise and fall for pier 6. Figure 12 shows concrete being poured while forms are being built at pier 3.

During the spring period work was concentrated on the approach spans. In excavating the column footings, open caissons were used. The caisson consisted of 2-inch by 6-inch lagging supported by iron rings 3-inch by ⅜-inch in section and 7 feet in diameter, placed at centres varying from 3 feet at the greatest depths to 5 feet at the surface. These 7-foot holes were carried down easily and very cheaply to depths of 30 feet. At a few locations where quicksand was encountered the hole was enlarged to 9 feet for the first 10 feet. When the caisson had penetrated into the glacial drift, the excavation was undercut in the final 5 feet to a diameter of 11 feet and this truncated cone, filled with concrete, became the footing upon which the columns rested. Figure 13 shows a few of the caissons on the south bank. All foundations were tested for alkali ground water conditions. No concentrations of harmful strengths were found except in the deep column excavations on the south approach where the presence of about 1,300 p.p.m. of sulphates in the water indicated the wisdom of using Kalicrete, a high alkali-resistant cement, in all concrete work below the ground water level.

It was felt that as the summer period would be very brief for the amount of work to be done, it might be wise to construct during the spring the rings of arches 1 and 5 which adjoined the shores. The rings of arch 1, on the north bank, were poured on May 24th but in arch 5 only the driving of the pile bents on the south bank was completed before the high water in June. On June 7th the river rose 5 feet in four hours and by June 8th was 23 feet higher than the winter level, one of the four highest stages reached in twenty-five years. One of the pile bents on arch 1 was broken away by the damming of debris and later it was discovered that this practically had the effect of striking the entire falsework. The piles for arch 5 which, at pier 5, were capped about 20 feet above the river bottom, vibrated violently until the water covered the caps, but after the water receded these piles were tested and found unharmed.

As soon as the high water receded, work on all spans was prosecuted with vigour. The pile driving was completed without accident, the pile driver was carried across the river at the elevation of the top of the piers and was of such a size that it could pass over the piers between the thicket of reinforcing rods which protruded from the piers at the spring line of the two arch rings. The falsework for the arch rings was carried on 30-foot piles. The bents on the longest arch were driven at 13-foot centres and contained six piles, while on the shortest on the same centres only four piles to the bent were required. The maximum load to be carried on any pile was set at 20 tons and an inspector supervised the driving of every individual pile to see that the pile reached the glacial drift level in any case and also that it was driven until the penetration under a 5,500-pound hammer averaged only one inch during the last ten blows. For the falsework supporting the arch rings, with the exception of the caps on the piles and each tier, which were dimensioned fir 8 inches by 10 inches, spruce poles, 7 inch tops, were used for vertical struts, and for bracing, smaller spruce poles with tops only 3½ inches. As this material was obtained from northern Saskatchewan it not only provided local labour, but was very economical, as after demolition it was all sawn up into firewood and most of the first cost recovered. As the material for the falsework was delivered at the water's edge on the south bank it was sorted and cut to length there and then wheeled by one man on a dolly along a runway built at pier level right across the river; this method was used due to relief restrictions, but it also proved very efficient and all the material for the falsework of arch 5 was wheeled on a dolly from the stock pile to its place by one man in three working days.

The joists, carrying the 2-inch by 8-inch lagging which formed the floor of the arch ring forms, were cut from 3-inch by 10-inch and 3-inch by 14-inch fir. A deflection of ⅝ of an inch was allowed and the joists were cut to such a curve that after deflecting this amount at the centre they would conform to the true curvature of the arch.

All concrete for the arch spans, with the exception of the rings on arch 1, was mixed on the high south bank and wheeled down the 4 per cent grade, the return trip empty was not difficult. The reinforcing steel for the arches was also delivered from the same location, consequently a second runway had to be built a few feet above the finished deck line, this runway can be seen in Fig. 14. Back forms were used on the arch rings for a few feet adjoining the piers where the slope of the surface was in excess of 35 degrees. One of the difficulties lay in supporting the formwork for the cantilevered sidewalk; instead of driving an extra row of piles eight feet outside of the ring edge the top caps were extended six feet on the outside edge and reinforced by knee braces, struts in turn were erected on these caps and supported the sidewalk forms.

Figure 14 taken August 12th, 1932, is an interesting picture as it shows various aspects of the work proceeding simultaneously. The floor systems of the two approaches are completed and the hand rail is being poured on the north approach. The pile driver is finishing driving the piles for arch 2 and is about to pass over pier 2. On arch 3 the final falsework bents are being erected and the rings of arch 4 are being poured. The columns of arch 5 have been poured and the deck is being formed. Again the absence of machinery is evident.

The last part of the work presented some unforeseen difficulties due to the fact that in 1932 in Saskatoon the first two weeks of October were the coldest on record, i.e. average mean temperature 34.25, average minimum 23.0, average maximum 45.5 degrees F. Usually outside concrete work can be done quite safely until the middle of October. Late in September the temperature dropped slightly below freezing several nights and arrangements were made to heat the aggregate and mixing water for concrete work but it was not possible to protect the finished concrete. As the various members were poured, however, resistance thermometers with temporary leads were buried and a record kept of the temperature maintained at the various points and, as will be referred to later, this made it possible to determine if and when supports and forms might be removed. The floor slab of arch 3, the last to be completed, was finished on October 6th. The weather, which had been cold several days before, was mild while the pouring was going on, but at 5 p.m. on the 6th the temperature started to drop very rapidly and by 6 a.m. on the 7th the temperature was 18 degrees. When the temperature started to drop, the sidewalk as it was finished was covered with hot sand, sawdust and tar paper, but the road slab was too large to be protected in this manner. Fortunately there was available a steam boiler which had been used to heat the mixing water and the only thing possible was to run hot water over the slab. This was done for three days and four nights until the weather moderated and by this expedient the temperature in the centre of the roadway was kept up to 56 degrees for the first day, 48 degrees for the second and well above freezing for the duration of the cold snap. No harm was done to the roadway, but the sidewalk, which was fresher when subjected to the cold and difficult to keep covered, was affected superficially at the curb edges. The hand rail was poured under these conditions, the top of the coping was covered with tar paper, boards and manure and that, together with the forms which were quite heavy, prevented any freezing and contrary to fears at that time, no harmful effect is yet apparent. By October 11th it was evident that sub-freezing weather would continue and the street railway paving, the floating span on the south end, the sidewalks and railing on the curved approaches of the bridge structure remained to be done.

The work on the street railway trackway was complicated by the fact that curing as well as frost protection was necessary and this was difficult due to the sub-zero weather. The concrete aggregate and mixing water were both heated so that the resulting concrete left the mixer at approximately 90 degrees. In addition, calcium chloride was added to accelerate the setting of concrete poured after October 13th. As soon as possible the trackway was covered over with tar paper, carefully lapped and this was covered with sand and manure. While pouring, 10 to 12 degrees of frost were experienced during the nights. The temperature at the surface of the pavement went down from 90 degrees on the first day to 60 degrees by the fifth day. The temperatures inside of the slab were undoubtedly much higher, and considering the circumstances it is felt that satisfactory curing was obtained as there was little loss of moisture through the tar paper and reasonable temperatures were maintained for a week. The tar paper and manure were kept on for a month and after a year's use the roadway is in excellent condition.

Concrete pouring on the floating span was not started until October 28th, and by this time temperatures of 10 degrees below zero were experienced. Special XXX high-early-strength cement manufactured by the Canada Cement Company was used on this portion of the work with entire success. All aggregate and water were heated so that the concrete went in at 90 to 100 degrees. As soon as the surfaces hardened they were covered immediately with tar paper and manure, twenty-four hours after the slab was poured the street railway track was laid and the trackway pavement poured. In forty-eight hours the asphalt pavement was placed on the roadway portions and the 10-ton roller carried without any damage. Temperatures on the surface were maintained well above 70 degrees for several days and in the centre of the heavy 24 by 48 stringers temperatures of well over 100 degrees were maintained as will be referred to later.

The specifications called for a 2,500-pound concrete in the arch rings and deck and a 3,000-pound concrete in the trackway pavement. For the rings a mix with five and a half bags of cement to the yard, having a slump of from 2 to 4 inches gave an average strength in test cylinders of 2,620 pounds per square inch; for the decks a slump of 5 to 6 inches was necessary and six bags to the yard were used with average indicated strength results of 2,600 pounds per square inch. For the trackway pavement the concrete had a slump of from 1 to 2 inches, was vibrated in place by a mechanical vibrator and contained seven bags of cement per yard; the resulting concrete had strengths between 3,000 and 3,500 pounds per square inch.

During construction, readings were made of the settlements of forms and members and the following records for arch 4 are submitted as typical. It was calculated that when the arch rings were poured the top would settle 1.5 inches; the actual average settlement was 1.32 inches with a maximum at one point of 1.56 inches and of this settlement the piles which were carrying 15 tons each

Fig. 14—Progress at August 10th, 1932.

were responsible for 0.12 inches, the balance being in the verticals and connections of the falsework. As has been stated the supporting of the cantilevered sidewalk was difficult and for this portion instead of the one inch calculated settlement an average of 1.5 and a maximum of 2-inch deflection was realized.

The bridge was formally opened for traffic on November 11th, 1932, less than eleven months after the contract had been awarded. The arrangement of connecting streets and their paving was delayed until the summer of 1933.

Costs

Owing to the very limited time available for preparing plans and also to the necessity of spending at least fifty per cent of the expenditure in local labour, it was decided that the city, through the city engineer's department, should purchase all materials excepting lumber, and that the general contract would be essentially for labour and the supplying of lumber, tools, equipment and so forth. Tenders were called for on a unit price basis and the following are the prices bid by the successful contractor.

| Items | Unit | Approximate Quantity | Total |
|---|---|---|---|
| Excavation: | | | |
| East girder span col. footings. | $ 5.50 | 2,800 cubic yards | $ 15,400 |
| All other excavation | 6.58 | 7,460 cubic yards | 49,086 |
| Cofferdams | 4,440.00 | 4 | 17,760 |
| Embankment | .66 | 10,000 cubic yards | 6,600 |
| Concrete: | | | |
| In piers and abutments | 4.40 | 8,000 cubic yards | 35,200 |
| Above springing line of arches. | 10.30 | 11,600 cubic yards | 119,480 |
| Fence | 2.36 | 2,500 feet | 5,900 |
| Sidewalk over earth fill | 0.09 | 10,900 square feet | 981 |
| Curbs over earth fill | .17 | 1,770 feet | 301 |
| Carborundum rubbing | .25 | 12,000 square yards | 3,000 |
| Waterproofing | 1.20 | 6,795 square yards | 8,154 |
| Piling | 0.50 | 2,000 feet | 1,000 |
| General | | | 900 |
| Total | | | $263,762 |

The minimum schedule of wages to be paid was set forth in the contract for the various classifications of labour employed, based on a rate of 45 cents an hour for common labour. All workers with the exception of one lead man in ten were to be rotated, no worker to be allowed to work over ten hours a day or to work over a set number of days a month, i.e. a man with no children could not earn more than $25 per month, while the maximum for a man with a large family was $37.50. The contractor could select only three men from his own staff, i.e. general superintendent, general foreman and accountant, all other employees had to be requisitioned for and were supplied to the contractor by the city relief office. The contractor had the right to discharge incompetent employees with the consent of the superintendent of labour. The above regulations meant a compulsory large turn-over and actually during the year's work on the main bridge fifteen hundred and ninety-three different men were employed.

That the natural hazards of the job and the exacting relief conditions introduced a great element of uncertainty, was proved by the fact that the tender of the lowest and successful bidder was less than fifty per cent of that of the highest and thirty-three per cent lower than the next responsible bidder. The quotations given above were for the use of hand labour only, alternative bids were asked in which the use of any or all machinery was allowed, and it is a remarkable fact that the tenders of the successful bidder under both conditions differed only slightly.

The total amount of the general contract based on unit price bid and the estimated quantities, amounted to $263,762.00. The contractor's final estimate for this work was $266,333.93. The aggregate for the winter months was purchased at 35 cents per cubic yard in the pit and the truck drivers were allowed $1.20 per yard for hauling it 10 miles to the site. The crushed rock was crushed at the site by the city's machinery and the unit cost of all aggregate per cubic yard of concrete in place was $2.48. The cement was purchased from the Canada and Marlboro Cement Companies for $4.03 per barrel in cloth bags minus a rebate of twenty cents per bag. Twenty-eight thousand, eight hundred and eighty-seven barrels were used on the bridge proper and an additional three thousand, five hundred and sixteen barrels for pavements and other works on the connecting streets at the approach.

Altogether 1,000 tons of reinforcing steel were used, this was purchased from the Manitoba Rolling Mills, ordered cut to specified lengths for a base rate of $63.40 per ton. As a relief measure to provide additional local labour, all bending work was detailed in the designing office and actual bending supervised by that department. One machine was used for bending slab steel and roadway dowels and two for heavier bending; operating these three machines concurrently made it possible to keep in tune with the contractor's requirements. One and one-eight-inch and one inch square bars 68 feet long were bent without difficulty. While the bending was undertaken essentially as a relief measure, the actual costs of $4.53 per ton for heavy and $9.26 for light bending indicate that it was also economical.

The cost of the bridge proper, exclusive of the street alterations at the approaches, was approximately $640,000, of which $324,000 was paid in wages to residents of Saskatoon city. This works out at a cost of $7.30 per square foot for the entire bridge.

In one of the typical river piers actual costs were as follows: For excavation $3.60 per cubic yard. For concrete, including all overhead expenses $4.86 per cubic yard made up of forming $1.82, mixing, pouring, transportation, and placing $2.06. Heating and protection $0.98. The total cost of the cofferdam was $3,914.40.

For the concrete in the superstructure the figure of $10.20 per cubic yard which included all piling, falsework, forming, placing steel etc., while very low, was slightly greater than the actual cost.

The asphalt pavement on the roadway sections was laid for $2.42 per square yard.

The total cost of this project including the bridge proper, compensation for land and buildings expropriated, engineering, flotation and all expenses was $843,178.15. The original estimate was $850,000.

The Arrand Construction Company, Saskatoon, was the general contractor. The asphalt paving was done by Carter, Halls and Aldinger, Winnipeg.

## III. Technical Data and Records

### Temperature Measurements

As has been stated the temperature stresses in arch rings subjected to wide variations in temperature, are of major importance. In order to obtain data on the actual temperature variations in this structure, thermometers were buried during construction in an arch ring and also in a pier and in the floor system. Readings have now been taken over a complete calendar year after the arch was completed. The arch selected was 5, the longest and most southerly unit, the pier selected was 5, a river pier which is the north support of that arch. Arch 5 has a clear span of 186 feet and an axis rise of 46.8 feet, the rings are 16 feet wide, 3 feet 3 inches thick at the crown and 6 feet 3 inches at the springing; the intrados curve consists of two segmental sections with radii of 106 and 132.83 feet respectively, the reinforcement consists of seventy one-inch square bars increased by 50 per cent at the springing. Five thermometers were buried in the west ring of the arch as follows: at the crown one 3 inches and one 19½ inches deep, at the springing line one 3 inches, one 19 inches and one 33 inches deep, all thermometers were placed about midway between the outer faces of the ring. The section of the pier where the thermometers were installed is approximately 13 feet by 65 feet. Three thermometers were placed in the pier, one 18 inches, one 36 inches and the third 72 inches deep. In the floor system three thermometers were buried, one in the centre of the road slab which consists of 15½ inches of concrete covered by 2 inches of asphalt pavement, one in the street railway slab which consists of 22 inches of concrete and the third in the centre of the curb stringer which is 15 inches by 30 inches in cross section.

Resistance thermometers were made up by using commercial telephone 500 ohm coils, insulated and placed in a brass tube ¾ inch in diameter and 7 inches long, the ends were well sealed with a preparation of 50 per cent paraffin and 50 per cent rosin, poured while hot, the leads consisted of rubber covered mine cable, which extended 2 feet, from there on No. 18 solid copper weather proof wire was used. All leads were buried in the concrete of the arch rings and deck and carried a maximum of 190 feet, so buried, to pier 6, where a panel was placed in a specially constructed shelter. The terminals were all carefully marked and the readings were taken with a portable wheatstone bridge. All coils were calibrated and conversion charts prepared to convert all readings to degrees Fahrenheit. Studies indicate that the readings are accurate to one half of one degree Fahrenheit and with the exception of one of the eleven coils no trouble has been experienced.

In this paper those portions of the continuous yearly record will be selected which will best illustrate the fluctuations and trends set forth in the following discussion.

One of the general conclusions arrived at from a careful study of all the data is the surprising effect of the temperature flow from the water in the river, through the pier and up through 100 feet of arch ring to the crown at an elevation of about 75 feet above the water line. The effect was so great that in February when minimum air temperatures of 36 degrees below zero were experienced, while the roadway slab went to 30 degrees below zero the mean daily temperature at the centre of the arch crown was never lower than 22 degrees below zero, that at the centre of the springing lower than 10 degrees below and that at the 72-inch depth in the pier lower than 3 degrees above zero. In the extreme hot periods of the summer again the maximum temperature of the crown and springing sections did not get within about 20 degrees of that obtained in the floor system. That the flow of heat in such structures was of such practical magnitude was first suggested to the writer by J. Mould, Jr.E.I.C., a graduate student at the University of Saskatchewan, who carried out some preliminary experiments during one winter on a bridge in Saskatoon.

The temperatures, then, of the various portions of the bridge are affected not only by the temperatures of the outside air but also by the water in the river. The temperature in any pier will evidently vary from the base and that portion below the ice or water level, which will be affected almost wholly by water temperatures, to the top where the effect of the outside air will be appreciable. For the purposes of this paper "pier temperatures" will refer to the temperatures at the level 8 to 10 feet above normal water level, where the thermometers were installed, a location which data indicated to be affected more by the water than the air temperatures.

The range of air temperatures during the year of record varied from the coldest day, February 7th-8th, 1933, with an absolute minimum of 36 degrees below zero, maximum of 23.7 degrees below zero and a twenty-four-hour mean of 29.3 degrees below zero, to the hottest day, June 16th, 1933, with an absolute maximum of 103 degrees in the shade, minimum of 66 degrees and a twenty-four-hour mean of 84.5 degrees. On the charts shown mean twenty-four-hour temperatures are plotted.

To avoid further complicating the charts the water temperatures were not plotted in every instance. The water temperature during the winter months is of course approximately 32 degrees, and during the summer weeks from the middle of June to the middle of August it had a mean approximately equal to that of the air for the same period. During this period in 1933 the average water temperature was 69 degrees, which compares with that of other years for which records are available. From the middle or last week of August the water temperature falls gradually to near freezing by some date in November or December, depending on yearly conditions. After the spring ice break-up, which in 1933 was on April 19th, the temperature rose within four days to about 50 degrees where it was maintained until the middle of May when a further jump to 60 degrees was experienced, and this temperature was maintained with minor fluctuations until the warm weather of early June.

In discussing the yearly variations it is helpful to observe that about the middle of August makes the best starting point as at that time the mean temperature of air and water have been steady and equal for about two months and as a consequence the temperature of the piers, arch rings and floor system approximate the same mean daily temperature. From that time until November or early December, the air and water temperatures have a common downward trend until the mean temperature of 32 degrees is reached. The temperatures of the various members of the structure, while subject to greater or less fluctuations and lag, depending on size and location, follow in their means the same long time trend. On November 5th, 1933, just before the occurrence of the cold spell which froze the river over and carried the air temperature well below zero, the temperatures of all members were grouped between the limits of 35 degrees at the centre of the piers, the warmest, and 27 degrees in the floor slab, the coldest, portion of the bridge. From that date on however the temperature of the air with minor fluctuations dropped until it reached its lowest point in February when the daily mean was 29.3 degrees below zero (i.e. 61 degrees below the water temperature) and then climbed back to 32 degrees just before

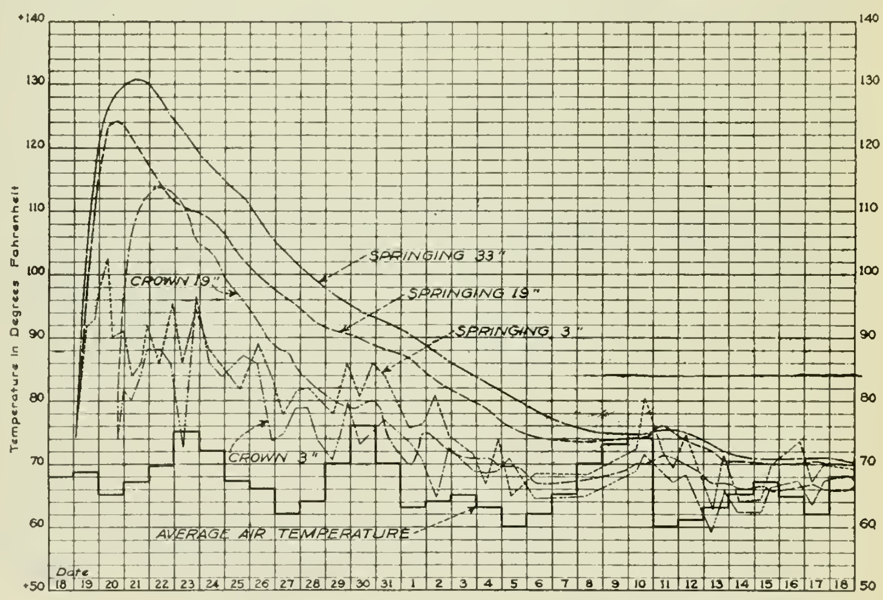


Fig. 15.

the spring break-up. The result is that temperatures of members vary depending on the relative influence of water and air temperatures, as will be illustrated in the charts. The temperature in the pier dropped due to air effect slowly but steadily from 32 degrees on December 12th to a minimum of 3 degrees on February 17th, an apparent lag of about nine days. From February 17th until the spring break-up the pier temperature rose slowly, reflecting a similar air trend; from break-up until early in July the trend upward under influence of both air and water was steeper until an average temperature of about 69 degrees was reached and held until the later weeks of August. The floor system on the other hand followed directly the mean daily air fluctuations with lags that will be referred to later. The temperatures in the arch ring followed a compromise course between the two. In the light of the above general discussion of trends the charts presented will be analysed briefly.

Figure 15 covers the period July 18th to August 18th, 1932, and includes records on the arch rings only, as the floor system was not poured until August 25th and the coils were not installed in the piers until September 17th. It is of interest only in that it shows accurately the temperature rise and fall due to the heat of chemical reaction during the setting period of the concrete and the time elapsed before return to the normal temperature for concrete at that time of year, i.e. about 70 degrees. At the springing section, which was poured on July 19th, a maximum temperature of 102.5 degrees was reached at the 3-inch coil in a little less than twenty-four hours and a widely fluctuating recession due to daily air temperature variations carried the temperature back to normal in about sixteen days. At the 33-inch location, as would be expected, a greater maximum of 131 degrees was reached after an interval of approximately sixty hours and a period of nearly a month elapsed before normal temperatures were again established. The curves for the crown section illustrate the effect in a mass only 38 inches in thickness as compared with the 66-inch springing section.

Figure 19 covers the period July 24th to August 12th, 1933, and while chronologically this period represented the

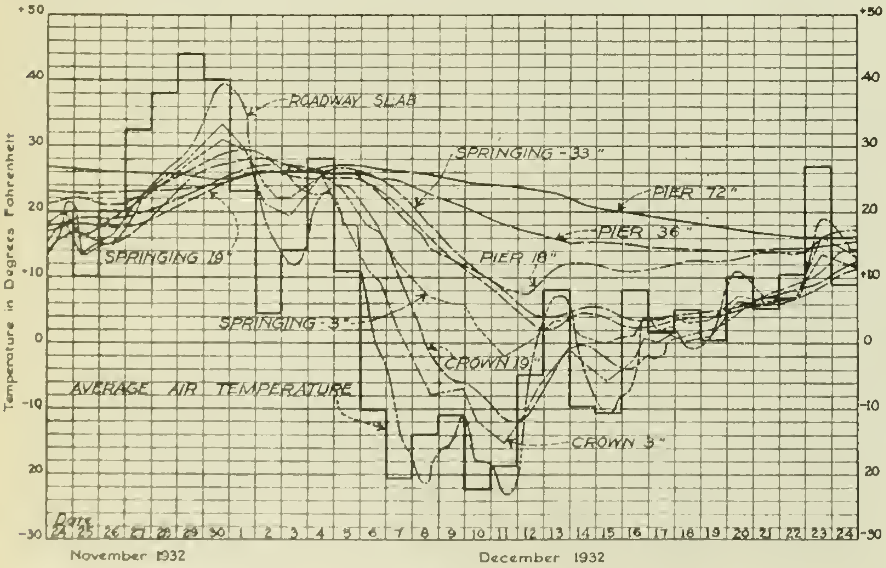


Fig. 16.

last portion of the observations, for the reasons stated in the preceding discussion it serves as an excellent starting point. The mean air temperature for this period is approximately 68 degrees as is also the mean of the water. It will be seen that the temperatures of pier at 18-inch, 36-inch and 72-inch depths are generally within 4 degrees of each other and are approaching the mean of 69 degrees. As would be expected the 18-inch readings fluctuate more than the 72-inch but all fluctuate less than the water and much less than the air. In plotting deck temperature only that of the coil in the roadway slab is recorded as for the most part the other two follow that one quite closely. The temperature of the roadway follows the average daily temperature quite closely as will be discussed later, and the springing and crown temperatures vary according to location and depth, all approach on the 12th the mean temperature of 69 degrees.

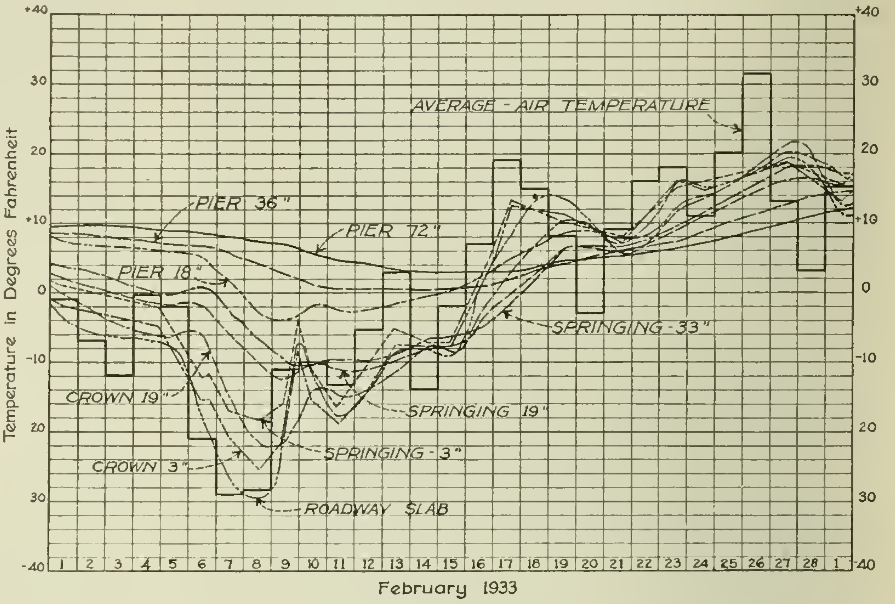


Fig. 17.

This general condition will undoubtedly prevail each year at some time during the middle or late part of August.

Figure 16, from November 24th to December 24th, 1932, shows the condition shortly after the date, November 13th, on which the river froze over. From November 1st to the 11th, the temperature of the air had been steadily falling and the water temperatures were approaching 32 degrees. The pier and arch ring temperatures were all lowering gradually while that of the roadway slab fluctuated with the air temperature more directly. On the 12th the air temperature dropped 16 degrees and another 8 degrees on the next day to 3 degrees below zero when the river froze over. This cold period lasted until the 19th when the temperature rose again. The roadway slab followed the outside temperatures directly, the 3-inch crown and, to a lesser degree, the 19-inch crown dipped steeply but less than the floor slab, the moderate drop of the 3-inch, 19-inch and 33-inch springing sections indicates the great effect of the pier as a heat regulator. The fall in the pier readings, especially at the 72-inch depth, was very moderate and steady and by November 27th when a mild spell set in the 72-inch pier temperature was only 6 degrees below the water temperature and the middle of the crown and springing temperatures 15 and 12 degrees respectively. The warm spell of November 27th to 30th caused all temperatures to rise and on December 1st again, as on November 11th, the temperatures at all the locations were within 4 degrees of each other. The cold spell, December 7th to 11th, was one of the two most severe dips of the year and is interesting as it shows clearly the drop and lag of the various thermometers. The roadway slab follows in a striking manner the mean daily temperatures but with a lag of about twenty-four hours on drops and much less on the rises. The pier temperatures are dropping slowly and will continue until the bottom of the trough is reached in February. The effect of piers as regulators on arch temperatures is again strikingly shown, the centre of the crown and springing section being respectively 11 degrees and 27 degrees above what would have been found in detached blocks of the same dimensions.

Figure 17, from February 1st to March 1st, shows the second and lowest drop in winter temperatures and the subsequent rise due to approaching spring, this chart and Fig. 18 showing the hottest condition of the year are especially interesting. During the coldest and hottest days readings were taken several times a day while normally readings were not taken more than once and sometimes when conditions were uniform only every other day, consequently excepting for the periods of extreme temperatures the curves are probably not accurate within two degrees. During the long cold spell in December (Fig. 16) it was found that the floor slab temperatures followed with remarkable regularity the mean daily temperature. The cold spell in February however was neither as long nor as steady as that in December although the absolute minimum temperature was lower. The road slab temperatures followed the minimum dip in the normal manner but in the preceding and following fluctuations the coincidence is not so good. No doubt this is due to the fact that after the first of February the sun was getting higher and often warm days with a high peak were combined with a long night period of uniform low temperature. Again quite mild and very cold days may alternate and the road temperature will not always follow violent fluctuations of one day only.

It will be seen in Fig. 17 that the pier temperatures were nearly uniform until the effect of the cold drop of the 6th on all pier readings is apparent and is quite marked on the 18-inch thermometer. Another interesting point is that the yearly low point on the 72-inch unit was reached about February 17th from which point a long swing upward started, the 36-inch and 18-inch locations had their turning point three to five days earlier and for the next half year the 72-inch location was the coldest of the three. In this cold dip, at the end of four cold months, the effect of the pier heat on the arch ring is very evident as even the 3-inch unit at the springing section had a minimum of about 11 degrees higher than would have been found in a detached block of the same thickness, while the centre of the springing was 17 degrees higher.

Figure 18, June 10th-26th, shows the hottest period of the year during which was recorded the highest maximum for a number of years. During the 15th, 16th and 17th, the hottest days, temperatures were read several times daily from early morning until late at night; the curves for these days then, will show daily fluctuations which are not available for the adjacent days. In this figure the river temperatures also are shown and it will be seen how the pier temperatures are approaching the water and air mean of about 68 degrees. During the very hot days the effect of direct radiation from the sun is apparent as the maximum temperatures in the floor system are well above the daily air mean but of course below the absolute air maximum. During the 16th, the hottest day, with a maximum air temperature of 103 degrees and a mean daily of 84 degrees, it is interesting to note that the road stringer which is 15 inches wide but not subjected to the direct rays of the sun reached a maximum temperature of 86.5 degrees. The street railway track which is 22 inches thick and receives the direct action of the sun on its surface reached a temperature of 86 degrees, while the roadway slab 15½ inches of concrete covered by a heat absorbent black asphalt surface reached a maximum of 93 degrees. It will also be noted that the 3-inch depths on both arch crown and springing sections were considerably affected by the action of the sun; the deeper locations at both sections fluctuated less violently and reached maximum temperatures of approximately 74 degrees within different periods of lag. Due to its location the springing section was more directly acted upon by the hot rays of the afternoon sun than was the crown and this effect is seen in the higher readings of the 3-inch springing section.

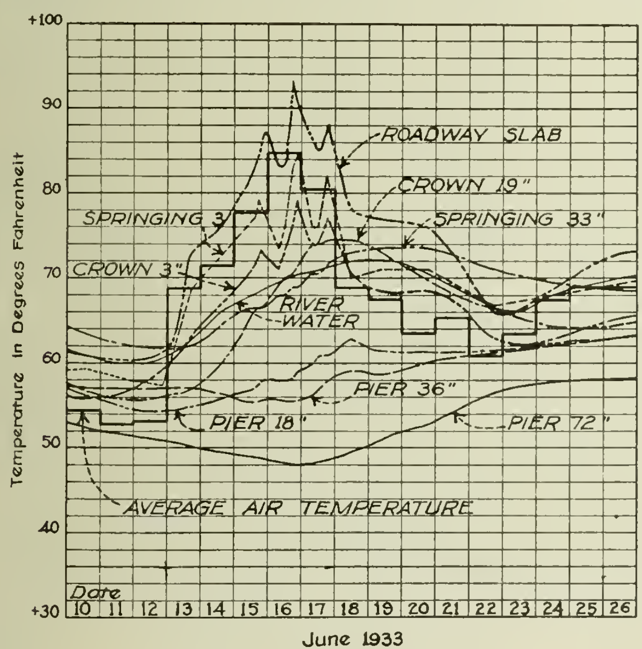


Fig. 18.

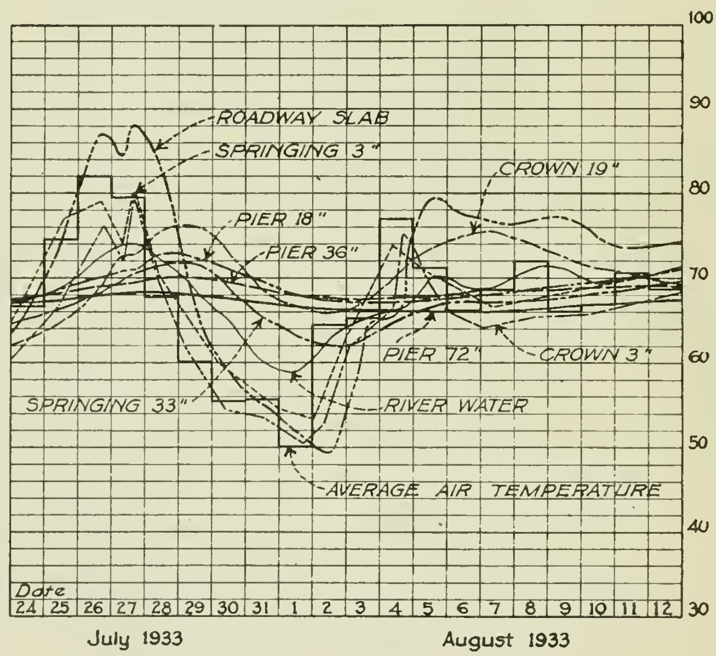


Fig. 19.

*Conclusions:*

In blocks thermally detached from contact with the ground or water the temperatures in blocks 2 feet thick, and probably in those 3 to 4 feet thick, will generally follow the daily mean of the air but if subjected to the sun in summer the temperatures will exceed the summer daily mean by 5 to 6 degrees.

In Saskatoon for such masses a safe range to assume for all time would probably be minimum temperatures of 48 degrees below zero and maximum of 100 degrees, this on the basis of possible minimum and maximum air temperatures of 60 degrees below zero and 110 degrees above.

For design of arches the problem is more complicated due to the fact that there will be differences between land and water spans, high and low arches and ribs of varying dimensions. For the arch under test probably the effective maximum for the arch as a whole will never exceed 90 degrees nor the minimum fall below minus 30 degrees. If the normal temperature be taken at 68 degrees this corresponds to a rise of 22 degrees and a fall of 98 degrees. In piers and structures in contact with water or ground the range of temperatures will vary widely depending upon the size, percentage of structure exposed to direct air temperatures and whether the pier is in water or on dry land.

### Deck Expansions

At each expansion joint on the bridge copper plugs were installed on both hand railings and records of movement have been kept throughout the year. With the temperature records which were always obtained simultaneously with the expansion readings, the coefficient of expansion may be calculated. From the coldest period in February with an average deck temperature of 26 degrees below zero to the hottest day in June with a deck temperature of approximately 90 degrees the total change in 1,117 feet of bridge was exactly 10 inches giving a coefficient of expansion for the reinforced concrete deck of 0.00000643 which checks remarkably well with a laboratory value of 0.0000065 for reinforced concrete of this quality. The flexible columns and expansion details have given no trouble and function with entire satisfaction.

### Arch Deflections

When the centring was struck under the rings of arch 5 a deflection of 0.84 inches was read and a further 0.36 inches when the deck was poured; theoretical calculations had indicated a total of 1.25 inches for these. Further readings have been taken throughout the year particularly during periods of extreme temperatures. The crown of arch 5 rose 1.47 inches in elevation in the period from the coldest spell in February when the calculated average temperature throughout the arch ring as a whole was 19 degrees below zero, to June 16th when the average ring temperature was 73 degrees. Theoretical analyses made previously had indicated a change of 1.31 inches for a 90-degree temperature difference which would give a theoretical change of 1.34 inches for the 92 degrees rise as compared with the actual 1.47 inches experienced. Considering the uncertainties in calculating average temperature conditions in a ring of changing cross section, and also the error that would be introduced by even a moderate uneven settlement of the supporting piers, the agreement between theory and results is reasonably close.

After recording temperature and expansion measurements throughout a year, and recalling that the deck changes in length almost one foot and the arch rings rise and fall about one and one half inches in every twelve months, one is impressed with a real appreciation of the deteriorating influences at work in all such structures.

### Strength of Partially Cured Concrete

Temporary installations of resistance thermometers proved very useful during the early days in October when, as has been set forth above, an unanticipated cold spell occurred during the pouring of the deck for arch 3. Due to the conditions surrounding the financing of the job it appeared to be necessary to have the contractor entirely complete the job before December 1st, 1932. This, of course, meant removing all forms and supports from the deck. This obviously involved a risk, as under such conditions it is normally impossible to calculate the strength developed in concrete members under subnormal curing temperatures; accordingly thermometers with temporary leads were placed in the roadway slabs, sidewalk slabs and floor beams, and readings taken several times every day until temperatures in these members reached 32 degrees. The following table will serve as typical of the temperatures in the floor beams:

Curing Temperatures in Floor Beam of Deck 5

| Date | Time | Air Temperature | Floor Beam Temperature |
|---|---|---|---|
| Oct. 5 | 16.30 | 68° | 81° |
| Oct. 6 | 8.30 | 38° | 97° |
| | 14.30 | 46° | 94° |
| | 16.45 | 42° | 92.5° |
| Oct. 7 | 11.00 | 40° | 73° |
| | 16.30 | 30° | 68.5° |
| Oct. 8 | 4.00 | — | 60.0° |
| | 9.40 | 25° | 55.5° |
| | 15.30 | 32° | 51.5° |
| Oct. 9 | 7.00 | — | 43.0° |
| | 17.30 | 30° | 39.0° |
| Oct. 10 | 9.30 | — | 36.0° |
| Oct. 11 | 9.30 | 36° | 34.5° |
| Oct. 12 | 11.30 | 52° | 34.5° |
| Oct. 13 | 17.00 | 56° | 38.0° |
| Oct. 14 | 9.00 | 42° | 38.5° |
| Oct. 15 | 9.00 | 35° | 40.5° |
| Oct. 17 | 14.00 | 30° | 32.0° |

**Fig. 20.**

It will be seen that this floor beam had approximately the following curing history: one day at 90 degrees; one day at 70 degrees; one day at 60 degrees; seven days at 38 degrees. According to tests* of the percentage of strength gained at different curing temperatures as compared with that at 70 degrees, it was calculated that the above floor beam had the equivalent of over seven days curing under normal conditions. Laboratory tests using the job cement and mix, indicated that seven-day strengths averaged about 1,500 pounds per square inch. As a further more severe check small cylinders were made up and stored in the laboratory for various periods from one to five days, after which they were placed in freezing temperatures and tested at twenty-eight days. It was found that no appreciable strength was gained after exposure to freezing conditions, but it was also found that for the mix being used, three days curing at 70 degrees could be depended upon to give strengths of about 1,200 pounds per square inch. It was found that a 2,000-pound mix would give 1,000 pounds per square inch and a 3,000-pound mix not more than about 1,300 pounds per square inch at three days. As it was certain that in the floor beam during the winter, stresses exceeding 600 pounds per square inch would not be developed, the contractor was permitted to load the span and remove the form supports after twenty-eight days. The temperatures in the slabs naturally did not rise as high nor were they maintained as long as those in the floor beam but similar calculations indicated that it would also be safe to remove forms and supports from these as well. When the above slab was being poured, test cylinders, unprotected, were placed on the slab and exposed to the air temperatures, these gave after two weeks of such curing only 500-600 pounds per square inch and it is apparent that there can be no useful comparisons made between the strength of concrete in a slab and that of a test cylinder of the same age which has cured under the same air conditions.

Thermometers were also placed in the stringers and roadway-slab of the floating span in which quick hardening

*Bulletin 81, Engineering Experimental Station, University of Illinois.

XXX Canada Cement was used and it may be interesting to note that, with air temperatures around 10 degrees and with the concrete being poured at 83 degrees, the temperatures in the stringer rose rapidly to a peak of 136 degrees in nine hours and temperatures above 70 degrees were maintained for five days. The thinner 8-inch slab dropped from 90 to 65 degrees in the first thirty minutes and then rose to 103 degrees within twenty-four hours, and remained above 70 degrees for a total of four days and as a result normal twenty-eight-day strengths were probably obtained in thirty-six to forty-eight hours. In a previous section details of methods for protecting these sections against frost have been given.

Probably the most unusual operation was the laying of the sidewalk immediately off the bridge resting on earth but supported by short piles, with outside temperatures well below freezing as previously noted. Thermometers were placed in the centre of this slab. Concrete was poured at a temperature of 85 degrees when the air temperature was 32 degrees. As the surface was being finished four hours later the concrete temperature had dropped to 51 degrees. After finishing, the surface was covered with tar paper and later manure placed on top of the paper, in another sixteen hours the temperature had only risen to 58 degrees—canvas tarpaulins were then spread over sections in turn and live steam applied, the temperature rose in twenty-four hours to 90.5 degrees under this treatment, the steam was then stopped and in twenty-four hours more the temperature fell to 64.5 degrees; the manure and paper were then removed and the sidewalk put in use, and after one year's use it appears to be in perfect condition.

## Pier Rotations

It is well known that during the construction of multiple arch bridges on yielding foundations the piers will rotate under the unbalanced thrusts developed. The magnitude of the rotation is a measure of the bearing value of the soil and Fig. 21 is a chart of the movements on the bridge under consideration. The measurements are recorded on the plan as inches of horizontal movement at the springing line. The actual measurements were taken by measuring the rotation of the vertical face of the pier. A plumb bob supported at a known distance from the face of the pier at the springing line was suspended and stilled in a container of oil, while at 2-foot intervals, vertically, four to seven permanent marks were made on the pier face and the horizontal distance from these points to the plumb line measured. As there were several points, a good check of the work was possible and unexpected accuracy was obtained. The angular deflection of the pier was changed to horizontal movement at the springing line and vertical movement at the edges of the pier footing by assuming that all movement took place about the longitudinal axis of the pier footing. Any error introduced by this assumption will not affect materially the calculated movements at the springing line, but there is possibility of serious error in estimating the actual settlement of the pier in this way. The other extreme premise would be to assume that the rotation occurred about the edge of the footing on which rotation would tend to relieve the pressure. For calculating the settlement of footings an average of these two methods has been used.

The dates of observation are given below the horizontal base line in each case, while the dates of completion of each particular operation on every span are placed directly above the illustration. The deflections of the springing line of the pier are given in magnitude in inches and the direction is indicated by placing these figures on the right or left of the vertical line through the pier according as the resulting movement was to the right or left. For instance the upper left hand line shows the date of completion of the various piers when the zero readings were taken. The next line shows that an observation was made on May 25th, and on the same date the rings of arch 1 were completed, and as a consequence pier 2 moved 0.25 inch to the right. The third line indicates that by June 2nd, pier 2 had moved 0.30 inch and that on July 20th, the arch rings of arch 5 were poured and no pier deflection was noted. The fourth line shows that after arch ring 4 had been completed there still was no movement indicated for pier 5, but that pier 2 had moved to the right a total of 0.60 inch by August 30th. As has been referred to before, the piling for arch 1 was driven in the spring when frost conditions undoubtedly caused imperfect driving of some piles and the high June floods carried away one bent of piles and although the remaining falsework seemed firm it evidently removed the greater part of the falsework support. This deflection of 0.60 inch on pier 2 was the most extreme noted and represents a settlement of the southerly pier edge of about 0.30 inch. It is interesting to note that this settlement according to the test data obtained corresponds to a pressure of about 5 tons per square foot, calculations indicated that with the rings of arch 1 poured and falsework removed the extreme pressure on the edge would be 4.5 tons per square

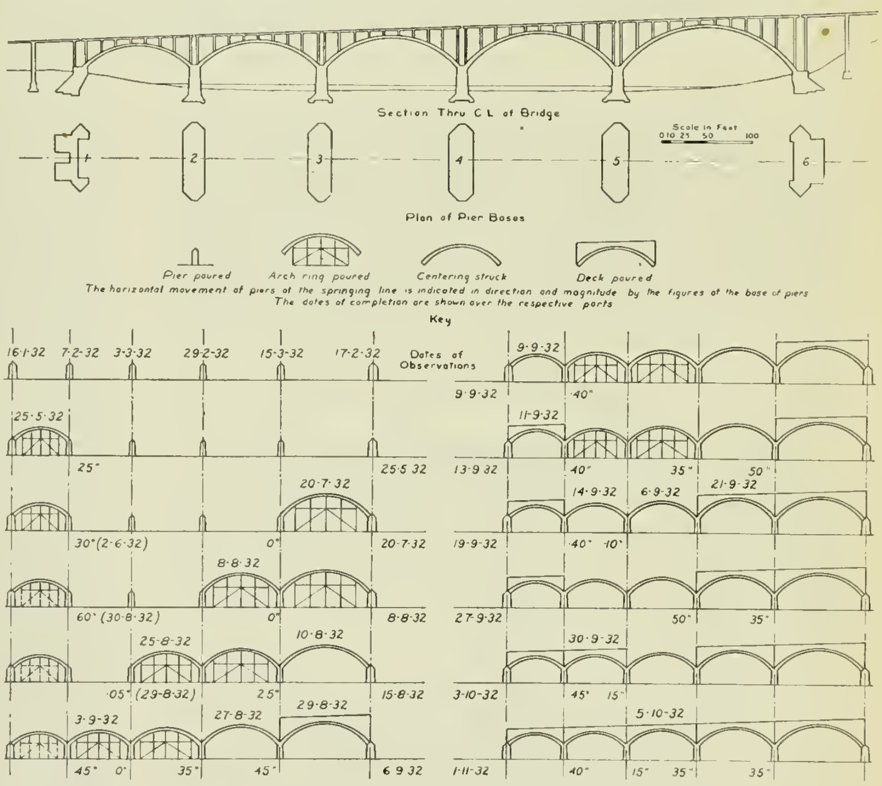


Fig. 21—Horizontal Movement of Piers during Construction.

foot. At pier 5 after the deck of arch 5 had been poured there was a displacement to the left of 0.50 inch, this indicates an excess settlement at the pier footings of 0.31 inch while the calculated maximum pressure is 4.0 tons per square foot, similar results were obtained at pier 4 under comparable load conditions. This analysis is interesting and suggestive but is not submitted as more than approximate. The last line on the left hand side shows that on September 6th, all arch rings had been poured, the falsework struck under arches 4 and 5 and the deck of 5 poured. Pier 2 has moved back to the left 0.15 inch since August 8th, pier 4 has moved to the left as would be expected after the striking of falsework on arch 4. The top lines on the right side show that pier 2 is still moving back and the third line down is interesting as it shows that even after the deck of arch 1 was poured and the falsework struck on arch 2, pier 2 did not move to the right as might have been expected. Once a series of arches is joined together the deflections do not always follow a logical order, and many apparently contradictory situations arise, for instance the last two lines seem to indicate that, with the completion of the final deck on arch 2, piers 3 and 4 both moved inward towards the centre of arch 3 instead of outward as might be expected. There is of course the possibility of error in measurement but the readings were checked and rechecked several times and the situation was probably caused by uneven settlement at piers 2 and 3. Undoubtedly there is a lag between load and settlement, also there are many other factors of uncertainty such as uneven settlement of falsework, slight variation of soil at different piers, difference in thrust of rings due to construction loads, etc., but it is felt that the measurements give valuable information about the bearing values of the soil and the behaviour of piers especially before several rings are joined.

Calculations indicate that the final deflection of pier 5 would introduce extra stresses in the concrete of arch 5 of 74 pounds per square inch at the springing and 95 pounds per square inch at the crown assuming the arch to be loaded with maximum live loads. The corresponding stresses introduced into arch 1 would be 197 and 250 pounds per square inch. These later stresses, while appreciable, are not alarming and in the author's opinion the plastic flow of the concrete in the rings will so adjust the internal stresses that these extra theoretical increases will not be serious.

The author, on leave of absence from the University of Saskatchewan, was responsible for the design and construction of this bridge as consulting engineer to the city engineer of Saskatoon, Mr. G. D. Archibald, under whose charge the project was carried out.

# Stresses in Stiffened Circular Tubes under External Pressure

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SUMMARY

The strength of circular tubes under external pressure has been considered by various authors in the past, but the methods adopted have not given results which can be used for purposes of practical design when dimensions are large and stiffening rings are of less than infinite rigidity. The usual treatment studies the elastic instability of perfectly circular tubes, rather than the stresses conformable to engineering practice; and circumferential stiffening rings or end conditions, if considered, are assumed to be of infinite stiffness. In short, the results cannot be interpreted in terms of thickness of plate, size of angle, stresses and true factor of safety.

The author of the present paper recognizes that perfectly circular tubes, especially in large sizes, can not be manufactured and he therefore includes this fact in his analysis. He recognizes that the stiffening rings, which are usually necessary, are not infinitely stiff and he therefore takes into account their yielding. The various possible forms of collapse, the spacing of stiffening rings and the stresses developed are also considered.

The elastic conditions of the case are complicated and the analysis can not be simple, but much of the work can be summarized in only two formulae, equations (27) and (40), which contain all an experienced designer is likely to need for daily use. The other results will, it is hoped, be of use to those who wish to study the subject in greater detail, and a numerical example is given.

The author has applied these methods for many years to the design of internal risers for his differential surge tanks, and he feels that the principles of the paper may hence be considered to have been abundantly verified by full size experiment. The same principles are also applicable to large penstocks under partial vacuum, to tunnel linings in soft ground and other problems not infrequently encountered.

* * * * *

The problem of the design of large circular steel tubes subject to external pressure, and of the arrangement of the stiffening rings, has long been a real nuisance to engineers because, so far as the author knows, a practical solution has not been available.

Such information as could be obtained from various studies of the matter has required on the part of the engineer too much inclusion of his own judgment, chiefly because the initial assumptions of perfection of shape and either no stiffeners or rigidly fixed ends led only to answers in terms of elastic instability under these ideal conditions, and not to stresses in a practicable structure. There has been no consideration of a proper factor of safety to be used with these answers, nor of the effect upon a factor of safety of the inevitable departures from theoretical perfection which must occur during construction. Hence one should assume at the beginning that the tube will not be perfectly circular, and that the stiffening rings will yield.

It will be shown that where the tube is not precisely round before external pressure is applied, the bending stresses are directly proportional to the initial amount of deviation from a true circle. It will be found that this consideration is so important that it is essential in the first place to know that the departure from a true circle is a certain specified small amount before a beginning, even, can be made toward the computation of the resulting stresses. In practice, therefore, it is necessary to assume a definite small variation within which it is no hardship for the manufacturer to keep and to base the design upon safe stresses according to the assumption.

It is then most important to check up the structure for roundness when it is finally in place; to make a record of the various eccentricities and if found to be out of round an amount greater than assumed, to reject the work or call upon the manufacturer to true it up according to specifications. If, fortunately, the structure is more nearly circular than was assumed, it will be proportionately safer.

Longitudinal butt joints should be used to avoid the eccentricity of laps, and the rib splices should be staggered and carefully designed. Standard riveting is usually adequate for the shearing stresses developed.

It may be interesting to describe just how a tube behaves when stiffened with circular ribs at intervals and subjected to uniform external pressure.

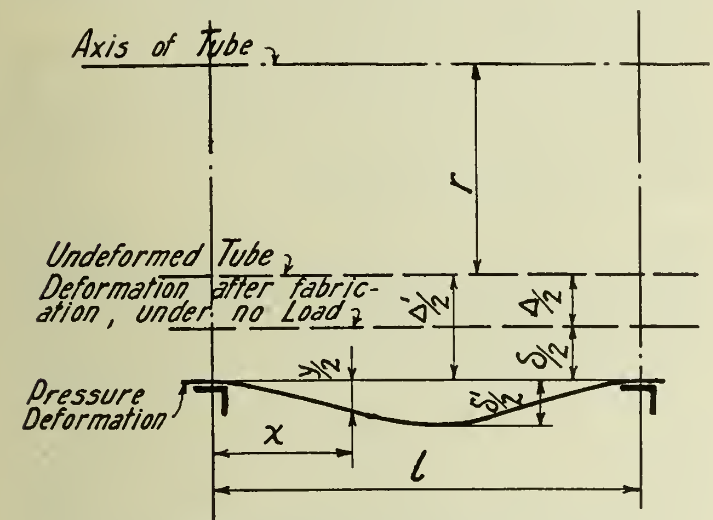



**Fig. 1—Longitudinal Section in Plane of Maximum Outward Deformation.**

When the tube is not precisely circular, its initial shape is usually slightly elliptical; two opposite sides bulging outward and the other two flattening inwards, with four symmetrically placed nodes where it intersects the equivalent circle. If uniform external pressure is applied to the tube, the various sections depart in varying amounts from the original ellipse, and this departure gradually increases with the distance from the ribs until it reaches a maximum at mid span, as shown in Figs. 1 and 2. Until failure occurs, these sections retain approximately the shapes of ellipses with various eccentricities. This variation in shape implies a longitudinal transfer of load to the ribs by beam action of the shell plating, which behaves as four beams having reactions at the ribs. Two of them bend towards each other in curves which are longitudinally concave outwards, and two bend away from each other in curves which are longitudinally convex outwards. These beams join at the nodes of the cross section, where the radius remains substantially unchanged.

Upon the application of pressure to such a structure, girth bending moments, both in ribs and plating, are created which are proportional to the initial deviation of the tube from circular form. These moments cause deflections which further increase the moments, and the process continues until equilibrium is attained, provided that the tube material is not stressed beyond its elastic limit. Complete failure occurs when the elastic limit is reached, as deflections then increase more rapidly than resisting moments, and the ultimate strength of the material does not become a consideration. That is, the ultimate strength of the structure is fixed by the elastic limit of the material in it. Otherwise expressed, if any permanent set remained upon removal of a load causing stresses beyond the elastic limit, it would be equivalent to the assumption of a greater initial deviation from circular form.

It will be shown that practical considerations of plate thickness, rib strength and spacing are usually such that the four-beam arrangement will continue through the point of failure provided a reasonable assumption of initial deviation is made. As long as the integrity of the four beams is maintained the shell will not tend to form a greater number, and this integrity usually prevails in practical cases where the initial deviation from the mean diameter is taken at 1 per cent of the radius.

If, however, the ribs are made disproportionately great in comparison with the shell thickness, other things being equal, it is possible to produce a design, though not a good one, where the integrity of the beams is not maintained at the point of failure of the shell plating.

When the beams are overloaded in this respect they will crumple up laterally beginning at the node points and if the material is perfectly homogeneous, and the thickness uniform, the shell will break into an even number of beams greater than the four already in evidence thus relocating a greater number of symmetrically placed nodes amounting to 6, 8, 10, 12, 14, 16, etc., according to conditions which will be set forth. A rib, however, although now under the influence of a larger number of beams tending to break it into a larger number of waves will, nevertheless, continue in its general elliptical form influenced only to a slight degree by the superimposed waves acting on the more or less stable ellipse.

The moment there is developed a number of beams greater than four, failure of the shell between the ribs immediately takes place because the beam resistance is enormously weakened by this readjustment, thus relieving the rib and throwing almost the whole burden upon the girth strength of the shell itself. Under these conditions the rib may remain practically intact.

It is clear that when the rib is not overdesigned in comparison with the shell thickness, it will fail simultaneously with the mid-girth of the shell and this will always take place with only four beams. Proper designs, therefore, exclude any number of beams greater than four.

The nature of the beam loads is interesting. As will be shown later, they are four in number, two positive and two negative. They comprise five components, of which the first two may be taken together to make one load, as follows:

*First*—(*a*) A uniform load (positive) proportional to the product of the pressure and the assumed initial departure from circular form.

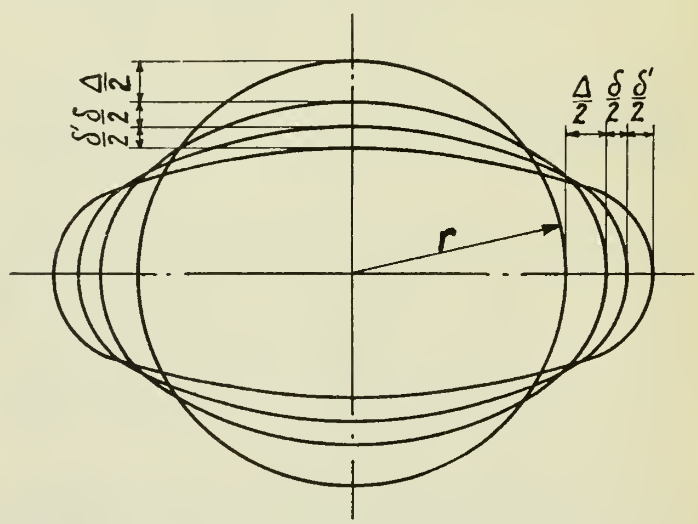



**Fig. 2—Exaggerated Cross Section Midway between Ribs.**

(*b*) A uniform load (positive) proportional to the product of the pressure and the further distortion of the rib due to the imposed load.

*Second*—A variable load (positive) proportional to the product of the pressure and the ordinates of the longitudinal elastic curve of the beam.

*Third*—A uniform load (negative) proportional to the further distortion of the rib.

*Fourth*—A variable load (negative) proportional to the ordinates of the longitudinal elastic curve.

Inasmuch as the individual deflections caused by each of these loads have their maximum at the same mid-point, the net deflection there resulting is the algebraic sum of the individual deflections and also the net maximum bending moment occurring at the rib is the algebraic sum of the individual bending moments.

Let us consider next the bending of these longitudinal beams under the loads described as variable, such that the load at any point on the length of the beam is proportional to the deflection at that point. In the interest of simplicity we may assume that the curve of such a loading is expressed by the equation

$$\frac{4\,x_c^2}{l^2} + \left(\frac{y_c}{h}\right)^{\frac{1}{2}} = 1 \qquad (1)$$

where $h$ is the (to be) known maximum ordinate and $x_c$ and $y_c$ are the co-ordinates of the curve, with the origin at mid span. This in fact is the equation of the deflection curve of a uniformly loaded beam with fixed ends. The mean ordinate of this curve is 8/15 times the maximum; the maximum deflection of a beam with fixed ends under this loading is $Bw_cl^4/EI'$ where $B = 0.0020213$ and $w_c$ is the maximum rate of loading at the centre. The end moments of the beam under this loading are $(2/35)(15\,W_Bl/8)$, where $W_B$ is the total load on the beam $= 8\,w_cl/15$.

By way of refinement of this assumption the author has determined, by empirical and graphical methods, a loading curve which is almost exactly proportional everywhere to the deflection which it causes on a beam with zero slope at its ends, and he finds the deflection coefficient $B' = 0.0019894$ differs by only 1.6 per cent from the value given by the approximate method above mentioned. The equation for this curve is

$$y_c = w\,(1 + \gamma^4 - 1.926\,\gamma^2 - 0.074\,\gamma) \qquad (2)$$

where $\gamma = 2\,x_c/l$ and $w$ is the maximum rate of loading. The deflection curve which results from this loading is

$$\frac{16EI'y_c}{wl^4} = 0.03183 - \gamma^2\left(-\frac{\gamma^6}{1680} + 0.00535\,\gamma^4 + 0.000617\,\gamma^3 - \frac{\gamma^2}{24} + 0.06812\right) \qquad (3)$$

Hence further correction of the loading curve to give closer agreement with the deflection curve is unnecessary. This value $B'$ is used with unyielding ribs; $B$ is used for yielding ribs.

The greatest error in using the approximate method of equation (1) would occur if applied to perfectly circular tubes with ribs of such excessive stiffness that the shell would fail without distorting them. Where there is any appreciable uniform load, and especially where it predominates, the error in using the method of equation (1) can be only a small fraction of 1.6 per cent and the use of this equation for yielding ribs is therefore entirely justified. Further, the deflection coefficients, if referred to total beam loads, differ only by 0.8 per cent.

The net loads on these beams alternate outward and inward, but the beams differ from free ones in that they are united at the node loci. This fact, however, introduces no particular complication, merely resulting in a shifting of the neutral axis from the centre of gravity of the arc to the base; i.e., to the chord through the nodes. This must be the case because otherwise if the beams were not united by shearing stresses, we should have equal and opposite stresses occurring at the same point. These beams, therefore, may accurately be treated as simple beams in which there is introduced just sufficient axial force, due to the shear, to shift the neutral axis from the centre of gravity to the edge.

To compute stresses and deflections in such a beam it is only necessary to make use of the large moment of inertia about the base. It is possible for these beams to deflect inwardly and outwardly with small motion without interference with each other, by virtue of a tangential slipping of the nodes, thus slightly humping up one beam while its neighbours are correspondingly flattened.

These relative girth motions disturb to a slight extent the accuracy of the moment of inertia figured on a true circular arc but for small motions such as we are considering, one is stiffened about as much as the other is weakened and no error is indicated because it is the joint or composite action in which we are interested.

The deflection of the beam as a whole is therefore considered to be that of the neutral axis at the base and this bears a definite relation to the deflection at the apex according to the number of beams developed. It should be distinctly borne in mind that such limiting equations as are herein set forth purporting to give the ultimate failure point of perfectly circular tubes are not recommended for the purpose of design and are given only to determine the proportions of a design in which stresses may be accurately figured with four beams and also possibly for the further reason of comparing such limiting results with those given by others who have treated only that phase of the question.

The author takes no particular interest in these limiting results because he has little confidence in them as criteria for the reasonable and economical design of large thin tubes with equally spaced *yielding* ribs, which is the only field intended to be covered by this analysis. The general polar equation of the elastic curve of the shell-girth which he has used, is the familiar one obtained by superimposing a sine curve upon a circle as follows:

$$R - r = (R_{\text{max.}} - r)\cos\frac{n\phi}{2} \qquad (4)$$

where $R$ is the radius vector and $n$ is the number of beams.

When $n$ is equal to four it will be seen that this curve approaches an ellipse as $R_{\text{max.}}$ approaches $r$ and the curve appears to be quite accurate enough for all practical purposes. The stress analysis will be carried out only with four beams because that is the only natural distortion which might exist and does exist, to some extent at least, prior to the application of load, either as a real measurable eccentricity or more subtly as a lack of homogeneity either of material or construction. The analysis will be based upon the assumption of a relatively thin shell and is intended only to cover a range in the values of $t/r$ of from 0.02 to 0.006, say.

It may be interesting to trace the behaviour of a perfect tube with fixed values of $a = l/r$ and $b = t/r$, but permitting both the rib and the pressure to increase in such a manner as just to produce failure.

Starting with a weak rib, it is clear that no more than four beams will be developed.

As the rib and load are increased, there would naturally come a time when the integrity of the beams could not be maintained and where there would be a sudden readjustment of the shell into a larger number of them.

This new number of beams may be any even number greater than four depending upon the values of $a$ and $b$. In other words, the number suddenly jumps from four to 6, 8, 10, 12, 14, 16, etc., without paying any attention to the intermediate possibilities when the number is greater than six. It increases as $a$ decreases so that if $b$ is fixed and $a$ is changed to the extent that the number of beams would have a free choice of two numbers and at the same time, of course, the same choice of keeping four, there would evidently be a series of values of $a$ for failure to take place with a free choice of three different numbers of beams for the same critical values of rib strength and pressure. This relationship can easily be demonstrated by trial with the equations given later, but it will not here be further considered as it is rather beside the point of the present purpose.

If the strength of the rib be further increased after the above critical point is reached an interesting thing happens.

It will be found that the corresponding increase in the pressure to keep at the point of failure needs to be practically nothing so that further increase of the rib strength all the way to infinity has a negligible effect upon the ultimate strength of the design. The reason for this is that the formation of a larger number of beams immediately relieves enormously the girth bending stresses in the rib and throws practically the whole burden upon the girth strength of the shell itself.

This is a fortunate circumstance because it is much simpler to figure the number of beams with a perfectly rigid and immovable rib and the critical pressure thus found is practically the same as would be required with a minimum finite rib just required to develop more than four beams.*

All these statements may be verified with the equations which are given later in the paper.

To begin the analyses, let us first consider a thin tube which, when under no load, has a cross section differing slightly from a circle according to equation (4). If a uniform pressure $p$ be then applied, the tube will deflect radially. If the maximum radial deflection is $\pm \delta/2$ and if $\pm\Delta/2$ and $\pm\Delta'/2$ are the initial and final maximum radial departures from circular form we have $\Delta'/2 = \Delta/2 + \delta/2$. An analysis of this case by well known methods of treating arch rings, not necessary here to elaborate, shows that the maximum bending moment $M$ where the radius vector is a maximum or minimum is

$$M = \frac{pr\Delta'}{2} \quad \text{(5)}$$

and likewise, when there are four beams

$$\delta = \frac{pr^3\Delta'}{3EI_o} \quad \text{(6)}$$

where $I_o$ is the moment of inertia of the wall of the tube or $t^3/12$ per unit length. In general terms, for any number of beams

$$\delta = \frac{4\,pr^3\Delta'}{EI_o\,(n^2 - 4)} \quad \text{(7)}$$

Hence

$$\delta = \frac{2\,r^2M}{3\,EI_o} \quad \text{(8)}$$

or in general terms

$$\delta = \frac{8\,r^2M}{EI_o\,(n^2 - 4)} \quad \text{(9)}$$

Also the extension or shortening of a side of an inscribed square, with its corners at the nodes, is found to be

$$\frac{pr^3\Delta'}{6\sqrt{2}\,EI_o} \quad \text{(10)}$$

or 0.3536 as much as that of the diameter.

The extension or shortening of a long side of an inscribed rectangle, the short side being the width of a beam, is found to be in general terms

$$\frac{8\,pr^3\Delta'\sin(\pi/n)}{EI_on\,(n^2 - 4)} \quad \text{(11)}$$

or $(4/n)\sin(\pi/n)$ as much as that of the radius.

Where $n$ is a multiple of 4, $\Delta'$ represents change in diameter.

*The greatest error due to this assumption occurs for values of $a\sqrt{b}$ between about 0.77 and 1.0.

Where $n$ is not a multiple of 4, $\Delta'$ represents twice the change in radius.

It may be argued that these deflections are strictly accurate only for inappreciable distortion because the distortion itself increases the moment, but in answer to this it may be pointed out that we are not now seeking absolute quantities but only the ratio of the deflection and bending moment which is highly accurate even for appreciable distortion.

With this preliminary step in mind, a table of nomenclature is given below for use in the subsequent development. The units are in terms of pounds and inches.

Nomenclature

$p$ = external pressure.

$p_v$ = that portion of the total pressure $p$ which is sustained by girth flexure of the tube plate at any section $x$ inches from a rib. It varies with $x$.

$p' = p - p_v$ = the portion of the total pressure $p$ at any section, which is transmitted by beam action to the adjacent ribs.

$p_b$ = value of $p$ for which $f = f_M$, that is, for which the maximum girth bending stresses in the ribs and at the midpoint of the shell are equal.

$p_e$ = value of $p$ for which $f = f_e$, that is, for which the maximum stress in the ribs reaches the elastic limit.

$p_e'$ = an approximate value of $p_e$.

$p_u$ = pressure of collapse for infinitesimal $\Delta$ with yielding ribs for suitable value of $n$.

$p_c$ = rupture pressure for infinitesimal $\Delta$ with unyielding ribs for suitable value of $n$.

$p_o = \frac{Et^3}{4r^3} = \frac{Eb^3}{4} = \frac{3EI_o}{r^3}$ = rupture pressure of an unstiffened tube for infinitesimal $\Delta$ with $n = 4$, or, in general terms,

$= \Theta Eb^3$ where $\Theta = \frac{n^2 - 4}{48}$ and $n$ = the number of beams.

$\rho = 1 - \frac{p_o}{p}$.

$r$ = radius of the undeformed tube.

$t$ = thickness of the tube shell.

$b = t/r$.

$l$ = spacing of ribs.

$a = l/r$.

$\Delta$ = maximum extension $\pm$ of the diameter initially existing before application of load, due to slightly imperfect construction.

$\delta$ = further extension of the diameter $\pm$ at a rib, due to the load.

$0.3536\,\delta$ = corresponding extension $\pm$ of the chord of a quadrant.

$\Delta' = \Delta + \delta$.

$\delta'$ = still further extension of the diameter at the midpoint between ribs, in excess of $\Delta'$.

$y$ = corresponding diametral extension at any point $x$ inches from a rib, varying from 0 to $\delta'$.

$I$ = moment of inertia of cross section of rib acting integrally with $d$ inches of tube plate, diminished by $d.t^3/12$. It is taken about the common centre of gravity of the two, just as if the rib were of infinite curvature. The value of $d$ is a matter of judgment and is considered later, but a few trials will easily show that its precise value is not of great importance.

$S$ = corresponding section modulus.

$e = I/S$.

$X = I/r^4$.

$s = S/r^3$.

$I'$ = the moment of inertia of a quadrant of unstiffened tube about its chord as a neutral axis = $0.0708\,r^3t$, for four beams, or in general terms,

$$I' = \frac{\pi\, t^3 r}{6\, n} \cos^2(\pi/n) + \left\{(\pi/n)\left[1 + 2\cos^2(\pi/n)\right] - 3\sin(\pi/n)\cos(\pi/n)\right\}\left\{r^3 t + \frac{r.t^3}{4}\right\}$$

$X' = I'/r^4$.

$S'$ = corresponding section modulus = $.2417\, r^2 t$ for $n = 4$.

$s' = S'/r^3$.

$E$ = modulus of elasticity.

$G = \frac{pr^3 l}{3\,EI} = \frac{pa}{3\,EX}$ or, in general terms, $G = \frac{4\,pa}{(n^2 - 4)\,EX}$.

$K = \frac{1.288\,p}{6.192\,Eb/a^4 - p\rho}$ with $n = 4$

$= \frac{Ap}{B'(\Sigma Eb/a^4 - p\rho)}$ in general terms, $n > 4$.

$C = 1 + \frac{8}{15}\,\rho K$.

$N = GC\rho$.

$f_c$ = unit girth stress of compression in rib = $pr/t$ (neglecting the area of rib). That is, the unit stress in the rib is assumed to be the same as the unit compressive stress in the plate, without the rib.

$f'$ = maximum girth bending stress in rib, including $d$ inches of plate.

$f = f_c + f'$ = maximum total girth stress in rib.

$f''$ = maximum longitudinal bending stress in a beam at a rib.

$f'''$ = maximum girth bending stress on a ring mid-way between ribs.

$f_M = f_c + f'''$ = maximum total girth stress in this ring.

$f_v$ = maximum girth bending stress in a ring of plate at any point $x$ inches from the rib.

$f_e$ = elastic limit of tube material.

$M'$ = maximum girth bending moment in rib corresponding to $f'$.

$M''$ = maximum longitudinal bending moment in plate corresponding to $f''$.

$m$ = maximum net girth bending moment per inch of plate at any point, $x$ inches from the rib, transferred to the rib by beam action.

$m'$ = corresponding bending moment sustained by the plate itself, giving rise to the stress $f_v$.

$A$ = .0026042 = 1/384 = deflection coefficient for a fixed beam uniformly loaded.

$B$ = .0020213 = deflection coefficient for yielding ribs.

$B'$ = .0019894 = deflection coefficient for unyielding ribs.

$w$ = beam load per running inch.

$W$ = total beam load.

$a'$ = value of $a$ when $f = f_M$ for infinitesimal values of $(p_u - p_b)$ and $\Delta$.

$$z = \frac{2\,e - t}{r}$$

$$\Sigma = \frac{X'\sin(\pi/n)}{nbB'\cot(\pi/n)}$$

* * *

When a tube, with circumferential ribs, is initially out of round by an amount $\Delta$ for its whole length, and when a uniform external pressure $p$ is applied, the maximum girth bending moment at any ring of unit length is, as in equation (5)

$$m + m' = \frac{pr\,(\Delta' + y)}{2} \qquad (12)$$

and the portion transferred to the rib is

$$m = \frac{p'r\,(\Delta' + y)}{2} \qquad (13)$$

whereas the remainder, sustained by the girth flexure of the plate is

$$m' = \frac{p_v r\,(\Delta' + y)}{2} \qquad (14)$$

We have already found in equation (8) that the deflection is $2\,r^2/3\,EI_o$ times the bending moment and as $I_o$ now equals $t^3/12$ we have for the deflection of a unit ring of plate

$$\delta + y = \frac{4\,p_v r^3\,(\Delta' + y)}{Et^3} \qquad (15)$$

whence

$$p_v = p_o\frac{(\delta + y)}{(\Delta' + y)} \qquad (16)$$

therefore

$$m = \frac{r}{2}\left[p\,(\Delta' + y) - p_o\,(\delta + y)\right] = \frac{pr}{2}\left[\Delta + \rho\,(\delta + y)\right] \qquad (17)$$

and

$$\int_o^l m\,dx = M'$$

With the assumed longitudinal curve of flexure, equation (1), this integration becomes simple with mean ordinate $y = 8\delta'/15$ and

$$M' = \frac{prl}{2}\left[\Delta + \rho\left(\delta + \frac{8}{15}\,\delta'\right)\right] \qquad (18)$$

We may now equate the deflection at the rib to $2\,r^2 M'/3\,EI$ and we have

$$\delta = G\left[\Delta + \rho\left(\delta + \frac{8}{15}\,\delta'\right)\right] \qquad (19)$$

We come now to the relation between the pressure and the beam load. If the girth stiffness and the beam action of the plate be temporarily neglected, then for any value of $x$ there are two opposing tangential forces, perpendicular to the longitudinal plane containing the tube axis and the centre line of the beam, each amounting to $p\,(\Delta' + y)\,dx/2$. The total of such forces on one beam is then

$$\int_o^l p\,(\Delta' + y)\,dx$$

Inasmuch as these opposing forces do not support each other with the girth stiffness neglected, they must somehow be entirely counteracted by the beam loads in a plane perpendicular to the plane joining adjacent nodes. As in Fig. 3 we can resolve into components along radii to the nodes, which cancel, and into components along radii to the centre

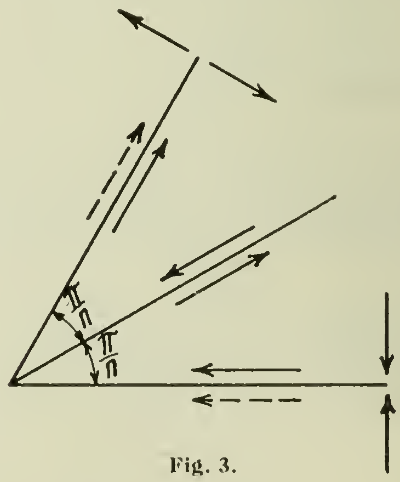



Fig. 3.

line which add, giving beam loads, when all beams are considered, amounting to $2\,p\,(\Delta' + y)\cot(\pi/n)\,dx/2$. If now we take into account the girth stiffness of the plate itself we have for each of four beams

$$w = p'\,(\Delta' + y) \qquad (20)$$

or in general terms

$$w = p' (\Delta' + y) \cot (\pi/n) \ldots\ldots\ldots\ldots (21)$$

and $$W = \int_o^l w\,dx$$

As the mean value of $y$ is $8\,\delta'/15$ this may be integrated with the aid of equation (16) and the relation $p' = p - p_v$ to give the total beam load which may be subdivided into the four components.

$W_1 = pl\,\Delta'$ (positive)
$W_2 = pl\delta'\,8/15$ (positive)
$W_3 = p_o l\,\delta$ (negative)
$W_4 = p_o l\delta'\,8/15$ (negative)

The deflection at the mid-span of the beam produced by the first and third rectangular load diagrams is

$$Al^3\,(W_1 - W_3)/EI'$$

and the deflection produced by the second and fourth load diagrams shaped like the deflection curve is

$$Bl^3\,(W_2 - W_4)\,15/8\,EI'.$$

The total deflection of the neutral axis at mid-span $= \dfrac{0.3536\,\delta'}{2}$

and this is made up of the algebraic sum of these deflections so we may write

$$\frac{\delta'}{2} = \frac{pl^4\,(A\Delta' + B\delta') - p_o l^4\,(A\,\delta + B\delta')}{0.3536\,EI'} \ldots\ldots (22)$$

Solving this we have $\delta' = K\,(\Delta + \rho\delta)$, and substituting in equation (19) and solving again we have

$$\delta = \frac{N\Delta}{\rho\,(1 - N)} = \frac{GC\Delta}{1 - N} \ldots\ldots\ldots (23)$$

Hence $$\delta' = \frac{K\Delta}{1 - N} \ldots\ldots\ldots\ldots\ldots\ldots (24)$$

Reverting now to equation (18) we may substitute for the deflections their values in terms of known quantities and write

$$M' = \frac{prl\,C\Delta}{2\,(1 - N)} \ldots\ldots\ldots\ldots\ldots (25)$$

whence the maximum girth bending stress in the rib is

$$f' = \frac{prl\,C\Delta}{2\,S\,(1 - N)} \ldots\ldots\ldots\ldots\ldots (26)$$

and adding the direct stress $f_c$ we get the maximum combined stress

$$f = f' + f_c \ldots\ldots\ldots\ldots\ldots\ldots\ldots (27)$$

Observe that $K$ is often nearly zero and may then be neglected. Consequently $C$ becomes $= 1$ and the preceding expressions are much simplified.

To obtain the stress $f'''$ we have from equations (14) and (16) $m' = \dfrac{p_o r\,(\delta + y)}{2}$.

Dividing this by the section modulus, $t^2/6$, we have

$f_v = \dfrac{3\,p_o r\,(\delta + y)}{t^2}$ or putting $y = \delta'$ we have

$$f''' = \frac{3\,Et\,(N + \rho K)\,\Delta}{4\,r^2\rho\,(1 - N)} \ldots\ldots\ldots\ldots (28)$$

and $$f_M = f''' + f_c \ldots\ldots\ldots\ldots\ldots\ldots (29)$$

Parenthetically, we may, in this equation, put $I = 0$ and obtain the girth bending stress for an unstiffened tube. $G$ and $N$ become $\infty$ and $f'''$ becomes

$$f_o' = \frac{3\,Et\Delta}{-\,4\,r^2\rho} = \frac{3\,Ebp\Delta}{(Eb^3 - 4\,p)\,r} \ldots\ldots\ldots (30)$$

And the total stress

$$f_o = f_o' + f_c \ldots\ldots\ldots\ldots\ldots\ldots (31)$$

It is apparent that failure will take place when $4\,p = Eb^3$ even for an infinitesimal value of $\Delta/r$, or, in other words, when $p = p_o$. This equation was stated by Boussinesq.

The stress $f''$ is usually unimportant, but it may be found in a manner similar to that used in deriving equation (22).

The longitudinal bending moment, in the plate at the stiffening ribs, produced by the rectangular loadings is $(W_1 - W_3)\,l/12$ and the bending moment at the same place produced by the loadings shaped like the deflection curve is

$$\frac{2}{35}\left(\frac{15}{8}\,(W_2 - W_4)\,l\right)$$

The total bending moment at the ribs is then the sum, so

$$M'' = \frac{1}{12}\,pl^2\left(\Delta + \rho\delta + \frac{24}{35}\,\rho\delta'\right)$$

and $$f'' = \frac{pl^2\left(1 + \frac{24}{35}.\,K\rho\right)\Delta}{12\,S'\,(1 - N)} \ldots\ldots\ldots (32)$$

Equating the values of $f'$ and $f'''$ and solving for $p$ we obtain the pressure which would produce equal maximum stresses in the rib and in the plate mid-way between them,

$$p_b = Eb\left[\frac{19.788}{a^4} - \frac{12.353\,X}{az}\right] + p_o \ldots\ldots\ldots (33)$$

or, in general terms, with $n > 4$

$$p_b = Eb\left[\frac{3.196\,\Sigma}{a^4} - \frac{49.411\,\theta X}{az}\right] + p_o \ldots\ldots (34)$$

Also, by forming the equation $N = 1$ and solving for $p$ we get a particular value of the pressure which produces an infinite stress in all equations and hence collapse even for infinitesimal $\Delta$. This pressure, which can not exceed $bf_c$ is

$$p_u = p_o + \frac{Q}{2} - \sqrt{\frac{Q^2}{4} - T} \ldots\ldots\ldots\ldots (35)$$

in which $$Q = \frac{E}{a}\left[\frac{19.788\,b}{a^3} + 9.588\,X\right]$$

and $T = \dfrac{59.364\,E^2 Xb}{a^5}$ for yielding ribs with $n = 4$,

or, in general terms, when $n > 4$,

$$Q = \frac{E}{a}\left[\frac{3.196\,\Sigma b}{a^3} + 38.352\,\theta X\right]$$

and $$T = \frac{38.352\,\Sigma\theta E^2 Xb}{a^5}$$

When $X$ is put $= \infty$ to give the pressure of collapse for unyielding ribs, the preceding equation becomes indeterminate, but upon evaluation by the theory of indeterminate forms we get another particular value of $p$, viz.:

$$p_c = Eb\left[\frac{\Sigma}{a^4} + \theta b^2\right] \ldots\ldots\ldots\ldots\ldots (36)$$

The same result may also be obtained by equating the denominator of $K$ to zero and solving for $p$.

It will be noted in the particular value given for $K$ when $n = 4$ that the coefficient of $Eb$ is slightly less than the value obtained by substituting $n = 4$ in the expression for $\Sigma$. This is because $B$ is used in the first and $B'$ in the second case.

When $p > p_b$, $f''' > f'$. When $p < p_b$, $f''' < f'$.

Eliminating $p$ in equations (33) and (35) and solving for the value of $a$, we have,

$$a' = \left[\frac{1.101\,z\,(z + 1.875\,b)}{X\,(z + 1.288\,b)}\right]^{\frac{1}{3}} = 1.033\sqrt[3]{\frac{z}{X}}\ \text{(nearly)} \ldots (37)$$

or, in general terms,

$$a' = \left[\frac{.0444\,\Sigma z\,(z + 1.875\,b)}{\theta X\,(z + 1.288\,b)}\right]^{\frac{1}{3}} = .354\sqrt[3]{\frac{\Sigma z}{\theta X}}\ \text{(nearly)} \ldots (38)$$

For infinitesimal values of $\Delta$ the following relations may be stated:

When $a < a'$, or $p_u < p_b$, failure is initiated at the rib causing simultaneous failure at the mid-point.

When $a > a'$, or $p_u > p_b$, failure occurs at the mid-point. The beam, at the point of failure, ceases to increase the load on the rib, although this is not taken into account in the derivation of equation (26). With $a$ only moderately greater than $a'$ the rib may not be strained beyond the elastic limit and may thus be left intact. No error is indicated in equation (26) for its intended purpose.

For appreciable values of $\Delta$, $f > f_M$ when $a = a'$ and $p < p_u$.

In practice it will seldom be found desirable or even advisable to make $p > p_b$ or even $a > a'$ and, therefore, equation (27) will practically always control the design.

In computing the stress $f$ care should be taken to choose a value of $p$ as great as is conceivably possible in the circumstances, because the stresses may increase rapidly if $p$ happens to be a little greater than was assumed. In any case the designer will probably grasp the method better if he repeats his calculations with a slightly higher value.

The importance of the quantity $\Delta$ has doubtless become apparent to the reader; in fact no intelligent idea of the stresses can be reached without it. Experience has shown that no hardship is imposed on a manufacturer if he is required to guarantee that $\Delta$ shall not be greater than one per cent of the radius, and this provision should be included in the specifications, and can hence be used as the basis for design, with reasonable stresses. If $\Delta$ should happen to be less than this, deflections and bending stresses will be proportionately reduced. No lesser value should however be used in computation.

As engineers we are not interested in knowing how great a pressure will certainly cause failure of an ideal shape; we wish rather to know how great a pressure will certainly *not* create dangerous stresses in an actual practicable shape: and these two pressures bear no definite relation to one another. Hence the computation of the first mentioned one, such as $p_u$ is of very doubtful value in design. The author therefore recommends only those of his equations which are used to find stresses when $\Delta = 0.01\,r$ to $0.02\,r$, but he has included such equations as (35) and (38) for comparison with similar equations which may have been presented by others. These and all other equations based on buckling should not be taken too seriously.

The assumption of four nodes and only four, for computing stresses, is based upon common observation of a physical fact. It is easily observable that a slightly deformed tube with reasonable shell thickness does, actually, develop exactly four nodes, two of the quarters approaching each other whilst the other two recede from each other.

There remains now only to point an easy way to tell when a design is a proper one, the stresses in which may correctly be computed with the foregoing equations.

It is evident that failure will take place with four beams so long as $p_e \gg p_c$.* While it is tedious to get a perfect value for $p_e$ with equation (27), it is, nevertheless, easy to arrive at a value $p_e'$ which is nearly right and always slightly greater than $p_e$.

This is accomplished by making $C = 1$ in equation (27) and solving for $p$ as follows:

$$p_e' = \frac{q}{2} - \sqrt{\frac{q^2}{4} - v} \quad \text{.......................(39)}$$

in which

$$q = \frac{E}{4\,a}(12\,X + ab^3) + b\left(\frac{3\,EI}{2\,rS}\frac{\Delta}{r} + f_e\right)$$

and
$$v = \frac{Ebf_e}{4\,a}(12\,X + ab^3)$$

*The more exact value $p_u$ may be used instead of $p_e$, but this refinement is not likely to influence the design. The correction is appreciable only for values of $a\sqrt{b}$ near 0.77 and up to about 1.0.

We are therefore sure that the stress equations may properly be used when $p_e' \gg p_c$.

Solving equation (39) for $a$ with $\Delta/r = 0.01$, we have

$$a = \frac{12\,X}{\frac{p}{E}\left[\frac{.06\,Ebe/r}{bf - p} + 4\right] - b^3} \quad \text{............(40)}$$

This equation is useful in determining very nearly a correct value of $a$ when the other features of the design are assumed.

The calculation of $p_c$ will be greatly facilitated by Table I. Having calculated $a\sqrt{b}$ observe the zone in which the result lies, using the proper column for $b$. The appropriate values of $\Sigma$ and $\Theta$ are found on the same line and are substituted in the simple equation (36)

$$p_c = Eb\left(\frac{\Sigma}{a^4} + \Theta b^2\right)$$

The value of $n$ shown on the same line, is to indicate the number of beams which will be in existence at the time of failure, if of course the ribs are strong enough to develop them.

The critical values of $a\sqrt{b}$ where $\Sigma$ and $\Theta$ change are found by making $p$ simultaneous in two equations having successive values of $\Sigma$ and $\Theta$. Inasmuch as both $\Sigma$ and $a\sqrt{b}$ vary to some extent with the actual value of $b$, such variation is indicated in the table.

If more exact values of $\Sigma$ are required for intermediate values of $b$ not listed they may easily be obtained by remembering that the percentage increase varies as $b^2$. Corrections of less than one per cent are not indicated.

An economical design can only be made with the aid of judgment. A reasonable design must first be tentatively assumed by recourse to such simple formulae as are available, after which the true stresses may be computed and if not suitable a new trial made.

If the ribs are chosen with too heavy a section, the calculated value of $a$ will be unduly large, and $p_e$ will be greater than $p_c$. If the rib is too small, the proper relation $p_e \gg p_c$ will prevail, but the difference between them will be too great for economy.

It will be found that if a design is laid out with good engineering judgment, the elastic limit will always be reached before the integrity of the four beams is disturbed; but in order to be sure that no more than four beams can be in evidence, it is better in all cases to check up to see that $p_e' \gg p_c$; if it should be, the values of $a$ and $X$ must be reduced, for the same stress and thickness of plate.

The writer is not interested in the values of $p_u$, as before stated, but it may be pointed out that the proper values of $\Sigma$ and $\Theta$ to be used are very nearly within the same ranges of values of $a\sqrt{b}$ as given in the table and furthermore, it would be always necessary to figure the value of $p_u$ with four beams to be sure that this is not less than the value figured for the proper range of $a\sqrt{b}$.

If the value of $a\sqrt{b}$ should be only a little smaller than a transition value where $\Sigma$ and $\Theta$ suddenly change, it is better in such cases to figure $p_u$ with two successive values of $\Sigma$ and $\Theta$, as well as the value for four beams, to see which of the three is the least, because the minimum value naturally controls. It is possible to make charts to determine the definite values of $\Sigma$ and $\Theta$ in this case as the table does for $p_c$ but this refinement is hardly worth applying to the use of an equation which is at best of very doubtful practical value.

No great importance is attached to a meticulous precision of values of $p_c$, a quantity which is practically useful only as a means of determining when a rib is too rigid for the plate thickness and spacing used with it. With this point of view in mind, $p_e'$ might usefully be compared with authentic values of $p_c$ obtained by other writers.

It should be understood that the author is not attempting to compete with others in the academic determination of the ultimate strength of perfect tubes: his efforts in that direction are intended only to present a simple formula such as (27) for purposes of practical design, when there is a clause, written in the specifications, that "no two diameters measured in any transverse plane shall differ by more than one per cent."

A close observer will immediately discover that the writer's simple conception of beam action does not completely take care of all the forces in evidence such, for example, as certain longitudinal tension due to relatively greater compression at the mid-point than at a rib and also due to the lengthening of the node loci by tangential slipping at the nodes but it is believed that any such refinements would have a negligible effect upon equation (27) and that such effect as they do have is not in the direction of error on the unsafe side.

In conclusion, the author hopes his critics will weed out any errors which he may have overlooked. It may be well to call attention to the fact that a designer who becomes familiar with the principles of the paper will be able to produce a practical design with formula (40) alone, but until then he should employ the other formulae whose importance has been mentioned in the course of the development.

Due acknowledgment is made to Jeffrey B. Macphail, A.M.E.I.C., for his assistance in editing this paper for publication. Those who saw the manuscript dated September 1932 will agree that he has clarified it considerably.

## APPENDIX

A numerical example will be interesting and helpful for understanding the application of the formulae. A single one will suffice, as will be seen when the law of similitude for these designs is stated.

The first point to be settled is the value of $d$, the length of plate which is assumed to be acting integrally with the ribs in resisting girth deformation.

When equal leg angles are used for ribs, and when the thickness of the plate is not less than that of the angle, a convenient empirical rule for which there is at least some theoretical justification is to take enough plate to increase the section modulus of the angle by 33 per cent. This corresponds roughly to an increase of 75 per cent in the moment of inertia of the angle. Exactness of the latter is not necessary, because the value of $a$ in equation (40) is not at all sensitive to changes in this element. If an angle with unequal legs is to be used, the value of $d$ should be calculated with the equal leg angle required by the rule, and this value would then be used for the unequal angle chosen.

This rule arises from the consideration that for reasonable working stresses with $\Delta/r = 0.01$ and rib spacing of $d$ inches, the structure is not weakened by assuming momentarily that the rivets uniting the angle and plate are removed, thus relieving the angle of compressive stress and putting it all in the plate.

In other words, the bending stress $f'$ in the unattached angle is less than the maximum combined stress $f$ when the angle acts integrally with $d$ inches of plate, even when the compressive stress $f_c$ is reduced by including the angle area with that of the plate.

Nothing is claimed for this rule except that it is safe for use. A smaller value of $d$ is certainly not necessary, and a reasonably larger value does not result in any appreciable economy. In some unusual case it might lead to a value of $d$ greater than $l$ but in that event one would of course take $d = l$.

The permissible percentage increases in the section modulus and moment of inertia of an angle due to the presence of the plate may of course be calculated in any particular case from the consideration of equal stress with and without the rivets, and it will be found that these increases may sometimes exceed 33 and 75 per cent respectively.

A good empirical rule for trial values is

$$S/S_a = 1.33 + 0.25\,(16 - k/t_a)\sqrt{b - 0.006}$$
$$I/I_a = (S/S_a)^2$$

where $S_a$ = section modulus of angle $k \times k$ inches in size and of thickness $t_a$ inches, and $I_a$ is the moment of inertia of the angle.

For an actual example, assume the following data:—

$\Delta/r = 0.01$ $\quad p = 15$ pounds per square inch
$r = 60$ inches $\quad t = 7/16$ inches
$E = 30 \times 10^6$ pounds per square inch
$f$ = maximum combined stress = 15,000 pounds per square inch
Rib = 6 inches × 6 inches × 7/16 inches angle
$f_e$ = elastic limit = 30,000 pounds per square inch.

In this case a value of 40″ was taken for $d$, increasing the section modulus of the angle from 4.07 to 5.435 and the moment of inertia from 17.68 to 31.53. These values, while not precisely according to the rule given, are sufficiently close to make no practical difference in the design.

Applying equation (40) we find that $a = 3.50$ and $l = 210$ inches. Applying equation (39) we find that $p_e' = 24.84$ pounds per square inch. We find also that $a\sqrt{b} = 0.299$ which gives, from Table I, the values $\Sigma = 0.00404$ and $\Theta = 2$. Applying equation (36) we find that $p_c = 29.1$, which is greater than $p_e'$ as it should be. Other values which arise from the appropriate equations are $\Delta = 0.60$ inches, $\delta = 0.18$ inches and $\delta' = 0.0016$ inches.

TABLE I

| Range of $a\sqrt{b}$ according to $b$ | | | 10,000 $\Sigma$ for $b < .005$ | Percentage increase in $\Sigma$ according to $b$ | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| $b \not> .01$ | $b = .015$ | $b = .025$ | | $b = .005$ | $b = .01$ | $b = .015$ | $b = .02$ | $b = .025$ | $\Theta$ | $n$ |
| ∞ to 1.954 | ∞ to 1.954 | ∞ to 1.954 | 62910 | | | | | | 1/4 | 4 |
| 1.954 to .778 | 1.954 to .778 | 1.954 to .778 | 2386.7 | | | | | | 2/3 | 6 |
| .778 to .404 | .778 to .404 | .778 to .405 | 240.83 | | | | 1.01 | 1.46 | 5/4 | 8 |
| .404 to .241 | .404 to .242 | .405 to .243 | 40.377 | | | 1.34 | 2.38 | 3.72 | 2 | 10 |
| .241 to .157 | .242 to .158 | .243 to .160 | 9.4168 | | 1.26 | 2.84 | 5.04 | 7.87 | 35/12 | 12 |
| .157 to .109 | .158 to .110 | .160 to .112 | 2.7451 | | 2.36 | 5.32 | 9.47 | 14.77 | 4 | 14 |
| .109 to .080 | .110 to .081 | .112 to .083 | .94168 | 1.02 | 4.08 | 9.18 | 16.31 | 25.49 | 21/4 | 16 |

Checking the stress by equation (27) we find that $f = 12{,}945 + 2{,}057 = 15{,}002$ pounds per square inch. This result is given with useless precision to show that it is slightly greater than the working stress assumed, but this difference is never of importance unless $a$ is greater than about 10 with plate thicknesses usual for large tubes. When $a < 10$ and when angles are used for ribs, with thicknesses about the same as that of the plate, equation (27) need not be used except as a check on the accuracy of numerical calculation.

Furthermore, equations (36) and (39) need not be used unless the leg of the angle is more than 14 or 15 times its thickness, and this ratio should be 10 to 15 times in the interest of economy.

These statements may be summarized by saying that equation (40) is alone sufficient for an experienced designer.

A useful law of similitude is found to exist, quite exactly enough for practical purposes. If an accurate scale drawing be made, without dimensions, the relation between stress and pressure can be found. For example, in the numerical example given above, if all the dimensions be reduced by one third, say, the tube would still support the same pressure with approximately the same stresses. The design would be as follows:

$r =$ 40 inches $t =$ 0.292 inches

$a =$ 140 inches

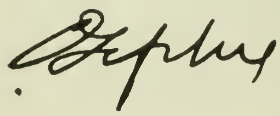
Ribs = 4 inches × 4 inches × 0.292 inch angles.

# Message From The President

During the past year it has been my privilege to visit the Branches of The Institute from coast to coast of the Dominion. Everywhere I found an admirable loyalty to The Institute and the objects for which it stands. On the part of our members there is a keen determination to help in every possible way in combating our present economic difficulties; the more fortunate of our members have helped generously both in money and effort in a general endeavour to ensure the welfare of those of their confreres who have found themselves in need. Thus the spirit of co-operation which has developed in the profession has shown its resourcefulness and solidarity.

The course of events during the latter part of 1933 gives many reasons for believing that we have passed through the worst of the emergency and that conditions are now improving slowly but surely. It is my hope and expectation that in the year now before us, this improvement will gather impetus, and continue with increasing rapidity.

With the expression of my gratitude for the unwavering support given to The Institute throughout this trying period, I extend to all our members my best wishes for a happy and prosperous New Year.



# The Forty-Eighth Annual General and General Professional Meeting

The Annual General Meeting for 1934 will be convened at Headquarters, 2050 Mansfield Street, Montreal, on Thursday, January 25th, 1934, at eight o'clock p.m.

After the transaction of formal business, the meeting will be adjourned to reconvene at the *Windsor Hotel, Montreal,* at ten o'clock a.m. on Thursday, February 8th, 1934, continuing with the professional sessions on the following day.

## Programme of Meeting at Montreal

(*Subject to Minor Changes*)

### Thursday, February 8th

9.00 a.m. *Registration.*

10.00 a.m. *Annual General Meeting* (Windsor Hall).
Reception and discussion of reports from Council, Committees and Branches.
Discussion of Council's proposals for amendment of By-laws.

12.45 p.m. *Formal Luncheon* (Rose Room).
Members $1.00.
Complimentary to visiting Ladies.
Welcome by the Chairman of the Montreal Branch, Dr. A. Frigon, M.E.I.C., and by His Worship the Mayor of Montreal.

2.15 p.m. *Annual General Meeting* (continued).
Scrutineers' report and election of officers.
Retiring President's address.
Induction of new President.

7.30 p.m. *Annual Dinner of The Institute* (Rose Room).
The President in the chair.
It is expected that the Prime Minister, the Right Hon. R. B. Bennett, K.C., P.C., LL.D., will address the members and ladies present.

9.30 p.m. *Reception and Dance* (Windsor Hall).
Tickets for Dinner and Dance, $2.50 per person.
Tickets for Dance only, $1.50 per person.
(Alexander's Orchestra.)

### Friday, February 9th

9.30 a.m. *Professional Sessions for the Presentation and Discussion of Papers.*

Oak Room. *Chairman*—P. B. Motley, M.E.I.C.

(1) *The Broadway Bridge, Saskatoon, Sask.*—by Dean C. J. Mackenzie, M.C.E., M.E.I.C., Dean of Engineering, University of Saskatchewan, Saskatoon, Sask.
(A reinforced concrete bridge over the South Saskatchewan River.)

(2) *Survey Work for the Lake St. Louis Bridge, Lachine*—by C. F. Draper, A.M.Inst.C.E., Lake St. Louis Bridge Corporation, Montreal.
(A steel highway bridge over the St. Lawrence, near Montreal.)

Prince of Wales Salon. *Chairman*—Dr. A. Frigon, M.E.I.C.

(1) *Stresses in Stiffened Circular Tubes under External Pressure*—by R. D. Johnson, M.Am.Soc.C.E., consulting engineer, New York, N.Y.
(To be presented by title only.)

(2) *Reflecting Telescope for the David Dunlap Observatory*—by R. K. Young, Ph.D., Department of Astronomy, University of Toronto.
(The largest telescope in the British Empire.)

(3) *Air Conditioning*—by G. B. Elliott, B.Sc., A.M.E.I.C.

12.45 to
1.45 p.m. *Buffet Luncheon* (Rose Room).
Tickets $1.00.

2.15 p.m. *Professional Sessions* (continued).

Oak Room. *Chairman*—P. B. Motley, M.E.I.C.

(1) *Substructure of the Lake St. Louis Bridge*—by J. A. Lalonde, B.A.Sc., A.M.E.I.C., Chief Engineer, A. Janin and Company Limited, Montreal.

(2) *Superstructure of the Lake St. Louis Bridge*—by W. Chase Thomson, M.E.I.C., Lake St. Louis Bridge Corporation, Montreal.

Prince of Wales Salon. *Chairman*—Dean E. Brown, M.E.I.C.

(1) *The Utilization of Magnesian Carbonates*—by F. E. Lathe, Director, Division of Research Information, National Research Council, Ottawa, Ont.
(For use in refractory materials and plastic cements.)

(2) *Department of National Defence Relief Camps and Projects*—by Major G. R. Turner, M.C., D.C.M., A.M.E.I.C., Assistant Director of Engineer Services, Department of National Defence, Ottawa.

8.00 p.m. *Smoker* (Windsor Hall) Music, and a Boxing Tournament.
Tickets $1.00.

The Ladies Committee is arranging for the entertainment of visiting ladies and a Ladies Programme will be issued.

### Hotel Arrangements

Members are recommended to make their reservations well in advance.

The management of the Windsor Hotel will give the following special rates (European Plan) to members attending the meeting:

Single rooms with private bath—$3.00, 3.50, 4.00, 4.50, 5.00 per day.

Double rooms with private bath—$5.00, 6.00, 7.00, 8.00 per day.

### Railway Rates

Both railways offer special return rates for groups of ten or more as follows:

(*a*) Organized parties having a minimum of ten up to fourteen persons: single fare and one half. Time limit sixteen days.

(*b*) Organized parties of fifteen or over: single fare and one quarter. Time limit sixteen days.

(*c*) Rate *good on coaches only*, a minimum of fifteen persons: single fare and one tenth. Time limit seven days.

All these fares require travelling together on the same train and date, with individual return on any train within the time limit.

THE
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OF CANADA



VOLUME XVII JANUARY 1934 No. 1

## The Forty-Eighth Annual Meeting of The Institute

The forthcoming Annual General and General Professional Meeting, to be held at the Windsor hotel in Montreal on February 8th and 9th, 1934, is being organized under the auspices of the Montreal Branch of The Institute, and, like the Ottawa meeting of last year, will last for two days. These, however, will be days of activity, for a very full programme has been arranged, an outline of which is given on another page.

The business sessions will be largely occupied by discussion on the far-reaching changes in the by-laws which have been proposed by Council. The most important features in these proposals are the establishment of one class of corporate member instead of the two classes now existing; the merging of the class of Student in that of Junior, and a reduction in the scale of annual fees. It is hoped that the arguments for and against these and the other proposals of Council will be thoroughly brought out in debate during the meeting, so that members may vote upon them subsequently in the letter ballot with full understanding as to their scope and probable results. It may be added that no Annual General Meeting of recent years has been called upon to consider matters of more vital importance to the welfare of The Institute.

At the professional sessions papers of a wide range of technical interest will be presented and discussed. The social features of the meeting will fully maintain the reputation which the Montreal gatherings have always had in that respect. They include a dance, and a smoking concert at which the principal feature will be a boxing tournament under the sanction of the A.A.U.

It is hoped that many visiting members from other branches will take advantage of the moderate rates offered by the railways and head for Montreal and the Forty-Eighth Annual Meeting.

## The E-I-C Engineering Catalogue 1933-1934

The many appreciative letters received regarding the first issue of the E-I-C Engineering Catalogue have fully justified the decision of the Council to continue the publication of this valuable reference book and indeed to enlarge it. The volume now in the press will be generally similar to that issued a year ago, but its contents will be materially extended both as regards the Products Data pages and the Indices.

A better understanding of the service that The Institute is rendering in publishing the Catalogue has resulted in a larger number of manufacturers including technical information regarding their products and greater attention has been given to the nature of the information they supply.

The Products Index, or list of engineering products which last year included some eighteen hundred items, will have twenty-four hundred different entries, and the Directory will contain some thirty-five hundred names in place of twenty-four hundred. It may be noted that: the Directory contains not only the manufacturers' names and addresses but also the names of their local representatives and the names of other firms they represent, if any. The names of Canadian representatives of British and foreign manufacturers also form a feature of the Directory.

The distribution of the new issue will also be extended. As was the case last year, copies will be distributed to all members of The Institute who fill in and return the inquiry cards which will be sent out in the course of a few days and the remainder of the issue of five thousand copies will be carefully distributed to those officers of important firms or organizations who can best make use of its lists and the technical information which it contains.

The new E-I-C Catalogue, like that of last year, is bound in a serviceable semi-flexible fabrikoid cover, and will fit either standard bookcases or filing cabinets, the overall size being 11⅜ inches by 8⅜ inches.

## Independent Springing in Motor Cars

The gradual process of development of the automobile during the past thirty years into a machine whose reliability is so remarkable, in spite of the unavoidable complexity of its structure, forms one of the most interesting stories in the records of mechanical engineering. During this period the general scheme of car design has undergone few radical changes, and the marked advances in riding comfort, reliability, performance and economy have largely been due to refinements in design and to the development of existing components based on the results of experience, together with improvement in the materials available, and the adoption of a number of accessories such as fuel pumps, shock absorbers, oil filters, and the like.

From time to time, however, an entirely new development leads to departure from some old and well tried arrangement, and important innovations are perfected involving change in some main feature of the car or its structure. Such ideas as the fluid flywheel, or complete stream lining of the body, seem likely to belong to this class. Another movement of this kind, which is now in progress, involves the adoption of independent springing for the wheels, a matter to which hitherto considerably greater attention has been paid in Europe than on this side of the Atlantic. Requiring, as it does, the complete abandonment of the conventional axle construction, it is a change which is being entered upon with caution, and only after thorough trial. Even in Europe there seem to be some differences of opinion with regard to this new development, although it has made great strides in Germany, where at the last Berlin Motor Show it was found on thirty per cent of all of the cars exhibited, and several British cars exhibited it at Olympia. Three important French automobile firms have adopted this system of construction, and it has been used successfully for many years by a prominent Italian builder. It is interesting to note that several of the biggest manufacturers in the United States and Canada have incorporated independent springing for the front wheels in their newest models.

The possibilities of independent springing have recently been discussed by a German engineer,* who points out that the undoubted improvement in riding qualities resulting from separate wheel suspension is mainly due to the reduction in the ratio of unsprung to sprung weight which it makes possible.

The proportion of any road shock which is transmitted by the springs to the frame and spring-supported mass of the car is increased by adding to the unsprung mass, and is diminished by adding to the sprung mass. Thus the introduction of front wheel brakes, while making for safety, did not improve riding qualities, but had rather the reverse effect, particularly on light cars. Road shocks are less noticeable in heavy cars, since they have a low ratio of unsprung to sprung weight. The smaller this ratio the less is the proportion of shock transmitted to the frame.

Thus there seems no question that the adoption of independently sprung wheels will be of particular advantage to the lighter cars, in which the unsprung weight bears so high a relation to the weight of the car as a whole. Further, a reduction in unsprung weight and the resulting improvement in springing, not only gives better riding but affords a more constant wheel grip than is possible with rigid axles. The tires show much less tendency to leave the road, which makes for more reliable steering in the case of the front wheels, and in the case of the back wheels avoids the disadvantages resulting from their tendency to spin whenever they lose contact with the road. Obviously, when the rear tires touch the road again severe friction develops between the tire and the road surface, resulting in strains on the transmission, and heavy wear on the tires.

Against these advantages must be set a number of difficulties which have to be overcome in obtaining a satisfactory solution of the springing problem, particularly in relation to the rear wheels. It is necessary to provide against the danger of a broken spring. The structure carrying the wheel must be adequately braced against all forces due to the application of the brakes or the reaction of the driving torque, and modifications are required in the steering gear, since the usual one-piece tie rod can no longer be employed. In the case of the rear wheels the abandonment of the conventional axle design involves additional universal joints, and increases the difficulty of satisfactory lubrication and maintenance, and it may be noted that such universal joints, if arranged in the driving shafts of the rear wheels, have to carry loads considerably greater than that transmitted by the universal joint in the propeller shaft of the car as usually designed.

It is true that some of the designs proposed for independently sprung wheels are more complicated and expensive in construction than the old conventional arrangements, but it seems that experience with this new development has now been such that simplification will result in schemes in which the costs of production and maintenance are quite reasonable, and which will make the undoubted advantages of independent springing available on a mass-production basis.

Both in Europe and America there is now a definite trend towards reduction in the weight of passenger cars. The introduction of a satisfactory system of independently sprung wheels will make it possible to insure in the light car of the future comfortable riding qualities which have hitherto only been available in automobiles of the heavier and more expensive makes.

*R. F. Colell, The Possibilities of the Independently Sprung Wheel, Engineering, December 8th, 1933, p. 619.

## Meeting of Council

A meeting of Council was held at the Royal York hotel, Toronto, on December 8th, 1933, at seven thirty p.m., with President O. O. Lefebvre, M.E.I.C., in the chair, and five other members of Council present.

The Council noted with appreciation the formation of a joint committee in Vancouver, composed of members of the Vancouver Branch of The Institute and local members of the American Society of Civil Engineers, to deal with local arrangements for the forthcoming Western Professional Meeting of The Institute, which is to be held in Vancouver at the same time as the Western Convention of the American Society of Civil Engineers in June or July of next year.

The report of the Finance Committee was received, and it was noted that the financial statement to November 30th, 1933, had been examined and approved. Eleven resignations were accepted, a number of requests for reinstatement were received, and sixteen members were placed on the Non-Active List.

The report of the Board of Examiners regarding the examinations of The Institute held on November 7th, 1933, was received, from which it was noted that three of the candidates examined had passed.

The report of the Past-Presidents' Prize Committee was received and approved.

A letter was presented from the chairman of The Institute's Committee on Engineering Education, expressing the opinion of the committee that in all cities where engineering faculties exist, the local branch of The Institute should form a small committee to keep in touch with questions of engineering education in that city. This was approved, and the Secretary was directed to communicate with the branches concerned.

The Council gave consideration to a memorandum presented by Mr. Newell in which attention was drawn to the desirability of providing for adequate preliminary engineering study of any projects to be carried out under the auspices of or with the assistance of the Dominion government. It was pointed out that such study was not only necessary from the economic point of view, but was particularly desirable as a means for affording employment to the young engineering graduates who at the present time have no opportunity of utilizing the training which they have received, and whose technical acquirements are not being put to profitable use under present conditions. A small committee was formed, under the chairmanship of Mr. Newell, to make recommendations to Council as to the further steps to be taken.

The newly elected officers of the Border Cities Branch were duly noted.

Mr. F. A. Combe, M.E.I.C., was named to represent The Institute on a committee being organized by the Canadian Engineering Standards Association to consider the preparation of a Safety Code for Mechanical Refrigeration.

A number of applications for admission and for transfer were considered, and the following elections and transfers were effected:

| *Elections* | | *Transfers* | |
|---|---|---|---|
| Assoc. Members | 4 | Assoc. Member to Member | 2 |
| Juniors | 3 | Junior to Assoc. Member | 1 |
| Students admitted | 7 | Student to Junior | 1 |

The Council rose at nine fifty p.m.

## Results of November Examinations of The Institute

The report of the Board of Examiners, presented at the meeting of Council held on December 8th, 1933, certified that the following candidates, having passed the examinations of The Institute, have satisfied the examiners as regards their educational qualifications for the class of membership named:

Schedule C—*For admission to Associate Membership:*
G. O. Nancarrow............Hamilton, Ont.

Schedule B—*For admission as Junior:*
W. L. Rice..................Toronto, Ont.
J. A. Sevigny, S.E.I.C....Three Rivers, Que.

## OBITUARIES

### Ormond Higman, M.E.I.C.

Deep regret is expressed in placing on record the death of Ormond Higman, M.E.I.C., which occurred at Ottawa, Ont., on November 9th, 1933.

Born at Duloe, Cornwall, England, on March 1st, 1850, Mr. Higman received his early education at a private grammar school at Menheniot, Cornwall, and at the High School, Plymouth, Devonshire. In 1867-1869 he took a course in chemistry at the Metropolitan School of Chemistry, London.

Coming to Canada in 1870, Mr. Higman entered the employ of the Montreal Telegraph Company at Ottawa as an operator, and in 1873 was promoted to the position of electrician and inspector of the Ottawa district, which office he retained for eighteen years. In September 1892, Mr. Higman was invited by the Minister of Inland Revenue to draft bills and regulations for a system of electrical inspection throughout Canada, and in July 1894, was appointed chief electrical engineer of the Inland Revenue Department, which position he held until 1921, when he became Director of the Electrical Standards Laboratories, Department of Trade and Commerce, Ottawa.

In 1893 Mr. Higman represented the Canadian government at the Electrical Congress in Chicago, and again at St. Louis in 1904. In February 1903, he was commissioned by Sir William Mulock, then Postmaster General, to investigate and report upon the working of the pneumatic tube system for the despatch of mail matter in the United States, and in July of the same year was appointed by the Minister of the Interior as electrical expert to the Commission to investigate the Ruthenberg process of electric smelting of magnetite ores at Lockport, N.Y.

In July 1905, Mr. Higman became chief of the Gas Inspection Service of the Department of Inland Revenue, this in addition to his other duties, and in 1906 was a member of the International Electrical Commission on Electrical Units and Standards.

Mr. Higman joined The Institute (then the Canadian Society of Civil Engineers) as an Associate Member on October 12th, 1893, and transferred to full Membership on May 2nd, 1907. He was placed on the life membership list in April 1926.

### Joseph Dufferin Peters, A.M.E.I.C.

It is with much regret that we record the death of Joseph Dufferin Peters, A.M.E.I.C., which occurred at Moose Jaw, Sask., on November 27th, 1933.

Mr. Peters was born in Perth county, Ontario, on April 8th, 1884, and received his early education at the Collegiate Institute, Stratford, Ont.

For two years Mr. Peters was plant operator and electrician with Barkey Bros., at Tillsonburg, Ont., and was subsequently with the London Electric Company, London, Ont. Later Mr. Peters was engaged on the installation and operation of a steam electric plant for the Moore Milling and Electric Company at Qu'Appelle, Sask., and in 1908 was appointed superintendent of the power plant of the city of Moose Jaw, Sask., which position he retained until 1930 when the plant was sold to the National Light and Power Company Ltd., of which organization he became general manager.

Mr. Peters became an Associate Member of The Institute on February 25th, 1919, and took a keen interest in Institute affairs, being vice-chairman of the Saskatchewan Branch in 1932.

## PERSONALS

Cecil H. Gunn, A.M.E.I.C., of the firm of John Gunn and Sons, Winnipeg, was re-elected as alderman for Ward One in Winnipeg at the election held recently. Mr. Gunn was the only candidate in any ward to be elected on the first count.

H. W. Furlong, A.M.E.I.C., is now a member of the staff of Sir Alexander Gibb and Partners, London, England. Mr. Furlong was formerly with Stone and Webster Engineering Corporation, Boston, Mass.

Elijah Cowan, S.E.I.C., who was connected with the draughting department of the International Paper Company, New York, N.Y., is now with the Lake St. John Pulp and Paper Company and is located at Dolbeau, Que.

C. H. Champion, A.M.E.I.C., has joined the staff of Howard Smith Paper Mills Limited, Cornwall, Ont. Mr. Champion was for a time in the mechanical department of Price Brothers and Company Limited, at Kenogami, Que.

F. Jno. Bell, M.E.I.C., has been appointed Canadian representative for Messrs. Braithwaite and Company Engineers Limited, London, England, with works at West Bromwich, and Newport, Wales. Mr. Bell, who is widely known in engineering and industrial circles throughout Canada, represents a number of other British engineering

F. JNO. BELL, M.E.I.C.

firms, including the well-known steam turbine builders, C. A. Parsons and Company, Ltd. He was president and general manager of the Canada Wire and Cable Company, Toronto, and subsequently held the same offices in the Leaside Munitions Company, Leaside, Ontario. Mr. Bell later became vice-president of the St. Catharines Steel and Metal Company, at St. Catharines, Ontario, and was for some years manager for the late E. A. Wallberg, M.E.I.C.

## ELECTIONS AND TRANSFERS

At the meeting of Council held on December 8th, 1933, the following elections and transfers were effected:

*Associate Members*

CADE, John Edwin, asst. chief engr., Fraser Bros. Limited, Edmundston, N.B.

McLENNAN, Allan John, B.Sc., M.Sc., (Mass. Inst. Tech.), plant elect'n., Shell Company of Canada, Pointe aux Trembles, Que.

FARROW, Richard Charles, Coldhayes, Liss, Hants, England.

*NANCARROW, Gilbert Owen, chief operating engr. of power plant, Hamilton Works, International Harvester Company, Hamilton, Ont.

*Juniors*

HATFIELD, Gordon Wallace, B.Sc., (McGill Univ.), asst. chemist, Atlantic Sugar Refineries Limited, Saint John, N.B.

PANGMAN, Arthur Henry, B.Sc., (McGill Univ.), control chemist, C. E. Frosst & Co., Montreal, Que.

*RICE, Walter Leslie, instr'man., water supply section, Dept. of Works, City Hall, Toronto, Ont.

*Transferred from the class of Associate Member to that of Member*

HEARTZ, Richard Edgar, B.Sc., (McGill Univ.), asst. engr., Power Engineering Company, Montreal, Que.

TRIMINGHAM, James Harvey, B.Sc., M.Sc., (McGill Univ.), chief engr., Power Corporation of Canada, Montreal, Que.

*Transferred from the class of Junior to that of Associate Member*

DESBARATS, George H., B.Sc., (McGill Univ.), supt. of Paugan power house of Gatineau Power Company, Low, Que.

*Transferred from the class of Student to that of Junior*

*SEVIGNY, Joseph Alfred, dftsman., St. Lawrence Paper Mills Co. Ltd., Three Rivers, Que.

*Students Admitted*

BENOIT, André Persilliers, (McGill Univ.), 481 Prince Arthur West, Montreal.

BROWN, Alan Coatsworth, (Univ. of Man.), 234 Sherburn St., Winnipeg, Man.

CLARKE, Stephen Herbert, (Faraday House Electl. Engrg. College), 1492 Bishop St., Montreal, Que.

DAIGNAULT, Lawrence George, (McGill Univ.), 2067 Church Ave., Montreal, Que.

DOBSON, Richard Nesbitt, (McGill Univ.), 6645 Molson St., Montreal, Que.

HAYES, Herman R., (Univ. of Alta.), 11129-90th Ave., Edmonton, Alta.

JOHNSON, James Richard, (McGill Univ.), P.O. Box 151, Revelstoke, B.C.

*Has passed The Institute's examinations.

## Unemployment Relief Committee Montreal Branch

The Unemployment Relief Committee of the Montreal Branch wishes to express through these columns its appreciation for an anonymous subscription of $20.00 to the Unemployment Relief Fund.

## BOOK REVIEWS

### Electrical Engineering Practice

*By J. W. Meares and R. E. Neale, Chapman and Hall Limited, London, England, 1933. 5½ by 8¾ inches, 920 pp. Figs., tables, 30s. net. Cloth.*

Reviewed by Professor H. J. MacLeod, M.E.I.C.*

This book is the third and last volume of the fourth edition of a work described by the authors as "A practical treatise for electrical, civil and mechanical engineers with many tables and illustrations." The first and second volumes received exceptionally high praise from many well-known engineering journals and this third volume maintains the same high standard. Every chapter shows that the authors combine a wealth of practical experience with sound theoretical knowledge, and their treatment of the subject successfully bridges the gap between the many excellent handbooks of data and the highly technical books written for specialists in various branches of electrical engineering.

This volume deals with electric motors and their control and with the many applications of electrical energy in industrial operations and processes, in hoisting, in mining, in agriculture, in traction and in ships. Chapters on specifications, depreciation and maintenance, testing and law are also included.

The treatment of each subject proceeds in easy manner from the elementary principles involved right through to practical applications. American as well as European practice has been considered, though naturally European, and especially British, practice predominates. This, however, does not prevent the book from being of value to engineers in this country.

Electric motors and their control are treated very fully. The principles of operation, the characteristics and suitable applications of the many different types of motors are set forth in a clear and interesting manner. The control and protection of the various types also receive extended treatment. These chapters are followed by a consideration of current practice and motor applications in the various lines of industry mentioned above.

The book is well printed and the subject matter is presented in a style that is admirably clear and critical. The three volumes of Electrical Engineering Practice would form a valuable addition to any engineering library.

*Professor of Electrical Engineering, University of Alberta, Edmonton, Alta.

### The Fuel Value of Wood

A report just issued by the Forest Products Laboratories, Ottawa, on the "Heating Value of Wood Fuels," gives a brief comparison of the fuel value of various species of wood, and also the relative heating value of wood and anthracite coal. The tests on which the article is based were made in a domestic hot-water heating installation by the Fuel Research Laboratories in co-operation with the Forests Products Laboratories.

The air-dry cordwoods used in these tests had a calorific value varying from 32 million B.t.u. per air-dry cord in the case of rock elm, down to 15.5 million for balsam fir or black cottonwood. In the former case approximately 1¼ cords was found to equal 2,000 pounds of anthracite—with the latter wood nearly 2½ cords would be required. In the particular domestic heating installation used for the tests it was found that about 2.3 pounds of well-dried hard maple containing about 20 per cent moisture gave a heating effect equivalent to that of one pound of good anthracite coal (12,900 B.t.u. per pound). In view of the wide use of wood as a domestic fuel, the report is intended for those using wood in domestic heating installations.

Copies of the report may be obtained from the superintendent of the Forest Products Laboratories, Ottawa.

## RECENT ADDITIONS TO THE LIBRARY

**Reports, Etc.**

*City of New York, Board of Water Supply:* Annual Report 1932.
*Canada: Forest Products Laboratories:* Heating Value of Wood Fuels.
*American Society for Testing Materials:* Standards 1933.
*The Institution of Mining and Metallurgy:* List of Members, 1933.
*Institution of Electrical Engineers:* List of Members, 1933.
*Canada: Dept. of the Interior, Forest Service:* Circular No. 38, The Effect of Kiln Temperatures and Air Seasoning on Ambrosia Insects (Pinworms).

## BULLETINS

*Speed Reducers*—A 4-page pamphlet received from the Hamilton Gear and Machine Company, Toronto, gives details regarding the new integral motorized speed reducers and increasers built as one self-contained unit. These are made in a full range of sizes in both worm gear and helical gear forms, of single or multiple reduction, to give almost any desired final speed.

*Tractors*—The Cleveland Tractor Company, Cleveland, Ohio, have published an 8-page booklet describing the new Diesel crawler tractor developing 85 h.p. This is a 6-cylinder solid injection engine of 5-inch bore and 6-inch stroke, with 19,000 pounds pull at 1.7 miles per hour.

*Concrete Roads*—"Concrete Road Design," a 60-page booklet published by the Portland Cement Association, presents a logical basis for the design of concrete slab for the predominating wheel loads, appropriate safety factors for each class of road, a simple method for determining the life expectancy of the slab in years, and relative efficiency and economy of various slab designs. Copies of this are available on application to the Association at 33 West Grand Avenue, Chicago, Ill.

*Hypo-Chlorination*—A 60-page booklet received from The Associated Chemical Company of Canada, Limited, Toronto, explains the term "hypo-chlorination," its various applications in the treatment of raw water and examples of its use in different municipalities. A number of tables on the strength of solutions necessary and the weight required to treat different volumes of water are given.

*Compressors*—A 26-page booklet issued by the Worthington Pump and Machinery Corporation, Harrison, N.J., gives details regarding the company's feather valve, horizontal duplex motor-driven compressors.

# Light-Weight, High-Speed Passenger Trains

*By E. E. Adams**

*A paper presented before the Railroad Division at the Annual Meeting, New York, N.Y., December 4th to 8th, 1933, of The American Society of Mechanical Engineers and published in "Mechanical Engineering," December, 1933. Slightly abridged.*

The public is probably generally aware of the fact that the passenger business of the railroads has been declining steadily in recent years because of the competition of the motor bus, the private automobile, and, recently, the airplane. In order to show the extent of this decline, compared with the increase in automobiles registered in the United States, the following figures are quoted.†

| Year | Passenger Miles | Automobiles Registered |
|---|---|---|
| 1911 | 32,371,444,793 | 619,500 |
| 1916 | 34,585,952,026 | 3,297,996 |
| 1920 | 46,848,667,987 | 8,225,859 |
| 1925 | 35,950,222,811 | 17,496,420 |
| 1930 | 26,814,824,535 | 23,059,262 |
| 1931 | 21,894,420,536 | 22,347,800 |
| 1932 | 16,974,591,000 | 20,903,422 |

Coincident with this decline in passenger business, the railroads have spent enormous sums of money for the replacement of light wooden equipment with heavy steel equipment which has very radically improved the safety and comfort of railroad travel. A modern ten-car passenger train, consisting of locomotive, head-end car, de luxe coach, diner, six Pullman sleepers, and observation car weighs approximately 2,000,000 pounds. An average of 100 passengers per train is considered a very satisfactory volume of business, which means a dead weight of 20,000 pounds per passenger. An ordinary 30-passenger bus weighs around 20,000 pounds, or about 667 pounds per passenger. An average five-passenger automobile weighs about 4,000 pounds, or 800 pounds per passenger. The result is that in recent years, with a few exceptions, the passenger business of the railways has been unprofitable when all costs are properly prorated.

There is a strong demand on the part of the public for increased speed, and with the present heavy class of equipment, such increase can only be made by shortening trains or increasing the power of locomotives, thereby materially increasing operating cost; and the possibilities of increased speed even under these conditions are very limited.

The obvious solution appears to be the development of light-weight, high-speed trains which can be operated at a minimum of expense, and such a development has recently been undertaken by the Union Pacific Railroad Company with the Pullman Car and Manufacturing Corporation as the builder. A three-car train is nearing completion, consisting of a forward car containing the power plant, a 33-foot mail apartment, and a small baggage room; a second car, which is a coach, seating 60 passengers; and a rear car, which is a coach, seating 56 passengers, with a buffet in the rear for serving light meals to passengers at their seats. See Figs. 1 and 2.

### Light Weight

A study was made of all available materials, including the aluminum alloys, stainless steel, and other steel alloys with physical properties intermediate between ordinary steel and stainless steel. It was finally decided to use aluminum alloys for the entire car structure, except for the bolsters, articulation castings, and truck frames, for which purpose there was used a special alloy cast steel having high tensile strength, high yield point, and great ductility. The net result is an estimated weight of 160,000 pounds for the three-car train.

The development of aluminum alloys has been the object of some very progressive research work as applied to new methods of car construction, the most interesting being the use of extruded metal shapes to take the place of the ordinary rolled shapes and pressings. These shapes are produced by merely forcing the hot metal through a die forming the cylinder head of the press. The producers of aluminum have co-operated with the car-builders and have been able to produce all of the desired shapes as outlined by the car designer with a relatively small outlay for dies, and such shapes are so accurate in dimensions that the designer is able to interlock various extruded-metal sections or shapes to produce cars of a minimum weight, maximum strength, and minimum deflection with simple shop fabrication.

Figure 3 is a cross-section of the light-weight train showing the various extruded sections which were used throughout the structure.

Aluminum plates can also be readily formed for the curved surfaces used in connection with streamlining. Aluminum can be readily riveted and spot-welded without injury to the material. It is believed that a great deal of development work will be done in connection with the use of high alloy steels, with the result that there will be strong competition between different materials in connection with producing the eventual light-weight passenger-carrying equipment.

### Streamlining

An exhaustive study was made of streamlining with the idea of reducing as much as possible the wind resistance to secure the obvious economy in power requirements. Advantage was taken of work done along these lines in connection with aircraft development. This, however, did not take into account the effect of ground resistance. It was concluded that an actual wind-tunnel test for each model or modification of it was necessary. Wooden models of the train, with detachable fronts and rears, were built, and front ends and rear ends of various shapes were constructed, all of which were subjected to wind-tunnel tests. Based upon the results obtained in these wind-tunnel tests, the final form of the train was determined, and a fairly accurate estimate was made of the power required for the speed desired.

The streamline models indicated a smooth canopy closing up the gap between sections, which is, of course, absolutely essential; but the accomplishment of this was a difficult task, taking into account the relative movement between car sections on curves. An aluminum shield which is the prolongation of the car contour, extends from the rear end of the forward section toward the front end of the following one. The extent of this projection is contingent on the minimum radius of curve to be negotiated. Closing up this gap between the hood projection and the following car section is a rubber sheet rigidly attached to the following car section, assuming the contour of the car and free to move at its forward edge. Spring actuated arms, mounted on the drum portion of the articulation with rollers bearing on the inner side of the projecting hood, keep this rubber stretched to close up the gap between the hood and the following car section.

### Structural Design

In order to secure the greatest strength with the least amount of material, a train of tubular cross-section was adopted, with the outer surfaces of aluminum sheets and frame-work built up of extruded aluminum-alloy sections. All of the metal in the framing is co-ordinated to act as a unit, whether for draught or buff, as it is impossible to deflect or stress any member without having adjacent members bear their proportion of the stress. This is at variance with the ordinary form of car design where draught or buffing shocks are taken by longitudinal underframe members. The underframe transmits certain loads to the side frame and the roof, but due to its design, only part of its area can be

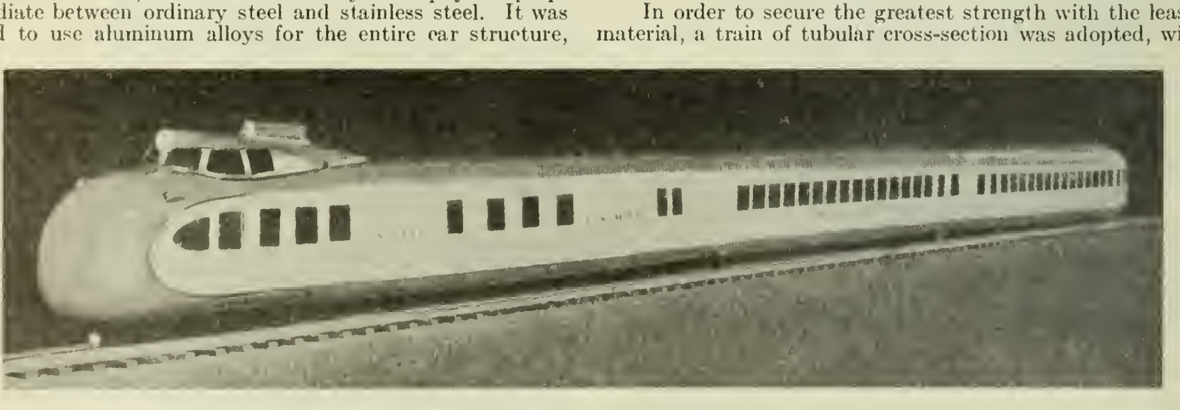

Fig. 1—High-Speed, Light-Weight Passenger Train under Construction.

*Vice-President, Pullman Incorporated, Chicago, Ill.

†From "Railroad Facts," published by the Western Railways' Committee on Public Relations.

utilized for load carrying; in other words, in the conventional type of car construction, much of the material or section does not take its proper part in bearing its share of stress.

Assuming the cross-section of the car to be a tube, there was naturally obtained a very large moment of inertia, which means closely controlled deflections, compensating for the high deflections otherwise produced by the low modulus of elasticity of aluminum.

The basic principle that has been developed in connection with these structures is that gusset connections should be avoided; all longitudinal members should extend the entire length of the car section, and transverse members should be in one piece for at least one-half of the cross-section.

As will be noticed from the cross-section, Fig. 4, below the roof is a duct running the entire length of the car, which is used as an air duct, also for lamps for indirect lighting. This duct acts as an effective compression member. The underframe portion of the cross-section is an I-beam built up of extruded metal and truss bracing. This, due to its shape and connections, forms an effective tension member that co-ordinates with the compression member in the roof.

Incidentally, the tubular design, which lends itself to economy in material requirements, also conformed to the best shape as developed in connection with streamlining, reducing very materially the retarding effect of side or quartering winds. It has been determined that a quartering wind confronting the train from either side, not a straight headwind, actually offers the greatest resistance because of the larger surface area presented to the forces present in the air current.

The net result of the light-weight and proper streamlined shape was rather graphically expressed by a well-known aeronautical engineer who supervised the wind-tunnel tests and who said that the new train "has possibilities of power economy not possessed by any other known vehicle."

"The new train will require 500 h.p. to propel it 90 m.p.h. with a load of 120 passengers and 25,000 pounds of mail and baggage. The ten-car conventional train which it replaces, carrying the same load at the same speed, requires 3,400 h.p.; a three-car conventional train requires 1,700 h.p.; six buses, similarly loaded, same speed, 1,500 h.p.; thirty automobiles, 3,600 h.p.; a river steamboat, 211,000 h.p.; and fifteen transport airplanes, 5,000 h.p."

Whenever light-weight equipment has been proposed, the usual reaction of an experienced railroad man is the hazard encountered at grade crossings when colliding with automobiles, trucks, etc., which, unfortunately, is of frequent occurrence. In order to protect against damage under such conditions, the front end or nose of this train was given most careful consideration. About half of the total weight of the train, or 80,000 pounds, is carried on the front truck, which necessarily requires a very massive support for the engine at the floor line. This floor-line construction forms the centre of the curved front end, and all of the structural members converge to form a strong parabolic arch, which should resist without damage the shock of any collision possible at highway crossings.

### Articulation

Articulation of body units of the train has been adopted as best suiting the requirements for high speed and smooth riding. It eliminates the objectionable overhang of non-articulated cars, also the necessity for couplers and draught gears and complicated vestibule arrangement. It also prevents, except to a limited degree, the independent oscillation of each individual car, thus tending toward a gliding motion of the entire train. It also permits the carrying of three cars on four trucks rather than six trucks, thus reducing track resistance as well as inspection and maintenance, and, incidentally, construction cost and weight.

Articulation is effected by attaching an extension casting to each adjoining end sill, these castings terminating in centre plates which rest one on top of the other, these two centre plates in turn resting on the truck centre plate. A heavy locking king-pin secures all three plates together. All centre plates are lined with "oilite" bronze to reduce friction. Side bearings are spaced each side of centre plates and are of special design, incorporating the use of rubber in shear, to deaden oscillation and contribute their share toward smooth riding.

### Trucks

All trucks are of the four-wheel type.

The front or power truck has 36-inch rolled-steel wheels and roller-bearing journals spaced outside of the wheels, due to space necessary for the two 300-h.p. ventilated motors of suspended type and geared to each axle. The armature shafts are also on roller bearings, the armature being wound for a safe maximum speed of 110 m.p.h. The remaining three trucks have 33-inch rolled-steel wheels, and all axles are provided with inside type roller bearings, the inside type being used to reduce air resistance. All roller bearings are liberally oversized for the weight and speed requirements of this train.

To minimize air resistance still further, all trucks are shrouded, wind-tunnel experiments on scale models having developed that the total air resistance of the train was thus capable of being reduced about 20 per cent from the truck shrouding alone. An intensive study was made of the basic requirements for a truck suitable for service of this type.

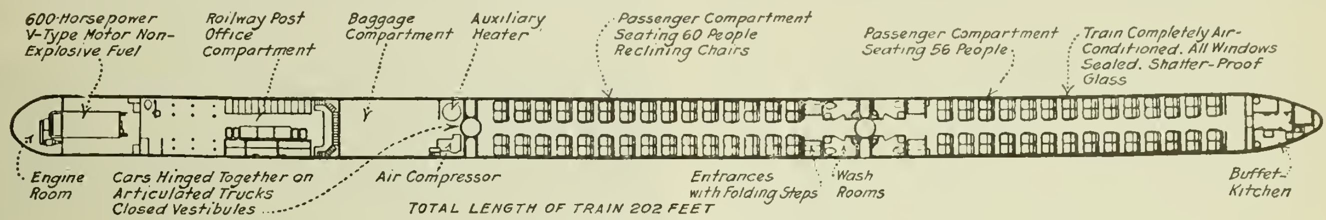


Fig. 2—Plan of High-Speed Train.

Few data were available concerning the stresses and deflections in trucks set up under operating conditions. By the use of extensometers and deflectometers, the builders of the train have studied truck action to obtain a true basis for correct design, resulting in low uniform deflections in connection with low uniform stresses for all parts of the structure. This insures, under dynamic conditions, the same safety as is indicated by the usual calculations covering static loading. Localization of stress must be avoided in all successful light-weight structures and material used only where it serves a purpose. There are instances where the static stresses have been quite low at all points, but under impact, the stresses at certain points exceeded the elastic limit of the material.

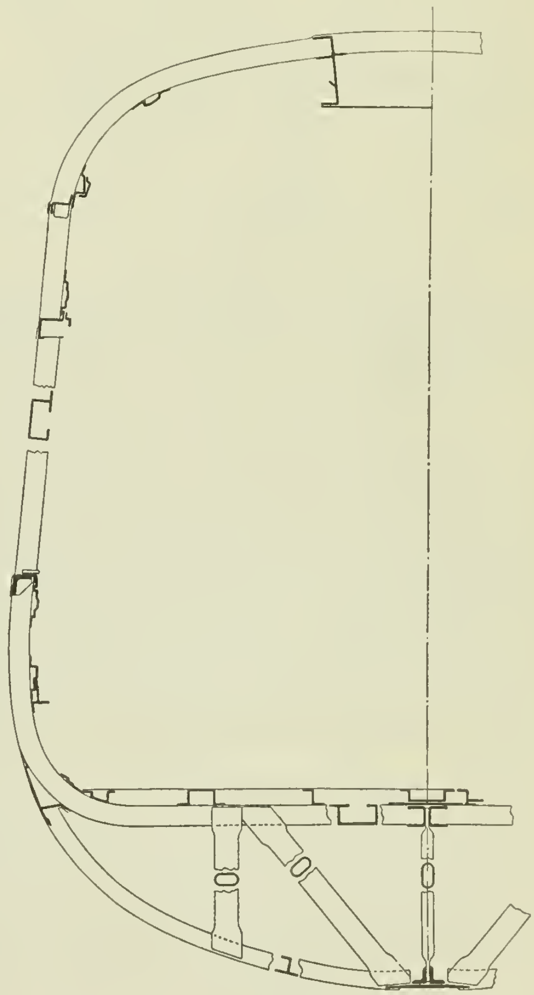

Fig. 3—Framing Showing Various Extruded Sections.

The trucks on this train are of cast steel; frames and transom being cast in one piece. An alloy cast steel was used, having a minimum yield point of 50,000 pounds per square inch and extreme ductility.

The advent of light-weight cars, with high-speed trains, high accelerations and decelerations, insistence by the public on elimination of noise, comparison with the automobile and the cushioning effect produced by its rubber tires, have resulted in a steadily growing sentiment that there should be something done along these lines by the designer of rail equipment.

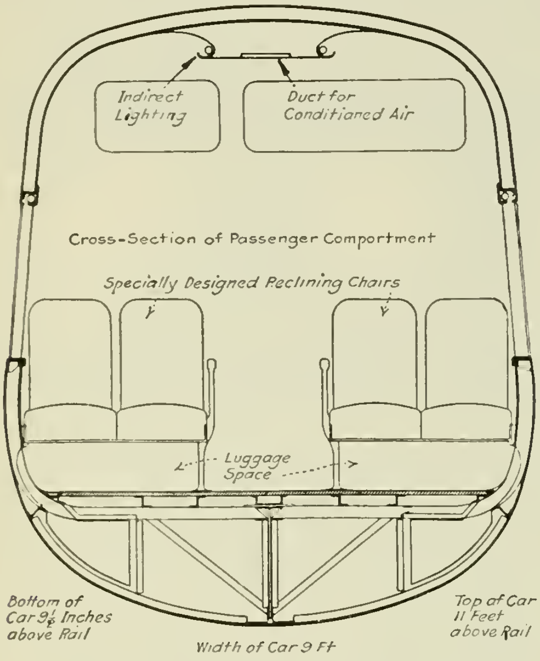


**Fig. 4—Cross Section of the Train.**

To meet this ever-increasing demand there have been several applications of rubber to both new and old trucks. New types of rubber compounds have been developed to meet the requirements of shear and compression loading, with proper movement under the imposed loads, and having relatively long life.

The trucks other than the power truck have inside journal bearings, and in lieu of the usual pedestals, the side frame has cutouts approximating the opening in the pedestal; but there is no metallic contact between the frame and any part of the journal box. The car weight is transmitted to the axle by means of rubber "doughnuts"* placed on each side of the axle. The sides of the journal box are extended either side of the axle, and between these extensions on the side frame are the rubber doughnuts, applied with sufficient compression so that the rubber has ample capacity in shear to perform its part in supporting the load, acting through the truck. In addition, there are coil springs working in parallel with the rubber so that for the usual static loading the doughnuts are lightly stressed. The compression load curve of the coil springs is much flatter than that of the rubber, so that the major portion of all impacts or live loads are carried by the rubber, the action of which is obvious. The rubber doughnuts are not only useful for vertical impact but, within a limited range, provide universal resistance, cushioning flange pressures and fore-and-aft forces, due to deceleration and acceleration.

All coil springs are mounted on rubber pads especially designed to soften shocks and "kill" metallic contact.

Rubber bushings are applied at each end of the truck bolster, the movable end bearing against hardened steel wear plates on the truck side frame, these to supplement the swing hangers in order to render them self-centring and provide a cushion effect.

Rubber is also used in connection with the chafing plates between the bolster and the transoms at the extremities of the bolster, thereby cushioning the traction and braking forces.

## Power Plant

The power plant for this train consists of a distillate-burning engine, developed especially for this service. It is of the twelve-cylinder "V" type, with cylinders 7½ inches in diameter and 8½-inch stroke, rated at 600 h.p. at 1,200 r.p.m. The entire engine frame, including the crankcase and cylinder water jackets, is of welded wrought-steel construction. The crankshaft, 5½ inches in diameter, which is dynamically and statically balanced, is made of chrome-nickel-molybdenum steel, having an elastic limit of 130,000 pounds per square inch, with a Brinell hardness of 300. No cast iron is used in the construction of this engine, except for the cylinder sleeves, which are made of a special grade of cast iron suitable for this purpose.

The distillate fuel is handled by special-type carbureters of the multiple-jet fixed-air-ratio type, which have been developed over a period of eighteen years, and are especially adapted to handling this heavy fuel. There is a separate carbureter having ten jets, attached directly to each cylinder head, and atomization of the fuel is accomplished without the application of heat. The fuel is supplied to the carbureter by electrically driven turbine pumps with gravity return to the fuel tank, and as floats and needle valves are not used, no surplus fuel is carried in the engine room. Fuel capacity is sufficient for a 1,200-mile run.

To facilitate streamlining further, the cooling radiators are located under the ceiling of the engine room, and cooling is effected by having a closed engine room under forced draught. This also supercharges the engine to some slight extent.

The motorman, with all of his controls and necessary instruments, is located in an elevated cab separated from the main engine room. From his elevated position he will have an increased visual range, and be removed from the noise of the power plant. His main operating controls consist of a throttle, a controller, and a brake valve. The brake valve is equipped with a "deadman's" control, requiring a motorman to keep either a hand or a foot on this control while the train is running, and if, for any reason, hand or foot is removed from this control, there is an immediate automatic closing of the throttle and application of brakes. The direct-connected generator is connected to the front end of the engine by means of a flexible coupling and is capable of developing approximately 425 kw., and the current, through remote control, is led directly to the two 300-h.p. traction motors on the front truck.

In addition to the main generator, there is an engine-driven auxiliary generator having a capacity of 25 kw. at 76 volts, which supplies current for battery charging, one of the two air compressors, air conditioning, and lighting. An additional 8-kw. engine-generator set at 76 volts is carried in the baggage compartment for service when the main power plant is shut down.

## Air Brakes

The air brakes for this train presented an important problem. In order to avoid rearranging the signaling system and also to avoid any additional operating hazard, it was necessary to be able to stop this train from 100 m.p.h. within the same distance that a conventional steam train could be stopped from the ordinary speeds at which they operate.

Heretofore, uniform braking retardation has not been possible, due to the fact that the coefficient of friction between brake shoe and wheels varies with the speed through a wide range, this coefficient decreasing rapidly at the higher speeds. In order to provide a uniform rate of retardation, it is necessary to control brake-shoe pressure automatically in proportion to the speed. In the new brake this is done by controlling cylinder pressure automatically by a very simple but effective device recently developed and thoroughly tried out, known as a "decelerometer." This instrument consists essentially of a movable weight of about 100 pounds, sensitively mounted on ball-bearing rollers, arranged to move in the line of motion of the train, and suitably restrained by a calibrated spring. This weight, acting through suitable leverage and a pneumatic valve, controls the brake-cylinder pressure accurately in proportion to its inertia, and, therefore, in proportion to the retardation of the train. Recent tests with this device on a gas-electric motor car developed a straight-line retardation graph from 76 m.p.h. to rest. Thus, by taking advantage of a simple natural law, it becomes possible to regulate brake-shoe pressure automatically in proportion to retardation and secure the maximum results in quick stopping.

If high rates of deceleration are used, it would be obvious that this device would control such deceleration up to a point at which the vehicle comes to rest, and by so doing, the sudden change from the high deceleration rate to a state of rest would result in a noticeable jolt at the end of the stop. In order to eliminate this, the decelerometer is provided with an ingenious valve device which changes the rate of deceleration to a low value just previous to the stopping of the vehicle. This results in a sudden final reduction in cylinder pressure to prolong the smoothness of deceleration to the end of the stop.

The air brake used on this train is a complete departure from conventional practice, both in its circuit and in the design of the various valves and parts used. The pneumatic feature is based on a two-pipe circuit consisting of a supervisory line and a control line. The supervisory line distributes the air to the reservoirs under each car and charges to the maximum pressure at all times. In conventional brakes it is not possible to charge the reservoirs during brake application. The purpose of the control line is to apply and release the brakes by admitting air to the pneumatic relay valve under each car, this valve controlling communication between each brake cylinder and its adjacent reservoir, and from the cylinder to the atmosphere. This control line passes from the engineer's brake valve through the decelerometer valve to the relay valve. This briefly describes the pneumatic operation. Parallel to this pneumatic circuit lies an electric circuit actuated by contact points on the engineer's brake valve, which operates a magnetic control feature on each pneumatic relay valve. This not only synchronizes but accelerates all brake applications and releases.

*Developed by C. F. Hirshfeld director President's Conference Committee on Research, American Electric Railway Association.

The use of a straight-air brake system demands adequate protection against operating failures in case of pipe rupture or other unforeseen causes. To overcome this the relay valve units are constructed so as to insure proper operation upon the depletion of pressure from both the supervisory and control lines. If the electric circuits should fail from broken lines or other cause, the pneumatic elements in the system will function in the usual manner to supply adequate braking power.

All brake cylinders are of aluminum and are mounted on the trucks, two cylinders per truck, and each cylinder acts on one pair of wheels only.

Air Conditioning and Ventilating

There is a duct on each side of the train below the floor line, and also a central ceiling duct, all of which are connected between cars by flexible bellows. Heat is obtained by passing air through the radiators of the engine. This air is forced by blowers through the floors ducts, a radiator outlet being located at each seat. Air is exhausted through a corresponding opening in the ceiling duct so that a definite circulation is obtained at each seat unit. An oil-fired hot-air furnace is installed in the baggage compartment and is capable of heating the train under all conditions should there be a failure of the heat from the engine radiator. It also provides heat for the cars at terminals or in the yards when the engine may not be operating.

A compressor is installed in the baggage room for cooling the air when desirable. For cooling, the circulation is reversed, cold air being discharged from the ceiling duct and exhausted through the floor ducts. In connection with both heating and cooling, approximately 25 per cent of fresh air is introduced in order to obtain frequent air changes and to keep a pressure in the car at all times for the exclusion of dust and cinders. The windows of safety plate glass are sealed in rubber and are set as nearly flush with the outside as practicable in order to minimize wind resistance. Two inches of a special fireproof insulation material is installed completely around the shell of the car and in the ends. This will give an unusual amount of insulation against heat and cold and also has special sound-deadening qualities.

Lighting and Seating

Careful study was made of lighting. Indirect lighting, from a trough on each side of the ceiling duct, was adopted. The light from this trough is reflected on each side against a properly curved ceiling cove in order to distribute it evenly at the reading position. The lights are so arranged that three intensities of light can be obtained, the lowest intensity being for night lighting while passengers are sleeping.

Seats were specially designed for this equipment, the object being to secure the maximum of comfort together with style and attractiveness. The space beneath the seats was kept clear to permit storage of baggage. The seat backs are adjustable with four positions. Seats are equipped with devices for the quick installation of an individual tray at the proper location for serving meals from the buffet.

Other Features

The side doors when closed are flush with the exterior, and are interlocked with steps which fold up and down as doors are closed or opened, a flush trap-door inside of the car completing this assembly.

Electric signals afford communication between train crew and motorman. A powerful headlight of special construction is streamlined into the roof of the motorman's cab, and this headlight is provided with a 10-inch vertical light beam in addition to the horizontal beam, for the purpose of added safety.

It will be noted that the fundamental objective was to produce a high-speed train which would have a low operating cost, and in addition, give the passengers safety, quietness, smooth riding, comfortable temperature, and fresh air, all of which, it is hoped and believed, will help in attracting passenger business back to the rails from other means of transportation.

## Meter Companies Merge

Negotiations have just been completed merging in Canada Neptune Meter Company Limited, and National Meter Company of Canada, Limited. The new company will be known as Neptune-National Meters Limited, with head office and factory at the plant of the former Neptune Meter Company Limited, located at 345 Sorauren Avenue, Toronto.

The manufacture of the two lines of meters will shortly be consolidated and carried on at the large and modern former Neptune plant.

The Sully Brass Foundry Company Limited, Toronto, which is owned by Neptune will become a subsidiary of Neptune-National Meters Limited.

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*The Swiss Electric Company of Canada Limited* announce the incorporation of a new company having an exclusive arrangement to distribute in Canada the products of Messrs. Brown Boveri and Company Limited, Baden, Switzerland, the Micafil A.-G., and other companies.

The headquarters of the Swiss Electric Company of Canada Limited will be temporarily in the offices of Messrs. Griswold and Company Limited, the former distributors of Messrs. Brown Boveri and Company Limited products.

After April 1st, 1934, it is intended to establish separate offices, which will be staffed with application and service engineers for the conduct of Canadian business.

# BRANCH NEWS

## Calgary Branch

*J. Dow, M.E.I.C., Secretary-Treasurer.*
*H. W. Tooker, A.M.E.I.C., Branch News Editor.*

Through the co-operation of the three prairie Branches of The Engineering Institute of Canada—Lethbridge, Calgary and Edmonton—each Branch in turn was privileged to see the Dominion government's official motion picture record of the "Arctic Patrol" and "The Fire Fighters of the Skies." These two most interesting and instructive records, the former a four-reel picture and the latter a two-reel picture, were shown to over eighty members and friends, many ladies being present, of the Calgary Branch on Thursday evening November 23rd, 1933.

The pictures of the "Arctic Patrol," as its name implies, depicted scenes of the 1929 patrol of the Canadian government vessel *Beothic* in Arctic waters, and, being an actual record of the vessel's supply voyage, gave an accurate picture account of conditions in the north.

The Branch was also very fortunate in having as its guest speaker the Venerable Archdeacon C. Swanson, who was for a number of years a missionary in the Yukon, and who recounted in a humorous fashion many of the difficulties under which the Indians live and the obstacles which had to be overcome to carry on the work of the Church.

The second picture, "The Fire Fighters of the Skies," depicted the Dominion government's method of patroling the immense forest areas by aeroplane and, in the event of forest fires, how the equipment for fighting them was brought into action by larger aeroplanes and the method of combating the fire.

After a hearty vote of thanks given the speaker by B. L. Thorne, M.E.I.C., the meeting adjourned at 10 o'clock p.m.

Methods of Handling Earth Fill Material

On Thursday evening, October 26th, 1933, Mr. J. K. MacKenzie of the Caterpillar Tractor Company gave an address on "Methods of Handling Earth Fill Material, with Special Reference to Levee Construction on the Mississippi River," to a large number of members and their friends.

Mr. MacKenzie showed, by means of motion pictures, how dirt was moved by caterpillar equipment to build the levees of the Mississippi river, and protect the cotton fields and farming areas. During the first eight months forty-two million yards of earth was moved.

A comparison of the recent developments of Diesel engines for tractor work over the old type of gasoline engines was made by the speaker, who stated that Diesel fuel costs about one half that of gasoline fuel, and the Diesel only uses approximately 56 per cent of what the gasoline engine uses. The fuel operating costs for five gasoline units was approximately $50 per day, while Diesel fuel for five units was $12.50 per day.

The meeting adjourned at 10 o'clock p.m.

Industrial Electric Tubes

"Industrial Electric Tubes" was the subject of a most interesting and instructive address presented to the members of the Calgary Branch and a large number of visitors on the evening of November 9th, 1933, by Mr. P. F. Peel of the Canadian General Electric Company. The address was illustrated by lantern slides and motion pictures.

Stating that all matter is composed of elements, the speaker went on to describe the electron theory. Progressing from the lightest to the heaviest elements, the number of electrons and protons comprising the different atoms increase with mathematical regularity. This makes possible the phenomena of electric current in metals and their absence in the lighter elements which gives us our electrical insulators.

Proceeding, the speaker dealt fully with the development of the various kinds of tubes such as the vacuum-filled gap and the gas-filled gap types.

The essentials of an electron tube are that it consists of the gap enclosed in an air-tight container by means of which no particular medium used can be regulated. That side of the gap connected to the positive potential is the anode; the opposite side being connected to the negative is the cathode.

The effect of heat greatly increases the activity of electrons in metal, which if applied to the cathode increases its electron emitting ability many hundreds of times, incidentally using a low anode voltage. This gives rise to the hot cathode type of tube which can be heated in any way desired. Cathodes are made of metals capable of withstanding high temperatures, such as tungsten. The cold cathode type made from some of the radio active metals such as selenium react to light in the same way that other types react to heat and so the photo-electric type of tube is possible.

The speaker then went on to name the various types of tubes and their uses: kenatron—high vacuum tube; pliatron—kenetron with grid or electric static control; magnitron—kenatron with magnetic control; phonatron—gas filled tube; thyratron—phonatron with grid or electrostatic control.

Pliatrons are the oldest and most generally known type of three-element tubes, the majority of radio tubes belonging to this class.

The thyratron type of tube is the one doing so much to revolutionize industry and has many unique applications.

Radio active metals constitute our heaviest and therefore our most unstable elements; their activity being greatly affected by light and heat. Tubes using these metals as cathodes are known as cold cathodes and are becoming extremely important in commercial applications. Some uses of the various types of tubes are: pliatrons—applied to certain types of self-levelling passenger elevators; thyratrons—furnishing field current for synchronous machines; controlling lighting load in conjunction with saturable reactors; application to wire drawing machines to maintain an even tension on the wire; regulating the quantity of material passing over a conveyor; burglar alarms; photo-electric tubes—counting pedestrians or vehicles or objects passing a given point; regulating the depth of material on a conveyor; controlling the density of syrup or other liquid food products; paper breaks in pulp mills can instantly be made known; doors can be made to open automatically by the approach of an individual; burglar alarms will promptly announce the presence of an unauthorized person.

Following the lecture an interesting discussion took place after which a hearty vote of thanks was given the speaker by P. Turner Bone, M.E.I.C. The meeting adjourned at 10.30 o'clock p.m.

## Hamilton Branch

*Alex. Love, A.M.E.I.C., Secretary-Treasurer.*
*V. S. Thompson, A.M.E.I.C., Branch News Editor.*

Tuesday, November 7th, 1933, was a red letter day for the Hamilton Branch when Dr. O. O. Lefebvre, M.E.I.C., The Institute's genial President, paid his official visit to the Branch. The Niagara Peninsula Branch joined with the Hamilton Branch on this auspicious occasion and many members and friends came from other points such as Toronto, Brantford and Galt.

The President arrived at 9 a.m. and was entertained by local members. He was taken to different places of interest and was also enabled to view the beautiful city of Hamilton from every vantage point.

The first official gathering was at 3.30 p.m. when a large party met at the offices of the Dominion Foundries and Steel Ltd. and were shown moving pictures of the manufacture of a car axle from the raw material to the finished article. The party was conducted through the plant by Mr. Frank Sherman and witnessed the tapping and subsequent charging of an electric furnace. Next the process of rolling 78-inch steel plates was seen. It is interesting to note that this is the widest steel plate rolled in Canada. The party also saw the tapping of an open-hearth furnace and pouring the molten metal into ingot moulds.

A smaller party visited the textile mill of Porritt's and Spencer and were shown the latest developments in the textile industry.

The city engineer, W. L. McFaul, M.E.I.C., conducted another party over the recently installed city filtration plant and pointed out its many interesting engineering features.

At an informal dinner in the Wentworth Arms at 6.30 p.m. (with an attendance of seventy-two) E. P. Muntz, M.E.I.C., who occupied the chair, welcomed to the Hamilton Branch Dr. Lefebvre, the President of The Institute. Dr. Lefebvre warmly thanked the members for the very kind welcome he had received. Mr. Muntz also introduced to the gathering Vice-President A. H. Harkness, M.E.I.C., of Toronto, A. B. Crealock, A.M.E.I.C., chairman of the Toronto Branch, W. R. Manock, A.M.E.I.C., chairman of the Niagara Peninsula Branch, and Mr. Crawford, president of the Babcock-Wilcox and Goldie-McCulloch Engineering Society, Galt.

At 8.00 p.m. members and friends to the number of 115 assembled in the Science Hall at McMaster University where Mr Muntz again presided. W. G. Milne, A.M.E.I.C., showed a reel of moving pictures of the total eclipse of the sun. These pictures were taken by Mr. Milne at Actonvale, Que., August 1932, when he accompanied the Hamilton party headed by the late Dr. Marsh.

Dr. Lefebvre next addressed the gathering and, commenting on the moving pictures, said they were of peculiar interest to him as they had been taken in his native county not many miles from his home town. He told the audience that he considered his election to the office of President as a very great honour indeed, because The Institute as a whole had selected one of the five per cent of the membership who were French-Canadians. It showed that The Institute did not consider race or creed in selecting men for high office.

The President told of the financial worries at Headquarters and how affairs were being managed. He told of the Plenary Meeting of Council last month and indicated what was likely to develop as the outcome of their deliberations. The Institute was to him something really worth while and he considered what he had paid in fees a sound investment, and he had derived manifold benefits as the results of this investment. He closed his interesting talk with an appeal to the older engineers to do everything they possibly can for the unemployed engineers, particularly those who have just recently graduated.

F. W. Paulin, M.E.I.C., the local Councillor of The Institute, voiced the sentiments of all present when he thanked the President for his interesting and inspiring talk.

At the close of the meeting coffee and sandwiches were served and a social half-hour was spent. This was the first meeting of the Branch in McMaster University and the facilities and accomodation provided by the University authorities were much appreciated by all present.

### Joint Meeting with Ontario Section, American Society of Mechanical Engineers

The Hamilton Branch, Engineering Institute of Canada, held a joint meeting with the Ontario Section, American Society of Mechanical Engineers, in the Science hall, McMaster University, on the evening of Tuesday December 12th, 1933. R. K. Palmer, M.E.I.C., past-chairman of the Branch, occupied the chair, and on behalf of the Branch extended a welcome to the members of the Ontario Section, A.S.M.E. Mr. Palmer also welcomed a large number of members and visiting friends from the Canadian Westinghouse Company, and spoke of their kindness in securing such an outstanding man as speaker of the evening.

On the invitation of Mr. Palmer, Mr. Ellis, chairman of the Ontario Section, A.S.M.E., assumed the chair and expressed the appreciation of the A.S.M.E. members at being invited to this meeting.

Mr. G. F. Mudgett, illuminating engineer of the Canadian Westinghouse Company and also chairman of the Toronto Chapter, Society of Illuminating Engineers, introduced the speaker of the evening. He spoke of his wide experience in the field of illumination, not only on streets and buildings, but in tunnels and under the sea. During the war Mr. Hibben was called on to devise special lighting equipment for use under water in salvaging a sunken submarine. He had also co-operated with Mr. Beebe in his deep water exploration.

The speaker, Mr. S. G. Hibben, manager of the Commercial Engineering Department, Westinghouse Lamp Company, Bloomfield, N.J., then addressed the meeting. He pointed out the great advantage and necessity of illuminants—in that 87 per cent of the knowledge obtained by the brain came through the optic sense. He also showed how rapid has been the development of the electric light in the past forty years. In that time the efficiency of lights expressed in light units per watt has increased from 1.4 to 26.0 which is about the limit with metallic filament lamps. By the ionization of various rare gases such as argon, neon, xenon, various illuminants of much higher efficiency have been produced.

He explained the problem of life and efficiency of lamps that confronts the manufacturer and by an interesting demonstration explained how a decision is arrived at.

The speaker predicted a wider use of colour in future lighting and showed the various colours derived from neon, argon, xenon, mercury and sodium, and showed slides of how concealed lighting is effectively used in stores, offices and the home.

Tables and charts showing the relation of mortality rates to hours of sunshine demonstrated clearly that the mortality from certain diseases was inversely proportional to the intensity of the sun's rays. The effect of the sun's health-giving rays can be closely approximated by ultra violet ray lamps, which are now used extensively in therapeutic work. A moving picture film showed the destruction of minute living organisms in a drop of water subjected to the rays of the ozone lamp which uses mercury vapour as the medium.

Sodium vapour lamps are being used more and more in street lighting and slides were shown which demonstrated their effectiveness.

At the close of the lecture G. A. Moes, A.M.E.I.C., moved a vote of thanks to the speaker and this was enthusiastically endorsed by those present.

Mr. Palmer pointed out that this lecture was ample demonstration of the value of The Institute to its members, particularly young engineers, when they could thus obtain first hand information from experts on important subjects not within the normal range of the practising engineer's activities.

The meeting adjourned at 10 o'clock p.m. but a great many remained to further inspect the equipment on view, and coffee and sandwiches were served.

This meeting fully demonstrated the advantage the Branch enjoys in being privileged to meet in McMaster University.

## Lethbridge Branch

*E. A. Lawrence, S.E.I.C., Secretary-Treasurer.*
*Wm. Meldrum, A.M.E.I.C., Branch News Editor.*

Dr. Wallace, president of the University of Alberta, gave a most inspiring address at a meeting of the Lethbridge Branch of The Institute held on Wednesday, November 8th, 1933, at the Marquis hotel, at 6.30 o'clock p.m.

Orchestral music was rendered during the dinner and the customary community singing was ably led by Bob Lawrence.

The meeting was open to the public and close to one hundred people were present when G. N. Houston, M.E.I.C., introduced the speaker. Dr. Wallace's subject was "Building a World."

### Building a World

In opening his address, Dr. Wallace stated that in the beginning life was composed of plant life; this developed into what were termed reptiles and later into mammals. All this took place before the advent of man, the knowledge of this coming to us through the work of geologists and archaeologists. From the time of man forward, we are able to get such knowledge from his writings, the knowledge therefore being more complete. In all this space of time, man has played a very small part and occupied a very short time.

During his short time on earth, man has accomplished much. He has learned to make use of his possessions. In the early ages, he made implements with which to kill his prey, that he might live; he made weapons to protect himself; he built rude huts for shelter. As he learned to make better use of his minerals and resources, he studied architecture and science. That he increased his knowledge in these lines is shown by the arts, paintings and fine buildings to be found in Crete and Egypt and later in Spain and southern France.

In the field of engineering, we have advanced notably. So in the field of science. Our astronomers and astrologers can tell us the distance stars are from us, the speed at which they are travelling from us, their weight, composition, etc. In regard to space and time, for instance, the Japanese statistics show that in about thirty-five years their birth and death rate will be almost equal and stationary. But they also know that at the end of that period they will have ten million more people to put to work. They know and admit that they are not a colonizing nation and therefore the only way they can keep their population working is by the expansion of industrialization. To do this, they must have raw materials. If Japan were sure that other countries would supply her with the raw materials to manufacture into goods that the world needed, she would be satisfied. But the world has not promised this to Japan in the past nor is it likely to do so in the future. Therefore, the only way Japan can be sure of having the necessary supply of raw materials is to possess them and possession means war such as Japan is engaged in at the present time.

China has no knowledge of her population because she is too backward at present. In the future, she will likely forge ahead and look for raw materials just as Japan is doing now.

Thus we have advanced in our scientific and engineering fields. But as a human race we have failed to learn how to live together. We have failed miserably on this point. We make peace pacts, pledges, sign agreements, etc., and then turn around and break them.

A great mistake we have all made is that we fail to see the problems of the world through the eyes of others. Our interests are too self-centred.

E. E. Eisenhauer, A.M.E.I.C., who moved the vote of thanks, expressed the appreciation of the audience for the very interesting and pleasant address given by one of Canada's outstanding speakers.

The Lethbridge Branch, Engineering Institute of Canada, held a meeting in the Marquis hotel on Saturday, November 25th, 1933, at which the wives and lady friends of the members were the guests of the evening. The chairman, J. Haimes, A.M.E.I.C., extended a welcome to all those present.

During the dinner, a fine selection of music was provided by the "Studio Trio," after which Bob Lawrence very ably led the community singing. Two very pleasing vocal selections were sung by Miss Janet McIlvena followed by two violin solos by Mr. Allan Murray, both artists being accompanied at the piano by Mr. Ralph Johnson.

The feature of the evening was the showing of two moving pictures, "Fire Fighters of the Skies" and "The Arctic Patrol." The projector was operated through the courtesy of Mr. Cyril Watson, the thanks of the Branch being tendered him by Mr. Haimes.

Following the pictures, those present repaired to the mezzanine floor in the Marquis where they became the guests of Mr. and Mrs. J. Haimes. Bridge was played until midnight when coffee and sandwiches were served.

## London Branch

*W. R. Smith, A.M.E.I.C., Secretary-Treasurer.*
*Jno. R. Rostron, A.M.E.I.C., Branch News Editor.*

A special dinner meeting was held on November 8th, 1933, in the Hotel London at which the speaker was the president of The Institute, O. O. Lefebvre, D.SC., M.E.I.C.

Some eighteen members were present to welcome the president and the meeting was presided over by the chairman of the Branch, V. A. McKillop, A.M.E.I.C.

Mr. McKillop, in introducing the speaker, said that he had already visited twenty of the twenty-five Branches throughout Canada and his object in so doing was to personally acquaint the members with what was happening to the profession, and consequently The Institute.

Mr. Lefebvre explained how the depression had affected financial standing of members of the engineering profession at large with the result that the revenue of The Institute was very much reduced.

Expenses had been very much curtailed. For example in the administrative costs the salaries of the staff were reduced 19 per cent last year and 5 per cent on top of that this year, although their work had increased. Services and publications had been limited, notably the Year Book and Transactions.

Reference was made to the desirability of obtaining uniform legislation throughout the provinces and to one fee covering admission to the Provincial Associations and The Engineering Institute.

As the speaker has visited and will visit all the Branches, it is not necessary to give a full resume of his talk, but suffice to say the difficulties under which The Institute was labouring were fully realized and a lengthy discussion took place on this and upon the standing of both The Institute and the Association.

The dinner was enlivened by musical selections by Mr. Archie McCulloch at the piano. The president's visit was much appreciated and he was accorded a warm welcome.

### The Engineering Profession

The regular November meeting was held in the board room of the Public Utilities Commission on Wednesday, November 29th, 1933, the chairman of the Branch, V. A. McKillop, A.M.E.I.C., presiding.

The speaker was A. B. Lamb, A.M.E.I.C., of Ottawa, president of the Association of Professional Engineers of Ontario.

Mr. Lamb opened his talk by a description of the meetings of the Ottawa Branch and went on to compare the lack of prominence of the engineering profession with those of law, medicine and theology.

The engineers did not appear in the public eye as a professional body as much as they should and the speaker advanced reasons for this. The remedy was organization, which he averred was slowly but surely progressing. He reviewed the present organization beginning with the British North America Act and subsequently the formation of the Canadian Society of Civil Engineers (now The Engineering Institute of Canada) and the Provincial Associations of Professional Engineers. He reviewed the legislation of these Associations of which eight out of the nine are protected by Acts of Provincial Parliaments, some strong and one notably weak, that of Ontario. He pointed out some of the weak spots in the latter and voiced the disappointment which was felt at the failure of the attempt in 1931-32 to get a revised Statute through the House. However, committees had been working ever since to iron out the difficult problems and before long a new Bill would be drafted which, it was thought, would sufficiently satisfy the objectors, chiefly chemical and mining.

An interesting discussion took place, after the speaker's remarks, concerning legislation, the status of the engineer, etc. The whole field of engineering was reviewed and it was felt that progress was being made in restricting the activities of unqualified practitioners. Colonel I. Leonard, M.E.I.C., past-president of the Association of Professional Engineers of Ontario, was present and gave a short resume of the policy of the Association with regard to legislation. Referring to loss of professional interest of the engineer he remarked that 80 per cent of the mining, mechanical and electrical engineering graduates in the United States joined large firms and worked up to business managers and executive positions, leaving only 20 per cent on the technical or engineering end.

E. V. Buchanan, M.E.I.C., pointed out that many engineers holding government and municipal positions were more or less debarred from taking part in public life.

A vote of thanks to the speaker was proposed by E. V. Buchanan, M.E.I.C., and seconded by J. A. Vance, A.M.E.I.C.

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# FORTY-EIGHTH ANNUAL MEETING

## Windsor Hotel, Montreal
## February 8th and 9th, 1934

*Courtesy Canadian Pacific Railway Company.*

**Dominion Square, Montreal.**

## Annual General Meeting
## Annual Dinner
## Reception and Dance
## Technical Sessions

**Programme of Meeting Appears on Page 27**

## Moncton Branch

*V. C. Blackett, A.M.E.I.C., Secretary-Treasurer.*

The regular monthly meeting was held in the City Hall on December 12th. Professor H. W. McKiel, M.E.I.C., chairman of the Branch, presided. A very interesting paper on the field control of concrete in the construction of the new pier and quay wall at West Saint John was read by J. Harold McKinney, A.M.E.I.C., assistant engineer, Saint John Harbour Commission. During the discussion that followed, F. O. Condon, M.E.I.C., expressed the opinion that a central mixing plant would have been more economical than several scattered units. The mix would be more uniform and fewer inspectors required. Mr. McKinney admitted the contention but stated that the matter had been left to the discretion of the contractors. C. S. G. Rogers, A.M.E.I.C., asked if there had been any difficulty in bonding the 18-inch facing of No. 1 concrete to the inner No. 2 concrete, and if any cracks had developed. The reply was in the negative. H. J. Crudge, A.M.E.I.C., enquired as to the time of mixing. Mr. McMcKinney stated that one and one-half minutes had been insisted upon and added that tests had shown that a longer time would have resulted in greater strength. A vote of thanks was extended the speaker on motion of F. O. Condon, M.E.I.C., seconded by E. R. Evans, A.M.E.I.C.

## Ottawa Branch

*F. C. C. Lynch, A.M.E.I.C., Secretary-Treasurer.*

How a fully developed town came into being in the wilderness connected only with the older settled parts of the country by a single line of railway, but with all the usual amenities of present day urban development, was described at an evening meeting of the local Branch on Thursday, October 26th, 1933. A. K. Grimmer, M.E.I.C., manager of the Town Department, Temiskaming, Quebec, was the speaker, his subject covering the "Development and Operation of Temiskaming as a Company-Owned Industrial Town." Group Captain E. W. Stedman, M.E.I.C., chairman of the Branch, presided.

### Development and Operation of Temiskaming

The speaker traced the course of the town from the time of the selection of the site less than sixteen years ago down to the present day.

The part played in reaching this objective by the application of the principles of town planning and of engineering and through intensive study of processes and elaborate research was aptly brought out by the speaker. The site selected was tributary to large areas of pulpwood which could be water-borne to the plant, and was also well located for obtaining water supplies and ample power cheaply developed from the Kipawa Lake area.

In the design and layout of the town itself, which was to furnish places of residence for the company employees, a model industrial community was aimed at, one which would attract and hold the best class of labour.

The controlling considerations in the selection of the townsite, after the industrial plant had been provided for, were briefly: geological structure, topographical conformation, proximity to potable water supply, exposure to sun and prevailing wind, proximity to plant, available building material, and natural beauty.

A decision was reached to meet the varying needs of the population by a general classification of the residences into officials', mechanics', helpers', and labour houses. Up to the present, however, no officials' type of houses have been built, officials meantime occupying other types. The general plan adopted for mechanics' houses was a six-roomed building with three bed rooms, bath, living room, dining room and kitchen, each having an approximate ground floor area of 625 square feet. Mechanics' helpers were similar, but with ground floor area kept down to 500 to 550 square feet. In the labour type the ground floor area was tentatively fixed at 450 to 500 square feet but in this classification more variation in type has been necessary on account of the variable sizes of families and the modern conveniences expected by the tenant.

The houses have practically every convenience expected in even large cities—the population varies from 2,200 to 3,200 persons.

School accommodation, allocation for churches, with one already built, a hospital, a motion picture hall, an athletic field, ski-jump, tennis courts, dressing rooms and equipment for a large out-door hockey rink, a concrete-lined wading pool for children, a nine-hole golf course, motor boat landing and a diving stage are just a few of the features of this interesting town. The planting of trees, shrubs and vines, competitions to foster the improvement of home surroundings, the construction by the town itself of an extensive rock garden and other measures have tended to transform the locality to one of beauty and interest to the citizen.

The address was accompanied by lantern slides and followed by a motion picture illustrative of the subject, after which the meeting was opened to discussion, in which a number of the members took part.

### International Highway, Mexico City-Laredo

The local Branch at their noon luncheon at the Chateau Laurier on November 2nd, 1933, had the pleasure of listening to an address by F. Jaime Gaxiola, newly appointed trade commissioner from Mexico to Canada. Mr. Gaxiola, an engineer by profession, graduated from the Polytechnic College of Engineering at Oakland, California, and in 1931 was appointed as engineer of the National Commission of Highways in the Location Section of the Pan-American Highway between Mexico City and Guadalajara City. He spoke on the subject "International Highway, Mexico City-Laredo (American Border)."

Group-Captain E. W. Stedman, M.E.I.C., chairman of the Branch, presided at the luncheon, and in addition head table guests included: Augustin Munoz Cabrera, consul-general for Argentina; Luis Sotto, acting consul-general for Cuba; Honourable H. A. Stewart; J. B. Hunter; Major J. G. Parmelee; Colonel A. E. Dubuc, M.E.I.C.; Dr. R. W. Boyle, M.E.I.C.; F. C. Askwith, A.M.E.I.C.: Alan K. Hay, A.M.E.I.C.; J. A. Ewart; H. W. Cheney; J. Sears, and C. McL. Pitts, A.M.E.I.C.

Mr. Gaxiola traced the course of railway and highway development in Mexico during the past generation, emphasizing the difficulties that had to be surmounted due to the topography of the country.

On account of the rapid increase in motor traffic in 1924, the National Commission of Highways was founded, which has now evolved into the Department of National Highways. The policy of this Department is to join several regions of the republic to the several existing railroad lines.

In 1926, a year and a half after the establishment of the department, the first modern highway was inaugurated joining the important city of Puebla (the capital city of the State of Puebla) with Mexico City. Since that time many other highways have been opened up. Some of these reach altitudes of 10,000 feet above sea level in their course across the country.

The Pan-American highway that will join Mexico and the United States on the western section is at present under construction and should be completed in the near future. Details of the location and the construction of this road were given by the speaker including the following items: length 770 miles, of which two-thirds are paved and the other third to be finished by the middle of next year; width of completed road, 30 feet: fenced on both sides as a protection for cattle; construction started from both ends; longest bridge, 1,500 feet long built of reinforced concrete; work done by contract; average cost $1,300 per mile. Further, the maximum allowable grade was 6 per cent for very short lengths and 5 per cent for longer stretches, the maximum curve allowed was 28 degrees with tangents of at least 100 metres between curves, no reverse curves being allowed. The highway is to form part of a Pan-American system which will ultimately connect with Argentina.

After the address a few minutes were devoted to discussion.

### The Treasury and Public Works Expenditure

Watson Sellar, Comptroller of the Treasury, addressed the noon luncheon on Thursday, November 16th, 1933, upon the subject of "The Treasury and Public Works Expenditure." Mr. Sellar has had extensive experience in the Federal Department of Finance. In 1930 he was appointed Assistant Deputy Minister of that Department and in 1932 was named to the newly created post of Comptroller of the Treasury.

Group-Captain E. W. Stedman, M.E.I.C., chairman of the local Branch, presided at the luncheon, and in addition head table guests were: Hon. E. N. Rhodes, W. C. Clark, Maj.-Gen. A. G. L. McNaughton, M.E.I.C., Capt. F. Anderson, M.E.I.C., W. T. Lucas, M.P., J. H. Campbell, C. H. Payne, B. J. Roberts, J. B. Harkin, L. L. Bolton, M.E.I.C., Noel J. Ogilvie, M.E.I.C., and E. Viens, M.E.I.C.

The address dealt with the procedure followed in government expenditures in Canada in so far as the control of these expenditures was concerned under the Consolidated Revenue and Audit Act. This act was originally copied from the English statutes and in this connection the speaker traced the history of the legislation, particularly in the Old Country, which led up to it.

The Consolidated Revenue and Audit Act, affirmed the speaker, was admittedly out of date by 1931, difficult to apply and expensive to administer. A revision was made and a new act came into effect on April 1st, 1932. This act entailed a number of changes one of which was that an official, to be known as the Comptroller of the Treasury, was made responsible for all payments. This involves a supervision over 3,500,000 transactions each year.

The speaker did not claim that an ideal system had been evolved in the short space of twenty months since this change came into effect, but every effort was made toward the ideal. If the Comptroller makes a payment when it is prohibited by law or Executive direction he assumes the responsibility, but if the transaction is permissible by law but objectionable on the ground of cost, waste or inefficiency, the originating Department must shoulder the blame.

On account of the variety of the work the accounting system must be simple yet comprehensive. While the speaker admitted the procedure is still more or less experimental he expressed the belief that the only way to build a sound control is to pivot the record on one document. Generally this is the contract order.

The Comptroller's office also, it may be expressed, act as "scouts" on behalf of the Minister of Finance who is responsible for the public credit. In performing this service this office must perforce delve into transactions which departments think is their own business.

The speaker then referred to the material diminution in works programmes which has been brought about during the past few years. This has coincided with a changed view point of the public towards public works. "There still are, of course," Mr. Sellar said, "those who dub all such undertakings as 'patronage.' To them, cost to construct, or financial return to the government are of no concern. The greater number of people, however, note that the tendency is to encourage public bodies to undertake activities which, not so long ago, were within the exclusive sphere of private enterprise. We feel that, when the public invades the field of commerce, we must, at least in part, accept the rules of commerce. The more important is that the undertaking should carry its own load, and not add it to the back of the general taxpayer."

At the present time there is a tendency on the part of civil servants to urge that works should be carried out either because they will provide employment or because the cost is less than it would have been a few years ago. The speaker was not impressed by such arguments, declaring that the need for the work should be the first consideration.

Elements of Town Planning

"Congestion is the cancer of modern life and development," stated Noulan Cauchon, A.M.E.I.C., in a noon luncheon address on November 30th, 1933, before the Ottawa Branch of The Engineering Institute at the Chateau Laurier. Mr. Cauchon was speaking upon the subject—"Elements of Town Planning."

Group Captain E. W. Stedman, M.E.I.C., chairman of the local Branch, presided, and in addition head table guests included: Hon. H. A. Stewart, Hon. A. Duranleau, C. A. Magrath, M.E.I.C., Professor F. E. Lloyd, Tom Moore, John M. Kitchen, F. L. Poulin, G. J. Desbarats, M.E.I.C., H. L. Seymour, Alan K. Hay, A.M.E.I.C., C. D. Wight, A.M.E.I.C., C. McL. Pitts, A.M.E.I.C., Caleb Medcalf, and Wing-Commander W. R. Kenny, A.M.E.I.C.

Mr. Cauchon in his address traced the development of town planning principles from the spectacular work of rulers of bygone days who wished to glorify their land, and, incidentally, themselves, down to the present day. Modern town planning, particularly British planning, he characterized as "The technique of social science of providing conditions of human welfare, resting upon biological requirements for the maintenance and enhancement of human life." Into this science there is focused the sciences of engineering and architecture, methods of efficiency and, in fact, the whole range of human knowledge in so far as it relates to the production and maintenance of well being and amenity.

Mr. Cauchon dealt with the question of movement of population along highways, differentiating between the requirements for their width, their length, and, also, their height. This latter dimension he explained relates to the height of buildings fronting upon such highways with the consequent inward and outward flow of human population and goods. To these three dimensions—the first one fixed, the second and third ones variable and cumulative—Mr. Cauchon added a fourth dimension, which is time.

Time combined with space which he translated as speed is also a variable and cumulative quantity limited only by certain mechanical and psychological considerations.

The speaker characterized the traffic problem as one in dynamics, the play of forces considered free from volition, and stated that the present usual checkerboard plan of sub-division with its cross intersections is a continuous example of interference and shock of forces. This plan was specifically denounced by Sir Raymond Unwin, the great British authority on town planning, in all his recent addresses in Montreal and Toronto. It has been worked out, for instance, that there are sixteen minimum collision points at a cross intersection. As a remedy to this situation, Mr. Cauchon brought forward his plan whereby streets would intersect each other in three way junctions at angles of 120 degrees. He maintained that the latter method of planning permits approximately three times the speed and gives five times the safety of traffic which moves through the present generally accepted checkerboard layout which is also choked by peak loads.

A further development of the three way junction idea was the addition of the principle of "Interceptor" which is a through traffic route permitting access and exit only at certain long intervals and affording continuous high speed. He showed that this principle is analogous to that of the storm sewer, the intercepting sewer, and the intercepting water main. At this point Mr. Cauchon made extended references to traffic conditions in Ottawa, explaining how the application of this principle would relieve local congestion and bring about badly needed improvements in and around the city.

The speaker devoted a short time to the development of the idea of art in town planning. He considered that art should not be understood merely as a decorative thing, but as an expression in the works and actions of every day life.

## Peterborough Branch

*H. R. Sills, Jr.E.I.C., Secretary.*
*W. T. Fanjoy, Jr.E.I.C., Branch News Editor.*

Annual Meeting November 28th

The note of optimism struck by J. E. Hammel, internationally-known mining man, was one of the outstanding features of the annual dinner of the Peterborough Branch, held at the Empress hotel Tuesday evening, November 28th, 1933.

Known in mining circles from Newfoundland to the Yukon and from the Arctic Circle to away south of the international boundary, Mr. Hammel declared that he thought the north country was going to be the making of Canada and did not see any reason why Canada with all her mineral wealth should be feeling the depression.

One of the most fascinating and romantic characters that has appeared locally for some time, Mr. Hammel, was introduced to the gathering by Lieut.-Colonel C. H. Ackerman as a man whose only satisfaction in life was to make some worthy contribution to the people of Canada.

The dinner at which V. R. Foster, A.M.E.I.C., chairman of the Branch, presided in the capacity of toast master, was outstanding not alone for the delightfully informal and extremely individualistic talk with which Mr. Hammel delighted the gathering but also by reason of the fact that Dr. Oliver O. Lefebvre, M.E.I.C., president of The Institute, was present with an inspiring message for the members of the Branch.

As a complimentary gesture to Dr. Lefebvre, Andrew H. DuChene of the local staff of the Canadian General Electric Company tendered a message of welcome to the guest in French.

Mr. DuChene stated that as the only French-Canadian member of the Peterborough Branch he had been commissioned to convey to Dr. Lefebvre in French the welcome of the Branch. As far as matter was concerned he could add little to that which had been so ably expressed by the chairman, but his purpose was to convey the gratitude of the Branch for the honour the President had done them in coming to address them at their annual dinner.

Dr. Lefebvre appeared delighted at the warmth of the welcome accorded him, and during the course of the evening replied to the message extended by his compatriot in French.

A. B. Gates, A.M.E.I.C., in proposing a toast to The Institute and its Branches referred to the cohesion of the various branches of The Institute and the force which held them together across a far-flung country.

The toast was responded to by the president, Dr. Lefebvre, and also by A. H. Harkness, M.E.I.C., vice-president of The Institute, and R. J. Durley, M.E.I.C., secretary of The Institute.

Upon assuming office, Dr. Lefebvre stated, he had set out with the purpose of paying a personal visit to each of the branches of The Institute in Canada. "This Branch," he said, "is the twenty-third I have visited."

The Institute, the speaker declared, was in good health notwithstanding the fact that it had felt the depression in the last few years. There was no profession, he believed, so intimately connected with human activity as the engineering profession. The engineer was active in every line of human endeavour, and as human activity decreased the engineer was the one who was the first to experience the reaction. As a result, he stated, many members of the profession had seen their incomes greatly reduced, while others had seen their incomes completely dissipated through unemployment.

The Institute had suffered in depleted revenues, and it had been found necesshry to reduce expenditures in several directions. While retrenchments had been made, Dr. Lefebvre emphatically declared that no effort would be spared to keep up the high standard of The Engineering Journal, nor to decrease the service which The Journal was rendering to members of the profession.

Speaking of the engineering profession as being in the forefront of public opinion, the speaker remarked that everyone recognizes the part the engineer plays in the development of the country. It had been stated however, he added, that engineers were responsible for over-production and over-development along certain lines. That was not so. The engineer had merely been called upon to draw up plans to produce certain results, and he had done his work well. Had the opinion of the engineer been referred to, Dr. Lefebvre was of the opinion that in many cases the engineer would have advised against certain things.

Dr. Lefebvre referred to the difficulty that was being experienced by young men who were graduating from the universities at the present time with engineering degrees, and with no outlet for their ambitions. These young men, he said, were finding it impossible to get jobs and were being driven into the ranks of the unemployed. He appealed to the older members of the profession to show sympathy to those unfortunate young men and to encourage them, and to instil into them the hope of better days ahead.

Dr. Lefebvre, who was the guest of Ross L. Dobbin, M.E.I.C., councillor of the Branch, during his brief stay in the city, was presented by Mr. Dobbin with an alarm clock, through the courtesy of J. H. Vernor, manager of the Western Clock Company. Earlier in the day Mr. Lefebvre had paid a visit to the Westclox plant.

Addressing his listeners in a free and easy, informal manner, Mr. Hammel regaled them with stories of the trail and the mining camps.

"Mines are not found, they are made," he said. "There is nothing to this mining game but horse sense, commonsense and guts—mostly guts."

Mr. Hammel paid tribute to the work of the engineer in the development of the North country, and spoke of the constructive help that was given to the mining men by the Provincial and Federal Ministers of Mines.

Offering encouragement to the youth of to-day, Mr. Hammel stated, "The main thing is to keep going, don't be afraid of not getting jobs. All you need is lots of pep and punch." That he said was advice he gave to a group of senior students at the University of Toronto in an address before them recently. It was the younger men the country had to depend on, the speaker thought, and he believed that all kinds of opportunities presented themselves in the northlands for men of resourcefulness and nerve, and that the north country was going to be the making of Canada.

## Quebec Branch

*Jules Joyal, A.M.E.I.C., Secretary Treasurer.*

Lundi le 4 décembre 1933, à 11 heures a.m., les membres de la section de Québec de l'Institut des Ingénieurs du Canada et quelques-uns de leurs amis ont eu le plaisir d'assister à une démonstration de quelques-unes des nombreuses applications pratiques de l'invention moderne qu'on appelle "Œil Électrique."

Cette démonstration eut lieu au Manège Militaire de Québec où le club Kiwanis local avait organisé une Kermesse au profit des enfants pauvres et l'Œil Électrique y était sans aucun doute la principale attraction.

Cette réunion fut tenue par suite d'une gracieuse invitation faite à notre président, Hector Cimon, M.E.I.C., par Monsieur A. D. Masson, gérant de la Canadian Electronics Limited, Montréal, qui était en charge de cette attraction.

Tous ceux qui ont pu répondre à cette invitation, une soixantaine environ, furent simplement émerveillés en face des possibilités de ce nouveau produit du génie humain.

Monsieur Masson fut le premier à nous adresser la parole et après nous avoir remercié d'avoir répondu en aussi grand nombre à son invitation, il nous cita une foule de cas où cet œil électrique peut être appliqué et nous en expliqua le fonctionnement; pour ne mentionner que quelques cas, cette invention peut être utilisée pour enregistrer le nombre de personnes entrant dans une salle, faire la sélection pour l'emballage des marchandises, protéger le caissier d'une banque contre toute attaque par des bandits, protéger la propriété contre les voleurs, ouvrir ou fermer les portes, etc., etc., l'œil électrique au moyen d'un relais met en mouvement le mécanisme approprié aux opérations qu'on lui destine.

Un autre représentant de Canadian Electronics Limited, Monsieur Ouimet, nous donna ensuite certains détails techniques au sujet de cet œil électrique qui peut se comparer à l'œil humain et lui est même supérieur à certains points de vue, par exemple il est beaucoup plus rapide et ne se fatigue pas.

Un Kiwanien de Québec, Monsieur Lucien Brousseau, nous donna ensuite la démonstration pratique en faisant fonctionner les divers appareils installés et nous invita à faire de la publicité au cours de la journée pour que tous ceux qui ne s'étaient pas encore rendus au Manège ne manquent pas d'aller admirer cette nouvelle découverte présentée pour la première fois au public de Québec et que nous n'aurons peut-être pas l'occasion de revoir prochainement.

Notre président, Monsieur Cimon, se fit l'interprète de l'assistance pour remercier Monsieur Masson de son beau geste envers les ingénieurs de Québec et avant de quitter la salle tous purent examiner à loisir les divers mécanismes qui avaient servi à cette démonstration.

## Saint John Branch

*Sidney Hogg, A.M.E.I.C., Secretary-Treasurer.*
*C. Gordon Clark, S.E.I.C., Branch News Editor.*

### Visit to H.M.S. Norfolk

During the summer about forty members of the Saint John Branch of The Institute paid an informal visit to H.M.S. Norfolk, a 10,000-ton treaty-class cruiser, the flagship of the West Indies squadron that came to Saint John to use the dry dock facilities there. The officers of the engine-room staff conducted parties to points of interest about the ship and afterwards entertained in the ward room.

### President's Visit

On Monday, October 23rd, 1933, at 7.30 o'clock p.m., the Saint John Branch held its first meeting of the season in the form of a dinner to meet Dr. O. O. Lefebvre, M.E.I.C., the president of The Institute. There were about forty members present, including several from outside Branches.

After toasts to the King and The Institute, G. A. Vandervoort, A.M.E.I.C., chairman of the Branch, introduced Dr. Lefebvre. In his address Dr. Lefebvre emphasized two points: the membership of The Institute and its relations with the provincial professional associations. Pointing out that membership has decreased, the speaker showed where necessary economies in the operation of The Institute were to be made. The Journal, however, must be retained and improved where possible. The Saint John Branch was cited as a Branch whose membership had continued to increase. A brief description was given of the growth of the professional associations and their relation to The Institute. Fuller co-operation was asked for, and the architects cited as an example of how effective this could be. The President in conclusion spoke of the apparent indifference of members to ballots sent out on various questions.

## Saskatchewan Branch

*S. Young, A.M.E.I.C., Secretary-Treasurer.*

The regular monthly meeting of the Branch was held in the Hotel Champlain, Regina, on Friday evening, November 24th, 1933, P. C. Perry, A.M.E.I.C., occupying the chair.

After disposing of several matters of business, the chairman called on J. N. DeStein, M.E.I.C., for a short address on the reproduction of plans.

### The Reproduction of Plans

After pointing out the necessity in certain cases for the making of plans in duplicate, triplicate, quadruplicate, etc., Mr. DeStein stated that, having the original plan, reproductions can now be made directly on sensitized linen or paper. The process was invented about twenty years ago and, though at first not entirely satisfactory due to the tendency of the linen or paper to deteriorate, the process has now reached a stage where plan reproductions can be made at considerable saving in cost.

The meeting then proceeded to the main topic of interest by the chairman introducing L. A. Thornton, M.E.I.C., whose subject was "Proposed Power Developments on the Saskatchewan River." In introducing the speaker, Mr. Perry recalled the fact that Mr. Thornton had been the first chairman of the Saskatchewan Branch of The Institute.

### Proposed Power Developments on the Saskatchewan River

In introducing his subject, Mr. Thornton drew attention to the fact that there is at the present time no immediate proposal to develop power on the Saskatchewan river, but that for the purpose of his address he would discuss one or two proposals which had been made during the last three or four years.

Dominion statistics show that Saskatchewan has the lowest water power development in Canada, there being only one such development, namely, that recently constructed on the Churchill river for the supply of power to the Flin Flon and Sherritt Gordon mines. The chief reason why hydro development had not been seriously considered was that potential sites of hydro power were situated a considerable distance from the load centres, and that the sites in question did not possess the same obvious natural advantages as were attached to water power sites in other parts of the Dominion. The Saskatchewan river was the only available source within reasonable reach of the population. It was classed as a navigable stream and there were no locations where a natural head of water could be developed.

The flow in this river had been recorded by the Dominion Water Powers Branch for many years and indicated the low minimum flow in the winter season of less than 4,000 cubic feet per second; that for 30 per cent of the year the flow would be less than 6,000 cubic feet per second; for 50 per cent of the year less than 14,000 cubic feet per second; and for the balance of the year ranging from 14,000 to 50,000 cubic feet per second. The river for all practical purposes might be taken to be entirely lacking in natural storage facilities and the only available storage would be the pondage which would be created by the erection of a dam at the power site, the use of which would be effective to some adjustment of hourly variations in load, but would be of little use for longer periods of regulation.

He referred to the report of Sullivan, Kipp and Chace, consulting engineers, made to the Power Resources Commission of Saskatchewan in 1928, in which the engineers discussed a site immediately below the forks of the north and south branches of the river. They adopted a dam height of 50 feet, not only because the river banks at that location were comparatively low and limited the height, but because the river bottom provided only a clay foundation, a condition which raised in their mind the doubt as to the practicability of providing a higher head. They estimated a maximum development of 50,000 h.p., which would be limited in output in the low flow months of the winter to 12,000 h.p., which latter fact would necessitate the continuous operation of steam plants during the winter, and their conclusion was that until such time as the load of the province during the seven summer months would absorb large quantities of power which could be developed at the site discussed, and very much in excess of the present day demand, consideration of such development should be deferred.

H. G. Acres and Company had been employed by the Saskatchewan Power Commission to make further investigation and report, and had reported in 1931 upon a site at Fort a la Corne, where the formation of the river made a dam of 125 feet in height possible, which with the minimum flows reported would promise a continuous supply throughout the year of 42,000 h.p. Foundation conditions were described as favourable. The Acres report recommended an ultimate development of 125,000 h.p., and it claimed that the economics of the situation warranted the project; that present steam costs and ultimate steam costs could be bettered by the cost of the hydro development. The total ultimate cost of the project, including transmission lines to the cities of Prince Albert, Saskatoon, Moose Jaw and Regina, would be $19,000,000, and the immediate cost about $15,000,000.

On account of the situation in the province as regards hydro possibilities, briefly referred to at the beginning of the address, the main interest in power development for many years has been in the erection of steam plants. The steam plants had reached a stage of high efficiency, possibly higher than in any other part of the Dominion when all factors were considered. These plants were still in first-rate condition and the investment must be carried, and, therefore, any hydro development, to compete must be in a position to deliver the power to the centres of load at distribution voltage at a cost comparable with the operating costs of the steam plants, exclusive of the investment costs, and it had been urged that, with the changed conditions of finance, for the present at least, the steam operating costs would be lower than possible costs of a present hydro development, as suggested by the Acres report.

The speaker discussed at some length the method adopted by the reports in question in reaching an estimate of the future loads available when the development was proceeded with. He pointed out that in the first place the principal interest in hydro development lay in the provision for future loads of much larger dimension than present day loads; that under normal conditions a healthy growth in the load might confidently be expected and must be provided for, either in this way or further extension of steam plants; that at the present time, however, the steam plants were adequate to supply all the present load and for some little time to come; and that at the present time also there was no growth in the load, and that until there was some promise of a return to normal conditions experience did not warrant reaching a definite conclusion as to the immediate future.

In the discussion following Mr. Thornton's address, those taking part were E. W. Bull, H. S. Carpenter, M.E.I.C., Arthur Townsend, E. H. Roberts, P. R. Genders, A.M.E.I.C., D. A. R. McCannel, M.E.I.C., L. W. Llewellyn, Jr.E.I.C., S. R. Muirhead, A.M.E.I.C., A. B. Coward and J. N. deStein.

A hearty vote of thanks moved by D. A. R. McCannell, seconded by J. McD. Patton, A.M.E.I.C., was voted to both speakers.

## Toronto Branch

*W. S. Wilson, A.M.E.I.C., Secretary-Treasurer.*
*O. Holden, A.M.E.I.C., Branch News Editor.*

On November 16th, 1933, a well-attended dinner meeting was held by the Toronto Branch at the Royal York hotel. The guest of honour was O. Lefebvre, D.Sc., M.E.I.C., President of The Engineering Institute of Canada. Dr. Lefebvre was introduced by the chairman, Archie B. Crealock, A.M.E.I.C.

Following his introductory remarks, Dr. Lefebvre referred to the financial problems of The Institute. He pointed out that The Institute had effected economies in a number of directions, including reductions in the salaries of the staff. These he felt, however, had been cut to the lowest possible level to which they could in justice be brought. Expenses for such items as the transactions and membership list were dealt with. The transactions, Dr. Lefebvre felt, were unnecessary, particularly at the present time, in view of the fact that all papers meriting publication were published in The Journal.

Dr. Lefebvre referred to the recent three-day Plenary Meeting of Council, indicating its importance, and pointing out that without the generous contribution of the branches from their own funds toward the expenses it is doubtful if it would have been possible to hold such a meeting.

The relationship of The Institute to the provincial associations of professional engineers was dealt with. There was, he felt, no need for friction or overlapping of the interests of these associations with those of The Institute, their aims and objects being entirely separate. The Institute had fostered the provincial associations with the object that these associations might fulfil a function which, by virtue of The Institute charter and the British North America Act, were beyond the scope of the parent body.

All members of The Institute were exhorted to encourage the younger members of the profession to become members and to take an active part in Institute affairs. He pointed out, however, that no matter how desirous we may be to increase the membership, this should not be done by lowering the standards of entrance. Dr. Lefebvre's address was rendered particularly entertaining by the ready wit and good humour of the speaker.

Eric P. Muntz, M.E.I.C., spoke briefly on behalf of the Hamilton Branch of The Institute.

A. H. Harkness, M.E.I.C., moved a vote of thanks, to which a hearty response was made by all present.

## Winnipeg Branch

*E. W. M. James, A.M.E.I.C., Secretary-Treasurer.*
*E. V. Caton, M.E.I.C., Branch News Editor.*

At the local Branch meeting of The Institute held on Thursday, November 2nd, 1933, Professor J. N. Finlayson, M.E.I.C., gave a very interesting paper on the "St. Lawrence Waterway Project."

### St. Lawrence Waterway Project

Professor Finlayson defined the St. Lawrence waterway project as a scheme to connect the oceans of the world with the Great Lakes of North America by means of a ship canal of a depth sufficient to allow of the unrestricted passage of vessels drawing 27 feet of water, and thus create a North American Mediterranean which will be to this continent everything that that inland sea is to Europe, Asia, and Africa. It also includes the simultaneous development of five million horse power of hydro-electric power, four-fifths of which will belong to Canada and one-fifth to the United States.

The most powerful support for the project comes from the United States located on or near to the St. Lawrence watershed between the Appalachian and the Rocky Mountains. Sixteen of these states including Montana in the west and Kansas in the south organized the Great Lakes-St. Lawrence Tidewater Association, which has issued a vast amount of literature favourable to the project. These states contain forty-five millions of people, about 40 per cent of the population of the Union, and produce 75 per cent of the wheat, 65 per cent of the corn, 100 per cent of the flax, 85 per cent of the iron, 3 per cent of the copper, 74 per cent of the zinc and 46 per cent of the lead in the United States.

The province of Quebec and a portion of New York state are opposed to the scheme. The strongest case against the proposed waterway is made by The Institute of Economics of the Brookings Institute, Washington, D.C. In 1929, the Institute published a work, edited by Doctor Harold G. Moulton, and containing articles by Doctor D. A. MacGibbon, formerly Professor of Economics at the University of Alberta, now a member of the Grain Commission of Canada, residing in Winnipeg. These authors have pointed out that Canada's interest in the proposed waterway is in many respects different from that of the United States. In the latter country, the principal arguments advanced in favour of the scheme are that it is necessary for the purpose of relieving railway congestion, that it will reduce transportation costs, and that it will lead to the development of vast water power resources. The Canadian transportation situation is, however, that there is no congestion of traffic; instead the existing transportation agencies do not have sufficient volume of traffic. The need is for additional tonnage for the railways rather than for the relief or any congestion present or potential. The Canadian public, through its various governments, has already invested in Canadian railways nearly a billion dollars in the form of subsidies, loans, lands and guarantees. Thus for the Canadian government to incur enormous expenditures for the construction of a waterway, designed to divert some of the traffic from the existing railways, including those that are owned and operated by the government itself, is unsound national policy.

Many boards, committees and commissions have reported on methods of obtaining the necessary improvements on the river. The International Joint Committee, a body created by the Boundary Waters Treaty of 1909, made a thorough examination of the project. Its report, often referred to as the Wooten-Bowden Report, was filed on December 19th, 1921. It found that the physical conditions of the St. Lawrence are favourable for improvements for navigation, which will be permanent and will have low upkeep costs, but that the simultaneous development of power is not a sound economic procedure, as the market to take the output is not in existence and cannot be expected to spring into being at once. Alternate plans for improving navigation and developing part of the power in the international rapids section were presented. In the spring of 1924, the Joint Engineering Board was appointed, composed of three Canadian and three United States engineers. Its report was published in November, 1926. It recommended the deep waterway for navigation purposes and presented plans for power houses with an ultimate installed capacity of about 2,700,000 horse power. The engineers differed on the question of power development of the international section of the river. The United States members favoured a single stage development with one dam at the foot of Barnhart Island near Cornwall. The Canadian members recommended a two stage development with dams at Ogden Island near Morrisburg and at Long Sault Island near Cornwall. The former plan called for a dam 75 feet in height which would be the means of flooding over 29,000 acres of land and several villages. The latter scheme would have one dam over 50 feet high near Cornwall and another 27 feet high near Morrisburg. There would be less flooding of land, not more than 6,000 acres. Another scheme (Scheme C) has been favoured by the Hydro-Electric Commission of Ontario. The upper dam would be erected at Crysler Island below Ogden Island. Nearly one million horse power would be obtainable two or three years sooner than by either Scheme A or Scheme B.

As regards costs, these have been carefully considered by the engineers who have reported on the project. Mr. Lesslie R. Thomson, M.E.I.C., a consulting engineer, residing in Montreal, prepared a paper for The Engineering Institute of Canada on the subject, in which he tabulated and analyzed the cost of the project. If the navigation enterprise alone is considered, the estimated cost is about $355,000,000, which sum includes the cost of the new Welland canal, $120,000,000, and that of deepening the channels between the upper lakes and of a new lock at Sault Ste. Marie, $60,000,000. If a power enterprise should be considered by itself, the cost of developing five million horse power will be $545,000,000. If a combined navigation and power development is undertaken the total cost would be $840,000,000, constituting a saving of $60,000,000. These figures do not include interest charges during construction and thus the ultimate cost may be said to be a billion dollars.

There has been much speculation as to the equitable division of costs between the two nations concerned. If Canada were to offer to pay for all the work to be done on her side of the international boundary line, her share would amount to nearly three-fourths of the whole, or about $700,000,000. This would place too great a burden on the Canadian taxpayer, and considering the greater advantages which the United States would derive from the enterprise, would be unfair to Canada. Any other division of the costs will require international negotiations. Many United States citizens have recorded protests against the expenditure of public money on an enterprise, or any portion of an enterprise, in a foreign country, urging the advisability of the alternate route to the sea via the Hudson. A few Canadians have questioned the sanity of a policy which allows the United States to become a paying partner in what they consider to be a purely national project. The phrase "The thin edge of the wedge" resounds throughout the country. On the other hand, many responsible representative citizens of both nations have expressed their belief in the ultimate evolution of a satisfactory basis of division of costs.

Owing to the general interest of the subject the meeting was thrown open to the public and a special invitation was given to the engineering body of the University of Manitoba to attend. An exceptionally large attendance resulted and an active and interesting discussion took place at the close of the paper.

MODERN CONSTRUCTION

A large gathering attended the local Branch meeting of The Institute on Thursday night, November 16th, 1933. The subject was "Modern Construction" and the speaker Mr. A. Stevenson, local branch manager of the Otis-Fensom Elevator Co. Ltd. To illustrate the subject two films were run showing the construction of the Empire State building and the new George Washington suspension bridge over the Hudson river.

The first film showed the process of fabricating the lower column section for the Empire State building and the erection of the steel proceeding floor by floor to the top.

Some interesting facts relative to the Empire State building were given by the speaker, such as:—

Total weight of structural steel in framework—60,000 tons.
Total weight of building—303,000 tons.
Height equivalent to 102 storeys.
Observation gallery 1,048 feet above Fifth avenue.
Tower observation gallery, accommodating fifty persons, 1,212 feet above Fifth avenue.
Building contains 67 elevators.
Total cost of building—$60,000,000.
Total revenue obtained the first year from persons visiting the observation tower $1,000,000 at $1 per person.
There were only five casualties during the construction of the building.

The next film shown was that of the construction of the George Washington suspension bridge. This structure is a highway bridge over the Hudson river and the total length of the bridge proper is one mile.

The picture showed first the construction of the anchorages, the two suspension towers and the temporary scaffolding. It then illustrated in detail the method of spinning the four suspension cables. These are 3 feet overall in diameter and each contains about 100,000 individual wires. The finished cable was closely wound with a layer of wire and then given a protective coating.

Other interesting facts relative to the construction of this bridge are:—

Total cost—$75,000,000.
Field construction plant—$1,500,000.
Scaffolding—$600,000.

At the close of the meeting an interesting discussion took place and a vote of thanks was finally tendered by J. W. Porter, M.E.I.C.

## British Standard Specifications

(ISSUED DURING SEPTEMBER AND OCTOBER, 1933)

*B.S.S. No.*

503—1933. *Creosote for Fuel in Furnaces.*
Specifies requirements for the specific gravity, viscosity, fluidity, water content, ash content and calorific value of creosote for use as a fuel in oil burning installations. Detailed appendices are included in which the methods of carrying out the various tests specified are fully described.

504—1933. *Drawn Lead Traps.*
This specification secures without additional cost hygienic and efficiently designed traps for use with baths, lavatory basins, bidets, sinks, etc.

505—1933. *Road Traffic Control (Electric) Light Signals.*
Prepared at the request of the Ministry of Transport and covers the optical requirements, the signal construction, the control requirements, the controller construction and the requisite tests, and in addition the elimination of surges, radio interference and regulations governing the use of Post Office plant are also included.

506—1933. *Methyl Alcohol (Methanol).*
507—1933. *Ethyl Alcohol.*
508—1933. *Normal Butyl Alcohol (Butanol).*
509—1933. *Acetone.*
The above four specifications form the first of a series of British Standards for solvents.

510—1933. *Single-Coat Asphalt (Cold Process).*
511—1933. *Two-Coat Asphalt (Cold Process).*
The above two specifications provide for the process of asphalt road surfacing in which the use of heat is either greatly reduced or entirely eliminated. Each comprises three sections: definitions, materials, and construction and workmanship. In a series of appendices are described tests demanded by the specifications.

*Prices:—2s. 2d. each, post free.*

British Standards Institution,
Publications Dept.,
28, Victoria Street,
London, S.W. 1.

## Additional Sewage Plant Recommended for Toronto

Construction of a large new sewage disposal plant has been recommended to the city council of Toronto, Ont., in a report prepared jointly by the firm of Metcalf and Eddy, Boston, and Gore, Nasmith and Storrie of Toronto. The entire project covered by the report would cost about $26,000,000.

The report recommends that the development be laid out to take care of the sewage from the area known as the Greater Toronto Sewerage District, that a population of 877,000 in 1948 and one of 1,564,000 by 1970 be planned for, that all flows up to two and one-half times the average daily flow be conveyed to the treatment plant, that complete treatment be given to all flows up to one and one-half times the average and the surplus be treated by sedimentation only. Elimination of the existing Eastern avenue sewage-treatment plant is called for, also provision for pumping the sewage coming to that plant to a new sewage-treatment plant at the mouth of Highland creek in Scarborough township, close to Lake Ontario, from which an outfall conduit will lead into Lake Ontario. The new pumping station adjoining the site of the Eastern avenue plant is estimated to cost $859,000, an outfall sewer from the pumping station to the proposed Highland creek plant to cost $9,374,000; the plant itself $9,435,000 and the outlet conduit $760,000. Intercepting sewers within the city would cost $5,411,000 and those to serve the outlying district $3,745,000.

The treatment process would consist of preliminary sedimentation, activated-sludge treatment of the settled sewage and digestion and mechanical dewatering of the sludge. The new plant would be 11 miles east of the existing plant. Its discharge would be carried into the lake a distance of 4,480 feet for discharge through a diffusing system about 34 feet deep. It is estimated that six years would be required to build the plant and put it in shape for operation.

## Reversed Refrigeration

Reversed refrigeration, or the process of heating a house in winter by means of the same equipment that cools it in summer, is an idea which is being carefully investigated by the Canadian Westinghouse Company. In summer, air conditioning equipment absorbs heat from inside the house, pumps it to the outside and discards it.

In winter the cycle is reversed; heat is picked up from the outdoors and brought inside to warm the house, coils inside the house which formerly absorbed heat become radiators, while outside coils instead of throwing off heat, absorb warmth from the outside air. The explanation lies in the fact that the atmosphere is only relatively cold; even zero F. is some 460 degrees above absolute zero. In reversed refrigeration, no heat is generated (except mechanical losses), but is merely pumped from the tremendous outdoor reservoir to the inside of the house. An experimental installation has heated an ordinary frame house satisfactorily in winter.

Vapour from the evaporator is compressed, thereby raising its temperature. Flowing through the condenser the gas becomes a liquid, liberating heat. Reaching the expansion valve, the pressure of the liquid refrigerant is so reduced that it boils and in vapourizing makes the evaporator colder than the outside air. Heat flows from the warmer outside air to the refrigerant and the vapour is again drawn off by the compressor to repeat the cycle.

Since heat is not generated but merely transferred from outside inside the house, an efficiency of 300-500 per cent is obtained—i.e., the electric current consumed in pumping produces three to five times as much house heat as if the same electricity were directly converted into heat.

There are, however, many problems yet to be solved before reversed refrigeration equipment can be made commercially possible.

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*Canadian Hoists and Conveyors Ltd., Montreal,* have introduced a new design of conveying belt and idlers. The outstanding feature of this new system is that it employs a flat belt on the edge of which rubber curbs are vulcanized, thus doing away with the troughing formerly necessary to permit a conveyor belt to carry its load. It is claimed that breaks in the belt fabric are eliminated, and that the belt carries a larger load than a troughed belt of equal width. The improved return idlers are likewise worthy of note as they are perfectly balanced aluminum tubes fitted with anti-friction roller bearings. The "Curbelt" can be adapted to existing troughed conveyors by fitting the troughed belts with curbs and converting the troughed idlers by mounting the inclined rolls on horizontal shafts. Bulletin No. CHC-750, describing the "Curbelt" and the "Superoll" will be sent on request to the company at New Birks Building, Montreal.

*Canadian Industries Limited* announce that due to the increased use of high explosives in Canada, especially in mining circles, the price of all types has been reduced by 25 cents per hundred pounds. This reduction has been made possible as a result of a greater volume of sales in the various divisions of C-I-L since last May, an improvement which, in the case of explosives, has brought the rate of production nearer normal.

# Preliminary Notice

**of Applications for Admission and for Transfer**

December 26th, 1933

The By-laws provide that the Council of The Institute shall approve, classify and elect candidates to membership and transfer from one grade of membership to a higher.

It is also provided that there shall be issued to all corporate members a list of the new applicants for admission and for transfer, containing a concise statement of the record of each applicant and the names of his references.

In order that the Council may determine justly the eligibility of each candidate, every member is asked to read carefully the list submitted herewith and to report promptly to the Secretary any facts which may affect the classification and selection of any of the candidates. In cases where the professional career of an applicant is known to any member, such member is specially invited to make a definite recommendation as to the proper classification of the candidate.*

If to your knowledge facts exist which are derogatory to the personal reputation of any applicant, they should be promptly communicated.

**Communications relating to applicants are considered by the Council as strictly confidential.**

The Council will consider the applications herein described in February, 1934.

R. J. Durley, Secretary.

* The professional requirements are as follows—

**A Member** shall be at least thirty-five years of age, and shall have been engaged in some branch of engineering for at least twelve years, which period may include apprenticeship or pupilage in a qualified engineer's office, or a term of instruction in a school of engineering recognized by the Council. The term of twelve years may, at the discretion of the Council, be reduced to ten years in the case of a candidate for election who has graduated from a school of engineering recognized by the Council. In every case the candidate shall have held a position in which he had responsible charge for at least five years as an engineer qualified to design, direct or report on engineering projects. The occupancy of a chair as a professor in a faculty of applied science of engineering, after the candidate has attained the age of thirty years, shall be considered as responsible charge.

**An Associate Member** shall be at least twenty-seven years of age, and shall have been engaged in some branch of engineering for at least six years, which period may include apprenticeship or pupilage in a qualified engineer's office or a term of instruction in a school of engineering recognized by the Council. In every case a candidate for election shall have held a position of professional responsibility, in charge of work as principal or assistant, for at least two years. The occupancy of a chair as an assistant professor or associate professor in a faculty of applied science of engineering, after the candidate has attained the age of twenty-seven years, shall be considered as professional responsibility.

Every candidate who has not graduated from a school of engineering recognized by the Council shall be required to pass an examination before a board of examiners appointed by the Council. The candidate shall be examined on the theory and practice of engineering, with special reference to the branch of engineering in which he has been engaged, as set forth in Schedule C of the Rules and Regulations relating to Examinations for Admission. He must also pass the examinations specified in Sections 9 and 10, if not already passed, or else present evidence satisfactory to the examiners that he has attained an equivalent standard. Any or all of these examinations may be waived at the discretion of the Council if the candidate has held a position of professional responsibility for five or more years.

**A Junior** shall be at least twenty-one years of age, and shall have been engaged in some branch of engineering for at least four years. This period may be reduced to one year at the discretion of the Council if the candidate for election has graduated from a school of engineering recognized by the Council. He shall not remain in the class of Junior after he has attained the age of thirty-three years, unless in the opinion of Council special circumstances warrant the extension of this age limit.

Every candidate who has not graduated from a school of engineering recognized by the Council, or has not passed the examinations of the third year in such a course, shall be required to pass an examination in engineering science as set forth in Schedule B of the Rules and Regulations relating to Examinations for Admission. He must also pass the examinations specified in Section 10, if not already passed, or else present evidence satisfactory to the examiners that he has attained an equivalent standard.

**A Student** shall be at least seventeen years of age, and shall present a certificate of having passed an examination equivalent to the final examination of a high school, or the matriculation of an arts or science course in a school of engineering recognized by the Council.

He shall either be pursuing a course of instruction in a school of engineering recognized by the Council, in which case he shall not remain in the class of Student for more than two years after graduation; or he shall be receiving a practical training in the profession, in which case he shall pass an examination in such of the subjects set forth in Schedule A of the Rules and Regulations relating to Examinations for Admission as were not included in the high school or matriculation examination which he has already passed; he shall not remain in the class of Student after he has attained the age of twenty-seven years, unless in the opinion of Council special circumstances warrant the extension of this age limit.

**An Affiliate** shall be one who is not an engineer by profession but whose pursuits, scientific attainments or practical experience qualify him to co-operate with engineers in the advancement of professional knowledge.

**The fact that candidates give the names of certain members as reference does not necessarily mean that their applications are endorsed by such members.**

**FOR ADMISSION**

BRAUNS—OTTO L. J., of 112 Andrews St., Sault Ste Marie, Ont., Born at Halmstad, Sweden, Oct. 22nd, 1903; Educ., 1924-28, Royal Institute of Technology, Civil Engr. (Chem.), 1928; 1923-24, ap'tice, Rydo Bruks Sulphite Mill, Sweden; 1928-29, lab. asst., dept. ind. chem., McGill Univ., Montreal; 1929-31, research engr., Abitibi Power and Paper Co. Ltd., Iroquois Falls, and 1931 to date, asst. chief chemist at Sault Ste Marie Divn. in charge of routine mill control work and research projects.

References: G. H. E. Dennison, F. M. MacQuarrie, C. Stenbol, A. H. Russell, J. H. Jenkinson.

CARRIE—G. MILROY, of Montreal, Que., Born at Owen Sound, Ont., May 13th, 1892; Educ., B.A.Sc., Univ. of Toronto, 1913; 1910, surveying, 1911, motor engrg., 1912, municipal engrg.; 1913-14, res. engr. i/c constrn., Chipman & Power; 1914-21, military service, including two years as asst. advisor to the Ministry of Communications and Works; public works, irrigation, surveys, rly., telephone and telegraph, electr'l., mech'l.—Iraq, with Headquarters in Baghdad; 1921-33, gen. mgr., Scottish Canadian Magnesite Co. and Canadian Refractories Limited; at present, gen. mgr. of latter company.

References: G. G. Ommanney, J. R. Donald, W. G. M. Cam, J. McLeish, C. Camsell, J. M. R. Fairbairn.

DUNCAN—GEORGE MARR, of 443 Durban St., Victoria, B.C., Born at Ellon, Aberdeenshire, Scotland, January 3rd, 1886; Educ., Public school and night classes in technical subjects; 1900-05, ap'tice with Wm. Davidson, Arch't. and Surveyor, Ellon; 1905-07, with above firm for two more years; 1907-09, attendant in elect'l. power stations with North British Railway Co., Scotland; 1909-15, dftsman., Public Works Dept., B.C. Govt., Victoria, B.C.; 1915-19, overseas with C.E.F., 2 years as chief dftsman. with chief engr., Canadian Corps; 1919-24, dftsman., 1924-26, acting ch. dftsman., 1926-29, chief dftsman., and 1929 to date, designing engr., with Public Works Dept., B.C. Govt., Victoria, B.C.

References: P. Philip, G. P. Napier, A. L. Carruthers, H. L. Swan, O. W. Smith.

JONES—MORLEY DEE WITT, of 40 Leopold Place, New Westminster, B.C., Born at Waterdown, Ont., April 3rd, 1891; Educ., Home Study, I.C.S.; 1909-10, rodman and instr'man., 1910-11, rodman and topog'r., C.P.R.; 1911-14, instr'man. on location and constrn., Can. Nor. Pac. Rly.; 1914-15, instr'man and res. engr., on revision and constrn. of P. and G.E. Rly.; 1915-19, overseas, Com. Sgt. Major, C.E.; 1919-28, farming, logging and land clearing contracts; 1928-29, inspr. and timekpr., constrn. and drainage, C.N.R.; 1929-33, instr'man., City of Vancouver, pavement constrn., etc.

References. H. A. Dixon, C. R. Crysdale, R. Rome, W. B. Greig, F. P. V. Cowley.

LIGERTWOOD—HENRY CORMACK GRANT, of Winnipeg, Man., Born at Aberdeen, Scotland, Sept. 23rd, 1896; Educ., B.Sc. (C.E.), Univ. of Man., 1924; 1915-17, chainman and rodman, Gr. Wpg. Water Dist.; 1920-21, dftsman., C.N.R.; 1922-23, dftsman., Manitoba Power Co.; 1926-31, office engr. and asst. to chief engr., Manitoba Power Co. Ltd., and Northwestern Power Co., Winnipeg, Man.

References: J. N. Finlayson, E. V. Caton, S. E. McColl, C. H. Attwood, W. Walkden.

MIALL—EDWARD, Jr., of Petewawa, Ont., Born at Vancouver, B.C., Dec. 5th, 1909; Educ., R.M.C., 1926-30. 1931-32, fourth year, civil engrg. Univ. of Toronto. Degree withheld pending supp. exams.; 1927-28 (summers), rodman, etc., Military Survey party, Dept. National Defence; Summer 1929 and 1930-31, foreman and dftsman., Rayner Constrn. Co. Ltd.; at present, sub-foreman Unemployment Relief Project No. 40, Petewawa, Ont.

References; G. W. Rayner, L. F. Grant, E. J. C. Schmidlin, N. Malloch, J. L. H. Bogart.

MORGAN—PHILIP HAROLD, of Beauharnois, Que., Born at Ebbw Vale, Monmouthshire, England, March 15th, 1889; Educ., Ebbw Vale County Grammar School; 1906-10, articled pupil, civil and mining engrg. dept., Ebbw Vale Steel, Iron & Coal Co.; 1910-12, asst. engr. with Ebbw Vale Company, on highway and rly. location and constrn., sewer constrn. and street improvements, etc.; 1912-13, dftsman., irrigation engrg. dept., C.P.R., Calgary; 1913-14, asst. engr., irrigation engrg. dept., C.P.R., Strathmore, Alta.; 1914-19, with Imperial Army overseas. Demobilized as Capt. and Adjutant of Cavalry Regt. Nov. 1918 seconded to Royal Engrs., and employed in charge of field surveys party on main triangulation of Palestine; 1919-21, asst. engr., irrig. dept., C.P.R., Strathmore; 1921-24, res. engr., Lethbridge Nor Irrig. Dist., Lethbridge, Alta. I/c concrete constrn. on portion of system, gravity type dams, headgates, chutes and flumes; 1924 (Feb.-Dec.), res. engr., Quebec Development Co., Isle Maligne, Que., hydro-electric development; 1925 (Jan.-Aug.), res. engr., Magrath Irrig. Dist., Magrath, Alta.; 1925-27, constrn. supt., Aluminum Co. of Canada, Shipshaw, Que.; 1927 (Feb.-July), location engr., Piedmont & Northern Rld. Co., Charlotte, N.C.; 1927 (July-Dec.), asst. engr., Southern Power Company, Charlotte, N.C.; 1927-28, asst. supt., Chute-a-Caron hydro-electric development, Alcoa Power Co. Ltd., Kenogami; 1929 (Jan.-July), asst. supt., Foundation Co. of Canada, Masson, Que., constrn. of pulp and paper mill; 1929-32, constrn. supt., i/c in field of power house constrn., and Oct. 1932 to date, constrn. supt., i/c of dredging operations, Beauharnois Construction Co., Beauharnois, Que.

References: G. P. F. Boese, H. G. Cochrane, F. H. Cothran, G. N. Houston, S. G. Porter, W. S. Lee, H. B. Muckleston, J. W. Rickey, M. V. Sauer, P. M. Sauder, R. S. Stockton, J. L. E. Price, K. M. Perry, F. H. Peters, G. E. LaMothe, L. C. Charlesworth, R. A. C. Henry, F. Newell, D. C. Tennant, J. A. Knight, T. H. Hogg.

SANCTON—GEORGE EDWARD, of Montreal, Que., Born at Scranton, Pa., Feb. 1st, 1884; Educ., 1903-06, Finsbury Technical College, London, England. Passed final exams.; 1902-03, shops, Fraser & Chalmers Ltd., Erith, England; 1906-11, Allis-Chalmers Bullock, sales and Cobalt local branch manager; 1912-13, sales, Mussens, Limited; 1913 to date, general manager, Fraser & Chalmers of Canada Ltd., Montreal, in charge of entire Canadian business of General Electric Co. Ltd., of London, England.

References: F. S. B. Heward, J. V. Angus, J. T. Farmer, C. J. Desbaillets, W. S. Lea.

WILSON—WILLIAM FAIRBAIRN, of 124 Wellington Crescent, Winnipeg, Man., Born at Banff, Scotland, Sept. 10th, 1880; Educ., private tutor, St. Andrews, Scotland, and Sandhurst; 1911-12, field engr., with Doulton & Co., London, on sewer disposal and water works in Moose Jaw, Sask.; 1914-18, on active service with B.E.F. Returned to Canada in 1918 with 70% disability. Discharged as temp. Major; 1919-20, intermittent employment with Good Roads Board; 1920-22, in consltg. capacity with Morgan & Co.; 1922-23, in hospital owing to war disability; 1924 to date, with Winnipeg Electric Company as follows. 1924-27, track constrn.; 1928, design and constrn. of bus garage; 1929, subway design and constrn.; 1929-30, appraisal and valuation of all physical properties with Bunnell & Co.; 1930-32, gen. mtce. of way; 1933, valuation of power plants of Winnipeg Electric and subsidiary companies.

References: N. M. Hall, E. V. Caton, L. M. Hovey, A. W. Fosness, W. B. Hobbs, J. T. Rose.

FOR TRANSFER FROM THE CLASS OF JUNIOR

CURREY—ALLAN ROBERT, of Montreal, Que., Born at Saint John, N.B., Jan. 2nd, 1909; Educ., B.A., 1925, B.Sc., 1927, Queen's Univ.; 1925 (summer), i/c water transportation, Stabell Gold Mines, Amos, Que.; 1926 (summer), asst. to mtce. engr., Canadian Locomotive Works, Kingston, Ont.; 1927-30, design and supervision of truck bodies, trailers, and labour saving devices, and 1930-33, general vehicles supervisor, Bell Telephone Co. of Canada, Montreal; at present, president and chief engr., Industrial Utilities Limited, Montreal, design and constrn. of apparatus for refining lubricating oil and operation of plant. (*Jr. 1927.*)

References: H. C. Nourse, A. M. Mackenzie, D. L. Stewart, R. W. Bastable, C. A. Allen, R. V. Macaulay, H. E. McCrudden, E. J. Turley.

EAGER—NORMAN H. A., of 4312 Montrose Ave., Westmount, Que., Born at Montreal, July 18th, 1900; Educ., B.Sc., McGill Univ., 1922, and M.C.E., Cornell Univ., 1923; 1923-24, res. engr., Illinois State Highway; 1925-26, supt. of constrn., Church Ross Co.; 1924-25, designing engr., Canadian Vickers, Ltd.; 1926-30, designing engr., Power Engrg. Co., and 1930 to date, industrial engr., dept. of development, Shawinigan Water and Power Company, Montreal, Que. (*Jr. 1925.*)

References: E. Brown, D. W. Ross, J. A. McCrory, C. K. McLeod, G. J. Dodd.

KURTZ—HAROLD JOHN, of Sudbury, Ont., Born at Burlington, Ont., Aug. 3rd, 1900; Educ., B.Sc. (Civil), Queen's Univ., 1926; 1926, instr'man., Welland Ship Canal; 1926-28, chainman, N.Y. Central R.R., Rochester; 1928-29, office engr., Tropical Oil Co., Barranca-Bermeja, Colombia, S.A.; 1929, i/c location and constrn., railroad for Timber Products Co., Trenton, Ont.; 1930-32, water and sanitary sewers, City of Sudbury; 1932-33, town engr., Thorold, Ont.; Aug. 1933 to date, supt., Ontario Refining Co., Copper Cliff, Ont. (*St. 1926, Jr. 1928.*)

References: P. E. Buss, W. D. Bracken, J. J. MacKay, F. W. Paulin, W. P. Wilgar.

PHILLIPS—JOHN BERNARD, of 1433 Bishop St., Montreal, Que., Born at Montreal, Aug. 19th, 1899; Educ., B.Sc. (Chem.), 1927, M.Sc. (Chem.), 1928, Ph.D. (Chem.), 1930, McGill Univ.; 1930-31, research assistantship, Mass. Inst. Tech.; 1931 to date, lecturer in chemical engrg., McGill University, Montreal, Que. (*Jr. 1927.*)

References: C. M. McKergow, R. DeL. French, J. R. Donald, A. R. Roberts, C. K. McLeod, C. V. Christie, A. Stansfield.

TOYE—ARTHUR MACFARLANE, of 205 Indian Rd., Toronto, Ont., Born at Toronto, June 26th, 1900; Educ., B.A.Sc., Univ. of Toronto, 1925; 1925-26, dftsman., Chapman & Oxley; 1926-31, estimator and asst. supt., John V. Gray Constrn. Co. Ltd.; Nov. 1931 to date, designing engr., Dept. of Highways of Ontario. (*Jr. 1926.*)

References: J. M. Oxley, A. B. Crealock, F. S. Milligan, A. A. Smith, A. Hay.

WINSLOW—KENELM MOLSON, of Toronto, Ont., Born at Stratford, Ont., Jan. 20th, 1898; Educ., B.Sc., McGill Univ., 1921; 1916, machinist, Canadian-Ingersoll Rand, Sherbrooke, Que.; 1917-18, Lieut., Can. Engrs., 14 mos. in France in charge of design, constrn. and operation of various water supply systems; With C.P.R. as follows: 1921-22, dftsman., mech. dept., Winnipeg; 1922-23, machinist, Angus shops, Montreal; 1923-24, mech. dept., Montreal, engaged on locomotive road tests; With Canadian Ingersoll-Rand Co. as follows 1924-25, asst. to mgr., compressor dept., Montreal; 1926-27, mgr., hoist and crusher dept., Montreal; 1928-29, district engr., Toronto; 1930-33, production engr., Sherbrooke; at present, sales engr., Dominion Engineering Works, Ltd., Montreal. (*Jr. 1922.*)

References: G. R. Pratt, H. E. Mott, E. P. Fetherstonhaugh, A. G. Riddell, J. G. Hall, A. A. Bowman, J. B. D'Aeth, S. R. Newton.

FOR TRANSFER FROM THE CLASS OF STUDENT

BOUCHER—RAYMOND, of Montreal, Que., Born at Stanbridge, Que., July 21st, 1906; Educ., B.A.Sc., in C.E., Ecole Polytechnique, Montreal, 1933; 1928-31 (summers), surveying, etc., with Quebec Streams Commission; at present pursuing studies leading to M.Sc., at Mass. Inst. Tech., Cambridge, Mass. (*St. 1932.*)

References: O. O. Lefebvre, A. Frigon, A. Boyer, A. Duperron, J. A. Lalonde.

HUNT—EDWARD VICTOR, of 240 Rushton Road, Toronto, Ont., Born at Durban, Natal, British South Africa, Feb. 11th, 1906; Educ., B.Sc. (E.E.), Univ. of Man., 1931; 1926-27-28 (summers), with Manitoba Power Company; July 1931 to date, with Canadian General Electric Company on transformer design, and 1930-31 and 1933 (Jan.-Aug.), test course. (*St. 1928.*)

References: C. E. Sisson, W. M. Cruthers, E. V. Caton, E. P. Fetherstonhaugh, N. M. Hall.

MOORE—WILLIAM HERBERT, of 466 Grosvenor Ave., Westmount, Que., Born at Belfast, Ireland, Sept. 10th, 1906; Educ., B.Sc., 1927, M.Eng., 1932, McGill Univ., 1927-28, demonstrator, elec. engrg. dept., and 1929-30, demonstrator, physics dept., McGill Univ., Montreal; Summers, 1924, checking, etc., Bell Telephone Co.; 1925, dfting., Northern Electric Co.; 1926, Lieut., R.C.C.S., Camp Borden; 1926, radio research, National Research Council of Canada; 1927, research asst. on ultra short radio waves for National Research Council in labs. of R.C.C.S., Ottawa; 1928, ship radio operator, Schooner "Morso," of Dominion Explosives Ltd., Toronto; 1928-29, engr. in charge of erection and operation of short wave radio station for Dominion Explosives Ltd., at Tavane, N.W.T.; 1930 to date, elec'l. (radio) engr., engrg. dept., Canadian Marconi Co. Ltd., Montreal, transmitter development and research. (*St. 1926.*)

References: C. V. Christie, W. A. Steel, J. H. Thompson, G. A. Wallace, E. W. Farmer.

PATRIQUEN—FRANK ANDREW, of 19 Horsfield St., Saint John, N.B., Born at Apohaqui, N.B., Aug. 2nd, 1906; Educ., B.Sc. (E.E.), 1930, B.Sc. (C.E.), 1931, Univ. of N.B.; 1931 to date, Junior engr., Saint John Harbour Commissioners, 2 yrs. office work, 6 mos. field work. (*St. 1930.*)

Refereuces: A. Gray, V. S. Chesnut, J. H. McKinney, D. G. Ross, J. Stephens.

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## American Concrete Institute Convenes in Toronto in February

The American Concrete Institute, a body with an international membership, will hold its 30th Annual Convention at the Royal York Hotel, Toronto, February 20th-22nd next.

Elements of the convention programme were discussed at a luncheon meeting in Toronto, November 8th, at which the American Concrete Institute, the Toronto Branch of The Engineering Institute of Canada, the Toronto Chapter of the Ontario Association of Architects, and the Toronto Building and Construction Association were all represented.

The American Concrete Institute is wholly devoted to service as a clearing house for technical information on concrete design, construction and manufacture. Its membership includes designing, consulting, construction and testing engineers, architects, constructors, makers of concrete products, and research workers in its field of interest. The convention this winter in Toronto is a recognition of a highly valued membership in Canada.

The Toronto convention will include six technical sessions in the three day period and to any or all of these meetings interested engineers will be welcome, whether or not they are members of the organization.

S. C. Hollister, professor of Structural Engineering at Purdue University, is president of the American Concrete Institute and R. B. Young, M.E.I.C., testing engineer of the Hydro-Electric Power Commission of Ontario, is a member of its Board of Direction. Mr. Young is also chairman of the Programme Committee of the organization and has been made chairman of the Toronto Convention Committee which has local organization work, preparatory for the meetings, in charge. The headquarters of the Institute are at Detroit, Michigan, in charge of Harvey Whipple, Secretary and Treasurer.

## Winnipeg Plans Interceptors and Sewage Treatment Plant

A sewage-treatment works is planned by the city of Winnipeg, Man., in order to relieve unemployment during the coming year. To this end, the city has retained W. S. Lea, M.E.I.C., consulting engineer of Montreal, to prepare plans for a large intercepting sewer and to advise in connection with the first installment of the treatment works. In February of last year, Mr. Lea submitted a report covering the needs of the city and of its six adjacent municipalities in regard to sewage treatment works for 260,000 people initially and 500,000 ultimately. At present crude sewage is discharged through fifty or more outlets scattered along a 20-mile stretch of the Red and Assiniboine rivers. Mr. Lea recommended the construction of an interceptor 7 miles long, designed for future extension upstream to permit of concentration of sewage from about 70 per cent of the population at a down-river site where ultimately the settleable solids would be removed from all the sewage delivered there, and about half of it subjected to some oxidizing treatment if and when the condition of the river so requires. The estimated cost of the ultimate project to the city is $1,000,000.

## Surety Bonds

The present form of fidelity coverage, which protect the employer and his shareholder's capital from impairment by pecuniary losses through dishonest employees absconding, or otherwise misusing funds entrusted in the employer's care, are varied and fairly well standardized.

The word "surety" covers a wide class of risks, of which the fidelity bond is one class. There are other surety bonds of all kinds to be had; bid and contract bonds, court, lien, immigration, lost securities and other miscellaneous bonds.

The "bid bond" in itself does not appear to be a great risk although it serves the purpose of a marked cheque, which in the usual course the contractor would deposit, it goes a little further and provides that the surety will underwrite the contract bond if the contractor has his bid accepted, so that the surety then, must take all precaution against the contractor under-estimating the contract and must employ qualified underwriters, who can analyse and immediately grant the bond upon consideration of the contractor's financial condition, his reputation, the number of contracts which he has on hand, and other considerations.

The "contract bond" usually guarantees that the surety will protect the obligee, or municipality, if it is for their benefit, or other private interests from any and all pecuniary loss resulting from the failure of the contractor to observe the terms of his contract, subject to certain conditions. In some cases, upon default it has been necessary for the surety company to become subrogated to the rights of the contractor and proceed with the performance of the contract to completion.

Contracting concerns, who in the usual course of business a few years ago deposited marked cheques as a guarantee that if the bid was accepted they would comply with the contract, are now realizing the benefit of "bid and contract bonds" which enable them to use the capital otherwise held up or covered with the marked cheque in furthering their business.

These forms of protection may be purchased in Canadian companies at premiums proportionate to the amount of protection desired and commensurate with the risk involved.

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*Canadian General Electric Company Ltd.* announces a new indicating lamp which can be used for signal-light indication or, in combination with control switches, to tell whether a circuit breaker is open, closed or tripped automatically. This offers the advantages of long lamp-life, low-wattage consumption and good visible indication.

The indicating lamp unit consists of a resistor of the vitreous-enamel type, a receptacle and escutcheon constructed of insulating material, a 24-volt lamp, a colour cap made of a special translucent compound, which may be clear, red, yellow, or green. The escutcheon, mounted in the panel hole from the front and the receptacle body, mounted from the rear, are threaded to make a compact unit when assembled. The resistor element slides over the receptacle body from the rear, and the complete device provides for soldered connections, or if not desired binding screws are included.

## EMPLOYMENT SERVICE BUREAU

The Service is operated for the benefit of members of The Engineering Institute of Canada, and for industrial and other organizations employing technically trained men—without charge to either party.

*All correspondence should be addressed to*

**The Employment Service Bureau, The Engineering Institute of Canada**
**2050 Mansfield Street, Montreal**

### Situations Wanted

ELECTRICAL AND RADIO ENGINEER, B.Sc., '28. Experience in the design and testing of broadcast radio receivers, including latest superheterodyne practice, and capable of constructing apparatus for testing same Also familiar with telephone and telephone repeater engineering. Thorough experience in design, and construction and inspection of municipal power conduits. Apply to Box No. 12-W.

MECHANICAL ENGINEER, Canadian, with technical training and executive experience in both Canadian and American industries, particularly plant layout, equipment, planning and production control methods, is open for employment with company desirous of improving manufacturing methods, lowering costs and preparing for business expansion. Apply to Box No. 35-W.

MECHANICAL ENGINEER, A.M.E.I.C. Married. Experience in machine shops, erection and maintenance of industrial plant mechanical and structural design. Reads German, French, Dutch and Spanish. Seeks any suitable position. Apply to Box No. 84-W.

YOUNG ENGINEER, B.A., B.SC., A.M.E.I.C., R.P.E., Ont. Competent draughtsman and surveyor. Eight years experience including design, superintendence and layout of pulp and paper mills, hydro-electric projects and general construction. Limited experience in mechanical design and industrial plant maintenance. Apply to Box No. 150-W.

PURCHASING ENGINEER, graduate mechanical engineer, Canadian, married, 34 years of age, with 13 years' experience in the industrial field, including design, construction and operation, 8 years of which had to do with the development of specifications and ordering of equipment and materials for plant extensions and maintenance; one year engaged on sale of surplus construction equipment. Full details upon request. Apply to Box No. 161-W.

CIVIL ENGINEER, age 44, open for employment anywhere, experience covers about 20 years' active work, including 7 years on municipal engineering, 2 years as Town Manager, 3 years on railway construction, 3 years on the staff of a provincial highway department, 2 years as contractor's superintendent on pavement construction. Apply to Box No. 216-W.

REINFORCED CONCRETE ENGINEER, B.SC., P.E.Q., eight years experience in construction design of industrial buildings, office buildings, apartment houses, etc. Age 30. Married. Apply to Box No. 257-W

MECHANICAL ENGINEER, B.Sc., McGill '19, A.M.E.I.C. Married. Twelve years experience including oil refinery power plant, structural and reinforced concrete design, factory maintenance, steam generation and distribution problems, heating and ventilating. Available at once. Location immaterial. Apply to Box No. 265-W.

ELECTRICAL ENGINEER, B.SC., '28, Canadian. Age 25. Experience includes two summers with power company; thirteen months test course with C.G.E. Co.; telephone engineering, and the past thirty months with a large power company in operation and maintenance engineering. Location immaterial and available immediately. Apply to Box No. 266-W.

DESIGNING DRAUGHTSMAN, experience in layout of steam power house equipment and piping. Wide experience in mechanical drive and details of machinery, gearing, and hoists. Accustomed to layout of small mill buildings of steel and timber, structural design and details. Good references. Present location Montreal. Apply to Box No. 329-W.

PLANE-TABLE TOPOGRAPHER, B.SC., in C.E. Thoroughly experienced in modern field mapping methods including ground control for aerial surveys. Fast and efficient in surveys for construction, hydro-electric and geological investigations. Apply to Box No. 431-W.

ELECTRICAL ENGINEER, B.SC., A.M.E.I.C., AM.A.I.E.E., age 30, single. Eight years experience H.E. and steam power plants, substations, etc., shop layouts, steel and concrete design. Location immaterial. Available immediately. Apply to Box No. 435-W.

CIVIL ENGINEER, B.A.SC., and C.E., A.M.E.I.C., age 30, married. Experience over the last ten years covers construction on hydro-electric and railway work as instrumentman and resident engineer. Also office work on teaching and design, investigations and hydraulic works, reinforced concrete, bridge foundations and caissons. Location immaterial. Available at once. Apply to Box No. 447-W.

SALES ENGINEER, M.A.SC. Univ. of Toronto, wishes to represent firm selling building products or other engineering commodities, as their representative in Western Canada. Located in Winnipeg. Apply to Box No. 467-W.

### Situations Wanted

CIVIL ENGINEER, B.SC., A.M.E.I.C., with six years experience in paper mill and hydro-electric work, desires position in western Canada. Capable of handling reinforced concrete and steel design, paper mill equipment and piping layout, estimates, field surveys, or acting as resident engineer on construction. Now on west coast and available at once. Apply to Box No. 482-W.

MECHANICAL ENGINEER, B.SC. Age 28, married. Four and a half years on industrial plant maintenance and construction, including shop production work and pulp and paper mill control. Also two and a half years on structural steel and reinforced concrete design. Available at once. Apply to Box No. 521-W.

CIVIL ENGINEER, Canadian, married, twenty-five years' technical and executive experience, specialized knowledge of industrial housing problems and the administration of industrial towns, also town planning and municipal engineering, desires new connection. Available on reasonable notice. Personal interview sought. Apply to Box No. 544-W.

ELECTRICAL AND MECHANICAL ENGINEER, B.SC., A.M.E.I.C. Experience includes C.G.E. Students Test Course and six years in engrg. dept. of same company on design of electrical equipment. Four summers as instrumentman on surveying and highway construction. Recently completed course in mechanical engineering. Available at once. Location preferred Ontario, Quebec, or Maritimes. Apply to Box No. 564-W.

#### Employment Service Bureau

This bureau is maintained by The Engineering Institute of Canada for the benefit of members and organizations employing technically trained men.

An enquiry addressed to 2050 Mansfield Street, Montreal, will bring full information concerning the services offered Details can also be obtained from Branch secretaries who are located in the larger centres throughout Canada.

Brief announcements of men available and positions vacant will be published without charge in The Engineering Journal and the Bulletin. Replies addressed in care of the required box number will be forwarded to the advertiser without delay.

An additional service also offered those who are unemployed or wish to change their positions, is the opportunity of placing their names and records on file at 2050 Mansfield Street for consideration by employers wishing to employ engineers. This is of great assistance as many employers will not advertise or wish to locate a suitable man on short notice. If desired the information contained in these records can be kept confidential.

Forms for registration purposes may be obtained from The Institute Headquarters or Branch secretaries.

CIVIL ENGINEER, age 25, single, graduate. Creditable record on responsible hydro and railroad work in both Eastern and Western Canada. Apply to Box No. 567-W.

MECHANICAL ENGINEER, A.M.E.I.C., with twenty years experience on mechanical and structural design, desires connection. Available at once. Apply to Box No. 571-W.

MECHANICAL ENGINEER, B.A.SC., '30, desires position to gain experience, and which offers opportunity for advancement. Experience in pulp and paper mill and one year in mechanical department of large electrical company. Location immaterial. Available immediately Apply to Box No. 577-W.

DOMINION LAND SURVEYOR, and graduate engineer with extensive experience on legal, topographic and plane-table surveys and field and office use of aero-photographs, desires employment either in Canada or abroad. Available at once. Apply to Box No. 589-W.

MECHANICAL ENGINEER, Canadian, technically trained; eighteen years experience as foreman, superintendent and engineer in manufacturing, repair work of all kinds, maintenance and special machinery building. Location immaterial. Available at once. Apply to Box No. 601-W.

### Situations Wanted

CHEMICAL ENGINEER, S.E.I.C., B.SC., University of Alberta, '30. Age 31. Single. Six seasons' practical laboratory experience, three as chief chemist and three as assistant chemist in cement plant; one year's p.g. work in physical chemistry; three years' experience teaching. Desires position in any industry with chemical control. Available immediately. Apply to Box No. 609-W.

DESIGNING ENGINEER AND ESTIMATOR, grad. Univ. of Toronto in C.E., A.M.E.I.C., twenty years experience in structural steel, construction and municipal work. Available at once. Apply to Box No. 613-W.

CIVIL ENGINEER, A.M.E.I.C., R.P.E., Ontario; three years construction engineer on industrial plants; fourteen years in charge of construction of hydraulic power developments, tower lines, sub-stations, etc.; four years as executive in charge of construction and development of harbours, including railways, docks, warehouses, hydraulic dredging, land reclamation, etc. Apply to Box No. 647-W.

MECHANICAL ENGINEER, A.M.E.I.C., Canadian, technically trained; six years drawing office. Office experience, including general design and plant layout. Also two years general shop work, including machine, pattern and foundry experience, desires position with industrial firm in capacity of production engineer or estimator. Available on short notice. Apply to Box No. 676-W.

ELECTRICAL AND CIVIL ENGINEER, B.SC., Elec., '29, B.SC., Civil '33. Age 27. JR.E.I.C. Undergraduate experience in surveying and concrete foundations; also four months with Canadian General Electric Co. Thirty-three months in engineering office of a large electrical manufacturing company since graduation. Good experience in layouts, switching diagrams, specifications and pricing. Best of references. Available immediately. Apply to Box No. 693-W.

MECHANICAL ENGINEER, B.SC., '27, JR.E.I.C. Four years maintenance of high speed Diesel engines units, 200 to 1,300 h.p. Also maintenance of D.C. and A.C. electrical systems and machinery. Draughting experience. Westinghouse apprenticeship course. Practical mechanical and electrical engineer with a special study of high speed Diesel engine design, application and operation. Location in western or eastern Canada immaterial. Apply to Box No. 703-W.

COMBUSTION ENGINEER, R.P.E., Manitoba, A.M.E.I.C. Wide experience with all classes of fuels. Expert designer and draughtsman on modern steam power plants. Experienced in publicity work. Well known throughout the west. Location, Winnipeg or the west. Available at once. Apply to Box No. 713-W.

ELECTRICAL ENGINEER, B.SC., University of N.B., '31. Experience includes three months field work with Saint John Harbour Reconstruction. Apply to Box No. 722-W.

MECHANICAL ENGINEER, age 41, married. Eleven years designing experience with project of outstanding magnitude. Machinery layouts, checking, estimating and inspecting. Twelve years previous engineering, including draughting, machine shop and two years chemical laboratory. Highest references. Apply to Box No. 723-W.

YOUNG CIVIL ENGINEER, B.SC. (Univ. of N.B. '31), with experience as rodman and checker on railroad construction, is open for a position. Apply to Box No. 728-W.

DESIGNING ENGINEER, M.SC. (McGill Univ.), D.L.S., A.M.E.I.C., P.E.Q. Experience in design and construction of water power plants, transmission lines, field investigations of storage, hydraulic calculations and reports. Also paper mill construction, railways, highways, and in design and construction of bridges and buildings. Available at once. Apply to Box No. 729-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.SC., Univ. of B.C. '30. Single, age 24. Sixteen months with the Allis-Chalmers Mfg. Co. as student engineer. Experience includes foundry production, erection and operation of steam turbines, erection of hydraulic machinery, and testing texropes and centrifugal pumps. Location immaterial. Available at once. Apply to Box No. 735-W.

CIVIL ENGINEER, M.SC., A.M.E.I.C., R.P.E. (Ont.), ten years experience in municipal and highway engineering. Read, write and talk French. Married. Served in France. Will go anywhere at any time. Experienced journalist. Apply to Box No. 737-W

ELECTRICAL AND RADIO ENGINEER, B.SC. '31, S.E.I.C. Age 25. Nine months experience on installation of power and lighting equipment. Eight months on extensive survey layouts. Two summers installing telephone equipment. Specialized in radio servicing and merchandising. Available at once. Location immaterial. Apply to Box No. 740-W.

CIVIL ENGINEER, graduate '29. Married One year building construction, one year hydro-electric construction in South America, fourteen months resident engineer on road construction Working knowledge of Spanish. Apply to Box No. 744-W.

SALES ENGINEER, B.SC., McGill, 1923, A.M.E.I.C. Age 33. Married Extensive experience in building construction. Thoroughly familiar with steel building products; last five years in charge of structural and reinforcing steel sales for company in New York state. Available at once. Located in Canada. Apply to Box No. 749-W.

DESIGNING ENGINEER, graduate Univ. Toronto '26. Thoroughly experienced in the design of a broad range of structures, desires responsible position. Apply to Box No. 761-W

## Situations Wanted

ELECTRICAL ENGINEER, B.Sc. (McGill Univ. '29). S.E.I.C. Married Experience in pulp and paper mill mechanical maintenance, estimates and costs and machine shop practice. Desires position with industrial or manufacturing concern. Location immaterial. Available on short notice. References. Apply to Box No. 770-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. Queen's Univ '29. Age 25. Married. Three years experience as construction supt. and estimator for contracting firm. Experience includes general building, bridges, sewer work, concrete, boiler settings, sand blasting of bridges and spray painting. Available at once. Apply to Box No. 776-W.

CIVIL ENGINEER, B.Sc., '25, JR.E.I.C., P.E.Q., married. Desires position, preferably with construction firm. Experience includes railway, monument and mill building construction. Available immediately. Apply to Box No. 780-W.

DRAUGHTSMAN, experience in civil engineering, forestry engineering, land surveying and house construction. Good references. Apply to Box No. 781-W.

ELECTRICAL AND SALES ENGINEER, S.E.I.C., grad. '28. Experience includes one year test course, one year switchboard design and two years switchboard and switching equipment sales with large electrical manufacturing company. Three summers Pilot Officer with R.C.A.F. Available at once. Apply to Box No. 788-W.

ELECTRICAL ENGINEER. Specializing in power and illumination reports, estimates, appraisals, contracts and rates, plans and specifications for buildings. Available on interesting terms. Apply to Box No. 795-W.

CIVIL ENGINEER, S.E.I.C., graduate '30, age 23, single. Experience includes mining surveys, assistant on highway location and construction, and assistant on large construction work. Steel and concrete layout and design. Apply to Box No. 809-W.

CIVIL ENGINEER, college graduate, age 27, single. Experience includes surveying, draughting concrete construction and design, street paving both asphalt and concrete. Available at once; will consider anything and go anywhere. Apply to Box No. 816-W.

CIVIL ENGINEER, B.E. (Sask. Univ. '32), S.E.I.C. Single. Experience in city street improvements; sewer and water extensions. Good draughtsman. References. Available at once. Location immaterial. Apply to Box No. 818-W.

CIVIL ENGINEER, S.E.I.C., B.Sc (Queen's '32), age 21. Three summers surveying in northern Quebec. Interested in hydraulics and reinforced concrete. Available at once. Location immaterial. Apply to Box No. 822-W.

CIVIL ENGINEER, B.Sc., A.M.E.I.C., with fifteen years experience mostly in pulp and paper mill work, reinforced concrete and structural steel design, field surveys, layout of mechanical equipment, piping. Available at once. Apply to Box No. 825-W.

ELECTRICAL ENGINEER. S.E.I.C., grad. '29, age 24, married; experience includes one year Students Test Course, sixteen months in distribution transformer design and eight months as assistant foreman in charge of industrial control and switchgear tests. Location immaterial. Available at once. Apply to Box No. 828-W.

CIVIL ENGINEER, B.A.Sc., D.L.S., O.L.S., A.M.E.I.C., age 46, married. Twelve years experience in charge of legal field surveys. Owns own surveying equipment. Eight years on technical, administrative, and editorial office work. Experienced in writing. Desires position on survey work, assisting in or in charge of preparation of house organ, on staff of technical or semi-technical magazine, or on publicity, editorial or administrative office work. Available at once. Will consider any salary, and any location. Apply to Box No. 831-W.

CIVIL ENGINEER, M.Sc., R.P.E. (Sask.). Age 27. Experience in location and drainage surveys, highways and paving, bridge design and construction city and municipal developments, power and telephone construction work. Available on short notice. Apply to Box No. 839-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. '32 (Univ. of N.B.) Age 25, married. Two years experience in power line construction and maintenance; one year of highway construction; one summer surveying for power plant site, location and spur railway line construction. Available at once. Location immaterial. Apply to Box No. 840-W.

CIVIL ENGINEER, B.Sc. '15, A.M.E.I.C., married, extensive experience in responsible position on railway construction, also highways, bridges and water supplies. Position desired as engineer or superintendent. Available at once. Apply to Box No. 841-W.

CIVIL ENGINEER, B.Sc. (Alta. '31), S.E.I.C., age 21. Experience, three summers on railroad maintenance, and seven months on highway location as instrumentman. Willing to do anything, anywhere, but would prefer connection with designing or construction firm on structural works. Available immediately. Apply to Box No. 846-W.

MECHANICAL ENGINEER, graduate, '23, A.M.E.I.C., P.E.Q., age 32, married. (English and French.) Two years shop, foundry and draughting experience; one year mechanical supt. on construction; six years designing draughtsman in consulting engineers' offices (mechanica lequipment of buildings, heating, sanitation, ventilation, power plant equipment, etc.). Present location Montreal. Available immediately. Montreal or Toronto preferred Apply to Box No. 766-W.

## Situations Wanted

MECHANICAL ENGINEER, JR.E.I.C., technical graduate, bilingual, age 30. Two years as designing heating draughtsman with one of the largest firms of its kind on this continent handling heating materials; three years designing draughtsman in consulting engineers' office, mechanical equipment of buildings, heating, ventilation, sanitation, power plant equipment, writing of specifications, etc. Present location Montreal. Available at once. Apply to Box No. 850-W.

BRIDGE AND STRUCTURAL ENGINEER, A.M.E.I.C., McGill. Twenty-five years' experience on bridge and structural staffs. Until recently employed. Familiar with all late designs, construction, and practices in all Canadian fabricating plants. Desirous of employment in any responsible position, sales, fabrication or construction. Apply to Box No. 851-W.

STRUCTURAL ENGINEER, B.A.Sc., A.M.E.I.C. Twenty-two years experience in design of bridges and all types of buildings in structural steel and reinforced concrete. Three years experience in railway construction and land surveying. Apply to Box No. 856-W.

MECHANICAL ENGINEER, B.Sc. '32, S.E.I.C. Good draughtsman. Undergraduate experience:—One year moulding shop practice; two years pipe fitting and sheet metal work; one year draughting and tracing on paper mill layout; six months machine shop practice; and eight months fuel investigation and power heating plant testing. Desires position offering experience in steam power plants or heating and ventilating design. Will go anywhere. Apply to Box No. 858-W.

MECHANICAL ENGINEER, age 31, graduate Sheffield (England) 1921; apprenticeship with firm manufacturing steam turbine generators and auxiliaries and subsequent experience in design, erection, operation and inspection of same. Marine experience B.O.T. certificate thoroughly conversant with Canadian plants and equipment. Available on short notice. Any location. Box No. 860-W.

CHEMICAL ENGINEER, B.Sc. (McGill '21), A.M.E.I.C., age 36, married; three years since graduation with pulp and paper mills; eight years in shops, estimating and sales divisions of well-known gas engineering and construction companies in the United States. Excellent references. Available on short notice. Apply to Box No. 866-W.

CONSTRUCTION ENGINEER (Toronto Univ. of '07). Experience includes hydro-electric, municipal and railroad work. Available immediately. Location immaterial. Apply to Box No. 886-W.

ELECTRICAL ENGINEER, graduate 1929, S.E.I.C. Single. Experience includes two years with electrical manufacturing concern and one on highway construction work. Available at once. Will go anywhere. Apply to Box No. 887-W.

CIVIL ENGINEER, B.Sc., Montreal 1930, age 26, single, French and English, desires position technical or non-technical in engineering, industrial or commercial fields, sales or promotion work. Experience includes three years in municipal engineering on paving, sewage, waterworks, filter plant equipment, layout of buildings, etc. Available immediately. Apply to Box No. 891-W.

ELECTRICAL ENGINEER, grad. Univ. of N.B. '31. Experienced in surveying and draughting, requires position. Available at once Will go anywhere. Apply to Box No. 893-W.

CIVIL ENGINEER, B.A.Sc., JR.E.I.C., age 29, single. Experience includes two years in pulp mill as draughtsman and designer on additions, maintenance and plant layout. Three and a half years in the Toronto Buildings Department checking steel, reinforced concrete, and architectural plans. Available at once. Location immaterial. At present in Toronto. Apply to Box No. 899-W.

ENGINEER, JR.E.I.C., specializing in reconnaissance and preliminary surveys in connection with hydro-electric and storage projects Expert on location and construction of transmission lines, railways and highways. Capable of taking charge. Location immaterial. Apply to Box No. 901-W.

MECHANICAL ENGINEER, Canadian, age 25, B.Sc. (Queen's '32). Since graduation on supervision of large building construction. Undergraduate experience in electrical, plumbing and heating, and locomotive trades. Available at once. Apply to Box No. 903-W.

DESIGNING ENGINEER, A.M.E.I.C. Permanent and executive position preferred but not essential. Fifteen years experience in designing power plants, engine and fan rooms, kitchens and laundries. Thoroughly familiar with plumbing and ventilating work, pneumatic tubes, and refrigeration, also heating, electrical work, and specifications. Apply to Box No. 913-W.

YOUNG CIVIL ENGINEER, JR.E.I.C. Six years as instrumentman on subway work. Two years as time-keeper cost clerk on building construction. Four years as job engineer on buildings, tunnels, dams, power houses. Location immaterial. Available at once. Apply to Box No. 916-W.

INDUSTRIAL ENGINEER, B.Sc. in M.E., age 25, married, is open for a position of a permanent nature with an industrial concern. Experience includes three years in various divisions of a paper mill and two years in an electrical company. Apply to Box No. 917-W

ENGINEER, B.Sc., A.M.E.I.C., R.P.E. (N.B.), age 35, married. Seven years' mining experience as sampler, assayer, surveyor, field work, and foreman in charge of underground development; two years as assistant engineer on highway construction and maintenance Available on short notice. Apply to Box No. 932-W.

## Situations Wanted

CIVIL ENGINEER, B.Sc., '25, McGill Univ., JR.E.I.C., P.E.Q., age 32, married. Experience as rodman and instrumentman on track maintenance. Seven and one-half years with Canadian paper company, as assistant office engineer handling all classes of engineering problems in connection with woods operations, i.e., road buildings, piers, booms, timber bridges, depots, dams, etc. Apply to Box No. 933-W.

ELECTRICAL ENGINEER, Dipl. of Eng., B.Sc. (Dalhousie Univ.), S.B. and S.M. in E.E. (Mass. Inst. of Tech.), Canadian. Married. Seven and a half years' experience in design, construction and operation of hydro, steam and industrial plants. For past sixteen months field office electrical engineer on 510,000 h.p. hydro-electric project. Available at once. Apply to Box No. 936-W.

CIVIL ENGINEER, B.Sc., O.P.E. Experience includes several years on municipal work-design and construction of sewers, steel and concrete bridges, watermains and pavements. Available at once. Apply to Box No. 950-W.

ELECTRICAL ENGINEER, twenty years experience, desires position, either temporary or permanent. Experienced in design, construction, and operation of power and industrial plants, and supt. of construction. Apply to Box No. 974-W.

INDUSTRIAL ENGINEER, B.Sc., in C.E. (McGill Univ. '30), graduate student in industrial engineering '33 session, age 27, single, available for a position of temporary or permanent nature with industrial concern. Has theoretical knowledge of latest methods of market analysis, production control, management and cost accounting. Also experience in the design and construction of industrial buildings. Location immaterial. Apply to Box No. 981-W.

CIVIL ENGINEER, B.Sc. (Univ. of Sask. '33), S.E.I.C., age 28, single. Experience in testing hydro-electric equipment, draughting, surveying, city street, improvements, technical photography. Available at once. Location immaterial. Apply to Box No. 986-W.

ELECTRICAL ENGINEER, B.A.Sc., '27, JR.E.I.C., A.A.I.E.E. Married. Age 31. One and a half years G. E. Test Course, Schenectady; four and a half years motor and generator design including induction motors, D.C. and A.C. motors and generators. Willing to do anything, design or sales preferred. Available at once. Present location Toronto. Apply to Box No. 993-W.

MECHANICAL ENGINEER, S.E.I.C., B.Sc., Queen's University '33. Age 24, desires position on power plant and power distribution problems, factory maintenance, heating and ventilation or refrigeration design. Willing to work for living expenses in order to gain experience. Apply to Box No. 999-W.

ENGINEER SUPERINTENDENT, age 44. Engineering and business training, executive ability, tactful, energetic. Had charge of several large projects. Intimate knowledge of costs and prices, reports and estimates. Available immediately. Any location. Apply to Box No. 1021-W.

CIVIL ENGINEER, B.Sc. (Queen's 14), A.M.E.I.C., Dominion Land Surveyor, 5 months' special course at the University of London, England, in municipal hygiene and reinforced concrete construction. Experience covers legal and topographic surveys, plane tabling and stadia surveying, railway and highway construction, drainage and excavation work. Available at once. Apply Box No. 1035-W.

ELECTRICAL ENGINEER AND GEOPHYSICIST. Age 36. Married. Seven years experience in geophysical exploration using seismic, magnetic and electrical methods. Two years experience with the Western Electric Company of Chicago, working on equipment and magnetic materials research. Experienced in radio and telephone work, also specializing in precise electrical measurements, resistance determinations, ground potentials and similar problems of ground current distribution. Apply to Box No. 1063-W.

ELECTRICAL ENGINEER, B.A.Sc. Univ. Toronto '28. Experience includes Can. Gen. Elec. Co. Test Course. Also more than two years in the engineering dept. of the same company. Available on short notice. Preferred location central or eastern Canada. Apply to Box No. 1075-W.

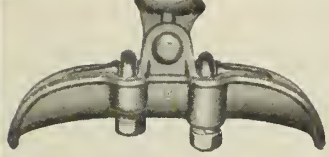
ELECTRICAL ENGINEER, B.Sc. Married. Eight years electrical experience, including operation, maintenance and construction work, electrical design work on large power development, mechanical ability, experienced photographer, employed in electrical capacity at present. Available on reasonable notice. Apply to Box No. 1076-W.

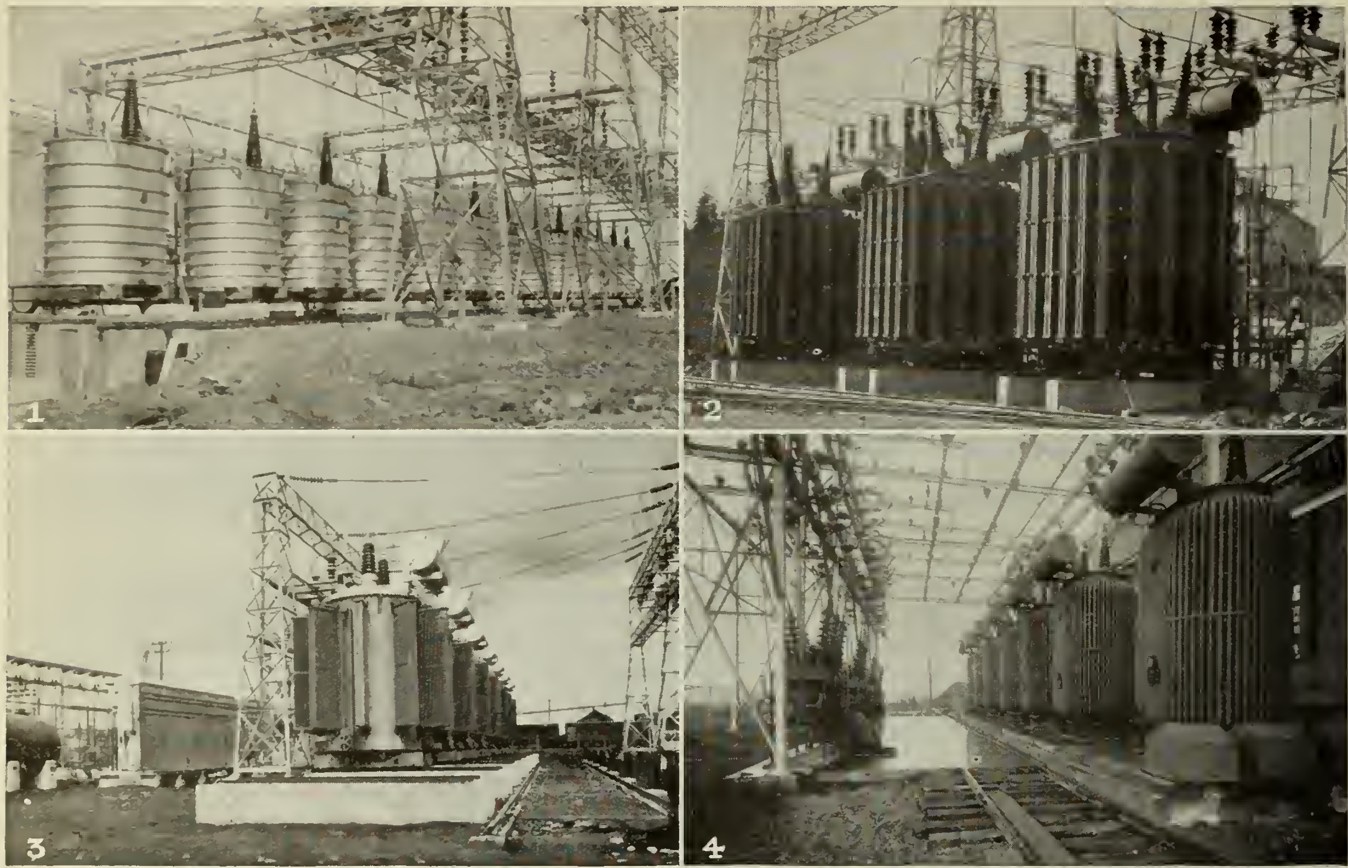
GRADUATE IN MECHANICAL ENGINEERING, 1927, desires opportunity in Diesel engine field, preferably in design and devolopment work. Skilled draughtsman and clever in design. Familiar with basic theories of the Diesel engine and in touch with recent developments and applications. Anxious to obtain a foothold with up-to-date company. No objection to shopwork or other duties as a start but would prefer shopwork and assembly if possible. Apply to Box No. 1081-W.

INDUSTRIAL ENGINEER, B.A.Sc. in Chem. Eng. (Tor. '31), S.M. in Indust. Eng. (Mass. Inst. of Tech. '32), S.E.I.C. Age 25 years. Northern Electric Training Course. Construction and sales experience. Rookefeller Research Associate at McGill University in industrial engineering for past year and to date. Desire work in production or financial departments of a manufacturing plant. Apply to Box No. 1098-W.









(1) *Thirteen G-E 15,700 kv-a., 220,000 grd.Y-13,200 volt, 25 cycle single-phase transformers, Chats Falls Station, H.E.P.C. of Ontario.*

(2) *Three G-E 22,500 kv-a., 110,000 Y-12,000 volt, 60 cycle three-phase transformers, Alexander Development, H.E.P.C. of Ontario.*

(3) *Seven G-E 5,000 kv-a., 110,000 Y-26,400 volt, 25 cycle single-phase transformers, Port Colborne Substation, H.E.P.C. of Ontario.*

(4) *Seven G-E 2,500 kv-a., 60,000-2400 volts, 60 cycle single-phase transformers, Bay Street Substation, B.C. Electric Railway Co., Victoria, B.C.*

# Years of Dependable Service from General Electric Power Transformers

General Electric power transformers have earned for themselves an enviable reputation for reliability, high efficiency, and good appearance in the hundreds of installations from Halifax to Vancouver. G-E power transformers have been built in sizes from 200 kv-a. to 36,000 kv-a. and in voltage ratings up to 230,000 volts. When you buy G-E power transformers you can rely on equipment incorporating the latest design evolved from years of G-E transformer manufacturing experience.

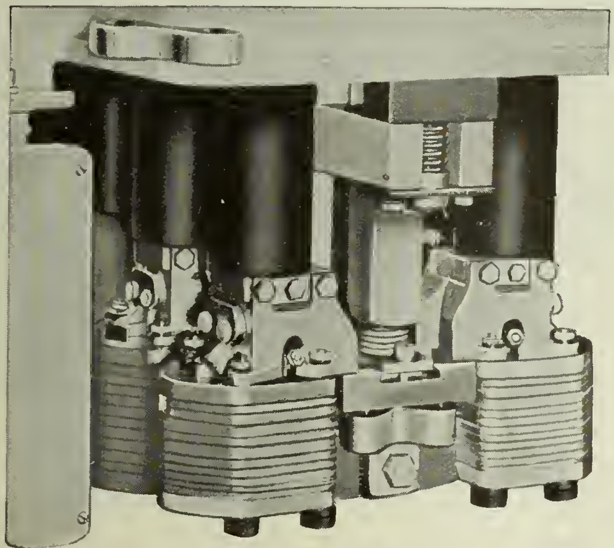
**MADE IN CANADA**

33-DA-1

## CANADIAN GENERAL ELECTRIC COMPANY LIMITED

Head Office - Toronto — Sales and Engineering Offices in Principal Cities

# Modernizing your old



## Circuit Breakers with De-ion Grids

*1200 Ampere, 15,000 volt, 3 P.S.T. electrically operated Type BK Oil Circuit Breaker with De-ion Grids*

WHEN you modernize your old circuit breakers with "De-ion Grids" you save the cost of making changes in the mechanical structure of the breakers. You also save considerably in the time required for the change-over. In addition, you very materially increase the rupturing capacity.

All that is required is the simple substitution of "De-ion Grids" and contacts for the older types of contacts. It is such unparalleled advantages as these that have made "De-ion Grids" the outstanding contribution in circuit interruption. But these advantages in their application to old breakers—important as they are—tell only part of the story. In operation, the performance of "De-ion Grids" is equally outstanding. In new breakers or in old ones "De-ion Grids" reduce arc voltages, lower the arc energy liberated in the breaker structure, and always extinguish the arc in the grid with a large factor of safety, resulting in lower tank pressures, and making possible new reclosing duty cycles. You can avail yourself of these vital economies by installing new "De-ion Grid" breakers or modernizing, at small cost, your old Westinghouse oil circuit breakers with "De-ion Grids."

*Detailed Information available at any of the district offices mentioned below—or send for Leaflet 20523-A*

CANADIAN WESTINGHOUSE COMPANY, LIMITED, HAMILTON, ONTARIO

**Branch Offices:** Vancouver, Calgary, Edmonton, Regina, Winnipeg, Fort William, Toronto, Montreal, Halifax

**Service and Repair Shops:** Vancouver, Calgary, Regina, Winnipeg, Toronto, Montreal

8140

CANADIAN WESTINGHOUSE

# Westinghouse Electric

# Purchasers' Classified Directory

*A Selected List of Equipment, Apparatus and Supplies*

**For Alphabetical List of Advertisers see page 16.**

A

**Acids:**
Canadian Industries Limited.

**Aerial Survey:**
Canadian Airways Ltd.

**Ammeters and Voltmeters:**
Bepco Canada Ltd.
Crompton Parkinson (Canada) Ltd.

**Angles, Steel:**
Bethlehem Steel Export Corp.

**Ash Handling Equipment:**
Babcock-Wilcox & Goldie McCulloch Ltd.
Combustion Engineering Corp. Ltd.
E. Long Ltd.

B

**Ball Mills:**
Dominion Engineering Works Limited.

**Balls, Steel and Bronze:**
Can. S.K.F. Co. Ltd.

**Barking Drums:**
Canadian Ingersoll-Rand Company, Limited.

**Bars, Steel and Iron:**
Bethlehem Steel Export Corp.

**Bearings, Ball and Roller:**
Can. S.K.F. Co. Ltd.

**Billets, Blooms, Slabs:**
Bethlehem Steel Export Corp.

**Bins:**
Canada Cement Co. Ltd.

**Blasting Materials:**
Canadian Industries Limited.

**Blowers, Centrifugal:**
Can. Ingersoll-Rand Co. Ltd.

**Blue Print Machinery:**
Montreal Blue Print Co.

**Boilers:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Canadian Vickers Ltd.
Combustion Engineering Corp. Ltd.
Foster Wheeler Limited.
E. Leonard & Sons Ltd.
Vulcan Iron Wks. Ltd.

**Boilers, Electric:**
Can. General Electric Co. Ltd.
Dominion Engineering Works Limited.
Northern Electric Co. Ltd.

**Boilers, Portable:**
E. Leonard & Sons Ltd.

**Boxes, Cable Junction:**
Northern Electric Co. Ltd.

**Braces, Cross Arm, Steel, Plain or Galvanized:**
Northern Electric Co. Ltd.

**Brackets, Ball Bearing:**
Can. S.K.F. Co. Ltd.

**Brakes, Air:**
Can. General Elec. Co. Ltd.

**Brakes, Magnetic Clutch:**
Northern Electric Co. Ltd.

**Bridge-Meggers:**
Northern Electric Co. Ltd.

**Bridges:**
Canada Cement Co. Ltd.
Dominion Bridge Co. Ltd.

**Bucket Elevators:**
Jeffrey Mfg. Co. Ltd.
Plessisville Foundry.

**Buildings, Steel:**
Dominion Bridge Co. Ltd.

C

**Cables, Copper and Galvanized:**
Northern Electric Co. Ltd.

**Cables, Electric, Bare and Insulated:**
Can. Westinghouse Co. Ltd.
Can. General Electric Co. Ltd.
Northern Electric Co. Ltd.

**Caissons, Barges:**
Dominion Bridge Co. Ltd.

**Cameras:**
Associated Screen News Ltd.

**Capacitors:**
Bepco Canada Ltd.
Can. Westinghouse Co. Ltd.
Lancashire Dynamo & Crypto Co. of Can. Ltd.

**Cars, Dump:**
E. Long Ltd.

**Castings, Brass:**
The Superheater Co. Ltd.

**Castings, Iron:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Canadian Vickers Ltd.
Dominion Engineering Works.
E. Leonard & Sons Ltd.
E. Long Ltd.
The Superheater Co. Ltd.
Vulcan Iron Wks. Ltd.

**Castings, Steel:**
Vulcan Iron Wks. Ltd.

**Catenary Materials:**
Can. Ohio Brass Co. Ltd.

**Cement Manufacturers:**
Canada Cement Co. Ltd.

**Chains, Silent and Roller:**
The Hamilton Gear & Machine Co. Ltd.
Jeffrey Mfg. Co. Ltd.

**Channels:**
Bethlehem Steel Export Corp.
Hamilton Bridge Co. Ltd.

**Chemicals:**
Canadian Industries Limited.

**Chemists:**
Milton Hersey Co. Ltd.
Roast Loboratories Reg'd.

**Chippers, Pneumatic:**
Canadian Ingersoll-Rand Company, Limited.

**Choke Coils:**
Ferranti Electric Co.

**Circuit Breakers:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.

**Clarifiers, Filter:**
Bepco Canada Ltd.
Crompton Parkinson (Canada) Ltd.

**Clutches, Ball Bearing Friction:**
Can. S.K.F. Co. Ltd.

**Clutches, Magnetic**
Northern Electric Co. Ltd.

**Coal Handling Equipment:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Combustion Engineering Corp. Ltd.
E. Long Ltd.

**Combustion Control Equipment:**
Bailey Meter Co. Ltd.

**Compressors, Air and Gas:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Canadian Ingersoll-Rand Company, Limited.
Foster Wheeler Co.

**Concrete:**
Canada Cement Co. Ltd.

**Condensers, Steam:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Canadian Ingersoll-Rand Company, Limited.
Foster Wheeler Limited.

**Condensers, Synchronous and Static:**
Bepco Canada Ltd.
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Crompton Parkinson (Canada) Ltd.
Harland Eng. Co. of Can. Ltd.
Lancashire Dynamo & Crypto Co. of Can. Ltd.
Northern Electric Co. Ltd.
Bruce Peebles (Canada) Ltd.

**Conduit:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co Ltd.

**Conduit, Underground Fibre, and Underfloor Duct:**
Northern Electric Co. Ltd.

**Conduits, Wood Pressure Creosoted:**
Canadian Wood Pipe & Tanks Ltd.

**Controllers, Electric:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.

**Couplings:**
Dart Union Co. Ltd.
Dresser Mfg. Co. Ltd.

**Couplings, Flexible:**
Dominion Engineering Works Limited.
Dresser Mfg. Co. Ltd.
The Hamilton Gear & Machine Co. Ltd.

**Cranes, Hand and Power:**
Dominion Bridge Co.

**Cranes, Locomotive:**
Dominion Hoist & Shovel Co. Ltd.

**Cranes, Shovel, Gasoline Crawler, Pillar:**
Dominion Hoist & Shovel Co. Ltd.

**Crowbars:**
B. J. Coghlin Co. Ltd.

**Crushers, Coal and Stone:**
Canadian Ingersoll-Rand Company, Limited.
Jeffrey Mfg. Co. Ltd.

D

**Dimmers:**
Northern Electric Co. Ltd.

**Disposal Plants, Sewage:**
W. J. Westaway Co. Ltd.

**Ditchers:**
Dominion Hoist & Shovel Co. Ltd.

**Drills, Pneumatic:**
Canadian Ingersoll-Rand Company, Limited.

**Dynamite:**
Canadian Industries Limited.

E

**Economizers, Fuel:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Combustion Engineering Corp. Ltd.
Foster Wheeler Limited.

**Ejectors:**
Darling Bros. Ltd.

**Elbows:**
Dart Union Co. Ltd.

**Electric Blasting Caps:**
Canadian Industries Limited.

**Electric Railway Car Couplers:**
Can. Ohio Brass Co. Ltd.

**Electrical Supplies:**
Can. General Elec. Co. Ltd.
Can. Ohio Brass Co Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.

**Electrification Materials, Steam Road:**
Can. Ohio Brass Co. Ltd.

**Elevating Equipment:**
E. Long Ltd.
Plessisville Foundry.

**Elevators:**
Darling Bros. Ltd.

**Engines, Diesel and Semi-Diesel:**
Canadian Ingersoll-Rand Company, Limited.
Harland Eng. Co. of Can. Ltd.

**Engines, Gas and Oil:**
Canadian Ingersoll-Rand Company, Limited.

**Engines, Steam:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Harland Eng. Co. of Can. Ltd.
E Leonard & Sons Ltd.

**Evaporators:**
Foster Wheeler Limited.

**Expansion Joints:**
Darling Bros. Ltd.
Foster Wheeler Limited.

**Explosives:**
Canadian Industries Limited.

F

**Feed Water Heaters, Locomotive:**
The Superheater Co. Ltd.

**Filtration Plants, Water:**
W. J. Westaway Co. Ltd.

**Finishes:**
Canadian Industries Limited.

**Fire Alarm Apparatus:**
Northern Electric Co. Ltd.

**Floodlights:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.

**Floor Stands:**
Jenkins Bros. Ltd.

**Floors:**
Canada Cement Co. Ltd.

**Forcite:**
Canadian Industries Limited.

**Forgings:**
Bethlehem Steel Export Corp.

**Foundations:**
Canada Cement Co. Ltd.

G

**Gaskets, Asbestos, Fibrous, Metallic, Rubber:**
The Garlock Packing Co. of Can. Ltd.

**Gasoline Recovery Systems:**
Foster Wheeler Limited.

**Gates, Hydraulic Regulating:**
Dominion Bridge Co. Ltd.

**Gauges, Draft:**
Bailey Meter Co. Ltd.

**Gear Reductions:**
The Hamilton Gear & Machine Co. Ltd.

**Gears:**
Dominion Bridge Co. Ltd.
Dominion Engineering Works Limited.
The Hamilton Gear & Machine Co. Ltd.
E. Long Ltd.
Plessisville Foundry.

**Generators:**
Bepco Canada Ltd.
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Crompton Parkinson (Canada) Ltd.
Harland Eng. Co. of Can. Ltd.
Lancashire Dynamo & Crypto Co. of Can. Ltd.
Northern Electric Co. Ltd
Bruce Peebles (Canada) Ltd.

**Governors, Pump:**
Bailey Meter Co. Ltd.

**Governors, Turbine:**
Dominion Engineering Works Limited.

**Gratings, M. & M. Safety:**
Dominion Bridge Co. Ltd.

H

**Hangers, Ball and Roller Bearing:**
Can. S.K.F. Co. Ltd.

**Headlights, Electric Railway:**
Can. General Elec. Co. Ltd.
Can. Ohio Brass Co. Ltd.
Can. Westinghouse Co. Ltd.

**Heat Exchange Equipment:**
Foster Wheeler Limited.

**Hoists, Air, Steam and Electric:**
Canadian Ingersoll-Rand Company, Limited.
Dominion Hoist & Shovel Co. Ltd.

**Humidifying Equipment:**
W. J. Westaway Co. Ltd.

I

**Incinerators:**
Canada Cement Co. Ltd.

**Indicator Posts:**
Jenkins Bros. Ltd.

**Industrial Electric Control:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.

**Injectors, Locomotive, Exhaust Steam:**
The Superheater Co Ltd.

**Inspection of Materials:**
J. T. Donald & Co. Ltd.
Milton Hersey Co. Ltd.

**Instruments, Electric:**
Bepco Canada Ltd.
Can. General Elec. Co. Ltd.
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# THE ENGINEERING JOURNAL

VOL. XVII
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FEBRUARY
1934

## *In this issue*



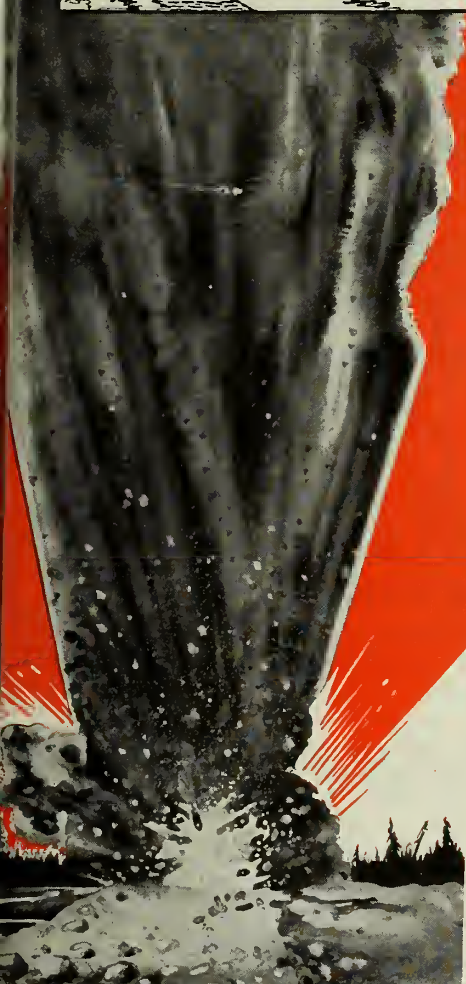
PUBLISHED MONTHLY BY

THE ENGINEERING INSTITUTE *of* CANADA

# *The Romance of Power Development in Canada*

## AT THE SITE OF A GRIST MILL

erected about the year 1800 at
the mouth of the St. Louis River

FOR centuries the de Beauharnois family was prominent in the life of Old and New France. It furnished Canada during the ancient regime with a governor and an intendant. About the year 1800 the Seigneur, to provide a more even flow in the stream at all seasons, built a small feeder canal from Lake St. Francis to the nearby headwaters of the St. Louis. These fundamental diversion rights are still in existence and are now held by the Beauharnois Power Corporation.

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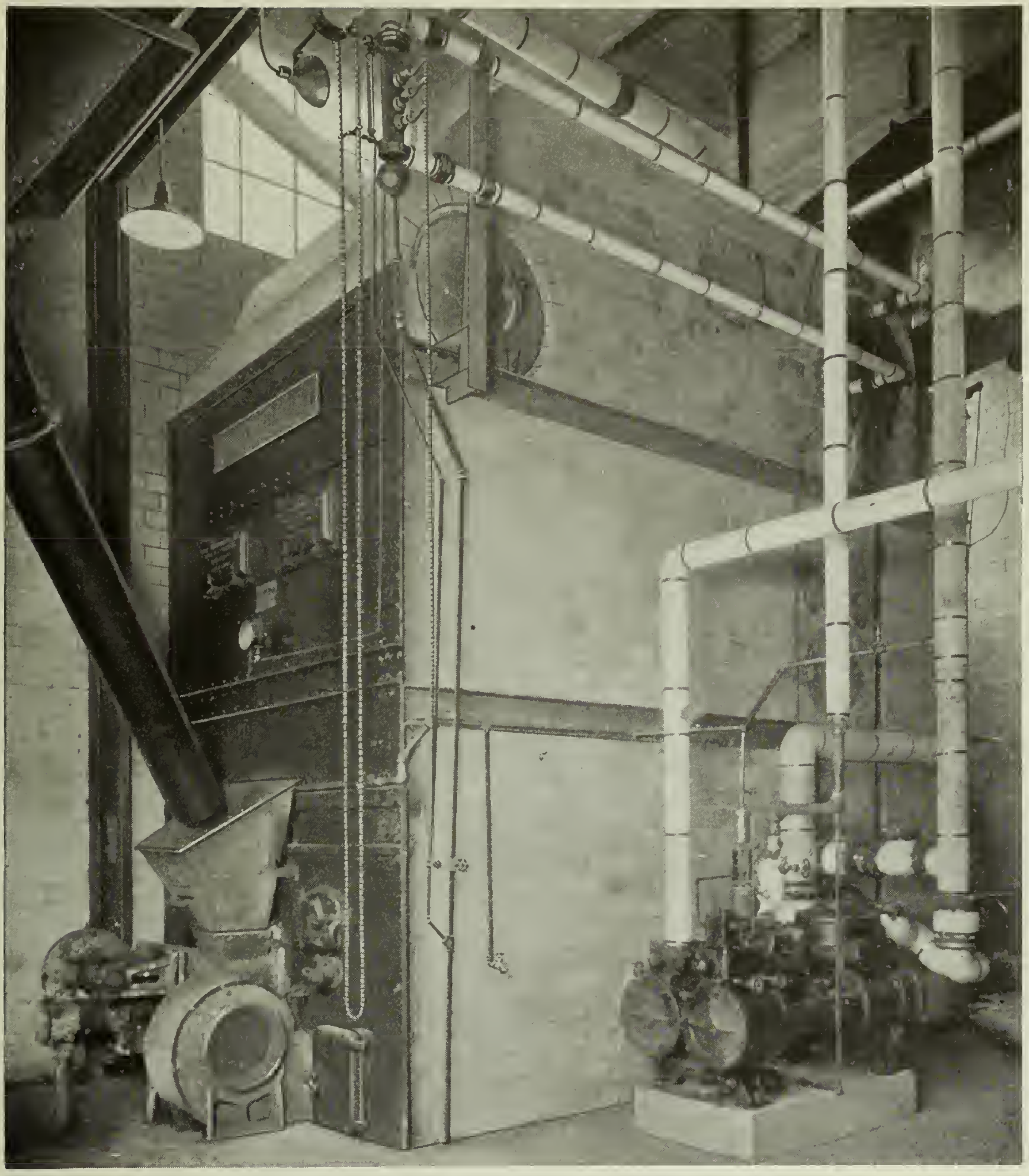

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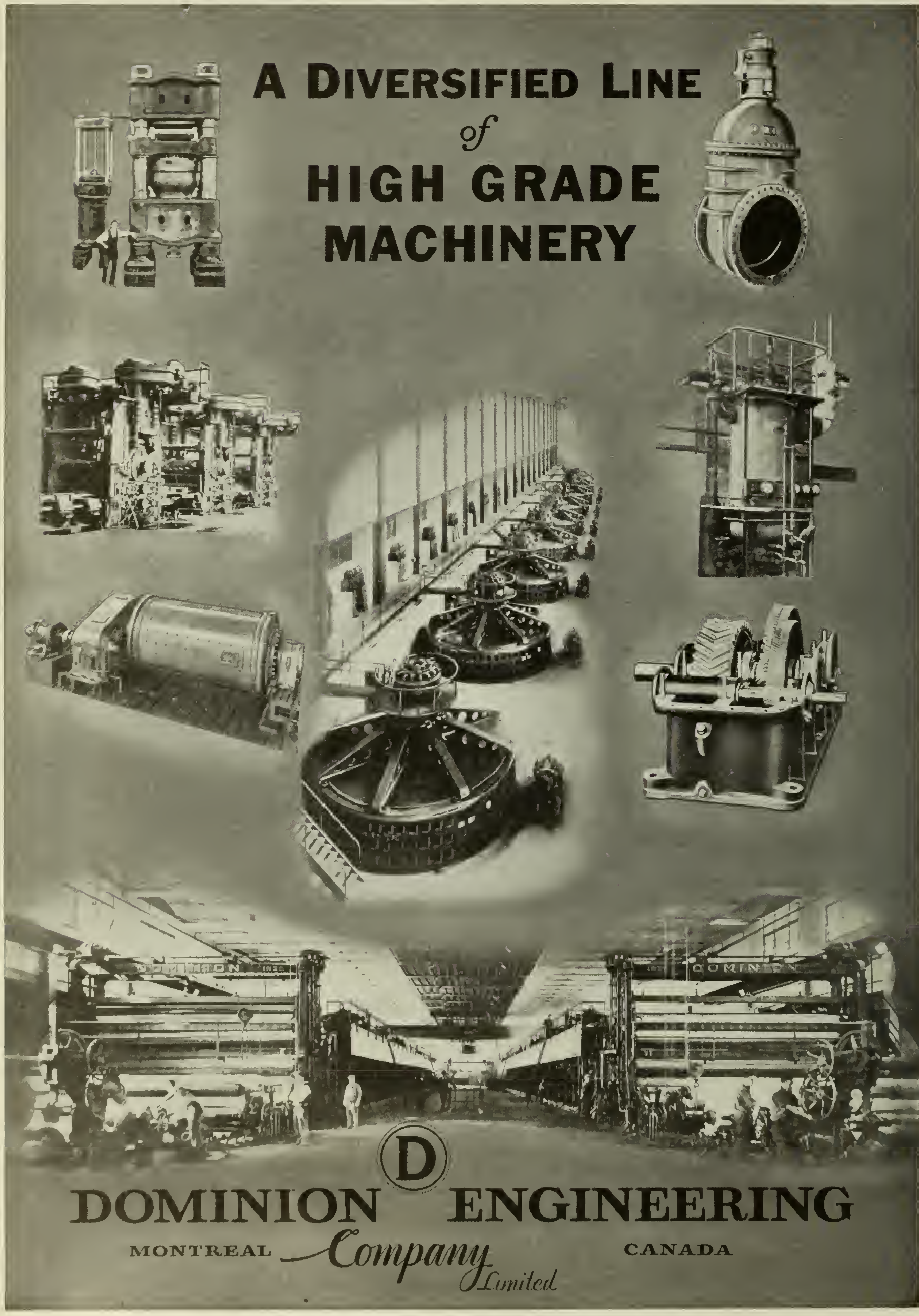
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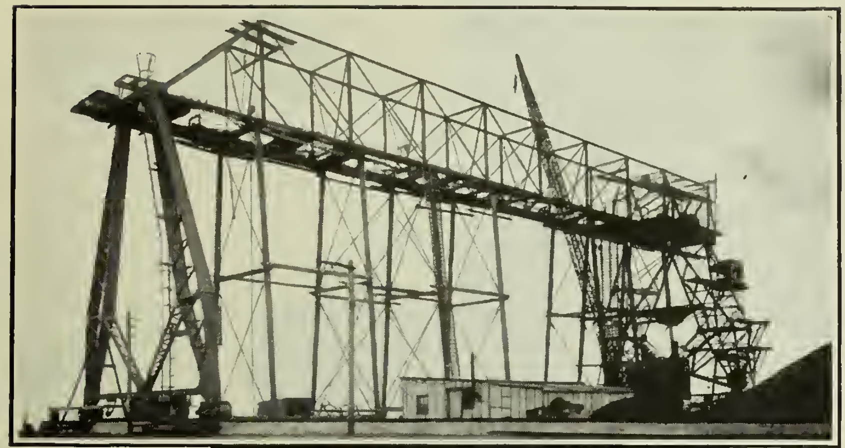



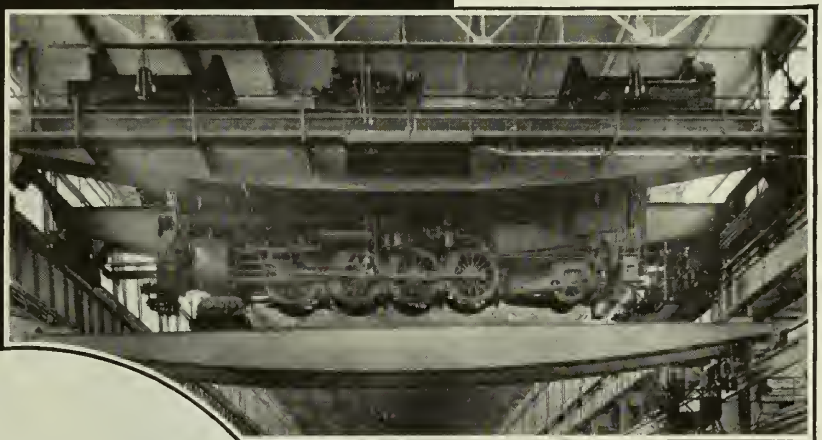

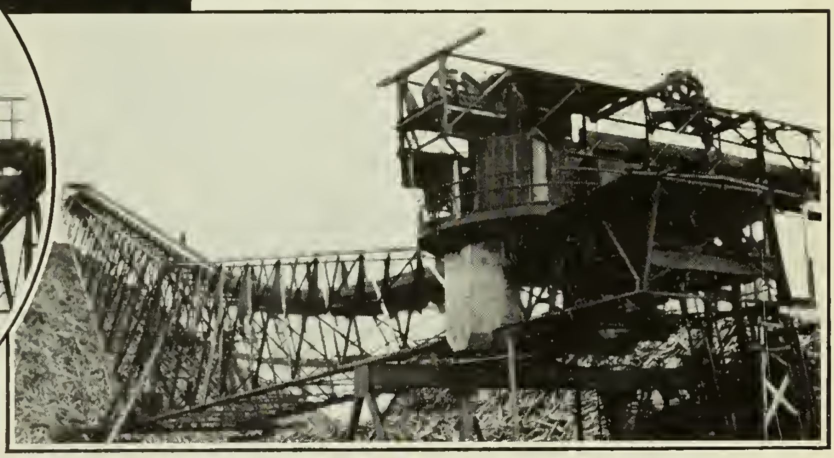

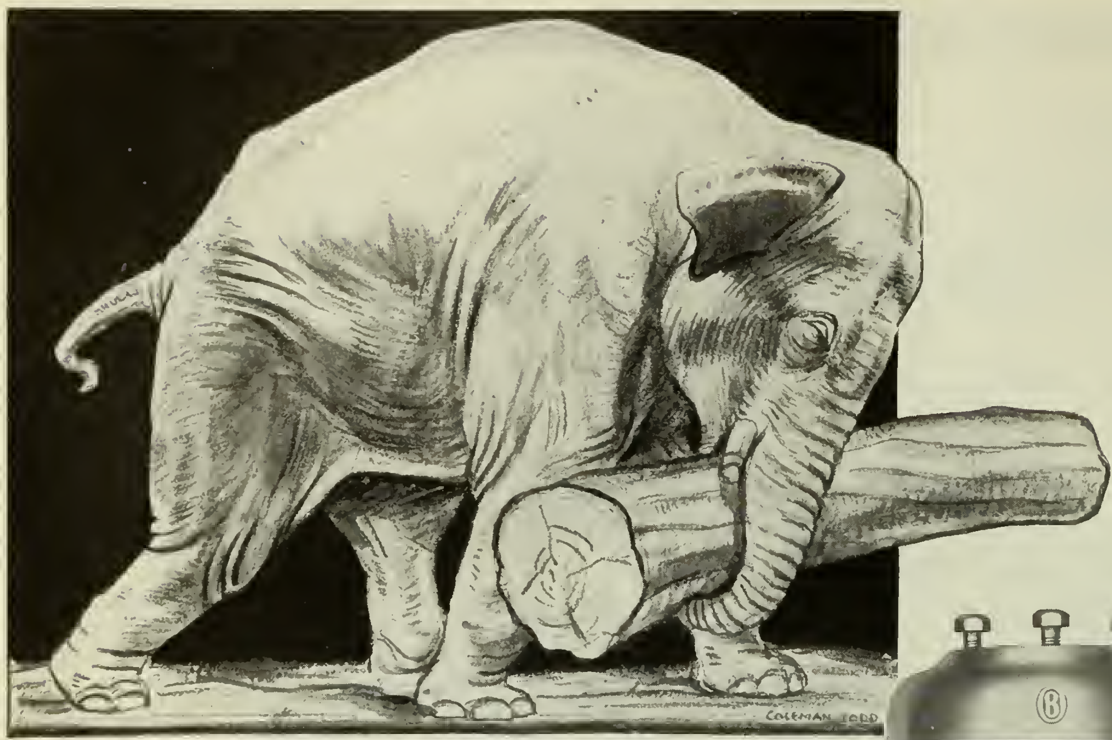

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## THE JOURNAL OF THE ENGINEERING INSTITUTE OF CANADA

*"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"*

**February 1934** | **Volume XVII, No. 2**

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# Department of National Defence Relief Camps and Projects

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**Paper to be presented at the General Professional Meeting of The Engineering Institute of Canada, Montreal, Que., February 9th, 1934.**

**SUMMARY.—Dealing with the relief work organized by the Dominion government in camps for the benefit of single, homeless, unemployed men, the paper gives details of the scheme, which in the first twelve months of its operation has afforded over 2,000,000 man-days of relief work at a cost of about $1.00 per man-day. A number of the supervisory and administrative positions in the camps are filled by unemployed professional men. As far as possible, the projects undertaken are such as can be carried out mainly by unskilled labour.**

The unemployment relief scheme administered by the Department of National Defence for the care of single homeless men owes its success, in no small measure, to the generous and hearty co-operation of The Engineering Institute of Canada; consequently the members, as a whole, of The Institute may be interested in the main features of this scheme. It is with a view to presenting this information to the membership at large that this paper has been prepared.

No one realizes better than the engineering profession the extent to which unemployment had spread in practically all branches of industry in Canada by the autumn of 1932, when it was estimated that there were between sixty and seventy thousand single homeless unemployed in Canada in need of relief. Many of these were dependent for accommodation and sustenance either on "hostels" financed through contributions from various sources, or on the generosity of the individual householder. Enforced idleness, scanty clothing, inadequate food and no immediate prospects of improved conditions combined to make the outlook of these unfortunate young Canadians most appalling. In addition to the problem of the care of many thousands of single homeless Canadians, the situation was further complicated by the large numbers of persons who had recently come to the country and who had not been absorbed. It is estimated that the number of men in this category amounted to nearly one hundred thousand. Unemployed under such conditions soon become unemployable, of no value to themselves and a menace to the state, in that they are potential recruits for organizations that thrive on misery and distress, fail to lend assistance, and do everything possible to increase human discontent so that the established order may be overthrown.

In October, 1932, it was proposed that the Department of National Defence utilize its Dominion-wide organization to administer and control a scheme for the relief of the single unemployed homeless men, this scheme to comprise the execution of various works that could be economically carried out to the general advantage of Canada. The works to be undertaken would anticipate by some years the ordinary programmes, so that by proceeding with them in the present no men are deprived of work at remunerative rates of wages which they might otherwise have had either now or in the near future. This Department possesses facilities for feeding, equipping and clothing large numbers of men, and these factors, combined with the fact that it has its own engineering, medical and administrative services, indicated that it was, from a general standpoint, a logical Federal Department to administer a scheme in which the direct feeding, clothing, etc. of the relief personnel are important features.

Apart from the economic value to the country of the works to be executed, the scheme propounded by the Department of National Defence aimed at improving the mental and physical condition of the single homeless unemployed by freeing them from the demoralizing effects of enforced idleness and providing them with wholesome food, adequate clothing, comfortable accommodation and, most important, with useful work to do. Further, the proposed scheme offered opportunities to certain classes of tradesmen to work at their trades and so maintain their efficiency, and also offered opportunities to unskilled labour to learn the rudiments of some useful trade.

The government gave favourable consideration to the scheme and on October 8th, 1932, an Order-in-Council authorized the Ministers of National Defence and Labour to arrange (during the period October 8th, 1932-March, 31st, 1933) for the care of a maximum of two thousand single homeless men in need of relief. The work specified was the clearing of twenty-four landing fields on the trans-Canada airway, repairs to the citadel walls at Halifax and Quebec, both of which are important national historical memorials; and the general improvement of air stations at certain other points.

From this modest beginning, the scheme has steadily expanded, with the result that the latest Order-in-Council (October, 1933) provides during the period November 1st, 1933-March 31st, 1934,[1] for the care of up to thirty-five thousand single homeless men on works such as clearing and grading of landing fields, forestry work, highway construction, dredging, and other work of a primitive nature not requiring any large expenditure on machinery or materials of construction. Projects are located in every province of Canada except Prince Edward Island where, to date, the problem of the single homeless man has not been serious. Work projects that require skilled labour have necessarily had to be kept at a minimum; to date the cost on this account and for machinery and materials purchased has been approximately 12 per cent of the total expenditure.

**Fig. 1—Frame and Canvas Camp Buildings, Kimberley-Wasa Highway, B.C.**

Proposals for works to be executed under this scheme emanate from various sources and, if they fall within the category of "works for the general advantage of Canada," they are considered by the Department of National Defence in conjunction with the Federal Department of Labour. No project is authorized, however, unless the preliminary estimates indicate that it can be executed economically, and the unemployment situation in the locality warrants its inception.

When a project is authorized, the responsibility for its execution is placed upon the Officer Commanding the Military District concerned or upon the official in charge of certain groups of projects which are under the direct control of National Defence Headquarters. These independent groups have been established in areas, such as Northern Ontario, remote from the Military District Headquarters in order to reduce the expense of administration and control.

Although the staffs of the Military Districts are utilized for the general administration of the projects, the projects themselves are, in practically all cases, directly in charge of civilian personnel. The technical supervisory personnel are graded as engineers, assistant engineers, foremen, sub-foremen and gang bosses, depending on the size and importance of the project. Appointments as engineers, assistant engineers, foremen and sub-foremen are, for the most part, filled by nominees of The Engineering Institute of Canada (and the provincial Associations of Professional Engineers working in conjunction with The Institute). They are normally married men selected by the various relief committees of The Institute or Provincial Associations on the basis of comparative need of relief, that is, provided technical qualifications and experience in handling men are equal. The positions of gang bosses are normally filled by capable practical men who have entered the camps as labourers. Promotion to grades up to and including foreman is given to practical men of marked ability if opportunity offers, but the positions of engineer and assistant engineer are reserved for qualified professional engineers. Up to December 15th, 1933, seventy-three members of The Institute (and seventy-one other qualified professional engineers) in need of relief have been cared for under this scheme, and it is hoped that thereby they may be assisted to maintain their professional efficiency until conditions permit their re-absorption in the economic life of the country in remunerative employment.

In the case of the larger projects, doctors, nominated by the Canadian Medical Association from members of the medical profession who are in need of relief, are engaged. In the case of smaller projects or where medical personnel in need of relief are not available, local practitioners are engaged at contract rates.

The remainder of the supervisory personnel—accountants, storemen, clerks, cooks and assistant cooks, and the relief labourers are selected in consultation with the local offices of the Employment Service of Canada or, in localities where such offices do not exist, in consultation with the municipal authorities concerned. The junior supervisory personnel are selected mainly from the ranks of married men in need of relief; the relief labourers are selected from the single homeless unemployed.

Personnel selected for the relief projects are given free transportation from the point of selection to the project. They are given free outward transportation, for a distance not exceeding the inward journey, if they definitely secure other employment, or on conclusion of the project.

**Fig. 2—Dining Hut, Long Branch, Ont.**

**Fig. 3—Hut Construction, Dundurn, Sask.**

Accommodation is provided in existing buildings if such are conveniently located, in tents for summer projects, or in frame huts which, as a general rule, are of the "sectional" type. During the winter of 1932-1933 mobile camps were established in railway boarding cars in a few cases, pending the erection of frame camp buildings. Canvas roofs have been used in a number of instances where the camps are required for only comparatively short periods in one place.

Fig. 4—Clearing, Lac Seul, Ont.

The food supplied is based on the standard army ration, which consists of:

| | | | |
|---|---|---|---|
| Bread | 1 pound | Butter | 2 ounces |
| Beef | 1 " | Cheese | 1 " |
| Potatoes | 1 " | Milk (evaporated) | 1 " |
| Fresh vegetables | 6 ounces | Split peas | ½ " |
| Bacon | 3 " | Salt | ½ " |
| Sugar | 3 " | Pepper | 1/36 " |
| Beans | 2 " | Coffee | ⅓ " |
| Jam | 2 " | Tea | ¼ " |

per man per day. This ration may be varied at the discretion of the official responsible for the project, provided that the medical officers are satisfied that it is not thereby unbalanced, and provided that the cost does not exceed that of the standard army ration. Contracts for food supplies are arranged by the Director of Contracts (Purchasing Agent) of the Department of National Defence. In addition to this ration, the relief personnel are given a free issue of ⅓ ounce per man per day of smoking tobacco, or the equivalent in chewing tobacco or snuff.

No man is selected for a relief project unless he is found to be medically fit for ordinary manual labour and free from communicable disease, the necessary medical examination being carried out at public expense. Personnel selected are given medical attention and hospital treatment, where necessary, free of cost, and their allowances are continued while undergoing medical treatment or while in hospital. Cases requiring simple hospital treatment are cared for in the project hospital hut, but serious cases are treated, under contract, in the nearest civic or municipal hospital. The medical personnel employed are responsible for the sanitation of the camps in accordance with provincial regulations.

Personnel taken on the strength of a project are given a free issue of such articles of clothing as they actually require up to a maximum authorized scale. The articles issued include boots, trousers, sweaters, shirts, underwear, caps, mackinaws or overcoats, rubber boots, mitts, etc. In addition, necessary articles such as towels, razors, razor blades, kit bag, etc. are provided. When a man leaves a project he is permitted to retain essential requirements but is required to hand in all other clothing issued. For example, a man leaving in summer is not allowed to take away a mackinaw or overcoat, whereas in winter he would be allowed to do so provided he had joined the project without a garment of this nature.

Facilities for outdoor sports are provided as far as local conditions permit the preparation of grounds for softball, soccer, etc. Sports equipment has been provided, in a number of cases, through the generosity of organizations and individuals, who have also furnished materials for indoor games, reading material, gramophones, radios, etc.

Education is not neglected and, through the cooperation of the Frontier College, the relief personnel who so desire are given the advantage of general education classes in elementary subjects.

In addition to the free transportation, accommodation, subsistence, tobacco, clothing, medical care and recreational and educational facilities indicated above, relief personnel receive the following cash allowances:

| | |
|---|---|
| Engineers and superintendents | $100.00 per month |
| Assistant engineers | 80.00 " |
| Medical officers | 70.00 " |
| Assistant medical officers | 60.00 " |
| Foremen | 60.00 " |
| Accountants | 50.00 " |
| Cooks | $40.00 to $50.00 per month |
| Sub-foremen | $40.00 per month |
| Storemen | 30.00 " |
| Assistant cooks | $20.00 to $30.00 per month |
| Gang bosses | $20.00 per month |
| Clerks and timekeepers | 20.00 " |
| Labourers | 20 cents per day for each day, or portion of day, actually worked. |

Fig. 5—Landing Field Site, Megantic, Que.

Fig. 6—Highway Construction near Tadanac, B.C.

No military discipline or drill is instituted in relief camps and the regulations which the personnel are required to observe are no more than are normally followed in the operation of an ordinary well-conducted construction camp. In only a few instances are the projects in direct charge of military personnel, and in the majority of camps the supervisory personnel are entirely civilian. Personnel are free to leave whenever they choose and, if they are not prepared to comply with the regulations prescribed, are discharged. They are not subjected to any punishment unless their actions require their arrest and conviction under the ordinary process of law.

**Fig. 7—Cribwork, Big Bend Highway, North of Revelstoke, B.C.**

The first project was opened on November 1st, 1932, and by October 31st, 1933, on a total of one hundred and one projects, 2,064,337 man-days of relief had been afforded. As many of these projects are newly opened, it is as yet too early to say conclusively that the total cost will be within the objective of $1 per man-day. The average cost, estimated on the basis of full establishment, for some eighty-seven projects which have been in operation for over three months is now down to 98 cents per man-day. Detailed analysis of the work performed on all projects shows an average labour efficiency of 56 per cent. It is also as yet too early to give precise figures of cost and created values with confidence, but it is clear that when created capital values are taken into account on a conservative basis, the net cost is substantially lower than the cost which would have been incurred had the men in question been cared for through direct relief.

### Criticisms of the Plan

The opposition of the radical elements in the country to this scheme is not difficult to understand, as no other attitude on their part could be expected. Certain sections of organized labour contend that the scheme is setting a bad example to private enterprise, municipalities, etc., and is fostering a general lowering of the standards of living. The attitude of the moderate members of the trades and labour unions appears to be that, while they appreciate the value of the scheme in that it takes men off the streets and gives them work which improves their health and morale, they feel that the work should be limited to projects requiring only unskilled labour or, if skilled labour is involved, that such should be paid at prevailing rates.

In considering the above objections, it should be remembered that this scheme aims at a measure of relief for "the single homeless unemployed." It seems illogical to contend that such personnel should receive prevailing rates of wages in preference to the large number of married men with families who are now unemployed. It is not the province or purpose of this article to discuss whether or not the government should embark on a Dominion-wide public works programme at prevailing rates of wages, but, if such a course were adopted, it is obvious that the unemployed with dependents would be absorbed before "single homeless men" with no dependents. Unless, therefore, a reconstruction scheme of such magnitude as to absorb *all* unemployed in the country were adopted, it is quite clear that the single homeless employed would remain in the same state as before the introduction of the existing scheme, as, invariably, this class is the first to be let out of employment and the last to be re-absorbed.

The scheme does not aim at lowering standards of wages—in fact, *the remuneration given is not classed as wages at all.* It is merely an allowance so as to permit the men to purchase the few small necessities which they require, and to avoid having to issue these articles on ration. It is recognized that "wages," as such, should be in conformity with the fair wage schedules, but the personnel cared for under this scheme are offered accommodation, food, clothing, medical care and a small allowance in return for their work *until such time as they can be absorbed in industry.* No restriction is placed in the way of a man who wishes to leave to accept a job or position—in fact men who secure work outside are given free transportation from the project in order to accept it. Further, every endeavour is made to place competent personnel in jobs, and men who desire to engage in harvesting or other seasonal work are given an assurance that they will be taken back on the project, if they so desire, when this temporary employment is finished.

The criticism that the works executed under this scheme should be confined to "primitive" work requiring only unskilled labour implies that the works requiring skilled labour are carried out exclusively by relief personnel, the skilled tradesmen among whom are "forced" to work at their trades under penalty of dismissal. Nothing is further from the truth. Skilled tradesmen among the relief personnel are encouraged to work at their trades, if opportunities offer, in the interest of retaining their manual efficiency, but if a carpenter or a plumber prefers working outside with a pick and shovel to working at his trade, he is allowed to do so. It is an established fact, however, that the majority of skilled tradesmen among the relief personnel infinitely prefer to work at their trades in order that they may retain their efficiency, and many young men who have had no opportunity to learn a trade welcome a job as a carpenter's helper, etc. in order that they may qualify as "handymen" when industry revives. Moreover, if there are insufficient relief personnel on a project who are capable of, or agreeable to, performing the "skilled" work

**Fig. 8—Making Concrete Blocks, Air Station, Trenton, Ont.**

required, married skilled tradesmen in the vicinity are engaged, on a rotation basis, at prevailing rates.

The argument that only "primitive" work should be undertaken would carry weight if there were sufficient of such work to absorb all the single homeless unemployed. However, this is not the case, and it has been necessary, in order to care for more of this class, to institute projects on which a certain amount of skilled work is required. It must be remembered also that projects involving skilled

**Fig. 9— Repairing Citadel Walls, Quebec, Que.**

labour, such as building construction, restoration of fortification walls, etc. require a large amount of complementary unskilled labour in the normal course of events. Moreover, the restriction of projects to the "primitive" type would mean that skilled tradesmen among relief personnel who wish to work at their trades would be denied this opportunity. The employment on "primitive" work of skilled tradesmen who wish to work at their trades is not only wasteful but is destructive of morale, and the main purpose of this scheme is to restore the morale of those who have been experiencing the demoralizing effects of idleness, living in hostels, feeding at soup kitchens and depending on the generosity of individuals for an occasional coin.

An argument has been advanced that the morale of this personnel would be enhanced and they would feel more independent if they were given an hourly rate, bought their own clothing, tobacco, etc. and had deductions made for board, medical care, etc. The answer is that under such a scheme, the cost per man per day to the government would necessarily be much higher than now if the man were to be assured a net $5.00 at the end of each month. In the matter of clothing, alone, the facilities of the Department of National Defence for purchasing and distributing in large quantities ensure that the required articles are supplied at only a fraction of the cost that the man would be obliged to pay if he purchased elsewhere. Surely, if the eventual result to the relief personnel is the same, the method which imposes the lighter load on the taxpayers should be adopted, apart from any question of the simplicity of the present method, and the fact that it enables the organization of the Department of National Defence to function in its normal method of supply and distribution of food, clothing, etc. without incurring heavy overhead costs.

### Comparisons with the United States Plan

The Civilian Conservation Corps of the United States is recruited primarily from single unemployed men, under twenty-five years of age, with dependents. Single unemployed over twenty-five years of age with dependents and single *homeless* unemployed of any age are not catered for. Each man in the Conservation Corps receives $5.00 per month for personal use and $25.00 is paid to his dependents. As far as the man cared for is concerned, the financial remuneration is practically the same in the United States and Canada.

The schemes differ in organization. In the United States nearly six thousand army personnel are employed full time on the scheme. In the same proportion, Canada would utilize three hundred to four hundred military personnel on full time, whereas less than a dozen are employed on this basis. Of course a number of military personnel are employed part time on the organization and administration of the work, in addition to their normal duties, but relief personnel are used practically entirely for camp staffs and superintendence of works.

Under the American scheme the relief personnel are enrolled for certain definite periods, while, under the Canadian scheme, a man is free to leave whenever he chooses.

The most important difference is in the matter of discipline. In the Civilian Conservation Corps discipline is enforced through the Summary Court-Martial scheme in operation in the United States Army. In the Canadian relief scheme, no powers of compulsion have been taken and the appeal is to the man's intelligence, not to his fear of punishment.

### Conclusion

Having due regard to the fact that the scheme described is for the purpose of affording a measure of relief to single homeless unemployed, it is claimed that, for the purpose intended, the scheme described is serving its purpose with fairness to the relief personnel eligible and with economy to the taxpayer. It is not contended that it is a solution of the unemployment problem, neither is it contended that it is properly applicable to single or married unemployed with dependents. Above all, it is desired to emphasize that it is not an attack on organized labour nor on the standards of living of those who live by manual labour. Single homeless men who are provided with wholesome food, good accommodation, adequate clothing, medical care, recreational facilities, tobacco and a net cash allowance of $5.00 per

**Fig. 10—Grading Landing Field, Salmo, B.C.**

month, with no worries or responsibilities, in return for a moderate amount of work, are probably better off than many married men on direct relief in these times of depression. The best answer to criticism of the plan is to visit the camps and see the men themselves. In only one camp—Long Branch—have professional agitators been able to make any impression, and it is established that a large number of the men who left that camp now regret that they allowed themselves to be influenced by the radical element.

In conclusion, it must be stated that the Departments of Labour and National Defence have been materially assisted in this scheme through the co-operation of other Federal Departments and of various provincial governments. As indicated earlier in this paper, The Engineering Institute of Canada has taken an active part in making this scheme a success through its nomination of competent engineers for supervisory positions, and the fact that The Institute has thus been in a position to assist its unemployed members, and other unemployed engineers, in need of relief should ensure that its value is enhanced in the eyes of the engineering profession generally.

Finally, it is satisfactory to record that there has been a steady flow of men from the camps back to industry, and it is confidently hoped that with the developing opportunities for regular employment this will continue and increase. The purpose has been to ensure that the efficiency—mental, physical and at their trades—of the men entrusted to the Departments' care is improved, so that they may be returned to the economic life of the country well able to resume their usual work.

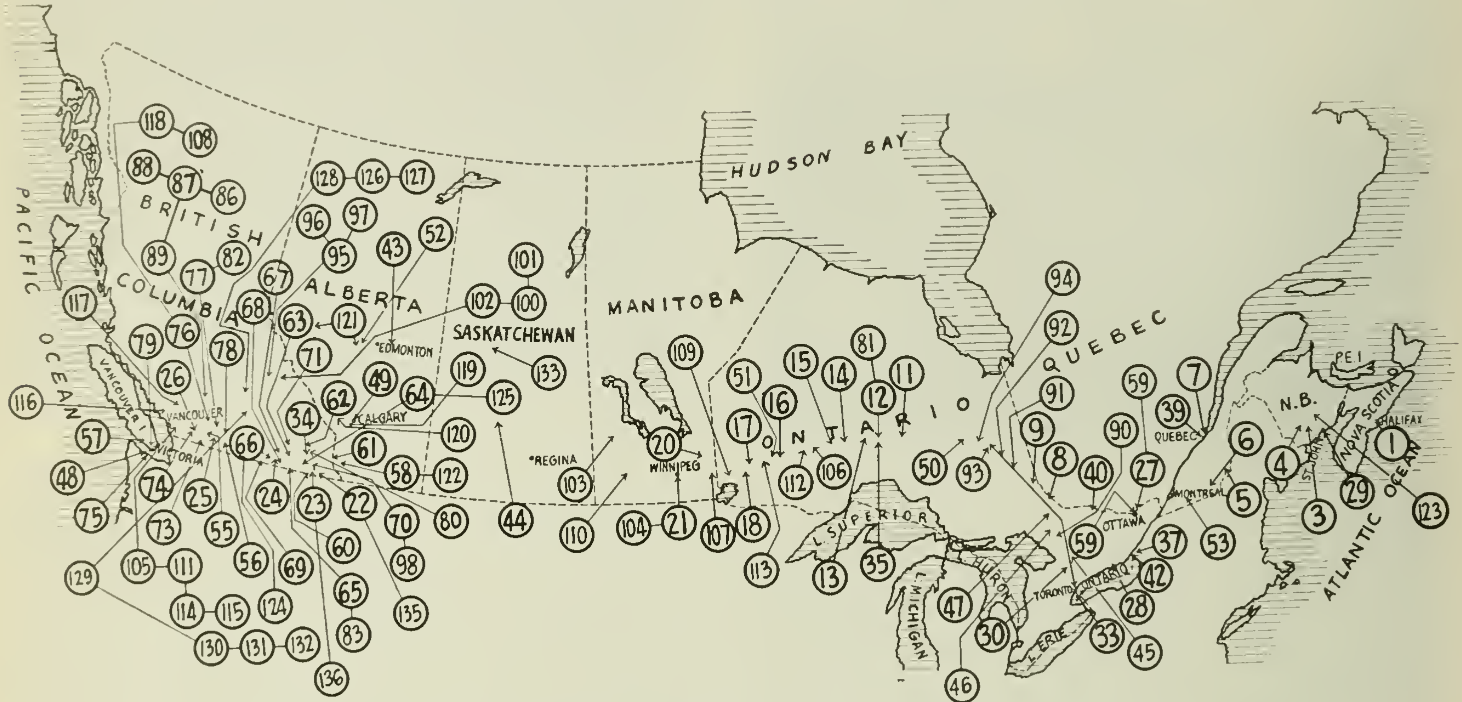


**Fig. 11**

**Department of National Defence Unemployment Relief Projects commenced by 1st January, 1934.**

| Project No. | Location | Classification | Establishment | Strength |
|---|---|---|---|---|
| 1 | Halifax, N.S. | Fortifications and H.S. | 265 | 134 |
| 3 | Blissville, N.B. | I. L. Fields | Closed for winter. | |
| 4 | Upper Brockway, N.B. | " | 6 | 5 |
| 5 | Megantic, P.Q. | " | 56 | 70 |
| 6 | Bishopton, P.Q. | " | 60 | 48 |
| 7 | Quebec, P.Q. | Fortifications and H.S. | 423 | 418 |
| 8 | Diver, Ont. | I. L. Fields | 115 | 98 |
| 9 | Gillies, Ont. | " | 49 | 49 |
| 11 | Pagwa, Ont. | " | 109 | 99 |
| 12 | Nakina, Ont. | " | 109 | 98 |
| 13 | Kowkash, Ont. | " | 109 | 66 |
| 14 | Lamaune, Ont. | " | 109 | 98 |
| 15 | Wagaming, Ont. | " | 109 | 97 |
| 16 | Sioux Lookout, Ont. | " | 109 | 90 |
| 17 | Amesdale, Ont. | " | 109 | 82 |
| 18 | Vermilion Bay, Ont. | " | 109 | 67 |
| 20 | Lac du Bonnet, Man. | Air Stations | 110 | 101 |
| 21 | Winnipeg, Man. | " | 109 | 98 |
| 22 | Yahk, B.C. | I. L. Fields | Closed for winter. | |
| 23 | Kitchener, B.C. | " | " | |
| 24 | Salmo, B.C. | " | " | |
| 25 | Princeton, B.C. | " | Completed. | |
| 26 | Hope, B.C. | " | 126 | 81 |
| 27 | Ottawa Air Station | Air Stations | 477 | 475 |
| 28 | Trenton, Ont. | " | 866 | 549 |
| 29 | Saint John, N.B. | Municipal Airport | 149 | 147 |
| 30 | Camp Borden, Ont. | Air Stations | 242 | 236 |
| 33 | Long Branch, Ont. | Tr. Camps, Barracks, etc. | 96 | 91 |
| 34 | Cranbrook, B.C. | Rifle Ranges | Completed. | |
| 35 | Group H.Q., Nakina, Ont. | I. L. Fields | 18 | 18 |
| 37 | Royal Military College, Kingston, Ont. | Barracks, Roads, etc. | 264 | 257 |
| 39 | Valcartier, P.Q. | Tr. Camps, Forestry, Roads, etc. | 1722 | 1632 |
| 40 | Petawawa, Ont. | Tr. Camps, Forestry, etc. | 1060 | 1023 |
| 42 | Barriefield, Ont. | Barracks, Roads, etc. | 542 | 536 |
| 43 | Cooking Lake, Alta. | Municipal Airport | Closed for winter. | |
| 44 | Dundurn, Sask. | Tr. Camps, Roads, etc. | 1474 | 1060 |
| 45 | Reay, Ont. | I. L. Fields | 119 | 90 |
| 46 | South River, Ont. | " | Closed for winter. | |
| 47 | Group H.Q., North Bay, Ont. | " | 16 | 16 |

| Project No. | Location | Classification | Establishment | Strength |
|---|---|---|---|---|
| 48 | Headquarters, Dist. 11, Victoria, B.C. | Administration | 19 | 17 |
| 49 | Headquarters, Dist. 13, Calgary, Alta. | " | 18 | 17 |
| 50 | Kapuskasing, Ont. | I. L. Fields | 109 | 109 |
| 51 | Lac Seul, Ont. | Clearing | 1758 | 931 |
| 52 | Winterburn, Alta. | Rifle Ranges | 107 | 100 |
| 53 | St. Johns, P.Q. | Barracks, etc. | 55 | 54 |
| 55 | Hope End, Princeton-Hope Highway, B.C. | Highway Construction | 565 | 305 |
| 56 | Princeton End, Princeton-Hope Highway, B.C. | " | 350 | 301 |
| 57 | West Coast Road, V.I., B.C. | " | 315 | 244 |
| 58 | Coleman, Alta. | I. L. Fields | Closed for winter. | |
| 59 | N.D.H.Q., Ottawa | Administration | 31 | 30 |
| 60 | Kingsgate (Eastport-Yahk), B.C. | Highway Construction | 154 | 154 |
| 61 | Crow's Nest-Michel, B.C. | " | 308 | 306 |
| 62 | Kimberley-Wasa, B.C. | " | 268 | 269 |
| 63 | Long Beach (Nelson-Fraser's Landing), B.C. | " | 308 | 115 |
| 64 | Goatfell (Creston-Goatfell), B.C. | " | 309 | 156 |
| 65 | Nelway (Nelway-Nelson), B.C. | " | 595 | 248 |
| 66 | China Creek (Castlegar-Trail), B.C. | " | 134 | 114 |
| 67 | Shoreacres (Nelson-Castlegar), B.C. | " | 134 | 134 |
| 68 | Rock Creek-Tadanac, B.C. | " | 154 | 140 |
| 69 | Sheep Creek (Rossland-Cascade), B.C. | " | Closed for winter. | |
| 70 | Group H.Q. Yahk, B.C. (East Kootenay) | " | 9 | 9 |
| 71 | Group H.Q., Nelson, B.C. (West Kootenay) | " | 10 | 12 |
| 73 | Hope-Rosedale, B.C. | " | 257 | 243 |
| 74 | Agassiz-Harrison Mills, B.C. | " | 501 | 451 |
| 75 | Esquimalt, B.C. | Barracks, etc. | 135 | 57 |
| 76 | Hope-Boston Bar, B.C. | Highway Construction | 509 | 426 |
| 77 | Group H.Q., Hope, B.C. | " | 12 | 12 |
| 78 | Group H.Q., Princeton, B.C. | " | 12 | 11 |
| 79 | Group H.Q., Sooke, B.C. | " | 5 | 4 |
| 80 | Cranbrook, B.C. | Municipal Airport | Closed for winter. | |
| 81 | Ogahalla, Ont. | I. L. Fields | 109 | 64 |
| 82 | Merritt-Princeton, B.C. | Highway Construction | 111 | 97 |
| 86 | Group H.Q., Spence's Bridge, B.C. | " | 9 | 9 |
| 87 | Spence's Bridge-Lytton, B.C. | " | 241 | 125 |
| 88 | Spence's Bridge-Cache Creek, B.C. | " | 277 | 205 |
| 89 | Spence's Bridge-Merritt, B.C. | " | 439 | 330 |
| 90 | Emsdale, Ont. | I. L. Fields | Closed for winter. | |
| 91 | Round Lake, Ont. | " | 61 | 56 |
| 92 | Ramore, Ont. | " | Closed for winter. | |
| 93 | Porquis Jct., Ont. | " | " | |
| 94 | Tudhope, Ont. | " | " | |
| 95 | Group H.Q., Salmon Arm, B.C. | Highway Construction | 11 | 11 |
| 96 | Salmon Arm-Sorrento, B.C. | " | 165 | 152 |
| 97 | Salmon Arm-Sicamous-Grindrod, B.C. | " | 307 | 236 |
| 98 | Roosville Cutoff, B.C. | " | 155 | 104 |
| 100 | Group H.Q., Revelstoke, B.C. | " | 11 | 11 |
| 101 | Big Bend (Revelstoke North), B.C. | " | 200 | 133 |
| 102 | Revelstoke-Sicamous, B.C. | " | 270 | 107 |
| 103 | Duck Mountain, Man. | Forestry | 225 | 122 |
| 104 | H.Q., District 10, Winnipeg, Man. | Administration | 11 | 11 |
| 105 | Point Grey, B.C. | Highway Construction | 200 | 167 |
| 106 | Allanwater, Ont. | I. L. Fields | 109 | 29 |
| 107 | Caddy Lake, Man. | " | 112 | 85 |
| 108 | Boston Bar, B.C. | " | 125 | 41 |
| 109 | Kenora, Ont. | " | 109 | 46 |
| 110 | Shilo, Man. | Tr. Camps | 112 | 40 |
| 111 | Group H.Q., Point Grey, B.C. | Highway Construction | 10 | 10 |
| 112 | Savant Lake, Ont. | I. L. Fields | 109 | 37 |
| 113 | Sunstrum, Ont. | " | 109 | 47 |
| 114 | White Rock, B.C. | Highway Construction | 296 | 237 |
| 115 | Aldergrove, B.C. | " | 144 | 121 |
| 116 | Pender Harbour-Half Moon Bay, B.C. | " | 277 | 249 |
| 117 | Squamish, B.C. | " | 136 | 122 |
| 118 | Boston Bar, B.C., Supply Warehouse | Administration | 2 | 2 |
| 119 | Sarcee Camp, Alta. | Rifle Ranges | 140 | 127 |
| 120 | Calgary-Banff, Alta. | Highway Construction | 683 | 652 |
| 121 | Edmonton-Jasper, Alta. | " | 350 | 100 |
| 122 | Frank, Alta. | " | 216 | 97 |
| 123 | Colter's Siding, N.B. | Forestry and Training Area | 600 | 397 |
| 124 | Taghum, B.C. | Highway Construction | 154 | 5 |
| 125 | Aldridge, B.C. | " | 154 | 33 |
| 126 | Group H.Q., Kamloops, B.C. | " | 9 | 9 |
| 127 | North Thompson River, B.C. | " | 234 | 74 |
| 128 | Dead Man Creek-Kamloops Lake, B.C. | " | 109 | 27 |
| 129 | Group H.Q., Kelowna, B.C. | " | 9 | 9 |
| 130 | Oyama, B.C. | " | 109 | 53 |
| 131 | Nahun, B.C. | " | 109 | 20 |
| 132 | Naramata, B.C. | " | 109 | 54 |
| 133 | Ladder Lake, Sask. | Prov. Airport | 55 | 22 |
| 135 | Yahk, B.C. | Highway Construction | 128 | 131 |
| 136 | Kitchener, B.C. | " | 128 | 122 |
| | Total | | 24,122 | 17,839 |

*Note on Abbreviations:*

Fortifications and H.S.........Fortifications and Historic Sites.
I. L. Fields....................Intermediate Landing Fields, Trans-Canada Airways.
Tr. Camps....................Training Camps.

# The Relation of Economics to Engineering

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(*Parts I and II now published, will be followed by Parts III and IV in an early issue*)

### Introduction

Civilization has now reached the stage where the different streams of knowledge, followed by the different sciences, are coalescing, and the artificial barriers raised by calling the sciences by different names are breaking down. Frequently it is when this coalescence of two subjects occurs, when some connecting channel between them is opened suddenly, that most striking advances in knowledge take place. Engineering and economics appear to be approaching such a stage now. Throughout their development the relations between the two sciences have been close and interwoven, and in the future it appears that the two will be more interrelated than ever. Since this study is concerned mostly, however, with the relations before this coalescence occurs, it is expedient to define the two sciences in their separate state.

Engineering may be defined as the science of controlling the forces and utilizing the materials of nature for the benefit of man. This is a broad definition, according to which the engineer may be regarded not only as applying the discoveries of science, but also as a creator producing that which has not previously existed. The conception is purely materialistic, and the engineer is regarded as applying his skill and learning to the solution of material problems in which the data are more or less concrete.

Economics, on the other hand, inclines more to the abstract, and is closely allied to the older political economy in its methods and aims, if not in all of its findings. It is the science dealing with the wants of man and their fulfilment; it is particularly concerned with the production, distribution and consumption of wealth, and the manner in which these activities affect the welfare of the community. Thus the economist, in his work, must attempt to understand human beings and be capable of dealing with the complexity of human relations. Much of his data are indefinite in nature, and he is forced to adopt somewhat of an abstract or philosophical attitude in his activities.

Throughout this paper a sociological point of view has been maintained. That is, the results of neither science have been regarded as ends in themselves, but all have been related to their effects upon social progress as a whole.

Since the background of this paper rests on the historical development of the two sciences, the whole first part of the paper is devoted to presenting this background in summary form. This history of their development establishes a *de facto* relation between them. Both are sciences and function primarily to further material progress, but both have secondary effects in making cultural advance possible. From the existing relations the discussion proceeds to outline what they should be. Present conditions, it is considered, indicate the need for a planned economy, and in such a system both engineering and economics have a place of importance. Equal status and stage of development is necessary, as well as closer co-operation in methods and closer coordination of results. The last part of the paper deals with the problem of changing the relations from what they are to what they should be. In general this can be accomplished by the two sciences assisting each other in method, and by the broader education of both engineers and economists.

Although a planned economy is recommended, with control in the hands of specially trained 'economic-engineers,' it is not Technocracy. The required changes in the industrial system can be brought about without scrapping the whole system and setting out on a programme of pure experiment and untried theories. Only when the seemingly logical modifications required in our present system have been tried and found wanting is such a course justified. In this paper, therefore, the attempt is made to see the logical modifications and to point out methods of accomplishing them through the closer relation of engineering and economics.

## Part I—Historical

### A. Development of Engineering

To the ancients, the term engineering referred exclusively to operations connected with building military works and engines of war, and this conception was broadened little until the eighteenth century. In order to know the gradual development of the science to its present broad outlines, therefore, it is necessary to trace briefly the growth of pure and applied science up to this time.

*Technology in Ancient Times*

Pure science did not always lead the way for applied science as it does now. For many centuries practice was in advance of theory, and it was not until substantial achievements in analysis had been made that pure science began to exert a creative influence upon applied science. A considerable amount of practical experience had to be accumulated before it was possible to build up a theoretical science.

As might be expected, technical advance was extremely slow during the period of initial accumulation of experience. Little interest was taken generally in technology, for under the aristocratic organization of society slave labour was abundant and labour-saving devices were, therefore unnecessary. Because the power units available even during the Egyptian times were so small, comprising as they did only man power, the development of any sort of complex mechanism was obstructed. Pulleys, levers, wheels and their combinations were known, and their knowledge of these the Egyptians passed on to the Greeks and Romans, but in Egyptian times their applications were almost exclusively in devices worked by man power.

The technology of the Greeks included a slow accumulation of improvements on the practical side—the available power was increased by the development of better harness and methods of using animals—but the more significant advance was in theory. Archimedes (287-212 B.C.) formulated the fundamental conceptions of hydrostatics and studied the quantitative laws of the lever, thus taking the first real step in the exact science of mechanics.

At this time the primary object of philosophy was regarded as the discovery of the eternal truths of nature, and the task of theoretical science was defined as the construction of hypotheses which would present the phenomena of nature as manifestations of these eternal truths. This general concept of the task of science was responsible for attention being directed towards logical demonstrations that involved pure reasoning, rather than towards experimental study of the phenomena.

The contributions of the Romans were largely in the field of military engineering and were eminently practical. They developed no new mechanical principles, but they made use of those they had acquired from earlier civilizations in constructing efficient engines of war, roads and waterworks. Otherwise they are important chiefly for passing along intact to future generations the technology they received.

*Broadening Scope in the Middle Ages*

During this long period, although the mechanical sciences still were allied nominally to philosophy and rested upon supposed axioms or upon primary metaphysical concepts, a growing body of doubt and controversy was evident. Out of the large volume of discussion which these controversies provoked, there arose new concepts of the problems of technology. By stages the conviction grew that true knowledge of the nature of things could be obtained only through systematic observation and experiment.

In applied science, the substitution of water and wind power for human and animal power probably first took place in the milling industry. The simplest application of water power to grinding dates back to the fifth century, but it was not until the twelfth century that gearing was applied to work the mills at higher speeds. The general mechanism of the geared mill was also adapted to the use of other forms of power, notably hand power and horse power, about the same time. The use of wind as a source of power is not established prior to the thirteenth century. The earliest known applications of water power outside the field of grinding grain are to be found in the textile industry. References to fulling mills driven by water power appear in the second half of the twelfth century, and references to mills for crushing woad and tan bark about the same time suggest a form of mill that might be applied to any light task of stamping, crushing, or fulling. Water-powered saw mills were the next step, dating from the fourteenth century. The development of the turret windmill in Italy towards the close of the fifteenth century was the last significant addition to the list of prime movers until the invention of the steam engine. Thus, by the fifteenth century, the extension of generalized power to tasks other than turning millstones was well started, and the initial efforts had met with modest success.

*Transition from Mediaeval to Early Modern Period*

The foundation of the theories of modern statics dates back to the thirteenth century, but the study of dynamics made little progress until the time of Leonardo da Vinci (1452-1519). His creative imagination was responsible for clearing away the old metaphysical impediments to the effective study of motion, and the problems of dynamics which he defined were later solved through the efforts of Galileo and Huygens. Before da Vinci's day engineering was concerned with military activities that were being extended by the development of gunpowder and artillery, but which were largely a direct continuation of a tradition reaching back into antiquity. Fifteenth century drawing and writing on mechanical subjects was confined to the military engineers and architects, with the former most in evidence. Leonardo da Vinci's career, however, marks a change in the established conception of the scope of engineering. Although he gave some attention to fortress construction and artillery, his interest was predominantly in the application of mechanism to industry. His work also created new bonds between pure and applied science, and he influenced greatly the trend towards more imaginative thinking which at last pushed theory ahead of practice.

The number of patents registered in the seventeenth century was large, and many of the inventions contained principles later to prove of great value. The swing to imaginative thinking, however, led to the conception of much apparatus long before there was any possibility of making it.

Although the mediaeval period must be credited with nearly all the preliminary work in the development of low-powered prime movers, the sixteenth and seventeenth centuries were marked by a substantial development of the range and character of the uses of power. The strictly new power problems of these centuries were concerned largely with pumps and pumping. Eventually a solution was found, and the new source of power was ultimately embodied in the steam engine.

The ending of the ancient period in the development of the mechanical and physical sciences was marked by the publication of Newton's "Philosophiae Naturalis Principia Mathematica" in 1686. In this notable work, besides modifying the principles of dynamics and statics as previously stated, Newton brought together the closely related sciences of physics, astronomy and mechanics in one comprehensive whole, and generalized the concept of gravitation.

*The Industrial Revolution*

For the next century and a half England took the lead in technical advancement. While continental scientists confined themselves chiefly to pure science, Englishmen busied themselves with the application of knowledge already available, and through patient experimentation they brought to bear upon the problems of industry the discoveries of their more brilliant continental contemporaries.

By the early eighteenth century the iron industry was in difficulties because the supplies of charcoal were giving out. In 1720 Wood applied coal to iron smelting furnaces successfully, however, and gave the industry new life. In the cotton textile industry weaving was enabled to outstrip spinning by Kay's invention (1733) of the flying shuttle. A great incentive was then given to invention by the government offering prizes for the best improvements to methods of spinning. The relation of spinning to weaving was soon reversed by a series of inventions applied to the former—notably Hargreaves' spinning jenny in 1764, Arkwright's water-powered spinning frame in 1769, and Compton's mule in 1779. Water power was replaced by steam power towards the end of the century, first in spinning, and later in weaving.

In 1760 Potten connected the valve and piston action of a steam pump and made it automatic. Profiting by the pioneer work of Newcomen and others, Watt, in 1769, patented the separate condenser and so produced a new type of engine. He then made his engine double-acting, which removed the obstacle to rotary motion, and the resulting prime mover revolutionized one industry after another. The final stage in the development of the steam engine, the high pressure engine, was made possible by the improvements in iron making in the last quarter of the century.

Beginning with the Grange brothers' successful operation of a reverberatory furnace in 1760, methods of refining and working iron developed rapidly. This opened up new uses for iron and steel, and soon led to the building of industrial machinery of iron. The most important of the early machine tools were lathes and boring machines. The lathe was strikingly developed, particularly for wood working, prior to 1774, but it was not until this date that a method for boring metal cylinders adequately was patented by Wilkinson. This is regarded as the first decisive step in the new methods of working in metals. The developing technique of the metal trades opened up new possibilities in quantity production and in the manufacture of interchangeable-part mechanisms, which laid the foundations of modern mass production.

With the development of the high-pressure steam engine, Trevithick and others began to experiment with its application to transport. It was not until the successful Rainhill tests of Stephenson's 'Rocket' in 1830, however, that the steam railway was definitely established on a practical basis. An age of feverish railway building began, until by 1848 nearly five thousand miles of railway line had been laid in Great Britain.

The great inventions of this period changed the relation of handwork to mechanical assistance. The accuracy of the work no longer depended upon the skill of the workman, but on the accuracy of his tools. Under the former method the tool was an aid to the worker's skill, and the amount of skill that had been transferred was small. In the new machines the transfer of skill and thought could be so great that the worker became merely an attendant guiding the machine. This transfer of skill was not based on the division of labour, although it made possible an extension of the principle. The result was, however, that the factory system of industry was facilitated, and rapidly displaced the domestic system in England.

*Beginnings of Modern Engineering*

As a result of the industrial revolution, various branches of engineering began to take on more of their present characteristics. Before this, however, there grew up a class of engineers who concerned themselves with works which were neither exclusively military in purpose (though some were akin, such as the making of roads), nor executed by soldiers. These men by way of distinction came to be known as civil engineers. In England, there was a great extension of roads and canals in the latter part of the eighteenth century, largely due to the agrarian revolution which concentrated the ownership of land in the hands of a decreasing number of proprietors and revived the enclosure system. This movement greatly increased the number and widened the scope of the new class of civil engineers.

It was not long before specialization took place in the wide range of activities covered by civil engineering, and this resulted in the separation of different branches of the science. The first of these were mechanical engineering and mining engineering; both became important as separate branches about the same time.

In the latter branch, the most marked development came first in the field of coal mining. The manufacture of iron and iron products, and the operation of steam powered mills and factories, necessitated abundant and inexpensive fuel. To meet these needs greater attention was devoted to methods of mining coal. Before the close of the eighteenth century the introduction of steam pumping had made it possible to sink deeper shafts, but the expansion of coal production became noteworthy only in the decade 1810-19. In that period wooden props were introduced, the steam boring machine was invented, Sir Humphrey Davy's safety lamp was brought into use, and in 1820 mechanical haulage underground began to be substituted for human labour. Thus by the end of the first quarter of the nineteenth century the separate science of mining engineering had been definitely established.

Mechanical engineering was important by 1820, and received a great stimulus from the early railway development. Because the industrial revolution came first in England, she had the equipment, experience and skill to supply the rest of the world when they wanted machines. During the middle of the nineteenth century, therefore, mechanical engineering received its greatest impetus in England. Its scope and power were greatly increased by the discoveries of Bessemer (1856), Siemens brothers (1866), and Snelus (1879) which created the modern steel industry; and by a series of inventions such as Nasmyth's steam hammer in 1838, de Laval's impulse turbine in 1882, and Parsons' reaction turbine in 1884.

Since the middle of the century, the industrial record in England has largely been one of expansion in size and output, and of specialization in the processes of manufacture. But it is in the United States that mechanical engineering has progressed most in developing the technique of interchangeable-part manufacture and mass production. The group of machine tools has become more and more automatic until manufacturing is possible wherein highly complex operations are carried on with only the simplest labour of attendance by humans.

Another branch of mechanical engineering which has attained prominence, particularly in the United States, during the first quarter of the twentieth century, is that specializing in internal combustion engines. Otto first introduced his four-cycle gas engine in 1876, and Daimler brought out his high-speed gasoline engine in 1883, but it was not until the century had turned that the ultimately most important field, the automobile, received much attention. Heavy oil engines began to assume characteristic form about 1885, but the special problems were not adequately solved until Diesel produced his first engine in 1895. Since that time the development of this engine has been steady, although its use is somewhat restricted to special circumstances.

*Newer Branches of Engineering*

About 1890 the field of mechanical engineering was restricted by the separation of the important branch of electrical engineering. By this time the importance which steam had attained since the industrial revolution began to be decreased through greater use of electric power.

The early history of electricity centres around the various types of accumulators. The next period is marked by the invention of the dynamo and motor, and before 1880 the primary accomplishments in lighting, power production, and traction were practically realized. The development of the incandescent light by Edison in 1879, however, was the outstanding achievement, as it involved the creation of the central electric station with its complementary distribution system. With the subsequent development of high tension transmission of alternating current it became possible to make increasing use of centralization in electrical production. Hydro-power from remote sections could now be used, and the economies of steam production in large central stations obtained. The degree of stability attained by interconnecting large systems further reacted to the benefit of industry. The abundant supplies of power which these developments released effected the transition from the Machine Age into the Power Age, and the nature of electric power facilitates a decentralization of industry in direct opposition to the concentration which steam power necessitates.

Communication engineering has grown up as a particularized branch of electrical engineering. Pithball, spark, electrolytic, and electro-magnetic telegraphs were all developed almost coincidentally with the discoveries in electricity upon which they were based. As early as 1844 a company was organized in America to link New York, Baltimore and Washington by telegraph. From this time the use of the telegraph spread rapidly as a means of land communication, and in 1850 the first submarine cable was laid, connecting Dover and Calais. Improvements were continually applied, so that land wires and submarine cables connected most of the civilized world by the end of the century.

Bell's invention of the telephone in 1876 opened up another important channel of communication. At first speech was transmitted only locally, but gradually the local systems, many of which sprung up when the Bell patents lapsed, were linked regionally and then by long distance circuits, so that interconnection is now possible between more than 99 per cent of all telephones in the United States. Since the war great strides have been taken in extending the range of telephone communication, particularly in the international sphere by radio.

The groundwork for wireless telegraphy and telephony was laid by Maxwell's electromagnetic theory and Hertz's analysis of electrical oscillatory disturbances. In 1901 Marconi established wireless communication between England and Newfoundland. Since then development of wireless has been continuous and rapid, until now wireless communications comprise every variety of traffic that can be handled by aid of wires, and some that cannot. Communication by speech or signal to near or distant points on land, sea or in the air, direction finding for ships or planes, and the broadcasting of information and programmes are samples of the services this development offers.

The present status of chemical engineering has been attained by a slow growth from the time of Faraday to the commercial development of electricity, and a rapid growth since then. Consequent upon the advances in technology which have definitely ended the shortage of man power, more attention has been paid to the problem of conserving natural resources, until today there is little hesitancy in attempting to synthesize any organic compound for which there is a demand, or to produce to order some special material. Thus chemical and metallurgical engineering have become increasingly important to the other branches of engineering and industry in general.

*Present Status and Future Outlook*

The transition to the Power Age which has been accomplished during the past two decades has far-reaching effects which are yet only partially realized. It means, first, that the great era of machine invention is past, being replaced by a time in which technological effort is directed towards obtaining more extensive and effective use of existing machines. In both the United States and England statistics of patented inventions now show a uniform tendency towards a decreasing rate of increase, and in some important branches an absolute decrease. It means, secondly, that the recurring shortages of man power which limited production in the past are now eliminated. The net result is that the problems of production, which have always received predominant attention in the past, have been solved (for the time being at least), and will require less attention in future. To retain the status of importance enjoyed when production considerations were uppermost, therefore, engineering must broaden its scope in order to be able to offer the same valuable assistance in solving the problems of distribution.

### B. The Development of Economics

Although economic science as such only dates back to about the sixteenth century, it is instructive to follow the development of economic thought from early times in order to understand the origin of the science. A certain unity in economic thought and continuity in its development exist to connect the present with ancient times.

*Earliest Beginnings*

Economic ideas of any definiteness were given their earliest expression in rules of conduct or moral codes formulated by priests and lawgivers. The underlying philosophy was broad and simple, and economic concepts were presented with ethics and religion as one whole. The tardy development among the ancients was principally due to the fact that economic phenomena were not important to peoples living relatively static and simple lives with the dominant classes supported by a servile population.

The Oriental civilizations (including the Egyptian and Hebrew) did little to develop economic ideas. In all there was a dominant priestly class which formulated and handed down traditions that minutely regulated everyday life, even in its economic phases. Their philosophy was characterized by lack of both individualism and materialism, and a disapprobation of industry other than agriculture, that made an industrial civilization impossible. Happiness for them was obtained by abolishing discontent through decreasing wants, rather than through satisfying them materially. Static ideals predominated, and material progress was effectively blocked by the caste system.

Although the Greeks continued to look down upon all industry except agriculture, they were more rational in their thinking. Instead of forbidding the accrual of interest on money in conformity with some divine edict, they argued about it. They were more concerned with the individual than the Hebrews or Hindus, and recognized to some extent the value of material wealth as an agency in furthering human happiness. The first use of the word 'economics' was by Xenophon in the title of a book on household economics, which was as far as the subject had progressed to this time.

Typically lacking in speculative originality, the Romans did little directly to advance theoretical economics. Indirectly they did exert a profound influence on future thought, however, by their development of a jurisprudence whose practical spirit furthered individualism through its doctrines concerning property, contract, interest, and so forth.

*Expansion of Scope During the Middle Ages*

In the Middle Ages (from the fall of the Roman Empire, 476, to about 1500) a very slow transition took place which resulted in the replacement of independent household economy by national economy. During this period commerce and handicrafts gradually encroached on the dominating position of agriculture, and slavery was slowly abandoned for serfdom and free labour. The Church became dissociated from politics and industry.

With the development of inter-town and inter-regional trade, and the gradual lapsing of merchant and craft guild restrictions, the relations of business men became more intricate and more impersonal. Expanding markets soon indicated the advantages of division of labour and of regional industrial specialization, which led to the replacement of the guild system of industry by the domestic system. The discovery of new lands (such as America) further broadened commercial interests, until common policies were found advantageous not only locally and regionally, but also nationally. It was out of the discussion of questions of public policy created by this realization of common interest and opposition of interest in diverse fields that the science of political economy attained a status of importance.

*Early Progress of Political Economy*

Viewing with envy the acquisition by Spain of wealth in the form of gold and silver from mines in America, other countries, notably France, Italy and England, sought to obtain the same results from the expansion of export trade. This was facilitated by the development of currency, banking, credit and shipping, and to this end public policies were determined which were intensely nationalistic in character. From these accepted policies the principles of the Mercantilists took form as economic theory in the early part of the seventeenth century.

War was common then, and a considerable degree of self-sufficiency was a practical necessity. Consequently the Mercantilists laid down the principles of a national political economy, not a cosmopolitan one. They identified the interests of the nation with the interests of its merchants, and underestimated the relative importance of agriculture and industry. The result was a body of government regulation of commerce and industry directed towards securing a large net profit in the form of treasure for the state as a trader.

About the middle of the eighteenth century, reaction against the naive confusion of economic welfare and money profits of the Mercantilists crystallized in the doctrines of the Physiocrats in France. They measured the welfare of the community, not by the profits of trade, but by the excess of the community's annual product over its cost. This meant that the soil was regarded as the real source of wealth since it alone yields a net product. They were distinctly abstract in their reasoning, and although their principles were partly fallacious, yet they saw the processes of economic life more as an interrelated whole than did the Mercantilists.

The publication in 1776 of Adam Smith's "An Inquiry into the Nature and Causes of the Wealth of Nations" opened a new era in economic thought and earned for its author the title 'father of political economy.' Smith shared some of the Physiocratic prejudices, but expanded the theory of wealth to give industry its legitimate place, believing that wealth could be increased only by making labour more effective. To do this he believed in a system of free competition and laissez-faire. Smith was much superior to the Physiocrats in building up his theories from observation of facts and history, but perhaps his greatest contribution was the simple and comprehensive picture he presented of the whole economic life of a nation.

*The Classicists and the National School*

As a result of the teachings of Adam Smith, and the character of the economic problems which arose out of the Napoleonic wars, and the swiftly changing industrial structure in England, the next group of economists were led to think of political economy as a natural, purely expository science. These Classicists employed the deductive method in their reasoning, starting from general data conceded to be beyond dispute and proceeding to deduce countless propositions, as in geometry. This school included such men as Malthus, Ricardo, Say and Mill, and was influential until the middle of the nineteenth century.

Sharply contrasted with the Classicists was the National or Historical School of which List is usually regarded as the chief exponent. They believed economic life to be something peculiar to a given nation at a given time, and therefore, the conception of universal natural laws of the Classicists was replaced by a restricted national historical view of political economy. The inductive method—i.e., basing general propositions upon certain definite observed facts—was employed, but the National School carried its ideas much further than the meagre empirical data of the times warranted.

The deductive method is essentially abstract, and the chief criticism of the Classicists is that they were led astray by their own abstractions. Having invented the 'economic man,' they formed their deductions as though such a person really existed. The National School, on the other hand, was grossly handicapped in the use of the inductive method because of the difficulty of observing facts connected with the social sciences. These facts are so diversified and intricate that observation can only be performed through the collective labour of thousands, and the necessary technique was not then available. The criticisms of the Classical and National Schools, therefore, are not directed towards their basic methods, but rather to the way in which they employed these methods.

*Further Broadening of Economics*

With the decline of the National School, economics was finally broadened beyond the political field, and its scope no longer was limited by preoccupation solely with national commercial policy. Among the subjects to which an increased amount of attention was given by the newer generation of economists were the mechanism of supply and demand, and interest and profits. Two schools are important in this group for their return to the deductive method, and for carrying it to extreme logical consequences.

The first of these, the Mathematical School, was led by Jevons, Walras, and Marshall, to name a few of the better known mathematical economists. They considered the relations which arise among men in any given circumstance as relations of equilibrium, much as in mechanics. Elaborate mathematical formulations of the conditions of equilibrium were devised, the great advantage of these being that it is then possible to depict the variety, complexity, and interdependence of all the factors which determine prices, costs, supply, demand, or distribution shares.

The second of the later deductive schools, the Psychological School, devoted its attention almost exclusively to the theory of value. They regarded value exclusively as the expression of human desires, assuming the economic behaviour of men to be governed from the standpoint of maximizing pleasure and minimizing pain. As a result of looking at the problem of distribution in this way, emphasis was given to important relations existing between one distribution share and another, relations which must be considered when analysing the repercussions of many economic proposals.

*Growth of 'Radical' Economics*

Utopian ideas concerning an ideal society were originally to be found only among the philosophers. Plato's "Republic" and More's "Utopia" are well-known illustrations of this fact. With the publication by Marx and Engels of the "Communist Manifesto" in 1848, however, the subject took on a decidedly political and economic tinge. During the next seventy years there grew up a body of economics which was radical in the sense that it repudiated the orthodox theories based upon the private ownership of capital or tools of production. The radical economists of this period, however, men such as Marx, Lassalle, Liebknecht, and Bukharin, for instance, were really more interested in the political aspects of the subject than in the truly economic questions. It remained, therefore, for men like Veblen, Cole, Laski, in the past two decades, to develop this branch of economics to a position of outstanding importance. The overthrow of capitalism in Russia, and the drastic changes since made in communist practice there, directed the attention of the rest of the world to both the good and the bad in the new system. As a result, some of the good points are considered adaptable in a modified system of capitalism, and are now being tried in the form of economic planning in different degrees in several countries.

*Present status and Future Outlook*

At the same time as there has grown up a number of distinct branches of study in economics, such as transportation, public finance, banking, population, their interrelation has been recognized in the growth of the central body of economic principles. The fact that each separate branch now has its special literature and engages the attention of a corps of specialists indicates that the advantages of division of labour are at last being recognized in economics, and augurs well for its future development.

The most important characteristic of the newer work in economics is its greater realism. The continued accumulation of records by governments and other bodies provides a widening range of economic experience for study and analysis, and so facilitates the realistic approach. Abstract conceptions have not lost their usefulness, but these conceptions are drawn, as much as possible, from the world of affairs. Thus economics, in its abstract reasoning, is coming to follow a procedure employed with great success in the physical and natural sciences. This procedure involves four stages:

(*a*) Observing facts without any preconceived notion;
(*b*) Formulating hypotheses to fit the observed facts;
(*c*) Deducing individual propositions from the general hypothesis;
(*d*) Verifying the deductions by experiment or specially conducted observation.

Despite the changes and contradictions which have characterized the development of economics, there still remains a general picture of communal economic life, sufficiently ordered to make analysis possible, but imperfect enough to make such analysis imperative. With the swing of attention from the problems of production to those of distribution the scope for practical economics is broadened immensely.

## Part II—What Are The Relations?

### A. Interrelated and Interdependent Development

In many ways both engineering and economics have been dependent upon each other in different stages of their development. At first the points of interdependence were somewhat haphazard, though none the less important. As the two sciences developed, however, they became more closely connected and mutually dependent. Always economics lagged somewhat behind engineering, with the result that the latter was often impeded in its development. In what follows, sample interrelations are indicated at different stages in the development of the two sciences.

*Connection in Early Times*

A conspicuous reason for the meagre technical advance made up to the time of the Greeks was the restricted nature of the markets, which provided no incentive to enlarge either the output or scope of the few hand industries then in existence. Economics embraced only domestic matters, trade was little more than barter with one's neighbours, so there were but few technical problems to challenge the best minds of the age.

A little later, the Romans, by their developments in military engineering, were enabled to gain political control over distant lands by conquest. The limited amount of trade which sprang up in the wake of the armies led to the cultivation of more distant markets, and so broadened the scope of economics slightly.

The slow development of technology which took place during the Middle Ages was closely linked with gradual changes in economic life, and this is well illustrated by tracing the developments within the milling industry.

About the fifth century water power began to be used in grinding. The mills were small, however, grinding was slow, and there were no professional millers. During the next five centuries almost no technical improvements were made in milling, although some centralization took place in the administration of the great estates and larger mills were built to be used by the tenants of the estates. Eventually some of the feudal lords claimed exclusive rights over milling, and both limited the number of mills that might be set up and forced all tenants to grind at the lord's mill. As a result of this concentration of milling, and the renaissance of town life in the eleventh century, a demand was created for larger mills which would work faster. Consequently, we find technology supplying the demand by the development of geared mills which greatly speeded up the work of grinding and first appeared about the twelfth century. In this instance, then, an economic development prepared the way for an advance in technology.

*Mutual Dependence in Early Modern Period*

Economics and other branches of learning are deeply indebted to technology for freeing them from the crushing burden of superstition and dogma which practically stopped all advances in knowledge during the Middle Ages. In technology the adoption of the experimental method resulted in mechanical developments which restored to man a sense of self-confidence that had long been lacking. Thus, science both cleared the way and set the example for pushing ahead in other fields.

Also, in a practical way, the first real step in broadening the scope of economics was dependent upon mechanical science. The invention of gun-powder and the consequent advances in military engineering facilitated territorial expansions of the great powers, and this forceful widening of markets fostered the formulation of common policies which grew into the science of political economy.

Inventions were plentiful in the sixteenth and seventeenth centuries, but their application to industry was restricted by several economic factors. In the first place, opportunities for the profitable use of the inventions were limited until some economic expansion took place and economic life became more complex. Secondly, lack of the necessary capital to promote the application of the conceived mechanical ideas proved a great obstacle. The same difficulty was encountered in applying more power to industry. The capital involved was large relative to the amount of power generated, so that, although power-using devices were known, their use was impossible in all but a few instances. Although some fortunes were large even in these times, they consisted largely of land, serfs and commodities, rather than easily transported capital. To provide the requisite mobility and concentration of capital the stock company was evolved, appearing first in Holland and then in England in the seventeenth century.

The effect of the agrarian revolution (which was purely economic) in England upon the development of civil engineering has been noted previously. The efficient system of roads, canals and harbours which resulted made the industrial revolution possible in England before other countries.

*Effects of Industrial Revolution*

While the industrial revolution was primarily technological, the economic consequences were most important. As a result of it England was transformed from a country with peasant occupations and local markets into an industrial nation with world-wide connections. To make the most of her new opportunities in world trade (gained by the removal of French competition resulting from the French Revolution) England made every effort to increase her industrial production, with the astounding advances in technology which we have seen. Conversely, the wide market which England commanded made economical production possible, and the immense wealth in metals and raw materials which poured into England from her colonies greatly facilitated industrial expansion.

England had an industrial revolution before the railway era partly because the extensive system of canals and roads gave ready access to the sea, which was nowhere far distant. In the other great industrial countries (Germany and the United States), however, the industrial revolution began only with the introduction of the railway. The chief obstacle to earlier industrial development in these countries was the inadequacy and difficulty of land transport. The civil engineer made the industrial revolution possible in England, and he and the mechanical engineer together did so in the other countries.

*Economic Effects of Modern Technical Developments*

The effect of communication on trade is somewhat analogous to that of transportation on industry. The advances made in methods of communication by technicians, consequently, are responsible for marked expansions in trade and widening of markets. By the telegraph, telephone and wireless, people all over the civilized world are now as closely connected as they were in neighbouring communities in ancient times. This virtual bringing together of vast numbers of people has had very complex effects on both economic and social life. While it has forced a broadened scope on economics, it has also raised problems in human relations on individual and national scales which are not yet adequately solved.

The industrialization based upon the use of steam power resulted in concentration of population in large centres. This also created many problems of a social and economic character—problems which were intensified as the concentration of population increased, and which have only been solved in part by subsequent technical advances (such as mechanization of agriculture, building of skyscrapers, development of motor, urban and fast suburban transport, etc.). The great expansion in use of electric power which has come with the twentieth century, however, has opened the way for decentralization in industry again. While little tendency to move in this direction has been shown, the possibilities are there. When economic developments permit, we may see the colossal centralized factories catering only to branches of production supplying the fundamental and universal needs of all men, and the adoption of small, individual, dispersed industries for making the infinite number of products of variable nature. Thus, industry may now be on the road to a better status, possessing the advantages of power machinery without the disadvantages of congestion.

The ability of chemical engineering to supplement natural resources, particularly those which are irreplaceable in nature or replaceable at a very slow rate, mitigates many otherwise insurmountable economic problems. In some instances not only mere substitutes have been produced, but actual equivalents, and sometimes items superior to those provided by nature. As a result of this growing interest in synthetic materials, competition today is not only between concerns, but also between dissimilar products, and research has come to serve industry as a weapon of both attack and defence.

It is evident from this brief survey that the relations of economics and engineering became extremely involved from about the time of the industrial revolution onwards. The two sciences have grown more and more closely together, so that it is impossible to say where a certain step in the development of one is responsible for a given step in the other. Cause and effect can no longer be separated with any degree of definiteness, and the interrelations can only be realized, not analysed.

*Economics has lagged behind Technology*

Furthermore, it is evident that the development of technology has consistently been in advance of economics. The deductive method (pure logic), for instance, was used in connection with technology in the time of the Greeks, but it was not widely adopted in economics until the early nineteenth century by the Classicists. Similarly, the experimental method was used in the mechanical sciences about 400 years before it found a place in economics (roughly 1500 as compared to 1900). Theory pushed ahead of practice in technology during the sixteenth century, but this did not happen in economics until the time of the Physiocrats about 1750.

The work of Newton and Adam Smith in their respective sciences is roughly comparable. Both were responsible for summing up the work that had been done before them, and for presenting a comprehensive view of the whole, preparatory to launching their sciences on greater periods of development. Both published remarkable books (Newton, his "Principia Mathematica" in 1686, and Smith, his "Wealth of Nations" in 1776), which are now credited with marking the close of the ancient period of development of the two sciences and the opening of the modern period. It is of some significance, therefore, that this point in the development of technology took place ninety years before it did in economics.

The evidences of this lead of technology over economics are plentiful even in this day. Whether the lead in time is as long as it was previously is unimportant; the fact remains that technology has consistently been in the lead. Many of the ills of the business and industrial world at the present time can be traced to the unbalance which exists between technological and economic advance. Production has outstripped distribution; the substitution of mechanical power for human labour has progressed faster than the knowledge of how best to utilize the added leisure; and the development of tools for furthering material welfare has progressed faster than the technique for controlling them.

*Lag Detrimental to Development of Technology*

Reference to the previous section shows several instances where technology was held back until economics took another forward step. Lack of common policies among business men resulted in narrow markets, which greatly limited the advantages and uses of many technical devices. Furthermore, restricted markets and trade produced little surplus capital, which was necessary to promote many of the mechanical inventions. From the time of the industrial revolution to the present, the use of machines has been frequently restricted simply because economic life has not been organized adequately to provide for the human labour thus displaced.

Another drag upon technological progress has resulted from the widespread swing to economic nationalism which has characterized the post-war period. Not only does this indicate lack of advancement in economic thinking, it indicates retrogression to the ideas of the National School which flourished in the latter half of the last century. As a result, restrictions are placed upon the distribution of products to distant markets, and the dissemination of technical information and processes among different nations. This in turn limits both the scale of technological advance and the importance of such results as are obtained.

The past twenty-five years have been characterized by the creation of vast industrial enterprises, which, if properly controlled, should result in tremendous material advances for mankind. Present conditions, however, are ample evidence of the fact that only a small part of the possible benefits (and a large part of the possible disadvantages) of this development have been obtained. One of the chief difficulties is that this mass production trend has produced problems of mass financing, mass management, and mass control, which are purely economic. But economics, in its backward state of development, has not been able to offer adequate solutions to these problems.

In the past, the problems of the world were problems of scarcity as well as of distribution. Today the first of these is practically eliminated, thanks to advances in technology, but the problem of distribution is more pressing than ever. It is no longer a problem of not being able to create the goods to reach a higher economic level, it is the problem of the distribution of plenty. The engineer has apparently done his work well, perhaps too well in view of the burden placed upon an inadequately developed system of distribution, the economist's special responsibility.

B. Connected Function in Furthering Material Welfare

Engineering and economics function primarily in the material sphere, both in theory and practice. They are scientific tools, functioning dependently, but past results have not been altogether satisfactory.

*Both Are Sciences*

Although both engineering and economics have frequently been called sciences, it is instructive to investigate the propriety of this designation. A science may be defined as a connected and systematized body of knowledge, possessing generality of form, but also sufficient homogeneity to enable isolation from other bodies of knowledge. The orderliness, generality and homogeneity of the basic phenomena underlying each branch of engineering are common knowledge and do not need demonstration here. The same, however, cannot be said for economics.

To be distinguished by the name, science, in the first place, economic phenomena must be connected within themselves and possess enough similarity to permit of separation from other phenomena. Such isolation is necessary so that, in analysing the phenomena, it is possible to deal separately with their different aspects and the different elements of which they are composed. Although there exist some doubts as to its complete separation from social philosophy in general, economics may safely be said to constitute a distinct, though not necessarily entirely independent, department of sociological speculation. It is possible, at least up to a certain point, to isolate the study of the phenomena of wealth from the study of other phenomena of society.

To be classed as a science, economics must also embrace an ordered body of data. Although economics has not passed through as rigid a classificatory stage as sciences of the type of zoology or botany, which deal with material objects falling into a natural system, a certain amount of collecting and systematizing economic phenomena has taken place, particularly in recent times. The existence of some measure of regularity and predictability in economic phenomena as applied to the individual is evident in the conduct of individual daily affairs. Everyday business is conducted on the assumption that men generally, if not individually, behave in similar fashion when placed in the same circumstances. Since individual affairs show some sort of order, the economic life of the community as a whole cannot be sheer confusion. It must, therefore, have some semblance of an ordered pattern which shows itself in laws or tendencies which can be discovered by observation and analysis. Thus, by maintaining that economics is a science, it is meant that it is possible to discover general laws of economic phenomena, to co-ordinate these laws, and to explain particular economic facts by means of them.

*Scientific Conception of Both Now Closer*

Until recently, the concept of science as applied to economics was broader and less rigid than when applied to engineering. The natural laws underlying engineering practice were regarded as absolute, while those regarding economic phenomena were looked upon more as tendencies than as laws. Now, however, the so-called natural laws are coming to be regarded as nothing more than good probabilities, while the economic tendencies are acquiring added definiteness and are also becoming good probabilities.

A further similarity between the two sciences is apparent as a result of the greater attention to causality which classification as a science now entails. Mere descriptive systematization can no longer constitute a science. Economics and the social sciences have always dealt predominantly with cause and effect, and now the natural sciences, during the later stages of their development, are concerned not alone with how the phenomena take place, but also with why they occur.

The detection of causal connection needs the assistance of some apparatus of reasoning, inductive or deductive, or a combination of both. Mere reflective observation cannot possibly give the requisite insight. In developing and using the necessary reasoning technique, engineering can assist economics materially, as will be outlined in a subsequent section.

*Both Equally Concerned with Material Progress*

The total wealth that any people can create is governed primarily by two factors: the natural resources of the country, and the tools of production, mental and physical, available for developing the resources. Highly developed tools of production make possible a high average level of material existence, but the realization of this average depends upon the social and industrial organization for the distribution of the created wealth.

By definition, then, both engineering and economics are fundamentally concerned with the material welfare of man. For, in supplying human wants, the function of engineering, briefly stated, has been to look after the methods of production, and that of economics, to organize production and distribution to supply these wants effectively. Thus, engineering is concerned with the tools for transforming man's environment to make life more liveable, while economics is concerned with the effective use of the tools, and with their results.

The above applies particularly to the practical field, but in the theoretical field the functions of the two sciences are not less important to the furthering of material progress. Researches in the domain of pure science frequently yield results that can be turned to great practical advantage. So generally important have these findings become, that many of the great industrial corporations have found it to their advantage to establish research departments in which the scientists are often allowed to work along lines that, in the beginning, show no relation to practical industry.

In the field of economics much the same condition is evident. The value of economic theories is rightly measured by their bearing on practical questions, but investigations which at the outset appear purely theoretical often disclose findings important from a practical standpoint. While the ultimate aim of economic investigation is to guide human conduct, the immediate object often is merely to obtain knowledge of positive facts. Such knowledge cannot be accurate and thorough if the theoretical enquiries are worked out piecemeal, as they arise in connection with particular practical issues, instead of being pursued systematically.

Broadly speaking, therefore, we may regard both engineering and economics as tools for furthering material progress. Engineering is virtually a tool for providing possibilities of material advance, while economics is a tool for making the best use of these possibilities. Since both conform to the requirements for classification as sciences, they are truly scientific tools. The relation between the two sciences is implicit in their classification in the above sense. Each is complementary to the other, and one cannot be said to be more important than the other.

*Actually Engineering Subordinated*

In view of the above, the gradual separation of responsibility and authority in the two sciences is significant.

When machines first appeared in industry, there was no clearly marked division between the industrial experts (engineers) and the business managers (economists). Not infrequently the designers of industrial processes and equipment both managed the shop and looked after the selling and financial end of the business. As the industrial system developed, becoming more involved, more specialized and of wider scope, the functions of the technological experts and the business managers grew apart. This division of function left the engineers to look after the productive end of business, while the economists decided on commercial grounds what the engineers could do, and how far they could go in doing it. As industry became still more mechanized and more complex, the work of the engineers became increasingly difficult and important, but the decision of the business managers continued to be final. In other words, more and more responsibility was placed on the engineers at the same time as their authority decreased in favour of the business managers.

This gradual separation of responsibility and authority has not been helpful to sound material progress (as will be shown in more detail later), particularly in view of the fact that the decisions of the business managers were made purely on commercial and not on social grounds.

### C. Secondary Effects on Cultural Development

The connection between engineering and economics in the material sphere is primary, but there is a secondary connection of the two sciences in relation to cultural life that is not so obvious. This arises from the fact that most cultural development, while not caused by advances in engineering and economics, is at least made possible by them.

*Necessity of Leisure and Wealth*

Cultural life, whether concerned with creative work in the arts or with the appreciation of such work, depends to a large extent upon the supply of leisure and wealth available to society. Creative work cannot be hurried, but must be allowed to pursue its course at ease. In the days when men had to spend all their time in procuring a living there was no opportunity for doing creative work in the arts. Leisure is necessary, preferably for a gifted part of the people all of the time, in order to create the means for enjoyment on the cultural side of life. Similarly, leisure must be available for all of the people some of the time, both to develop and to make use of the ability to enjoy these creations.

The function of wealth is complementary to that of leisure in facilitating cultural development. To make possible the maintenance of part of the population engaged in unproductive creative work all the time, and of the whole population in leisure part of the time, society must possess a surplus of material wealth above the requirements for daily sustenance. The greater this surplus wealth, the greater can be the cultural development, and provided it is properly distributed, the more widespread can be its enjoyment.

*Functions of Engineering and Economics*

The part of both sciences in bringing about the necessary material development is obvious. Through technical advances in industry and agriculture the creation of both wealth and leisure is made possible, and through the proper operation of economics its realization is effected. On the extent that effective co-ordination of the two is worked out, therefore, depend the lengths to which cultural development can go.

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(*To be continued*)

The Broadway Bridge, Saskatoon, Sask.

# The Reflecting Telescope for the David Dunlap Observatory

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**SUMMARY.—After explaining the principles on which reflecting telescopes are based, the author mentions the preliminary considerations which led to the placing of the contract for this large telescope. The general arrangement of the instrument and the various parts of its mounting and accessories are described, including the tube, the declination axis, the polar axis and driving gear and the driving clock. A brief description of the building and dome follows.**

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The principle of the telescope was discovered about the year 1608. The first famous telescope of Galileo was one and five-eighths inches in diameter and about twenty inches long. At that time the making of a telescope would not have been considered an engineering problem. The principles of the telescope are the same now as then but the increase in size from an inch or so to several feet makes all the difference. There is probably no instrument which necessitates the combination of technical and engineering skill to such an extent if the final product is to be satisfactory. A description of the 74-inch telescope of the David Dunlap Observatory, Toronto, will be of interest to members of The Institute.

The principles upon which a reflecting telescope is based are illustrated in Figs. 2*a* and 2*b*. In *a* the Newtonian form is shown, so-called after Sir Isaac Newton, its inventor. The light from a distant source is imagined coming from the right in a sensibly parallel beam which strikes the mirror *A*. The front surface of *A* is made hollow, being a paraboloid of revolution. This type of surface reflects the rays of all colours to the same point *D*, called the prime focus. In the Newtonian type of telescope, a plane mirror is placed at *B* in the path of the converging beam and inclined at 45 degrees to the axis, so that the beam is bent through a right angle and the focus is near *C*, where it may be examined with a magnifying glass or eyepiece.

In *b* we have the Cassegrain form of the telescope. The light which is reflected from the silvered glass mirror *A* in this case falls on a convex mirror *B* before it reaches the focus, and if the convex mirror is a portion of an hyperboloid of revolution, all the rays will be reflected back to a point near *C*. It is necessary in this case to have a hole in the centre of the mirror *A* to allow the light to reach the focus *C*.

These schemes look so simple that it is not at first apparent why it should be a difficult problem to make a telescope several feet in diameter. In the first place, however, the mirror *A* must be truly parabolic in shape with departures of the order of one-millionth of an inch. It must be very rigid to resist flexure and consequently heavy. The best material from which to make a mirror yet discovered is glass. In the instrument now described the mirror will consist of a solid disc about thirteen inches thick weighing about 5,000 pounds and made of pyrex. The advantages of pyrex are that it has a small temperature coefficient of thermal expansion and is a stable glass. The disc has been cast at the Corning Glass Works, Corning, N.Y., and is now in England at the optical shops of Sir Howard Grubb, Parsons and Company, at Newcastle-on-Tyne, where it will be ground and finished.

In the second place the telescope must be capable of being pointed towards any object without loss of time and must be driven by some mechanism to follow the object continuously as it moves across the sky. It must not only keep the object in the field of view but must hold the image stationary. A drift of the image of a thousandth of an inch during the course of an exposure when the telescope is being used for photography would seriously affect the definition of the picture. The engineering difficulties confronting the telescope maker in thus keeping the tube so accurately pointed are about equivalent to keeping a gun pointed on a target an inch in diameter at a range of twenty miles while the target is moving at the rate of five feet per second.

The mechanical parts which support the mirrors are usually spoken of as the "mounting." The whole instrument must be sheltered by a building which can be opened to permit a view in any direction and provide means of convenient access for the observer to any part of the telescope.

The positions of objects in the sky are located with reference to imaginary circles drawn among the stars very similar to the circles of longitude and latitude on the surface of the earth. They are however given different names when drawn in the sky. Those which correspond to the circles of latitude on the earth are termed declination circles and that declination circle corresponding to the equator on the earth is termed the celestial equator. The angular distance of a star north or south of the celestial equator is called *declination*. The circles corresponding to longitude circles on the earth are termed right ascension circles and the corresponding angular co-ordinate is called *right ascension*. Right ascension is numbered from the zero right ascension circle and increases toward the east. Thus the position of any star in the sky is designated by its declination and right ascension in a manner very similar to the location of points in the earth's surface by latitude and longitude. Due to the rotation of the earth the sky appears to rotate about an axis, so that there are two points in the sky at which the earth's axis produced cuts the celestial sphere, and about which the stars seem to revolve. Of course, in the northern hemisphere only the north celestial pole can be seen and indeed its elevation above our horizon will be equal to the observer's latitude. Due to the rotation of the earth also the right ascension circles drawn among the stars come in turn to the meridian and that right ascension circle which coincides with the meridian is called the *sidereal time*. If any star on its right ascension circle is not on the meridian it is said to have an *hour angle* measured east or west in time from the meridian, the sky apparently rotating 15 degrees per hour.

The technique of telescope making has evolved gradually. Experience has had to point the way for advances and, as in other lines of engineering production, the changes are suggested by the weaknesses of former models. There are comparatively few firms that have sufficiently large machinery to handle the massive castings which support the optical parts, and, when we combine with this the fact that the number of firms which have had experience in telescope building is very small also, we see that the project could be tendered for by a very restricted few. In 1927, when Mrs. D. A. Dunlap expressed her willingness to provide the means to construct a large telescope, tentative specifications were drawn up and in June of 1928 sent to four firms, the Carl Zeiss Company of Germany, the Sir Howard Grubb, Parsons and Company of England, the Warner and Swasey Company of Cleveland, and J. W. Fecker of Pittsburgh. The preliminary specifications stipulated the general form of the mounting but left considerable latitude in detail. The Warner and Swasey Company did not submit any tender and the design of the Carl Zeiss firm was not attractive as it was of a very radical nature. There was not much difference in the designs of the other two firms but after due consideration it was decided to accept the tender of the Sir Howard Grubb, Parsons and Company, England. This was a very fortunate choice because the decrease of the pound sterling

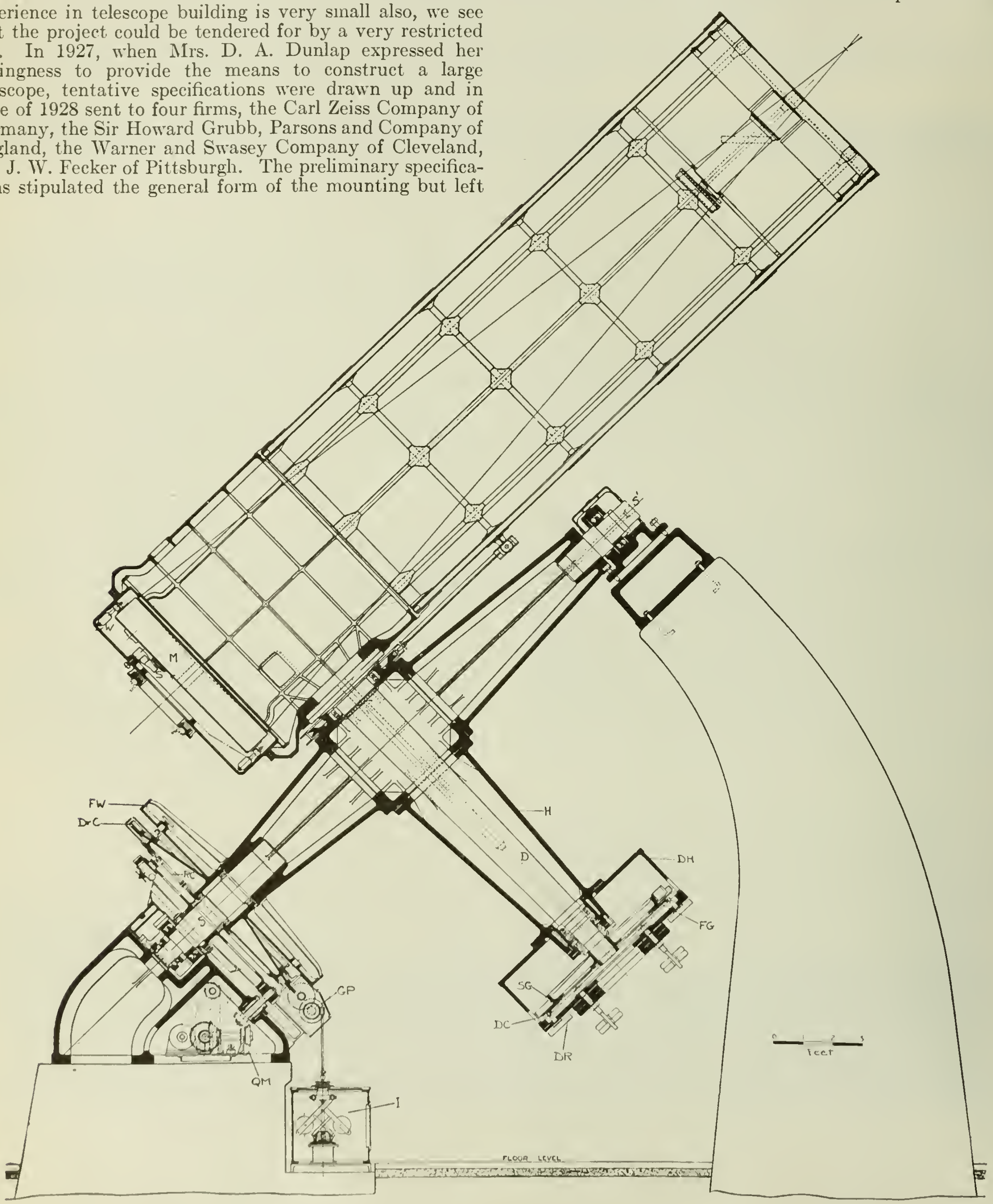
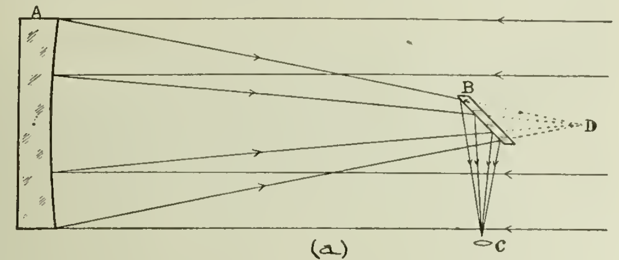



Fig. 1—General Arrangement of 74-inch Reflecting Telescope.

and the inflation of the American dollar later made the cost of the telescope very much less than it would have been had the contract been let in the United States.

The general form of the mounting is shown in Fig. 1 and a photograph as it appeared in the workshops prior to shipment is shown in Fig. 3. The essential features of any mounting are the tube which supports the optical parts and two axes of rotation at right angles to each other. The



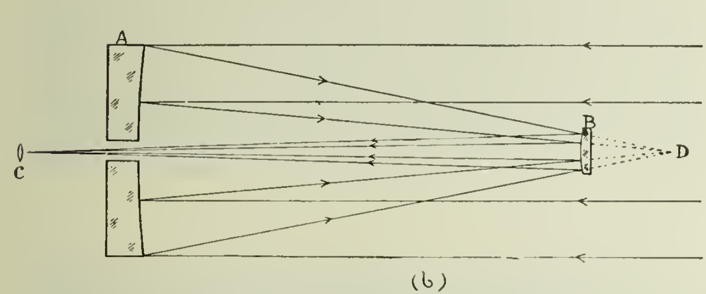




Fig. 2—Principle of the Reflecting Telescope.

*polar axis* (*SS'* in Fig. 1) must point to the celestial pole and the *declination axis D* to which the tube is attached provides another degree of freedom so that the tube may be pointed to any part of the sky. The polar axis is rotated by clockwork *I* in such a way that the telescope will continue to follow an object as it moves from east to west across the sky in its diurnal rotation. This is the equatorial form of mounting.

There are many forms of the equatorial mounting, which differ in the way the tube is attached to the declination axis, the latter attached to the polar axis, and the way in which the polar axis is supported. The kind of mounting selected for the 74-inch telescope is usually called the English type. As can be seen from Fig. 1, the polar axis is supported at both ends by two piers and the tube is carried on one end of the declination axis. In very heavy telescopes the polar axis is sometimes built in the shape of a large O and the declination axis supported by bearings at each end of the short diameter. This design is adopted in the mounting for the 100-inch telescope at Mount Wilson, California. In other telescopes the declination axis is attached to the polar axis beyond the two bearings of the latter. The 40-inch telescope of the Yerkes Observatory, Chicago, is an example of this type of mounting. In other telescopes again the polar axis is built in the form of a massive fork with two prongs and the tube of the telescope is mounted between the arms of the fork as in the 60-inch telescope of the Mount Wilson Observatory. Each type has its peculiar advantages in regard to strength, accessibility, and freedom of motion. The form adopted for Toronto has been very successful in the 72-inch telescope at Victoria, B.C.

When the contract was awarded in 1930 the main outlines only of the instrument were specified and Sir Howard Grubb, Parsons and Company began work on the detailed drawings. It seemed advisable toward the spring of 1930 for the author to spend some time in England going over the plans of the instrument with the manufacturer, and F. Jno. Bell, M.E.I.C., the Canadian representative of the firm, arranged to have the author visit Newcastle while the essential features were being drafted. This enabled much more rapid progress to be made than would have been possible if all the details had to be settled by correspondence.

On the author's arrival in England early in July 1930 the drawings were found well underway. Fortunately the firm had recently completed the 36-inch reflecting telescope for the Edinburgh Observatory and were engaged on a 40-inch telescope for the Stockholm Observatory. As there are many parts very similar in all telescopes, it was easy, from the parts of the 40-inch, many of which were in the workshop, to form a picture of the proposed new telescope. The completed drawings of the Edinburgh telescope were also a great help. In addition, the author had had a long experience with the 72-inch reflecting telescope at Victoria, B.C., and since the proposed mounting was very similar to this, conferences with Mr. Young, the manager of the optical works, enabled rapid progress to be made on the final design. When the author left towards the end of August no work on the actual construction had been done but the plans were so far advanced that construction was started in the fall.

### The Tube

The tube of the telescope which immediately supports all the optical parts is made in three sections. These three sections are called the mirror cell, the centre piece, and the skeleton, and are shown in Fig. 1. There are several features that the tube must possess. It must be as light as possible but must carry the 5,000-pound mirror at the bottom and the small mirrors at the top with a minimum amount of flexure. It must permit a free circulation of air so that light rays, in their passage through the tube to the

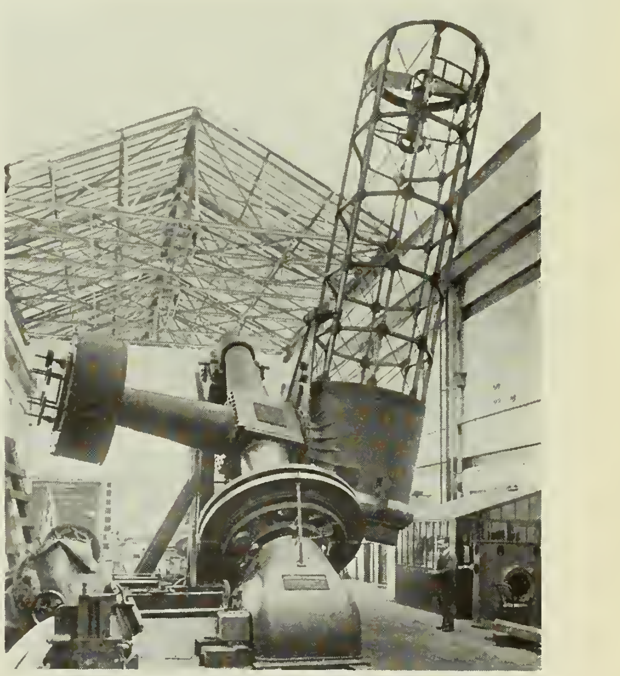


Fig. 3—Telescope with Tube Nearly Vertical.

main mirror and back, travel in a homogeneous medium. It must be capable of adjustment for alignment so that the optic axis is truly at right angles to the face to which the declination axis is attached. In order to reduce vibration to a minimum it should be mounted as close to the polar axis as possible.

The mirror cell consists of a steel-ribbed casting, weighing about 2,100 pounds. The mirror is supported on the bottom by a system of discs 7 inches in diameter in three sets of three each. These supports are shown in Fig. 1 at *S*. Each disc is mounted on a universal joint and the web-work which supports each set of three discs can be moved in or out to set the mirror with its face perpendicular to the optic axis. The disposition of the various discs is such that each carries its share of weight. Very careful attention was also given to the edge support. It is

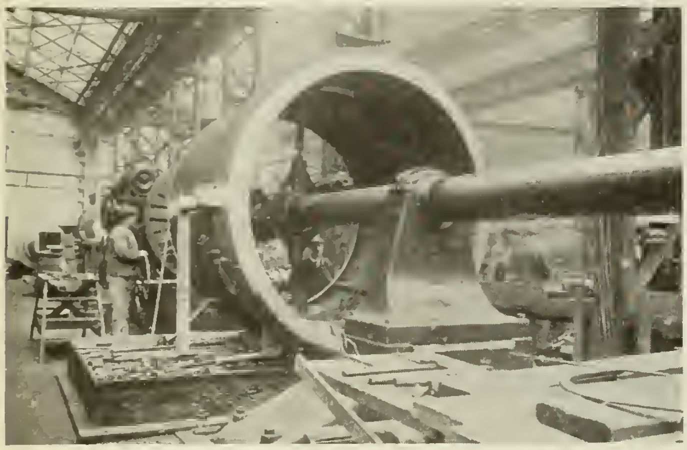


**Fig. 4—Truing Faces of Centre Piece of Tube.**

surrounded by arcs of a strong steel rim which fits into a groove in the disc. Heavy weights shown at *W* are attached to this rim by universal joints and are also attached by brackets attached to the interior wall of the mirror cell. When the tube is vertical there is no thrust on the edge of the mirror but as the tube assumes a horizontal position the weights act as levers with the brackets on the mirror cell acting as fulcrums and support the resolved component of the weight of the mirror so that in all positions the mirror is, as it were, floated. This might seem an elaborate system of support but the mirror is so sensitive to any distortional stresses that there is danger of the disc being warped if the stresses are not as uniform as possible in all parts. The mirror cell is bolted by a flange to the central casting.

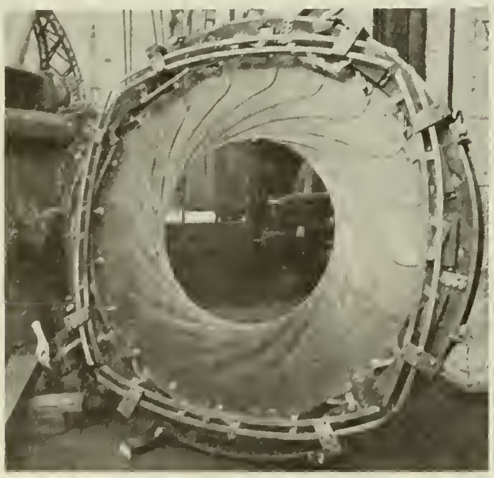


**Fig. 5—Iris Diaphragm at Half Aperture.**

The centre piece of the tube is also of steel and is heavily ribbed, weighing 4½ tons. A boss is cast on one side where it bolts to the declination axis. Instead of making a perfectly flat contact between the flange on the declination axis and the centre piece, they touch along a rim only. The purpose of this precaution is to reduce the rate of flow of heat from the tube to the declination axis and thence to the rest of the massive parts of the telescope. This flow of heat has a tendency to take place in the early evening when the telescope is first put into use and the result seems to be that the part of the tube next the polar axis becomes a little cooler or warmer than the outer parts. There is then a temperature gradient across the disc and this produces a slight cylindrical warping and consequent astigmatism in the reflecting surface. It is necessary that the face of the boss and the two faces, where the mirror cell is bolted on at the lower end and the tube at the upper, be at right angles. The operation of truing these up may be seen in Fig. 4.

Immediately above the mirror and attached to the centre piece is an iris diaphragm similar in construction to that used in ordinary cameras. It is operated by a graduated hand-wheel on the outside of the tube and may be used to stop down the telescope and serves also as a protection to the mirror when closed. It is shown at half aperture in Fig. 5.

The skeleton part of the tube, which is bolted to the upper flange of the centre piece, is made of duralumin I-beams, cross-braced by rods also of duralumin threaded right and left hand at the ends into T-anchors. By means of these brace rods, which can be seen in Fig. 3, the tube may be made to twist slightly or to shift in any direction without twisting. The rods are tightened to a point where each is under tension in any position of the tube. Careful

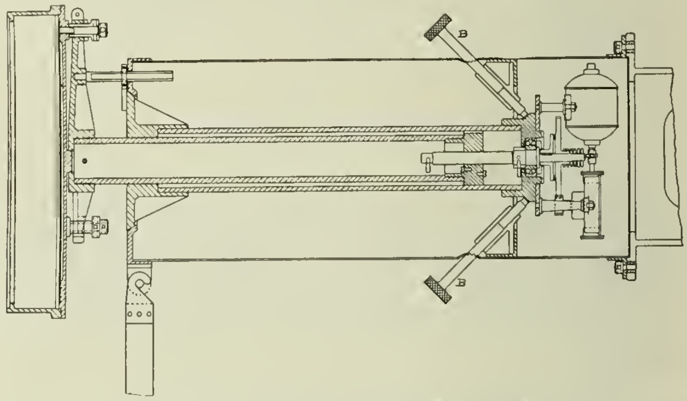


**Fig. 6—Cassegrain Mirror Mounting.**

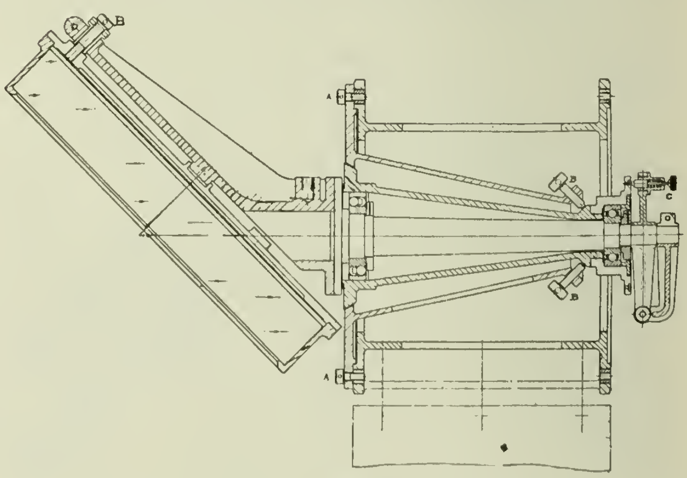


**Fig. 7—Newtonian Mirror Mounting.**

tests when completed have shown that, under the extreme position of flexure, the outer end does not sag more than one-sixteenth of an inch. The skeleton part of the tube supports at its upper end the secondary mirrors which may be of the Newtonian or Cassegrain form. The 74-inch telescope is designed to be convertible to either form. Figure 3 shows the Cassegrain mirror in place and in Fig. 1 the position the Newtonian mirror occupies is shown by dotted lines. Sectional elevations of these two attachments are shown in Figs. 6 and 7. Very convenient arrangement is provided in both these mirrors for bringing them into alignment with the axis of the tube by means of the screws *BB*. By shifting the dowel pin *C* (Fig. 7) in the Newtonian form the mirror can be rotated and the rays of light brought to the side of the tube in any one of four positions. This is almost essential because, in working at

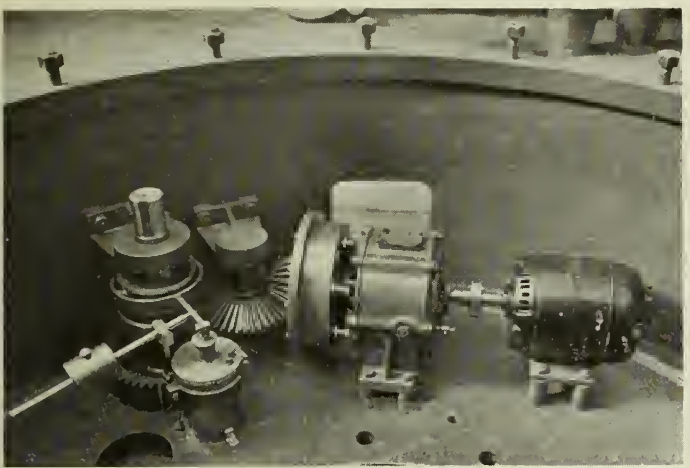


Fig. 8—Declination Quick Motion Gear.

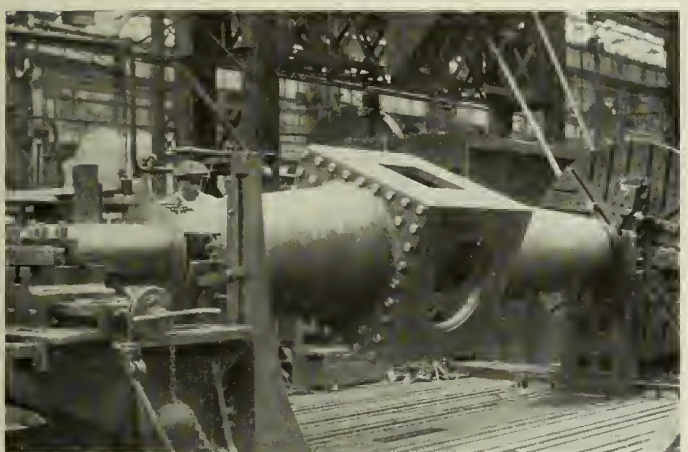


Fig. 9—Truing Polar Axis.

the upper end, it is convenient to bring the focus to that side of the tube which is the easiest to reach. By loosening the screws *AA* the Newtonian may be removed and the Cassegrain fastens to the same flange. When the Cassegrain mirror is in place the observer is situated at the base of the tube for observation. In a large telescope of the reflecting type the changes in temperature, causing expansion and contraction in the tube and mirror, alter the position of focus. Changes in the focus may be made by altering the position of the Cassegrain mirror and in the 74-inch telescope this is done by a small motor mounted in the tube which attaches the mirror in position. The observer has only to touch a button at the lower end of the tube and the focus is adjusted in or out as desired.

### The Declination Axis and Housing

The declination axis, to which the tube of the telescope is attached, consists of a steel forging 13 feet long with a flange at the inner end 3½ feet in diameter. Its weight is about 3½ tons. A hole has been trepanned through its centre to permit the electric wiring to pass to the tube and to the outer end. It is supported at the inner end by a radial ball-bearing 17 inches inside diameter, and at its outer end is carried by a radial bearing and double thrust bearing fitting into a tubular steel casting (*H* in Fig. 1) which is called the *declination sleeve.* All the bearings have been specially made with considerably less clearance than in commercial bearings. A spur gear (*SG* in Fig. 1) is keyed to the outer end of the declination axis which serves to turn the tube quickly in declination. The power for this motion is supplied by a motor inside the *declination housing DH.* A photograph of this motor and gearing is shown in Fig. 8. It can be clamped or unclamped by a magnetic clutch, the controls for which are mounted on the pier of the telescope. Bolted to the large spur gear is a graduated circle *DC* (Fig. 1) which by an index enables the observer to read the declination at which the tube is set. This *declination circle* is divided to single degrees, but in order to read the declination more accurately a fine spur gear *FG* bolted to the graduated circle drives two small drums *DR*, and these are graduated to a least reading of five minutes. Small electric lights illuminate the declination circle and drums so that the reading may be conveniently seen from the operator's position beside the pier. The declination housing is made intentionally heavy so that its weight counterbalances the weight of the tube. Additional weights are attached to the housing to adjust the balance. It can be seen from Fig. 1 that no extra weight has been attached to the declination axis proper, thus reducing flexure to a minimum and facilitating a free motion in declination. When the telescope has been brought to the correct declination setting, within a minute of arc, the quick motion gear is disengaged and the observer, on looking through the telescope, will see the star, but usually not in the centre of the field of view. It is necessary to have some fine adjustment whereby the tube may be moved by very small amounts. The mechanism which effects this is called the *declination slow motion.* It is shown in Fig. 1 and in Fig.

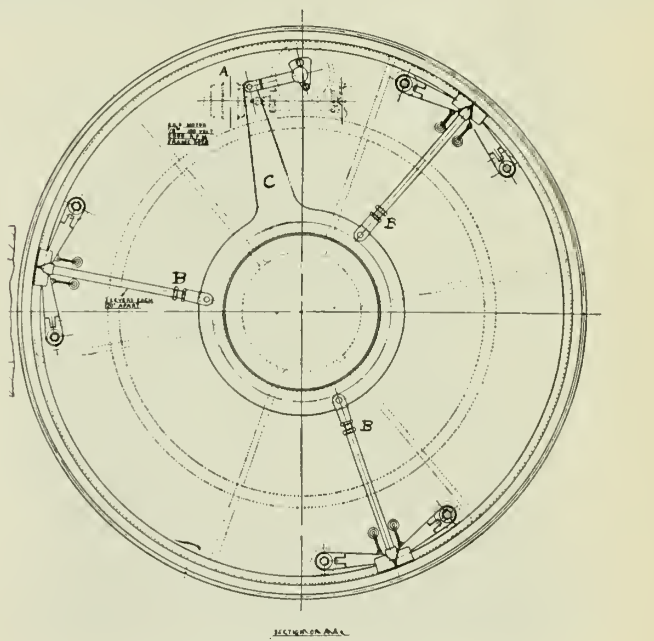



Fig. 10—Right Ascension Slow Motion Clamp.

3 between the polar axis and the tube. A fabricated steel arm about seven feet long is mounted on a V-ring which can be clamped or unclamped to the polar axis. The outer end of the arm carries a nut mounted on a link motion which can be moved in either direction along a screw attached to a bracket fastened on the tube. A motor operates a two-speed gear to turn this screw for giving the slow motion in declination. The motor is operated by two

separate switches. For the faster motion a dog-clutch, operated by a solenoid in parallel with the motor, connects the gear to the slow motion screw and moves the tube fifteen minutes of arc in one minute of time. For the slower motion an electro-magnet brings a differential gear into action and the tube moves thirty seconds of arc in one minute of time. The circuit which actuates the magnetic clutch in the declination housing for quick motion is inter-

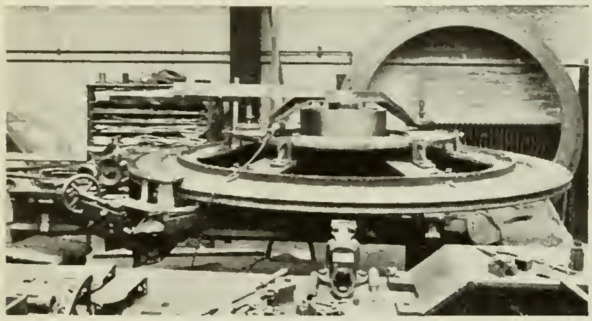


**Fig. 11—Cutting Teeth in Driving Circle.**

locked with the clamping motor on the V-ring so that it is impossible to have the two clamps engaged at the same time.

### The Polar Axis and Driving Gear

The polar axis, which carries the declination axis and housing, is best seen in Fig. 9 where it is shown on a lathe. It consists of three sections, a central hollow steel cubical casting to which is bolted two tapered hollow steel castings. Forged steel pivots are shrunk into the ends of the steel castings. Figure 9 shows the operation of truing the polar axis. It is 22 feet long and weighs $9\frac{1}{2}$ tons. Having been trued up it was never taken apart but henceforth treated as a unit. It runs in self-aligning ball bearings with a ball thrust bearing at the lower end. The housing at the upper end provides means of adjustment in elevation and azimuth to bring the axis $SS'$ in line with the celestial pole. Keyed to the lower end of the polar axis is a large spur gear $S$ which engages with the quick motion motor $QM$ in Fig. 1 for moving the telescope in right ascension. This motor is engaged with the gear by a magnetic clutch. When the clutch is engaged and the motor started, the telescope rotates in right ascension, and in order to bring the telescope quickly to rest when the motor is released, the clutch continues to engage for a few seconds and acts as a drag. This is a very convenient arrangement in preventing the overrunning of the telescope beyond the desired reading. The *driving circle* (*Dr. C* in Fig. 1) for moving the telescope to follow the motion of the stars is mounted on the lower pivot immediately above the quick motion spur gear. It turns freely on ball-bearings but can be clamped to the axis through the spur gear. The clamping arrangement is shown in section at *RC* in Fig. 1 and a plan is shown in Fig. 10. A small motor (*A* in Fig. 10) rotates the arm *C* and the toggle arms *B*, which are mounted eccentrically, push out wedges into a V-groove on the inner edge of the driving circle. The driving circle itself is a steel casting, and a bronze rim, in which the teeth are cut, has been shrunk onto its outer edge. The pitch diameter is 8 feet cut into nine hundred and sixty teeth. The operation of cutting the teeth in this wheel is shown in Fig. 11, in which it will be observed that a finely divided silver circle is mounted directly over the worm wheel. The positions of the teeth are governed by the divisions on this circle so that the driving circle is a copy of this tested circle. This procedure eliminates the danger of periodic errors. The teeth were carefully hobbed and ground and the worm finally run in with rouge to ensure a perfectly smooth fit. Mounted above the driving circle at *FW* in Fig. 1 is a free wheel called the *sidereal circle*. It is mounted on the boss of the driving circle and can be easily rotated by any one of six hand-wheels attached to it and fitted with pinions gearing into a wheel attached to the driving circle. The metal rim of this wheel is 3 inches wide and graduated on both edges to one minute of time divisions. The lower set of divisions read against indexes fixed to the guard of the driving circle and therefore mark sidereal time, while the upper set of divisions are read by indexes which are attached to the polar axis and therefore read right ascension. On starting work at the beginning of the night the clock is started and the sidereal circle moved by means of the hand wheels till the lower graduations read the correct sidereal time. As the sidereal circle is attached to the driving circle the lower scale will continue to read the sidereal time. In order to set the telescope on any star it is necessary only to engage the quick motion and turn the telescope about the polar axis until the upper scale reads the right ascension of the object. The driving circle is then clamped to the polar axis and the quick motion clamp freed. The quick motion clamp in right ascension and the clamp for the

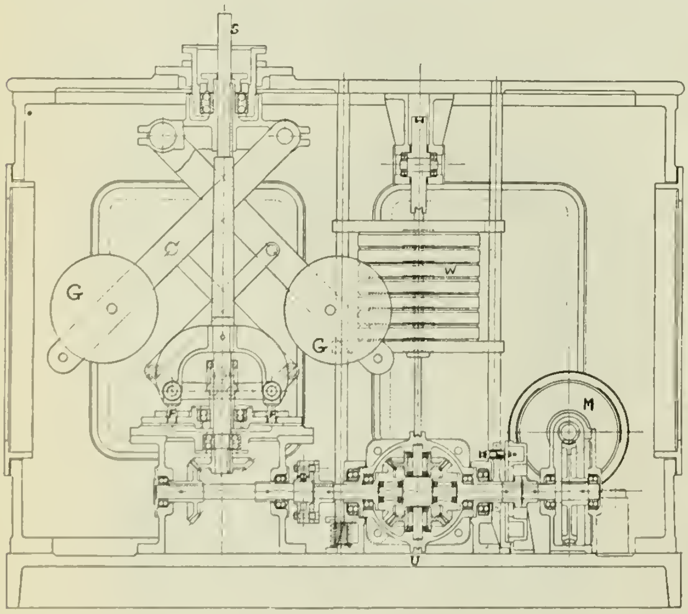



**Fig. 12—Driving Clock.**

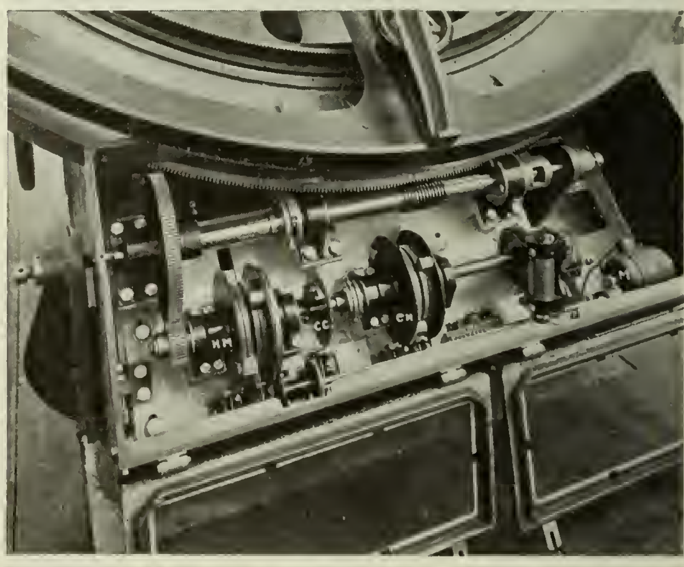


**Fig. 13—Gear Plate and Driving Worm.**

driving circle are actuated by an interlocked circuit so that it is impossible to have both on at the same time.

### The Driving Clock

The position of the driving clock is shown at *I* in Fig. 1 and a cross-section through the vertical spindle is given in Fig. 12. The cross-arm governor *G* is driven by the weight *W*. The motor *M* turns at the right speed to keep the weight floating on its vertical guides. Ordinarily if the motor is turning at the correct rate the position of *W* will be stationary and the outer housing of the differential gear *U* will be at rest. But if the motor turns too fast or slow the weight rises or falls and the outer housing turns, without affecting, however, the torque applied to the governing spindle. In order to keep the weight *W* suspended and to govern the motor, the weight is attached to a lever arm, not shown in the drawing, which actuates a resistance in series with the motor slowing the latter down if the weight gets high and speeding it up if the weight falls low. As the governors speed up, the link motion spreads and brings into play two friction pins at *FF* and the speed is checked. The moment that these engage can be regulated by turning the heavy weights *GG* which are mounted eccentrically. A clock of this type runs very accurately but not with the precision necessary to keep the image of the star perfectly stationary. Therefore, instead of gearing the spindle *S* directly to the driving worm, it communicates to a gear plate shown in Fig. 12, and at *GP* in Fig. 1, the function of which is to correct for any small irregularities in the clock drive and at the same time provide means of slow motion of the telescope in right ascension if it is desired to shift the position of the star in the field of view. The spindle of the driving clock *S* connects with the worm and worm wheel of the gear plate shown at *D* in Fig. 13. If the clock is driving at exactly the right rate this shaft turns one revolution in twenty-four seconds. Mounted on this shaft at *CC* is a thin disc in the circumference of which are cut twenty-four V-shaped notches, and into these notches beats the armature of a solenoid which is connected to the seconds beat of a sidereal master clock. Provided the disc *CC* runs at the correct rate the armature accurately strikes the depressions but if the wheel runs too fast or slow the armature shifts the wheel slightly and it is connected with the differential *HM* to keep the worm drive in synchronism with the notched wheel *CC*. For a slow

**Fig. 14—View of Site from Southeast showing Piers.**

motion the differential *HM* may be rotated by the motor *M* and for a still finer motion the differential *GM* can be locked or released by a dog-clutch. The motion imparted by the motor *M* is never sufficient to completely overcome the normal rate of drive so that the driving screw is always engaged with the driving circle and hence all difficulties of backlash avoided.

The complete mounting as described above was received in Toronto on October 15th, 1933.

### The Building and Dome

The building to house the telescope, though out of the line of ordinary construction, did not require so long to complete. The contract for it was let in November 1931, and it was received on July 31st, 1933. In the meantime the piers to support the telescope and the foundations of the building had been built.

**Fig. 15—Building with Dome Partially Erected.**

Figure 14 shows the cement piers in place and the nature of the surrounding country. The site chosen is a hill about 800 feet above sea level and 100 feet above the surrounding

**Fig. 16—Observing Platform.**

country, 12 miles north of the city limits of Toronto. The piers consist of reinforced concrete and extend 25 feet underground to a foundation of hard clay which extends farther down for more than 150 feet. On the east side of the pier a pit 6 by 10 feet extends to the bottom of the foundations. An elevator is mounted in this pit for removing the mirror and mirror cell. The mirror can be readily taken off for the purpose of resilvering.

Figure 15 shows the circular building and dome as it stood at the end of September. Since then the telescope has been put in place and the dome covered. As the construction of the building and dome presents a number of unusual features a brief description will be of interest. The entire building is of steel construction. The circular base and dome have double walls, and open louvres at the base of the building admit air which circulates to the top and exits through baffle plates at the top of the dome. The inside and outside of the dome is covered with "agasote," a kind of hard paper product, and the outside is further protected by a sheeting of copper. By this means the interior is kept cool during the day and in the evening when observations are started the whole building soon assumes the temperature of the outside air and the definition is not interfered with by heated air currents which would undoubtedly be the case if any quantity of heat were stored in the walls.

The dome, which weighs about eighty tons, rests on twenty-four rollers 27 inches in diameter mounted on self-aligning ball bearings and running on a circular track. Lateral rollers keep the dome in position as it is rotated. The rotation is effected by means of an endless steel cable passing around an annular channel ring fixed to the base of the dome and over two tangent pulleys to a winding gear. The dome is 61 feet in diameter and has an opening at one side, 15 feet wide, extending from the bottom to 7 feet beyond the zenith. Two parallel shutters run on rails at the top and bottom of the dome and are operated by wire ropes connected to a motor-driven gear which opens or closes the two shutters simultaneously. To protect the telescope from wind blowing in at the open shutter, two wind screens, motor operated and consisting of heavy sail cloth, can be used to cover the part of the opening not in use. One runs from the top of the opening downward and the other from the bottom upward and are guided in tracks fixed to the inside of the shutter opening. A novel feature of the dome, and one which should make it more convenient to operate than any previous models, is the method of access to the upper end of the tube. Two parallel segmental platforms are fixed to the inside of the dome, the lower one at the base of the opening and the upper one at a 16-foot higher level. Rails are mounted on these platforms and a circular arc bridge connects the two platforms. The bridge is shown in Fig. 16. The entire bridge can be moved laterally on the rails of the platforms and a small observing carriage travels up the curved arch. The small observing platform can be swung around on a pivot to enable the observer to place himself in a convenient position with respect to the eyepiece of the telescope.

No effort has been spared by the manufacturers to make the entire mechanism, mounting and dome in the best way possible. The workmanship is of the highest quality throughout and when finally completed the telescope will be the largest in the British Empire.

The magnitude of the telescope will make it a powerful instrument of research, and the major part of the programme of the observatory will be devoted to investigations into the motions and distribution of the stars. One evening per week however will be devoted to viewing the heavens when the public will be invited to visit the observatory and look at the planets, the moon and other objects in the sky.

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Note: The illustrations, with the exception of Figs. 14 and 15, which are from photographs taken from the roof of the administration building of the observatory, are from photographs and drawings kindly supplied by the Sir Howard Grubb, Parsons and Company.

# Report of Council for the Year 1933

Observers of the course of events during 1933 appear to agree on one point, namely, that last spring saw the lowest level of the country's industry and commerce. Since then there has been a definite though comparatively small improvement in many branches of manufacturing activity and general business, extending over practically the whole of Canada. Unfortunately this has not as yet affected to any marked degree the industries in which engineering work is involved, nor has there been any appreciable increase in the employment of engineers. The construction industry in particular is still at a very low ebb, although there are some prospects of better conditions in 1934.

Thus 1933 has been a most difficult year for members of The Institute, and many have found it impossible to meet their annual fees. Your Council has thought it necessary to refrain from applying in full the provisions of the by-laws regarding arrears of fees, and has established a Non-Active List, on joining which, a member, while retaining a nominal connection with The Institute, ceases to incur further indebtness, and can on request resume active membership at any time without formal reinstatement. A considerable proportion of the drop in membership reported for this year is due to the establishment of this list, which is intended more particularly for those members who are unemployed.

The Institute's income, both from members' fees and from advertising in The Institute publications, has shown a marked decrease, and your Council has been faced with the necessity of adjusting expenditure to a falling revenue whose amount could not be predicted. As a result of this situation, although rigid economy has been practised and expenditures have been kept within the budget, the year's operations show a deficit. It is, however, a matter for some satisfaction that under these conditions the shrinkage in our active membership has not been greater, and that it has been possible to carry on the most essential services of The Institute to its members with but little disturbance.

The financial situation of The Institute, as shown by the report of the Finance committee, demands careful consideration, since it indicates that The Institute's reserves have had to be drawn upon. Your Council considers it essential to prevent the continuance of this condition, and is taking such measures as are possible to further limit expenditure and to promote the revenue from advertising. But to meet the difficulty, it is essential that all members who can possibly do so continue to support The Institute by regular payment of their annual fees. It will be appreciated that your Council's action in extending credit, and carrying a large number of members on the Non-Active List has been immediately reflected in decreased revenue from members' fees.

Your Council would also direct particular attention to the report of the Membership committee, which rightly stresses the necessity for increased activity as regards building up the membership, both on the part of branch executive committees and the membership of The Institute at large. At this time there are hundreds of our present members whose circumstances are such as to have compelled them to discontinue, temporarily at all events, their support of The Institute. On the other hand there are in all of our branch districts many qualified engineers who would be able to take part in The Institute's work with benefit to themselves and to The Institute, and have not yet done so. These possible members can only be brought in if present members who know them will render a service to The Institute by placing their names in the hands of their branch officers for the necessary action.

To aid the efforts of the branch membership committees, your Council has thought it advisable to make a temporary reduction of the entrance fee to $5.00 for all classes of Institute membership, a measure which will be submitted to the membership for confirmation at the Annual General Meeting.

From the report of The Institute's Committee on Unemployment,* it will be noted that while unemployment has been widespread among our membership, comparatively few cases of dire need have been reported, occurring principally in the larger centres, and these have been dealt with by voluntary contributions from the members of the branches chiefly affected. The number of our members now seeking employment shows a regrettable increase over 1932, but the situation has been greatly helped by the action of the Department of National Defence in making available for members of The Institute and of the Associations of Professional Engineers a considerable number of supervisory positions in connection with the Department's Relief Work Camps. In this connection The Institute is greatly indebted to the Minister of National Defence, the Minister of Labour, and to Major-General A. G. L. McNaughton, C.M.G., D.S.O., M.E.I.C., Chief of General Staff, who has carried out the Department's very effective programme.

The proposals of the Committee on Development and the discussions upon these formed the basis of the debates at the Sixth Plenary Meeting of Council which was held in October last. As a result of this meeting your Council has drafted a set of by-laws proposing such changes as seem desirable at this time, and these will be submitted for discussion at the Annual General Meeting. Council recognizes with gratitude that the contributions so freely granted from the funds of the various branches made it possible to hold the Plenary Meeting.

Should the proposed changes in the by-laws meet with approval and become effective, it is hoped that they will react favourably on The Institute's relations with the various Associations of Professional Engineers. The movement for the co-ordination of the activities of these several bodies is being dealt with by a Committee of Eight (the successor to the original Committee of Four), which is composed of representatives of the eight Provincial Associations, and is understood to be making definite progress in its task.

While it happens that every member of this committee is a corporate member of The Institute, the committee does not include any official representative of The Institute as a body. It will be remembered that in 1931 The Institute was requested to withdraw from the committee then functioning, in order to meet the views of one of the professional associations and secure the co-operation of that association in the committee's work. Your Council, however, still feels that the co-ordination movement is one in which The Institute has a very real concern, and remains willing to assist that movement in any possible way.

This attitude was clearly expressed in a resolution passed unanimously at the recent Plenary Meeting, to the effect that The Institute should "co-operate in every way possible with the Provincial Associations of Professional Engineers, particularly in endeavouring to secure a generally

*Printed in The Journal for December 1933, pp. 528-30.

acceptable system of registration of engineers in all parts of the Dominion."

Your Council has followed with interest the work of the National Construction Council of Canada, a body on which The Institute is represented by two of its members, and notes with pleasure that that Council has formulated what appears to be the most promising construction recovery scheme that has yet been put forward. The National Construction Council estimates that a general revival of construction activity on the part of private interests would make it possible to find direct and indirect employment for nearly half a million men, and that Council is accordingly endeavouring to obtain the assistance of the Dominion Government in making credits available at low interest rates for private construction.

The E-I-C Engineering Catalogue, the first issue of which appeared early in 1933, met with an encouraging reception, not only from the membership of The Institute, but also from the considerable number of industrialists and manufacturers to whom it was made available. The second and enlarged issue of that Catalogue is now in the press, and will be found of increased service to our members, besides bringing The Institute and its activities into closer relations with industry. It is intended to publish this Catalogue annually.

Your Council has noted with great appreciation the results of the President's visits to the twenty-five branches of The Institute, in developing a better understanding of The Institute's problems as a whole by our membership, and in familiarizing the members of each branch with the activities and points of view of the others. Journeys of this kind are most effective in promoting unity of sentiment and definiteness of aim in our widespread membership.

The Forty-Seventh Annual General and General Professional Meeting took place in Ottawa on the 7th and 8th of February, 1933, and fully maintained the reputation of the Ottawa Branch as organizers and hosts. The business sessions were of unusual interest, as they dealt with the proposals of the Committee on Development. After lengthy discussion, it was decided that the proposals for the amendment of by-laws to be submitted to the membership for acceptance should be discussed and prepared at a Plenary Meeting of Council to be held in Montreal as soon as possible. Active discussion on the unemployment situation as regards Institute members was also a feature of the meeting. At the Annual Dinner The Institute was honoured by the presence of the Governor-General and the Countess of Bessborough, and His Excellency delivered a felicitous address to the members and ladies present.

On July 13th, 14th and 15th, 1933, The Institute held a Maritime General Professional Meeting at White Point Beach, Queen's County, Nova Scotia, under the auspices of the Halifax Branch and with the active co-operation and support of the Nova Scotia Association of Professional Engineers. The Halifax members, on whom most of the organization work fell, are to be congratulated upon the success of the gathering. The officers of the Mersey Paper Company and those of the Nova Scotia Power Commission gave generous support throughout the meeting, which was noteworthy as being the first occasion on which a General Meeting of an association of professional engineers has been held conjointly with a Professional Meeting of The Institute.

### Roll of the Institute

During the year 1933, one hundred and twenty-eight candidates were elected to various grades in The Institute. These were classified as follows:—Three Members, twenty-two Associate Members, five Juniors, ninety-six Students, and two Affiliates. The elections during the year 1932 totalled two hundred and three candidates.

Transfers from one grade to another were as follows:— Associate Member to Member, seven; Junior to Associate Member, fifteen; Student to Associate Member, two; Student to Junior, nine; a total of thirty-three.

The names of those elected or transferred are published in The Journal each month immediately following the election.

### Removals from the Roll

There have been removed from the roll during the year 1933, for non-payment of dues and by resignation, twenty-nine Members, seventy-two Associate Members, twenty-nine Juniors, eighty Students, and eight Affiliates, a total of two hundred and eighteen.

Thirty-six reinstatements were effected and eleven Life Memberships were granted.

Two hundred and twenty-four names were placed on the Non-Active List; and one hundred and thirteen names on the 1932 Non-Active List were carried forward, making a total of three hundred and thirty-seven names on the Non-Active List.

### Deceased Members

During the year 1933 the deaths of thirty-three of The Institute's members have been reported as follows:—

#### Members

Browne, James Edward
Bucke, William A.
Butler, Matthew Joseph, C.M.G.
Caddy, Arthur E.
Davis, Allan Ross
Doucet, A. Emile
Grant, Alex. MacDonald
Hannaford, Robert Maitland
Higman, Ormond
Leahy, Maurice J.
Lindsay, William Bethune, C.B., C.M.G., D.S.O.
Mackenzie, Allan Campbell
Mullen, Charles Augustine
Selig, Alonzo Clarence
Warren, Philip Ridsdale, O.B.E.
Wilson, Robert M.

#### Associate Members

Armstrong, William Dun
Cameron, Charles Scott
Mackay, John Murray
Melling, H. T.
Peters, Joseph Dufferin
Robertson, John Donald
Scott, Henry Maurice
Spence, William Archibald
Spreckley, John Alfred
Sutherland, Angus Lynn
Wallace, David Gemmell
Waring, George Hart
Webb, Stanley Chipman
Weicker, Julius John
Yandall, Byron Angus

#### Junior

Marlatt, Victor Egerton

#### Student

MacMurray, John A.

### Total Membership

The membership of The Institute as at January 1st, 1933, totals four thousand and seventy. The corresponding number for 1932 was, four thousand, three hundred and sixty-nine. These figures do not include those members who have been placed on the Non-Active List.

| | 1932 | 1933 |
|---|---|---|
| Honorary Members | 9 | 9 |
| Members | 1,012 | 965 |
| Associate Members | 2,059 | 1,894 |
| Juniors | 401 | 346 |
| Students | 842 | 820 |
| Affiliates | 46 | 36 |
| | 4,369 | 4,070 |

Respectfully submitted on behalf of the Council,

O. O. Lefebvre, m.e.i.c., *President.*
R. J. Durley, m.e.i.c., *Secretary.*

### Finance Committee

The President and Council:—

Your committee respectfully submits herewith the auditors' report for the year 1933, which indicates that a deficit of over $3,700.00 has been incurred. Such an impairment of the assets of The Institute naturally leads to great anxiety on the part of your committee, and has warranted an exhaustive investigation as to its causes and even more so as to its future prevention.

At the beginning of the year it was realized that the revenues of The Institute would be very much reduced and accordingly a balanced budget was prepared based on a revenue and expenditure of $60,500.00 for the year 1933, as against $72,500.00 for the year 1932. This budget included provision for a Plenary Meeting of the Council, and for the usual activities to a large degree, but drastic economies were introduced by eliminating the publication of the E.I.C. News, reduction of library service, and for the third time a reduction in the salaries of the staff was put into effect. While expenditures have definitely been kept within the budget allowances, the revenues, especially from Members' fees and from Journal advertising, dropped off to an even greater extent than anticipated. During the first nine months of the year, however, there was every indication that losses from these sources would be counteracted from other sources; unfortunately, however, this anticipation did not materialize.

The following table gives a statement of the principal amounts in the budget and the actual amounts of the corresponding items of the revenues and expenditures of The Institute for the year 1933, also, for comparative purposes, the figures for the year 1932.

| | *1932* | *Budget for 1933* | *Actual Amount for 1933* | *Per cent of 1932* |
|---|---|---|---|---|
| Arrears of fees | $ 2,927.72 | $ 1,250.00 | $ 1,658.86 | 56 |
| Current fees including *Journal* subscriptions | 34,151.94 | 31,000.00 | 29,178.08 | 85 |
| *Journal* advertising | 18,930.84 | 12,000.00 | 10,863.65 | 63 |
| Catalogue advertising | 10,752.61 | 12,500.00 | 12,176.87 | 112 |
| Total revenue | 72,528.79 | 60,500.00 | 56,320.12 | 74 |
| *Journal* expense including salaries | 20,385.30 | 16,650.00 | 16,549.79 | 81 |
| Catalogue expense including salaries | 11,272.47 | 12,150.00 | 12,923.09 | 115 |
| Office expense including salaries | 16,416.95 | 15,550.00 | 13,924.94 | 85 |
| Total expenditure | 72,453.22 | 60,500.00 | 60,115.85 | 83 |

A diagram is also attached hereto giving in graphic form the major items of The Institute's revenues and total expenditures over the past ten years. It will be noted that revenues have dropped from over $80,000.00 to $56,000.00, (or if it had not been for the Catalogue, to $43,000.00), that is to say the revenue for 1933 was, on a comparable basis, only a little over one-half that of 1929 or 1930. The revenue from fees was well maintained

(*Continued on page 77*)

## STATEMENT OF ASSETS AND LIABILITIES AS AT 31st DECEMBER, 1933

### Assets

| | | |
|---|---|---|
| **Current:** | | |
| Cash on hand and in Savings Account | | $ 113.41 |
| Accounts receivable | $13,685.55 | |
| *Less:* Reserve for bad debts | 804.43 | |
| | | 12,881.12 |
| Arrears of fees—Estimated | | 2,500.00 |
| | | 15,494.53 |
| **Special Funds**—Per Statement attached: | | |
| Investments | 10,964.93 | |
| Cash in Savings Bank | 316.71 | |
| Due by Current Funds | 1,314.98 | |
| | | 12,596.62 |
| **Investments**—At cost: | | |
| $100 Dominion of Canada 4½%, 1946 | 96.50 | |
| $200 Dominion of Canada 4½%, 1958 | 180.00 | |
| $4,000 Dominion of Canada 4½%, 1959 | 4,090.71 | |
| $500 Province of Saskatchewan 5%, 1959 | 502.50 | |
| $1,000 Montreal Tramways 5% 1941 | 950.30 | |
| $2,000 Montreal Tramways 5%, 1955 | 2,199.00 | |
| $500 Title Guarantee and Trust Corp. Certificate | 500.00 | |
| 2 Shares Canada Permanent Mortgage Corp | 215.00 | |
| 40 shares Montreal Light, Heat & Power Cons. N.P.V. | 324.50 | |
| | | 9,058.51 |
| **Advances to Branches** | | 400.00 |
| **Deposit**—Postmaster | | 100.00 |
| Advance Travelling Expenses of staff | | 150.00 |
| **Prepaid Expenses:** | | |
| Stationery | 520.46 | |
| Stamps | 75.00 | |
| Unexpired insurance | 160.00 | |
| | | 755.46 |
| **Gold Medal** | | 45.00 |
| **Library** | | 1,787.81 |
| **Furniture**—Balance as at 1st January, 1933 | 4,886.39 | |
| Additions during the year | 32.62 | |
| | | 4,919.01 |
| **Land and Buildings** | | 89,041.64 |
| | | $134,348.58 |

### Liabilities

| | | | |
|---|---|---|---|
| **Current:** | | | |
| Bank Overdraft—Secured | | | $ 9,687.66 |
| Accounts Payable | | | 1,391.68 |
| Estimated cost of completing Catalogue | | | 7,400.00 |
| Rebates due to Branches | | | 589.22 |
| Amount due to Past Presidents' Fund | | | 1,314.98 |
| | | | 20,383.54 |
| **Special Funds:** | | | |
| Leonard Medal | | $ 613.25 | |
| Plummer Medal | | 606.85 | |
| Fund in aid of Members' families | | 2,045.44 | |
| Past Presidents and Prize Fund | | 5,308.53 | |
| War Memorial Fund | | 4,022.55 | |
| | | | 12,596.62 |
| **Surplus:** | | | |
| Balance as at 1st January, 1933 | | 105,764.15 | |
| *Deduct:* | | | |
| Excess of Expenditure over Revenue for the year ending 31st December, 1933 | $3,732.73 | | |
| 1932 Catalogue expenses paid in 1933 | 663.00 | | |
| | | $ 4,395.73 | |
| | | | $101,368.42 |
| | | | $134,348.58 |

Montreal, 16th January, 1934.

Audited and verified, subject to our report of this date.

Ritchie, Brown & Co.,
*Chartered Accountants.*

## STATEMENT OF REVENUE AND EXPENDITURE FOR THE YEAR ENDING 31st DECEMBER, 1933

### Revenue

| | | |
|---|---|---|
| **Membership Fees:** | | |
| Arrears | $ 1,658.86 | |
| Current | 22,766.43 | |
| Advance | 309.44 | |
| Entrance | 807.00 | |
| | | $25,541.73 |
| **Publications:** | | |
| *Journal* subscriptions and sales | 6,411.65 | |
| *Journal* advertising | 10,863.65 | |
| *E-I-C News* advertising | 30.50 | |
| Catalogue advertising—Estimated | 12,176.87 | |
| | | 29,482.67 |
| **Income from Investments** | | 548.77 |
| **Refund of Expenses of Hall** | | 667.50 |
| **Sundry Revenue** | | 79.45 |
| **Excess of Expenditure over Revenue** For the year ending 31st December, 1933 | | 3,732.73 |
| | | $60,052.85 |

### Expenditure

| | | | |
|---|---|---|---|
| **Building Expenses:** | | | |
| Taxes—Property and Water | | $ 2,078.04 | |
| Fuel | | 484.15 | |
| Insurance | | 124.00 | |
| Light | | 278.62 | |
| Caretaker's wages and service | | 907.50 | |
| Repairs and expenses | | 1,079.65 | |
| | | | $4,951.96 |
| **Publications:** | | | |
| *Journal*—Salaries | $ 4,872.46 | | |
| Expenses | 11,677.33 | | |
| | | 16,549.79 | |
| *E-I-C News* Expense | | 112.97 | |
| Catalogue—Salaries | 4,345.20 | | |
| Expenses | 8,577.89 | | |
| | | 12,923.09 | |
| Sundry printing | | 215.45 | |
| | | | 29,801.30 |
| **Office Expenses:** | | | |
| Salaries—Secretary and staff | | 10,782.85 | |
| Postage and telegrams | | 1,252.56 | |
| Office supplies and stationery | | 981.08 | |
| Legal and audit fees | | 275.00 | |
| Telephone | | 321.60 | |
| Messenger and express | | 87.31 | |
| Miscellaneous | | 224.54 | |
| | | | 13,924.94 |
| **General Expenses:** | | | |
| Annual and Professional Meetings | | 1,915.85 | |
| Plenary Meeting of Council | $1,933.16 | | |
| *Less:* Collected from Branches | 805.95 | | |
| | | 1,127.21 | |
| Meetings of Council | | 210.31 | |
| Travelling—Secretary | | 122.16 | |
| Branch stationery | | 185.24 | |
| Students' Prizes | | 33.76 | |
| *E-I-C* Prizes | | 287.50 | |
| Library—Salaries | $595.10 | | |
| Expenses | 774.10 | | |
| | | 1,369.20 | |
| Interest, discount and exchange | | 124.71 | |
| Examination—Cost less amount collected | | 75.00 | |
| Papers' Committee | | 30.45 | |
| Committee on Development | | 170.59 | |
| Committee on Unemployment | | 146.55 | |
| National Construction Council | | 150.00 | |
| | | | 5,948.53 |
| **Rebates to Branches** | | | 5,426.12 |
| | | | $60,052.85 |

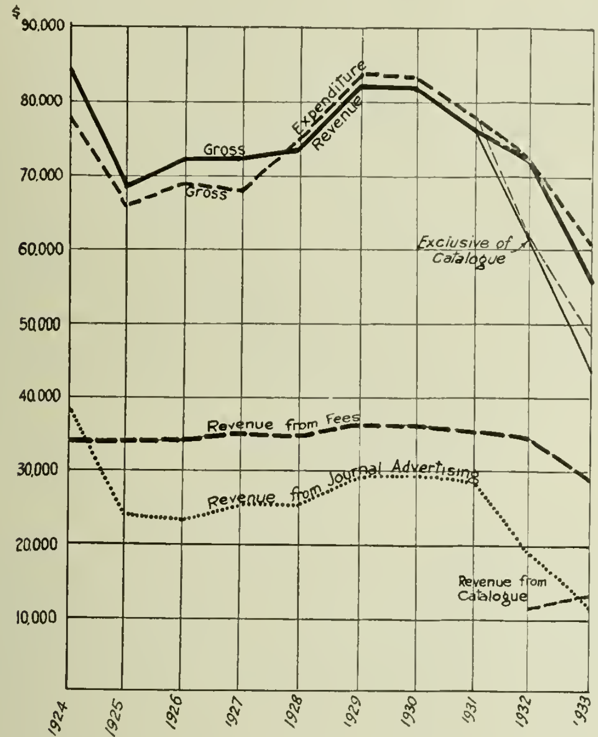
## SPECIAL FUNDS

| | | | Represented by: | | |
|---|---|---|---|---|---|
| ***Leonard Medal Fund:*** | | | | | |
| Balance as at 1st January, 1933 | $ 615.44 | | $500 Title Guarantee and Trust 6% 1933 Certificate | $ 500.00 | |
| *Add:* Bond interest | 30.00 | | Cash in Savings Bank | 113.25 | |
| Bank interest | 2.81 | | | | |
| | 648.25 | | | | |
| *Less:* Cost of Medal | 35.00 | | | | |
| | | $ 613.25 | | | $ 613.25 |
| ***Plummer Medal Fund:*** | | | | | |
| Balance as at 1st January, 1933 | 577.09 | | $500 Dominion of Canada 4½% 1959 Bonds | 500.00 | |
| *Add:* Bond interest | 27.50 | | Cash in Savings Bank | 106.85 | |
| Bank interest | 2.26 | | | | |
| | | 606.85 | | | 606.85 |
| ***Fund in Aid of Members' Families:*** | | | | | |
| Balance as at 1st January, 1933 | 2,042.70 | | $1,000 Province of Ontario 4½% 1964 Bonds | 1,022.17 | |
| *Add:* Bond interest | 100.00 | | $1,000 Dominion of Canada 4½% 1959 Bonds | 972.97 | |
| Bank interest | 2.36 | | Cash in Savings Bank | 50.30 | |
| Premium on U.S. funds | 3.36 | | | | |
| Donation | 12.02 | | | | |
| | 2,160.44 | | | | |
| *Less:* Advanced to families | 115.00 | | | | |
| | | 2,045.44 | | | 2,045.44 |
| ***Past Presidents' and Prize Fund:*** | | | | | |
| Balance as at 1st January, 1933 | 5,146.76 | | $3,000 Montreal Tramways 5% 1955 Bonds | 2,490.00 | |
| *Add:* Bond interest | 240.00 | | $1,500 Title Guarantee and Trust Corp. 6%, 1933 Certificate | 1,500.00 | |
| Bank interest | 10.88 | | Cash in Savings Bank | 3.55 | |
| Premium on U.S. funds | 6.64 | | Due by Current Funds | 1,314.98 | |
| Interest on loan | 6.25 | | | | |
| | 5,410.53 | | | | |
| *Less:* Cost of Prizes | 102.00 | | | | |
| | | 5,308.53 | | | 5,308.53 |
| ***War Memorial Fund:*** | | | | | |
| Balance as at 1st January, 1933 | 3,815.08 | | $2,000 Dominion of Canada 4½% 1959 Bonds | 2,000.00 | |
| *Add:* Bond interest | 210.00 | | $2,000 C.P.R. Collateral Trust 5% 1934 Bonds | 1,979.79 | |
| Bank interest | 3.72 | | Cash in Savings Bank | 42.76 | |
| | 4,028.80 | | | | |
| *Less:* Interest on loan from Past Presidents' Fund | 6.25 | | | | |
| | | 4,022.55 | | | 4,022.55 |
| | | $12,596.62 | | | $12,596.62 |

### Finance Committee

(*Continued from page 75*)

until this last year. The Journal advertising revenue was well maintained until 1931, but dropped off to about one-third of normal in 1933.




The question naturally arises as to whether there are any of The Institute's activities which in themselves are a direct loss and which might have been dispensed with if it could have been foreseen at an earlier date that the revenues were going to be less than anticipated. It will be seen from the Financial Statement that the expenditure on The Journal has exceeded its receipts by over $5,000.00 (in this connection it must be borne in mind that the item "Journal subscriptions" is in reality a part of the membership fee) and that Annual and Professional Meetings and the Plenary Meeting are responsible for over $3,000.00 of expenditure. These are all essential activities of The Institute and probably there has been no time when it was more important that a Plenary Meeting of the Council should be held. The only way to have avoided the deficit (with the foresight of only $56,000.00 revenue) would have been to have made drastic inroads into the general activities of The Institute or to have reduced the staff or to have made still further reductions in salaries.

What of the future? In view of the change of management which takes place early in the year, it is only natural that a retiring Finance committee hesitates to take any drastic steps, and nearly one-third of the year has passed before a new Finance committee can take office and be in full operation. In view of the present conditions, however, your committee has already instituted some economies, but on the whole is of the opinion that a balanced budget can be presented and adhered to for the year 1934, and that subsequently it will be possible to build up a substantial surplus year by year.

In the past the revenues of The Institute fluctuated within quite narrow limits and it was comparatively simple to prepare a reasonable budget, but nevertheless, as the diagram indicates, it was apparently impossible to avoid deficits even in those years when revenues were comparatively stable. It would appear advisable in future that every budget contain a reasonable sum for "unknown contingencies."

In connection with the serious drop of revenue from fees it is to be noted that this is far greater than the actual drop in membership, and is a natural reaction of the times. Nevertheless, the problem as to the treatment of members who have not paid their fees is one of great difficulty. The best solution would appear to be a half way course between extreme leniency and a strict compliance with By-law requirements. It is hoped that the members will themselves do their part towards reducing the difficulty of this problem.

Your committee would like to take this opportunity of expressing appreciation of the action of the Branches in so generously defraying part of the cost of the Plenary Meeting of the Council, and one of the bright spots of the year has been the fact that the President has made a personal visit to every Branch of The Institute without expense to The Institute.

Respectfully submitted,

J. L. Busfield, m.e.i.c., *Chairman.*

### Nominating Committee, 1934

Appointments to the Nominating Committee for the year 1934 have been made by the various Branches, and the Chairman has been appointed by Council, as shown on the following list, which is now presented for announcement at the Annual Meeting in accordance with the By-laws:—

*Chairman:* H. W. B. Swabey, m.e.i.c.

| *Branch* | *Representative* |
|---|---|
| Cape Breton | R. R. Moffatt, a.m.e.i.c. |
| Halifax | J. B. Hayes, a.m.e.i.c. |
| Saint John | G. G. Murdoch, m.e.i.c. |
| Moncton | G. E. Smith, a.m.e.i.c. |
| Saguenay | N. F. McCaghey, a.m.e.i.c. |
| Quebec | P. Methe, a.m.e.i.c. |
| St. Maurice Valley | J. H. Fregeau, a.m.e.i.c. |
| Montreal | F. S. B. Heward, a.m.e.i.c. |
| Kingston | W. Casey, m.e.i.c. |
| Ottawa | F. H. Peters, m.e.i.c. |
| Peterborough | A. L. Killaly, a.m.e.i.c. |
| Toronto | J. J. Spence, a.m.e.i.c. |
| Hamilton | J. R. Dunbar, a.m.e.i.c. |
| London | F. C. Ball, a.m.e.i.c. |
| Niagara Peninsula | C. G. Moon, a.m.e.i.c. |
| Sault Ste Marie | C. Stenbol, m.e.i.c. |
| Lakehead | H. G. O'Leary, a.m.e.i.c. |
| Border Cities | W. J. Fletcher, a.m.e.i.c. |
| Winnipeg | T. C. Main, a.m.e.i.c. |
| Saskatchewan | L. A. Thornton, m.e.i.c. |
| Lethbridge | R. Livingstone, m.e.i.c. |
| Edmonton | R. J. Gibb, m.e.i.c. |
| Calgary | B. L. Thorne, m.e.i.c. |
| Vancouver | T. E. Price, a.m.e.i.c. |
| Victoria | H. F. Bourne, a.m.e.i.c. |

### Past-Presidents' Prize Committee

The President and Council:—

At a meeting held on May 26th, 1933, the Council of The Engineering Institute of Canada appointed the following—F. M. Gaudet, m.e.i.c., C. M. Goodrich, m.e.i.c., R. A. C. Henry, m.e.i.c., S. G. Porter, m.e.i.c., and Lesslie R. Thomson, m.e.i.c. (chairman) as members of the Past-Presidents' Prize Committee for the year 1933.

Immediately upon its constitution the committee laid out and agreed upon a method of work that would facilitate the task to be performed. This understanding included:—the giving to each essay of a pseudonym under which it would be marked, an agreement among all members of the committee that each would do his reading and judging without any consultation whatever with any other member of the committee, the knowledge of the key to the pseudonym to remain solely with Mr. Durley, the Secretary of The Institute, and several other points, all of which are available in the files of The Institute.

The closing date for reception of essays has normally been June 30th, but the Council extended the date this year until July 31st, 1933. As a result nine (9) essays were received and given to the committee for review.

As a result of its work your Committee is unanimous in putting the essay "Holborn" first in order of relative standing, and the committee recommends unanimously that in view of the merit and quality of the "Holborn" essay the Council of The Institute award the Past-Presidents' Prize for the year 1933 to the writer of the essay so identified.

Your committee also recommends unanimously that honourable mention be accorded to the writer of the essay identified "Oxford."

Respectfully submitted,

LESSLIE R. THOMSON, M.E.I.C., *Chairman.*

"Holborn"—Eric G. Adams, S.E.I.C., Cockfield Brown and Co. Ltd., Canada Cement Building, Montreal.

"Oxford"—C. G. Cline, A.M.E.I.C., Niagara Falls, Ont.

R. J. DURLEY, M.E.I.C., *Secretary.*

### Gzowski Medal Committee

To the President and Council:—

Your committee, having examined carefully all of the papers eligible for the Prize Year 1932-33, have decided to recommend that the Gzowski Medal be awarded to M. Eaton, A.M.E.I.C., for his paper on "Automatic Operation of Electric Boilers."

Respectfully submitted,

C. J. MACKENZIE, M.E.I.C., *Chairman.*

### Plummer Medal Committee

The President and Council:—

In the unanimous opinion of the committee, the award for this medal goes to A. G. Fleming, M.E.I.C., for his paper on "The Development of Special Portland Cements in Canada," which appeared in the May and June, 1933, issues of The Engineering Journal.

Respectfully submitted,

HAROLD J. ROAST, M.E.I.C., *Chairman.*

### Leonard Medal Committee

The President and Council:—

Your committee having studied all of the papers eligible for consideration for the award of the Leonard Medal for the prize year 1932-33, begs to recommend that the gold medal be awarded to:

C. H. Hitchcock for his paper on "Diamond Drilling Practice" published in the C.I.M.M. Bulletin, June 1933.

Respectfully submitted,

L. H. COLE, M.E.I.C., *Chairman.*

### Students' and Juniors' Prizes

The reports of the examiners appointed in the various zones to judge the papers submitted for the prizes for Students and Juniors of The Institute were submitted to Council at its meeting on January 16th, 1934, and the following awards were made:—

*H. N. Ruttan Prize* (Western Provinces)—No award.

*John Galbraith Prize* (Province of Ontario)—To C. W. Crossland, S.E.I.C., for his paper on "The Rationalization of Load Factors for Aeroplane Wings."

*Phelps Johnson Prize* (Province of Quebec, English)—to L. A. Duchastel, Jr.E.I.C., for his paper on "The Rapide Blanc Development."

*Ernest Marceau Prize* (Province of Quebec, French)—To R. Boucher, S.E.I.C., for his paper on "Projet d'aménagement hydro-électrique."

*Martin Murphy Prize* (Maritime Provinces)—No papers received.

### Membership Committee

The President and Council:—

At the meeting of Council in February 1933 the question of membership in general came up for discussion and it was felt that increased attention should be given in all our Branches to encouraging eligible men to apply for membership or for transfer. Council realized that many engineers were finding it difficult to get along on reduced income, and that a considerable number were actually without employment. This situation has resulted in some resignations and many applications to be put on the Non-Active List. Yet the opinion was freely expressed that for these very reasons it was all the more necessary that real efforts be made to increase our membership, especially in view of the belief that there are many capable and qualified engineers in various centres who are not members of The Engineering Institute and would be quite willing to send in applications if suitably approached.

Council therefore appointed the following committee to encourage membership activities in all our Branches:—

A. Frigon, M.E.I.C.
F. S. B. Heward, A.M.E.I.C.
C. K. McLeod, A.M.E.I.C.
D. C. Tennant, M.E.I.C., *Chairman.*

In April last, a circular letter was sent out to all Branches drawing attention to the need for action as regards membership, and outlining the course which the committee proposed to take. Branches that had not appointed a sub-committee on membership were requested to select at least one member who would be willing to co-operate with The Institute's committee in all matters relating to membership within the branch territory.

Following this, in June, a circular was sent to all corporate members of The Institute, accompanied by a form which each member was invited to fill in with the names and qualifications of any engineers known to him who might be prospective members, or who, if members of The Institute, seemed eligible for transfer.

In response to this 274 names had been sent in to Headquarters up to October 16th. These have been checked and classified, as per the attached sheet, from which it appears that of the names sent in 203 had no previous connection with The Institute; 11 were already active members; 13 had previously applied for membership, but had not been admitted, and 47 had been members previously but had resigned or been removed from the list. Your committee feels that the list of 203 names is by no means representative of the number of eligible engineers in the country who do not belong to The Engineering Institute. After classification, the replies were sent back, on August 22nd, to the branches concerned, with a request that each branch authority, after investigation, should approach those it considered desirable as prospective candidates. We are now awaiting the results of this action.

In your committee's opinion the close attention of Council should be given to the present situation as regards membership. Very few applications for admission are being received. This situation is partly explainable by the existing economic situation, but is no doubt aggravated by the uncertainty as to changes which may be made in the conditions and qualifications for membership. It is in some cases difficult to approach prospective candidates unless the proposed changes in the constitution of The Institute are settled, and your committee would urge that a decision on these matters be arrived at at the earliest possible date, and, further, that whether the proposals of the Committee on Development are accepted by the membership or not, no further drastic changes in the conditions of membership should be proposed for at least five years.

Your committee would draw attention to the desirability of entering into closer relationship, if possible, with the undergraduate body in the engineering schools, before whom the advantages of joining The Institute should be definitely presented during their college course. The body of engineering students at the universities should form our principal recruiting ground, and it is recommended that the deans of the various schools be approached with a request (*a*) to arrange for the prominent display of announcements regarding The Institute and membership therein, (*b*) to permit at each college some one member of the university staff to be available to give information regarding The Institute and furnish forms of application for admission when requested, and (*c*) to arrange each year for the advantages of Institute membership to be explained in short addresses to the student body, preferably by recent engineering graduates.

Your committee considers that the recent action of Council in provisionally reducing the entrance fee for all classes of membership to five dollars will be of considerable assistance, particularly as this involves the temporary abolition of transfer fees, except from the class of Student to that of Junior.

Your committee does not agree with the opinion of those few members who consider that in view of unfavourable economic conditions no effort whatever should be made to attract members to The Institute. On the contrary, it is felt that a determined effort should now be made at all events to maintain The Institute's membership at its present figure of approximately 4,000. This figure does *not* include the members (over 300 in number) who have been placed on the Non-active List. Even in normal times our membership was subject to losses from deaths, resignations and removals for arrears, approximating 300 per annum.

Existing conditions are shown by the following figures covering the nine months January 1st to September 30th, 1933. The total membership on September 30th, 1933, was 4,059, *not* including 323 members then on the Non-active List. This shows a reduction of 310 since January 1st, made up as follows:—

| | | |
|---|---|---|
| Removals from List | 146 | |
| Resignations | 59 | |
| Deaths | 23 | |
| Placed on Non-Active List (Jan. 1st to Sept. 30th) | 201 | |
| | | 429 |
| Admissions (including 85 Students) | 107 | |
| Reinstatements | 12 | |
| | | 119 |
| Net loss | | 310 |

It is felt that these statistics clearly show the necessity for increased activity as regards new members.

Respectfully submitted,

D. C. Tennant, M.E.I.C., *Chairman.*

*Committee:*

A. Frigon, M.E.I.C.
F. S. B. Heward, A.M.E.I.C.
C. K. McLeod, A.M.E.I.C.
D. C. Tennant, M.E.I.C., *Chairman.*

Note by the Chairman:—

The above report was presented at the Plenary Meeting of Council on November 1st, 1933. It may be observed that the annual reports of the branches, received since then, make no mention of the results of the efforts of their membership committees, a fact which seems regrettable. Your committee had hoped that before the end of the year applications for admission would have been received through the branches from a considerable proportion of the 213 prospects whose names were originally sent in by individual members, checked over by headquarters, and returned to the branches for further action. Since September 1st, 1933, however, only twenty-five applications for admission have been received at headquarters, and some of these are apparently due to headquarters' efforts to assist the applicants in obtaining employment.

The action taken by Council in October in reducing the entrance fee to $5.00 for all classes of membership for a limited time has no doubt been helpful, but it is impossible as yet to say to what extent. Your committee would ask Council to bring the urgency of the situation again to the attention of all the branches, pointing out the necessity of placing the membership work of each branch in the hands of active and enthusiastic members.

D. C. Tennant, M.E.I.C., *Chairman,*
Membership Committee.

## Papers Committee

The President and Council:—

The personnel of the Papers committee remained the same this year as previously. Zone representatives formed contacts with members of Branch executives in charge of programme in their respective zones, and in a number of instances arranged exchanges of speakers between neighbouring branches. A number of requests from branches for assistance in arranging for speakers were dealt with.

Assistance and suggestions were requested and received from members of the committee in connection with the programme for the technical sessions of the Annual General Meeting.

Communications received from some of the smaller branches indicate increasing difficulties in developing satisfactory programmes for meetings, due to various causes, chief among which is the reduction in engineering and construction activity, and the consequent lack of papers on current projects. Assistance of considerable value could be given to branches if the committee was in a position to advise branches of impending visits to their locality of members who would be willing and in a position to address branch meetings. There is a field here in which the committee may act with advantage to branches by collecting and transmitting information of this type to those points at which it would be useful. Suggestions that assistance of this kind be given have been received from a number of branches. The committee would welcome the receipt of information from members that would assist it in complying with these requests.

Respectfully submitted,

J. J. Traill, M.E.I.C., *Chairman.*

## Publication Committee

The President and Council:—

Your Publication committee reports that, in view of the fact that a volume of Transactions will not be published this year, no papers have been submitted to it and, therefore, no meetings have been held.

Respectfully submitted,

Hector Cimon, M.E.I.C., *Chairman.*

## Library and House Committee

The President and Council:—

During the year every effort has been made to carry on the work of the library and information service although with reduced staff. The following particulars will indicate the extent to which our members have taken advantage of The Institute's facilities in this connection:—

| | |
|---|---|
| Requests for information | 661 |
| Requests for text books, periodicals, reprints, etc | 495 |
| Technical books borrowed | 103 |
| Bibliographies compiled | 36 |
| Accessions to library | 642 |
| Requests for photoprints | 33 |
| Total pages of photoprints | 173 |

The following books were presented to the library by Professor R. W. Angus, M.E.I.C.:—

Elements of Engineering Thermodynamics, by J. A. Moyer, J. P. Calderwood and A. A. Potter. Wiley.
Evaporating, Condensing and Cooling Apparatus, by E. Hausbrand. Van Nostrand.
Heat Transmission, by W. H. McAdams. McGraw-Hill.
Air Conditioning, by J. A. Moyer and R. U. Fittz. McGraw-Hill.

The following book was presented to the library by Professor T. R. Loudon, M.E.I.C.:—

Unemployment and Relief in Ontario, 1929-1932. A Survey and Report by H. M. Cassidy, B.A., Ph.D., under the Auspices of the Unemployment Research Committee of Ontario. J. M. Dent and Sons Ltd.

Nineteen recently-issued technical works have been sent in by publishers for review in The Engineering Journal. Very few technical books have been purchased, the library appropriation having been barely sufficient to cover the technical periodicals necessary to maintain the completeness of our files.

It will be noted that the enquiries for information show about 30 per cent increase over last year.

Certain work necessary for the repair and maintenance of the headquarters building has been carried out during the year. This has included the renewal of the grates and sundry equipment in connection with the heating installation, repairs to the roof and outside iron work, flashing, etc., and the renewal of some of the exterior woodwork. The necessary repairs, pointing, etc., of the exterior brickwork and masonry have also been executed. The expenditure in connection with the above was approximately $500.

Respectfully submitted,
D. C. Tennant, M.E.I.C., *Chairman.*

## Report of the E.I.C. Members of the Main Committee of the Canadian Engineering Standards Association

The President and Council:—

The Institute nominees on the Main Committee of the Canadian Engineering Standards Association are now as follows:—

P. L. Pratley, M.E.I.C., retires March, 1934.

Dean C. M. Mackenzie, M.E.I.C., retires March, 1935.

J. Morrow Oxley, M.E.I.C., retires March, 1936.

Three new committees have been formed during the year, dealing with Oil Circuit Breakers, Enamelled Magnet Wire, and a safety code covering the construction, installation and operation of Oil Burners.

The prevailing industrial conditions have seriously affected the income of the Association. There have been fifteen resignations from sustaining membership, and eight sustaining members felt compelled to reduce their subscription. It is gratifying, however, to report that this was offset to a certain extent by the addition of eleven new sustaining members during the year. Sustaining memberships at present number sixty-three, and the total amount received from membership fees will be $5,250, which is a decrease of $545 from 1932.

The headquarters of the Association have been moved to Room 3064, National Research Building, Ottawa, where quarters have been provided by the National Research Council, and this saving in rent, together with the cut in staff salaries which has been continued, enabled the Association to carry on for the year.

The Secretary had the privilege of addressing the annual meeting of the Electrical Contractors' Association in Kingston and had an opportunity of explaining the situation with regard to the Canadian Electrical Code, particularly the question of approval of electrical apparatus. The Secretary also attended the annual meetings of The Engineering Institute of Canada, the Canadian Institute of Mining and Metallurgy, the Dominion Fire Prevention Association, the Chambers of Commerce, and the Canadian Manufacturers Association.

An effort is being made to carry out the resolutions which were made at the Imperial Conference in 1932, and at the present time a comparison between British and Canadian specifications is being made and a special Joint Panel on Structural Steel has been organized to prepare Canadian specifications for steel with the object of securing greater uniformity in different parts of the Empire.

The publication of the C.E.S.A. Bulletin has been continued and results have amply justified its publication. No Year Book, however, has been published for 1932 owing to the lack of necessary funds.

### Work in Progress

#### A — Civil Engineering and Construction

*Building Materials.*—The Panel on Brick Sizes has prepared a preliminary report based on the results of the questionnaire which was circulated throughout the Dominion. This report will shortly be presented to the Committee on Building Materials. The replies to the questionnaire indicated a majority opinion in favour of standardization and the Panel will recommend that one size of brick be used for all purposes, but it is expected that the size will be somewhat larger than the size recommended in 1927.

In connection with building codes, several members of the Association are acting on a special committee in connection with the building code for the City of Toronto, and it is understood that recognition will be given to existing C.E.S.A. standard specifications.

Referring to standard contract forms which have been jointly adopted by the Canadian Construction Association and the Royal Architectural Institute of Canada, the results of the discussion by the Sectional Committee of Civil Engineering and Construction indicated considerable difference of opinion. This matter was finally discussed at a meeting of the Main Committee of the Association, held in Ottawa in May, 1933, and as a result it has been decided that the Association will not take any action in endorsing this contract form at present, the belief being that this is somewhat outside the field of the Association's work, particularly on account of the legal questions involved. It is possible that this may be reconsidered at some future time, however.

#### B — Mechanical Engineering

*Screw products.*—The standard for Binder Head Screws has been issued as B 35–1933; after considerable negotiations agreement was obtained on one design of screw and four different sizes, two of them making provision for alternative diameters of head. It is believed that this standard will effect a great improvement in the situation which has hitherto existed and that this standard will be almost universally used.

The standard for Machine, Carriage and Plough Bolts is still held up waiting for up-to-date information, as there has recently been a change in the manufacturing situation.

Panels have now been organized to deal with standards for Wood Screws and Small Rivets, but a start will not be made until up-to-date data has been obtained.

*Safety Code for Passenger and Freight Elevators.*—The committee held their first meeting during the year, and a draft code was sent out for comment. A summary of the comments received has been prepared and sent out to the members of the committee and it is hoped to have a second meeting shortly. Present indications are that this code will be very acceptable to the different authorities throughout the Dominion.

*Safety Code for Mechanical Refrigeration.*—A committee is now being organized to prepare this safety code, and it is planned to study particularly questions involving health in the use of this equipment. The co-operation of provincial governments, and insurance, manufacturing and public health organizations is being solicited.

*Oil Burners.*—A committee has been organized to prepare Dominion regulations on which tests can be made. The laboratories of the National Research Council are now equipped to make these tests and the laboratory staff is co-operating in the preparation of these regulations. It is proposed at the present time to cover only two types—atmospheric or gravity feed type, and the automatic or power-operated type. A draft covering definitions and construction of oil burners of the atmospheric type has been prepared and is now out for comment.

C — Electrical Work

*Canadian Electrical Code.*—During the year a provincial code committee has been organized in the province of Prince Edward Island, so that nine of these committees are now in operation. The third edition of the Code is still under consideration and every effort will be made to have it issued during 1934, as there seems to be a general demand for this new edition.

In connection with Part II of the Code, the specifications for Portable Electric Displays and Incandescent Lamp Signs and Electric Floor Surfacing and Cleaning Machines have been issued, and specifications for Electric Clocks and Electric Fixtures are now in the press. Specifications for Service-entrance and Branch Circuit Breakers, Fractional Horsepower Motors, and Electric Portable Lighting Devices will shortly be in the press. The draft specification for Enclosed Switches has been revised and discussed at a meeting of the Panel on Specifications, and a complete revised draft has been sent out for comment. Meetings of the Panel on Specifications have been held to discuss the specifications for Capacitors (Electrical Condensers), Transformers for Luminous-tube Signs and Oil-burner Ignition Equipment, Industrial Control Equipment, Electric Heating Pads, Insulated Conductors for Power-operated Radio Devices, Cable for Luminous-tube Signs and Oil-burner Ignition Equipment, Outlet Boxes, Soldering Lugs, and Motor-operated Blowers and Stokers, and revised editions of these draft specifications have been sent out for comment. Specifications for Cord Sets and for Gasoline Measuring and Discharge Devices have been prepared and sent out for comment and will shortly be discussed at a meeting of the Panel. A draft specification for Oil Circuit Breakers has also been prepared and sent out for comment and this will be considered also by a special committee on Oil Circuit Breakers.

In connection with both Parts I and II of the Code, the Association has inaugurated a system of bulletins to electrical manufacturers, in which information is given on proposed changes in Code rules or in laboratory requirements. Five of these bulletins have been issued to date.

With reference to Part III of the Code, the only progress which has been made is in connection with the work of Sub-panel No. 3 on Inductive Co-ordination, but the draft covering Principles and Definitions in connection with Radio Interference has not yet been finally approved. In connection with the work of Sub-panel No. 1, Overhead Systems, a special report from the railway group has been sent out for comment, and it is hoped to incorporate this report in the general report from the Sub-panel, but it has proved exceedingly difficult to make rapid progress in this work.

*Watthour Meters.*—The revised specification for a.c. watthour meters and the new specification for demand meters is now before the committee for letter ballot, but there are still some points on which approval has not been obtained. It is believed that these specifications will not conflict with regulations of the National Research Council covering approval of type.

*Enamelled Magnet Wire.*—A committee has been organized to discuss specifications for enamelled magnet wire, and one meeting has been held at which a draft specification was presented. This is now out for comment.

*Insulated Power Cable.*—The draft covering paper-insulated lead-covered cable is before the committee for comment, this specification having been prepared by a special panel of the committee.

G — Ferrous Metals

*Heavy Steel Shaft Forgings.*—The first meeting of this committee has now been held and a draft specification has been prepared and sent out to the members of the committee for comment.

As previously recorded, a special Joint Panel of the Committees on Steel Highway Bridges, Steel Railway Bridges, and Steel Structures for Buildings, has been organized to prepare material specifications, and an endeavour will be made to recognize up-to-date practice and to secure as much uniformity as possible with present Empire standards.

Co-operation and Publicity

A very close contact has been maintained with the electrical committees of the British Standards Institution, in connection with the work on approval specifications under Part II of the Canadian Electrical Code. Draft copies of the different specifications have been sent for comment and the comments which have been received have been very helpful. Drafts have also been submitted to the Underwriters' Laboratories at Chicago, and to the National Electrical Manufacturers Association at New York, and comments from these sources have also been very helpful.

The technical press and newspapers have been very generous in giving publicity to the work of the Association, particularly to the announcement of new publications.

The sale of publications has been most encouraging and there is every evidence that the interest in the work of the Association is increasing.

Regular exchange of publications with the different national standardizing bodies has been continued. This applies particularly to the British Standards Institution, the Standards Association of Australia, and the South African Branch of the British Standards Institution. It is announced that the South African Branch of the B.S.I. is considering the establishment of a South African Standards Institution.

Respectfully submitted,

P. L. Pratley, m.e.i.c., *Chairman.*

## Committee on Biographies

The President and Council:—

The Committee on Biographies submitted a policy and method of procedure to the Plenary Meeting of Council in September 1931 which was designed to produce consistent and effective results in the future; the policy was approved but qualified with reference to the matter of financial expense. During 1933 the financial restriction made it possible to publish only one biography—that of the late E. H. Keating.

It is observed that a sister society on the same continent has for many years printed in their Transactions very carefully prepared memoirs of deceased members; consulting one annual volume pulled at random from the shelf it was found to contain sixty-two memoirs occupying one hundred and thirty-four pages of rather small type. Engineers are perhaps traditionally rather careless of the amenities of life but your committee is inclined to feel that many Canadian engineers would be appreciative if their Journal gave a little more attention to those who made their mark in the engineering world but are now no longer with us. Your committee hopes that in future annual budgets of The Institute the work of preparing and printing suitable biographies will receive its quota and thus be given some status as one of the activities which The Institute intends to maintain on some permanent and suitable basis.

Respectfully submitted,

F. H. Peters, M.E.I.C., *Chairman.*

### Honour Roll and War Trophies Committees

The President and Council:—

During 1933 efforts have been continued looking to the completion of the checking and confirmation of the names, approximately one thousand in number, to be inscribed on the bronze tablet or Honour Roll recording the names of those who served. Final particulars are still lacking regarding a very few cases, details regarding which have been very difficult to verify, but it is hoped that it will soon be possible to place the contract for the large tablet.

Respectfully submitted,

C. J. Armstrong, M.E.I.C., *Chairman.*

### Board of Examiners and Education

The President and Council:—

The results of the examinations held during 1933 for admission to The Institute are as follows:—

| *Description* | *No. of Candidates* | *No. of Papers Written* | *No. of Papers Passed* | *Failed* | *No. of Candidates Completely Passed* |
|---|---|---|---|---|---|
| Examined under Schedule "A" (Student) | 1 | 5 | 2 | 3 | 0 |
| Examined under Schedule "B" (Junior) | 5 | 10 | 6 | 4 | 2 |
| Examined under Schedule "C" (Associate Member)— | | | | | |
| Electrical Engineering | 1 | 2 | 2 | .. | 1 |
| Mechanical Engineering | 1 | 2 | 2 | .. | 1 |
| Structural Engineering | 1 | 2 | 2 | .. | 1 |
| Totals | 9 | 21 | 14 | 7 | 5 |

It is to be noted that under Schedule "C" for Associate Membership all of the candidates presented papers that passed the standards set by The Institute.

In Schedules "A" and "B" classes for Students and Juniors the papers indicate a failure on the part of the candidates in the fundamental ground work necessary for a training in the subjects written. The number of text books prescribed by The Institute for study under the different subjects is unusually large and we would suggest to the Council the advisability of confining the necessary studies to be made by the candidates to a smaller number of text books.

For the last two years your Board has had under consideration the question of admitting graduates from the Royal Military College without further examination and the majority of the Board has advised that the Royal Military College should be recognized as a "School of Engineering recognized by the Council" as mentioned in Section 8 of The Institute By-laws. We understand that this recommendation has been accepted by the Council.

Respectfully submitted,

William Gore, M.E.I.C., *Chairman.*

### Unemployment Committee

The President and Council:—

As the report of this committee as submitted to the Plenary Meeting of Council was printed in full in the December issue of The Engineering Journal, it is not thought necessary to reproduce it. It may be noted, however, that since that time the appointments of ten more engineers to the Supervisory Staffs of the Department of National Defence Unemployment Relief Projects have been authorized, six of these being in connection with the new camps in New Brunswick. This brings the total of Engineer Relief appointments to 143. Attention is drawn to the paper by Major G. R. Turner, M.C., D.C.M., A.M.E.I.C., entitled "Unemployment Relief Projects," which appears in the February issue of The Journal, and describes the work of the Department of National Defence, in connection with these camps.

Respectfully submitted,

D. C. Tennant, M.E.I.C., *Chairman.*

### Employment Service Bureau

The President and Council:—

During the past year it has again been found exceedingly difficult to locate vacancies or opportunities for employment for our members. Very few enquiries have been received from employers for engineers.

Many of those registered with our Employment Service Bureau comprise civil and electrical engineers, while the demand has been chiefly for those with sales, mechanical, chemical and mining experience. It has therefore been necessary for a large proportion of our unemployed members to attempt to obtain employment in other fields, which unfortunately seems to have proved exceedingly difficult.

Again, many of the positions of which we received notification were difficult to fill, as employers were often exacting and generally some unusual qualifications or experience were required.

The number of members now registered with our Employment Service Bureau is 378; of this number, however, some sixty or seventy are known to be in temporary positions.

While it has only been possible to fill a relatively small number of positions during the past year, it is encouraging to find that a larger proportion of the positions filled have been of a permanent nature than during the past two or three years.

From our correspondence with the Branch Unemployment Committees and individual members it would still appear that a considerable number of members have not thought it desirable to register with our Employment Service Bureau. This is very regrettable, as on a number of occasions we have found it necessary to advise employers that we did not have anyone registered with the necessary experience.

The Institute has again been able to supply a limited amount of work to members of The Institute, in connection with the E-I-C Catalogue and mailing of circulars.

The following figures show the extent of the Bureau's work for 1933:—

| | *1933* | *1932* |
|---|---|---|
| Number of registrations during year—Members | 138 | 166 |
| Number of registrations during year—Non-Members | 46 | 18 |
| Number of members advertising for positions | 102 | 132 |
| Replies received from employers | 21 | 34 |
| Vacant positions registered | 92 | 117 |
| Vacancies advertised | 4 | 18 |
| Replies received to advertised vacancies | 16 | 162 |
| Men notified of vacancies | 147 | 143 |
| Men's records forwarded to prospective employers | 210 | 219 |
| Placements — temporary and permanent — definitely known | 50 | 58 |

The above figures do not include the placements on the Supervisory Staffs of the Department of National Defence Unemployment Relief Projects, in which the Employment Service Bureau worked in conjunction with the Branch Unemployment Committees.

Respectfully submitted,

R. J. Durley, M.E.I.C., *Secretary.*

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# Branch Reports

## Border Cities Branch

The President and Council:—

The work of the Border Cities Branch has been carried on during 1933 by the following committees:

| | |
|---|---|
| Papers and Entertainment | E. M. Krebser, A.M.E.I.C., Chairman. |
| | H. J. Coulter, Jr.E.I.C. |
| | W. A. Dawson, A.M.E.I.C. |
| | T. H. Jenkins, A.M.E.I.C. |
| Reception | H. J. A. Chambers, A.M.E.I.C. |
| Membership | W. A. Dawson, A.M.E.I.C., Chairman. |
| | D. T. Alexander, M.E.I.C. |
| | C. F. Davison, A.M.E.I.C. |
| | T. H. Jenkins, A.M.E.I.C. |
| Publicity | R. C. Leslie, A.M.E.I.C. |
| Representative on the Directorate of the Border Chamber of Commerce | C. G. R. Armstrong, A.M.E.I.C. |
| Institute Nominating Committee | W. J. Fletcher, A.M.E.I.C. |
| Unemployment Committee | A. E. West, M.E.I.C., Chairman. |
| | A. J. M. Bowman, A.M.E.I.C. |
| | J. E. Porter, A.M.E.I.C. |

Meetings

The Executive committee met eight times during the year to deal with the various questions which arose. The Unemployment committee met three times to deal with the problems which related to unemployment.

Including the Annual Meeting, eight regular meetings have been held, and one special meeting held to visit the site of the Livingstone Channel project.

The following is a list of the meetings held together with a note on the subject, speaker, and attendance.

Jan. 13.—**Life and Conditions in Soviet Russia** by John Banks, erection engineer for the Palmer-Bee Co., Detroit. Attendance, 26.

Feb. 10.—**Station CKOK** by W. J. Carter, chief engineer of Station CKOK. A tour of the station was also made. Attendance, 21.

Mar. 7.—**Technocracy** by C. M. Goodrich, M.E.I.C., chief engineer of the Canadian Bridge Co., Walkerville. Attendance, 33.

April 21.—**Conditions and Developments in the Near East and the Orient** by Colonel John W. Warden, O.B.E., D.S.O. Attendance, 18.

May 19.—**The Livingstone Channel Project** by Messrs. G. A. Dixon and K. Heagy of the U.S. Engineers Office, Great Lakes District. Attendance, 26.

May 27.—**Visit to the Livingstone Channel Project.**

Oct. 13.—**Safety Engineering and Personnel Management** by G. A. Kuechenmeister, of the Dominion Forge and Stamping Co., Walkerville. Attendance, 18.

Nov. 9.—**Institute Affairs.** Visit of Dr. O. O. Lefebvre, M.E.I.C., President of The Engineering Institute of Canada. Attendance, 22.

Dec. 1.—**Annual Meeting,** Election of Officers, and Joint Meeting with The Association of Professional Engineers of Ontario. Speaker, A. B. Lambe, A.M.E.I.C., President of the Association of Professional Engineers of Ontario. Attendance, 26.

Average attendance per meeting, 26.

Average attendances for other years:—

| *1928* | *1929* | *1930* | *1932* |
|---|---|---|---|
| 38 | 34 | 28 | 25 |

Membership

Status of membership, December 31st, 1933:—

| | *Resident* | *Non-Resident* | *Total* |
|---|---|---|---|
| Members | 15 | 2 | 17 |
| Associates | 25 | 9 | 34 |
| Juniors | 2 | 3 | 5 |
| Students | 7 | 4 | 11 |
| Affiliates | 1 | .. | 1 |
| Total | 50 | 18 | 68 |

A comparison of our status of membership for other years is shown in the following table:—

| | *1930* | *1931* | *1932* | *1933* |
|---|---|---|---|---|
| Members | 23 | 24 | 21 | 17 |
| Associates | 50 | 53 | 42 | 34 |
| Juniors | 12 | 12 | 8 | 5 |
| Students | 16 | 15 | 11 | 11 |
| Affiliates | 1 | 1 | 1 | 1 |
| | 103 | 105 | 83 | 68 |

Financial Statement
(For the year ending December 31st, 1933)

| *Receipts* | | |
|---|---|---|
| Cash on hand—January 1st, 1933 | $177.97 | |
| Rebates to December, 1933 | 124.20 | |
| Rebates for December, 1933 | 10.35 | |
| Branch News | 2.87 | |
| Dinner receipts | 70.20 | |
| Unemployment Committee Fund | 6.00 | |
| | | $391.59 |

| *Expenditures* | | |
|---|---|---|
| Printing | $ 47.52 | |
| Stamps and telegrams | 9.09 | |
| Speaker's expenses | 22.10 | |
| Dinners | 95.05 | |
| Telephone | 2.40 | |
| Miscellaneous | 16.35 | |
| Unemployment Committee Fund | 35.00 | |
| Advance to Plenary Meeting Fund | 15.60 | |
| Balance in bank | 138.13 | |
| Accounts receivable | 10.35 | |
| | | $391.59 |

Respectfully submitted,

R. C. Leslie, A.M.E.I.C., *Chairman.*

T. H. Jenkins, A.M.E.I.C., *Secretary-Treasurer.*

## Calgary Branch

The President and Council:—

On behalf of the Executive committee, Calgary Branch, we beg to submit the following report of our activities for the calendar year 1933:—

Membership

| | *Dec. 31st, 1933* | | |
|---|---|---|---|
| | *Resident* | *Non-Resident* | *Total* |
| Members | 16 | 7 | 23 |
| Associate Members | 45 | 11 | 56 |
| Juniors | 9 | 2 | 11 |
| Students | 1 | 3 | 4 |
| Branch Affiliates | 14 | 1 | 15 |
| | 85 | 24 | 109 |

During the year our Branch and The Institute have lost three valuable members through the passing on of J. A. Spreckley, A.M.E.I.C., Major C. C. Richards, and W. D. Armstrong, A.M.E.I.C.

The Executive met twelve times during the year to discuss and dispose of the various items transacted.

Owing to various reasons our executive decided to postpone the annual ball, and instead a supper dance and bridge was held for members, and a limited number of friends, in the Renfrew Club. This proved a very successful function, and requests have been made for similar entertainment in the near future.

A joint dinner is being arranged, and sponsored by our Branch, with the Association of Professional Engineers of Alberta and the Canadian Institute of Mining and Metallurgy, at the Renfrew Club, February 10th, 1934.

Students and Juniors of the Calgary Branch, Students now in Alberta University, and others residing in the Branch district who have graduated from any university within the last two years, have been invited to compete for a prize of twenty dollars ($20.00) given by the Branch. The rules governing the award of the prize are as follows:

1. The award shall only be made if, in the opinion of the examiners, a paper of sufficient merit has been presented.
2. The papers must be the bona-fide productions of those contributing them and must not have been previously made public or contributed to any other Society in whole or in part.
3. Notice of intention to compete and the subject of the paper must be in the hands of the Secretary not later than December 1st.
4. The papers submitted will be judged by a special committee appointed by the Branch executive.

The same papers presented by Students and Junior members of The Institute will be eligible to compete for The Institute prize.

Fourteen general meetings were held during the year, with fair attendance at each. The following are the dates and subjects presented:—

Jan. 12.—**The Manufacture of Steel** by L. R. Brereton, A.M.E.I.C., metallurgist for the Dominion Bridge Co. Attendance, 25.
Jan. 26.—**The Manufacture of Portland Cement** by the late W. D. Armstrong, A.M.E.I.C. Attendance, 35.
Feb. 9.—**Forestry** by Mr. H. G. Reynolds. Attendance, 40.
Feb. 23.—**Getting Out a Modern Newspaper** by Mr. C. A. Hayden. Attendance, 25.
Mar. 11.—Annual Meeting and Election of Officers. Attendance, 15.
April 17.—Dinner at Renfrew Club to welcome the President of The Institute, Dr. O. O. Lefebvre, M.E.I.C. Attendance, 37.
April 28.—**Protection of Inductive Windings Against Lightning** by A. B. Cooper, M.E.I.C. Attendance, 58.
Sept. 2.—**Annual Field Day and Golf Tournament.**
Oct. 12.—**Television** by Mr. Alick Mitchell. Attendance, 130.
Oct. 26.—**Methods of Handling Earth Fill Material With Special Reference to Levee Construction on the Mississippi River** by Mr. J. K. Mackenzie. Attendance, 52.
Nov. 9.—**Industrial Electron Tubes** by Mr. P. F. Peel. Attendance, 84.
Nov. 23.—**Arctic Patrol** (four reels) and **Forest Fighters of the Skies** (two reels) with reminiscences of the Yukon, by the Ven. Archdeacon Swanson. Attendance, 108.
Dec. 1.—Dance and Bridge, Renfrew Club. Attendance, 72.
Dec. 14.—**Reminiscences of Experiences in Africa South of the Equator** with films of wild life in Africa, **A Trip Through Egypt, and Big Game in India** by P. J. Jennings, M.E.I.C. Attendance, 67.

FINANCIAL STATEMENT
(Year ending December 31st, 1933)

| | | |
|---|---|---|
| *Receipts* | | |
| Value of bonds | $989.66 | |
| Dues collected from Affiliates | 33.00 | |
| Interest and savings | 135.87 | |
| Rebates | 171.36 | |
| | | $1,329.89 |
| *Liabilities* | | |
| Net value of assets—Bonds | $989.66 | |
| Cash in bank | 111.38 | |
| Expenditures, net | 228.85 | |
| | | $1,329.89 |

Respectfully submitted,
H. J. McLean, *Chairman.*
John Dow, *Secretary-Treasurer.*

## Cape Breton Branch

The President and Council:—

The annual report of the Cape Breton Branch is as under:—

During the year the Branch held six meetings as follows:—

1932
Dec. 15.—Annual Meeting at which a paper on **The Significance of the Washability Curves in Coal Washing** was read by Mr. J. L. Bowlby.

1933
Jan. 12.—**The Mystery of Oak Island, N.S.** by M. R. Chappel, Affil.E.I.C.
Feb. 23.—**The Development of the Modern Motor Car** by Mr. T. H. Morris.
Mar. 25.—Joint Meeting at which Professor G. V. Douglas, A.M.E.I.C., lectured on **Shackleton's Antarctic Expeditions.**
May 30.—**Some Recent Developments in the Telephone Business** by Mr. J. I. Marshall.
Oct. 26.—Luncheon Meeting addressed by President O. O. Lefebvre, M.E.I.C., who spoke on **Institute Affairs.**

The average attendance at the above meetings (not including that of March 25th, which was public) was 23, and a lively discussion always followed the reading of the paper.

The Branch has suffered a slight loss in membership but it is hoped that this will be recovered during the next year.

We are pleased to announce that we have secured speakers for each month of the winter season.

FINANCIAL STATEMENT

| | | |
|---|---|---|
| *Receipts* | | |
| Balance brought forward | $227.65 | |
| Rebates | 77.70 | |
| Tickets to meeting | 5.50 | |
| | | $310.85 |
| *Expenditures* | | |
| Printing | $ 2.00 | |
| Meetings | 13.45 | |
| Subscription to expenses Plenary Meeting Council | 13.20 | |
| Postage and telegrams | 5.70 | |
| Balance | 276.50 | |
| | | $310.85 |

Respectfully submitted,
R. R. Moffatt, A.M.E.I.C., *Chairman.*
Sydney C. Mifflen, M.E.I.C., *Secretary-Treasurer.*

## Edmonton Branch

The President and Council:—

On behalf of the Executive committee of the Edmonton Branch we beg to submit the following report for the year 1933.

MEMBERSHIP

| | Dec. 31, 1932 Resident | Non-Resident |
|---|---|---|
| Members | 13 | 2 |
| Associate Members | 26 | 7 |
| Junior Members | 4 | .. |
| Student Members | 27 | .. |
| | 70 | 9 |

| | Dec. 31, 1933 Resident | Non-Resident |
|---|---|---|
| Members | 11 | 2 |
| Associate Members | 23 | 6 |
| Junior Members | 3 | .. |
| Student Members | 33 | .. |
| | 70 | 8 |

MEETINGS

The following meetings of the Branch were held during the year:—

Jan. 16.—**Fractures** by Professor I. F. Morrison, Professor of Applied Mechanics, University of Alberta. Attendance, 24.
Feb. 12.—**System Load Apportionment and Supply** by H. J. McLean, A.M.E.I.C., production superintendent of the Calgary Power Co. Attendance, 52.
April 4.—**The Present World Depression and the Way Out** by Dr. Einer Jensen, of the Department of Political Economy, University of Alberta. Attendance, 26.
April 8.—Dr. O. O. Lefebvre, M.E.I.C., addressed the meeting on the affairs of The Institute. Attendance, 27.
Oct. 25.—**David Thompson** by Professor N. C. Pitcher, Professor of Mining Engineering at the University of Alberta. Attendance, 24.
Nov. 21.—The programme consisted of the following items:—
**Northern Culture**—a short address by Dr. R. C. Wallace President of the University of Alberta.
**The Arctic Patrol**—a four reel film.
**Forest Fighters of the Skies**—a two reel film. Attendance, 40.

Four meetings of the Executive committee were held to deal with special questions which arose.

FINANCIAL STATEMENT

| | | |
|---|---|---|
| *Receipts* | | |
| Balance on hand, January 1st, 1933 | $271.26 | |
| Rebates from Headquarters | 90.15 | |
| Rebates due from Headquarters, December 30th | 11.40 | |
| | | $372.81 |

*Expenditures*

| | | |
|---|---|---|
| Expenses of meetings | $ 83.75 | |
| Postage | 11.00 | |
| Printing | 16.66 | |
| Contribution to expense of Plenary Meeting | 11.90 | |
| Honorarium to Secretary-Treasurer | 50.00 | |
| Miscellaneous—telegrams and exchange | 1.95 | |
| Balance on hand, December 31st, 1933 | 197.55 | |
| | | $372.81 |

Special Unemployment Relief Fund

| | |
|---|---|
| Receipts | $ 20.00 |
| Expenditures | 20.00 |

Respectfully submitted,
Robert M. Dingwall, a.m.e.i.c., *Chairman.*
R. M. Hardy, s.e.i.c., *Secretary-Treasurer.*

## Halifax Branch

The President and Council:—

On behalf of the Chairman and Executive committee, the following report on the activities of the Branch for the past year—1933—is submitted.

Including the Annual Meeting there have been seven regular meetings and eight meetings of the Executive. The following is a summary of the meetings held:

January.—Annual Banquet held in conjunction with the Nova Scotia Association of Professional Engineers.

February.—Report on Plenary Meeting of Council by Professor F. R. Faulkner, m.e.i.c. Paper on **The Salvaging and Repairs to S.S. "Prince David"** by Mr. D. Scouler, general superintendent of the Halifax Shipyards. Attendance, 30.

March.—Meeting was addressed by Dr. F. H. Sexton on the subject of **Technocracy.** Dr. Sexton's address was followed by a very interesting discussion. Attendance, 32.

July.—Summer meeting in co-operation with the Nova Scotia Association of Professional Engineers was held at White Point Beach on Thursday, Friday and Saturday, July 13th, 14th and 15th. Attendance, 120.

October.—General business meeting of the Branch and to meet the President of The Institute, Dr. O. O. Lefebvre, m.e.i.c. Attendance, 35.

November.—Annual Students Meeting at the Nova Scotia Technical College. Meeting took the form of open forum, principal speakers being the chairman, H. S. Johnston, m.e.i.c., Howard Fellows, a.m.e.i.c., and W. A. Winfield, m.e.i.c., on the subject of the **Future of the 'Engineer-in-Training.'** Attendance, 105.

December.—Annual Meeting of the Branch which was held at the Halifax Hotel on Thursday, December 21st, and as well as the general business of the Branch, a very interesting paper was delivered A. F. Dyer, a.m.e.i.c., on **The Stabilization of the Construction Industry with view to Alleviation of Unemployment.**

The attendance at meetings was equal to that of last year and it is interesting to note that more members are taking part in the discussions.

The Maritime Professional Meeting of The Institute held at White Point Beach, N.S., in July deserves further reference. This gave an effective demonstration of the way in which the educative and technical work of The Institute can be carried on in conjunction with the official duties of a Professional Association. Representatives of all four Maritime Branches of The Institute were present as well as members of the Associations of Professional Engineers of Nova Scotia and New Brunswick.

The committee in charge of the meeting worked out a programme of technical sessions, visits and entertainment which proved particularly enjoyable.

The professional papers presented included "Use of the Back Pressure Turbine in a Modern News Print Mill" by J. H. Mowbray Jones, a.m.e.i.c., chief engineer, Mersey Paper Company; "Supervisory Control and Automatic Protection as Applicable to Hydro-Electric Developments in the Maritimes" by Howard Fellows, a.m.e.i.c., assistant chief engineer, Nova Scotia Power Commission; "Modern Practice in the Construction of Portland Cement Concrete Road Surfaces" by K. MacKenzie, Nova Scotia Department of Highways; and "Use of High-Ash Pulverized Coal in Steam Boilers with Special Reference to Results Obtained at Seaboard Plant, Glace Bay, N.S." by K. H. Marsh, m.e.i.c., chief engineer, Dominion Steel and Coal Corporation.

Visits included one to power developments on the Mersey river and the newsprint mill of the Mersey Paper Company.

The finances of the Branch are in good shape—even in face of increased expenditures made necessary by the Summer Meeting at Liverpool and also the contribution to the Plenary Meeting at Montreal. The financial statement is as follows:

*Receipts*

| | | |
|---|---|---|
| Cash on hand, January 1st, 1933 | $391.77 | |
| Rebates | 267.90 | |
| Branch News | 4.63 | |
| Bank interest | 11.44 | |
| | | $675.74 |

*Expenditures*

| | | |
|---|---|---|
| Meetings | $127.90 | |
| Secretary's office | 88.87 | |
| Mailing list | 30.00 | |
| | | $246.77 |
| Cash on hand | | 428.97 |
| | | $675.74 |

Respectfully submitted,
H. S. Johnston, m.e.i.c., *Chairman.*
R. R. Murray, a.m.e.i.c., *Secretary-Treasurer.*

## Hamilton Branch

The President and Council:—

The Executive committee of the Hamilton Branch, Engineering Institute of Canada, submits the following report for the calendar year 1933.

The Branch year formerly closed on May 31st but in September, 1933, the Branch by-laws were amended to make the Branch year correspond with the calendar year, so the report of 1933 includes half of the 1932-33 session and a short linking session from June 1st to December 31st, 1933.

Thus two Executive committees held office during the year, and the latter committee has been re-elected to office for the year 1934.

The following meetings and visits were held:—

Feb. 1.—Special Business Meeting and Professional Meeting.
**The Value of Photography to Engineering** by a Committee: A. R. Hannaford, a.m.e.i.c., Chairman; W. Hollingworth, m.e.i.c., J. A. M. Galilee, affil.e.i.c., J. G. Morrow, W. A. T. Gilmour, jr.e.i.c., T. S. Glover, a.m.e.i.c., E. T. Sterne, C. H. Cunningham. Attendance, 65.

Mar. 15.—Joint Meeting with Hamilton Chapter, Ontario Association of Architects.
**The Empire State Building and the George Washington Bridge,** motion pictures showing construction of these structures, shown and explained by John Parkin, Otis-Fensom Elevator Co., Hamilton. Attendance, 100.

April 21.—Joint Meeting with Toronto Section, A.I.E.E.
**Recent Progress in Research** by Thos. Spooner, assistant director of Westinghouse Research Laboratories. Attendance, 200.

May 10.—Annual Meeting and Professional Meeting.
**Some Problems of a Chemical Engineer** by Professor C. E. Burke. Attendance, 60.

July 25.—Visit to Plant of Regal Brewing Co., Hamilton. Attendance, 40.

Sept. 12.—Joint Meeting with Hamilton Section, Canadian Chemical Assn.
**Radium** by J. D. Leitch, b.sc., Department of Public Health, Toronto. Attendance, 150.

Sept. 26.—Visit to City of Hamilton Filtration Plant. Attendance, 15.

Oct. 10.—Joint Meeting with Babcock-Wilcox & Goldie-McCulloch Engineering Society at Galt.
**Some Aspects of Scientific Management** by Professor E. A. Allcut, m.e.i.c., Toronto. Attendance, 50.

Nov. 7.—Joint Meeting with Niagara Peninsula Branch E.I.C.
Visit to Plant of Dominion Foundries and Steel Ltd. Attendance, 50.
Visit to Textile Mill of Porritts and Spencer. Attendance, 12.
Visit to City of Hamilton Filtration Plant. Attendance, 10.
Dinner at Wentworth Arms. Attendance, 72.
Professional Meeting—Address by Dr. O. O. Lefebvre, m.e.i.c., President of The Engineering Institute of Canada.
Moving pictures of total eclipse of sun (1932) by W. G. Milne, a.m.e.i.c. Attendance, 115.

Dec. 12.—Joint Meeting with Ontario Section, A.S.M.E.
**Modern Lighting Research** by S. G. Hibben, manager, Commercial Engineering Department, Westinghouse Lamp Co., Bloomfield, N.J. Attendance, 100.

This year has seen the presentation of the first of the committee papers—**The Value of Photography to Engineering** by Mr. Hannaford and his committee. This paper evoked a lot of local interest and has also appeared in the November issue of The Journal.

It is expected that the second committee paper on **The Status of the Engineer in Industry** by J. B. Carswell, m.e.i.c., and his committee will be given early in 1934.

During the year the Branch has been afforded the privilege of holding its meetings in the Science Hall, McMaster University, a privilege which has been greatly appreciated by the members.

Membership

| | Dec. 31st, 1932 Resident | Non-Resident | Total |
|---|---|---|---|
| Members | 27 | 6 | 33 |
| Associate Members | 47 | 10 | 57 |
| Juniors | 13 | 2 | 15 |
| Students | 35 | 0 | 35 |
| Affiliates | 2 | 0 | 2 |
| Branch Affiliates | 16 | 0 | 16 |
| | 140 | 18 | 158 |

| | Dec. 31st, 1933 Resident | Non-Resident | Total |
|---|---|---|---|
| Members | 28 | 6 | 34 |
| Associate Members | 40 | 10 | 50 |
| Juniors | 10 | 3 | 13 |
| Students | 31 | 3 | 34 |
| Affiliates | 2 | 0 | 2 |
| Branch Affiliates | 16 | 0 | 16 |
| | 127 | 22 | 149 |

In addition to the above we have six Associate Members and one Junior on the non-active list.

Financial Statement

*Receipts*

| | | |
|---|---|---|
| Balance, January 1st, 1933 | | $ 68.40 |
| Branch Affiliates | 51.00 | |
| Rebates | 207.90 | |
| Branch News | 19.00 | |
| Interest | 59.65 | |
| Journal subscriptions | 6.00 | |
| | | $343.55 |
| | | $411.95 |

*Expenses*

| | | |
|---|---|---|
| Printing and postage | $ 71.15 | |
| Meeting expenses | 78.01 | |
| Stenographer (1½ years) | 75.00 | |
| Sundry | .65 | |
| Travelling expenses | 89.40 | |
| Student's Prize | 15.00 | |
| | | $329.21 |
| Due from Headquarters | | 32.87 |
| Bank balance, January 1st, 1934 | | 49.87 |
| | | $411.95 |

Assets

| | | |
|---|---|---|
| Bonds at cost | $915.00 | |
| Lantern (less depreciation) | 120.00 | |
| Bank balance and due from Headquarters | 82.74 | |
| | | $1,117.74 |

Respectfully submitted,
H. B. Stuart, a.m.e.i.c., *Chairman.*
A. Love, a.m.e.i.c., *Secretary-Treasurer.*

## Kingston Branch

The President and Council:—

During the year 1932-33 the Kingston Branch met six times, as follows:—

1932

Oct. 18.—Annual Meeting and Dinner.

Dec. 13.—Dinner and special meeting to discuss the report of the Committee on Development.

1933

Jan. 12.—A paper on **Welding in Structural Engineering** was presented by Mr. Frank P. McKibben, President of the American Welding Society.

Feb. 9.—In conjunction with the Engineering Society of Queen's University a meeting was held at which an address on **Writing for Engineers** was read by Mr. G. C. Monture, editor of the Mines Branch, Ottawa.

Feb 17.—Following a dinner at the Badminton Club, Squadron Leader G. E. Wait, R.C.A.F., gave a most interesting talk on **Aviation To-day.**

April 1.—The final paper of the season was on the **Development of Diesel Engines** by Lieut.-Col. F. J. Schmidlin, r.c.e., m.e.i.c.

Employment

Kingston has been less affected by the difficult times of the last three years than larger places. On the other hand many recent graduates have failed to find satisfactory places, or indeed any places at all, while a few of the more experienced members have also been out of work. The situation was greatly helped by the inauguration of the projects under the Department of National Defence, about twelve members obtaining employment thereon. On the opening of these projects, your Executive was asked to nominate a certain number of candidates for positions and all but three or four of those who had registered as unemployed were placed. In this connection it is felt that attention should be drawn to the services rendered to the profession by Major-General A. G. L. McNaughton, c.m.g., d.s.o., m.e.i.c., Chief of the General Staff who has had the direction of these projects and who made it a definite policy to employ only members of the E.I.C. or of the Professional Associations in the higher positions.

Municipal Affairs

The representative of the Branch on the International Bridge Committee of the Chamber of Commerce attended most of the meetings. M. E. Crouch, a.m.e.i.c., one of our Branch members rendered such valuable services to the Committee that he was asked to become a member.

The proposal of the city of Kingston to proceed with the construction of sewage works suggests the advisability of our forming a small committee to confer with the proper officials and give such assistance as we may.

Membership

| | Hon. Members | Members | Assoc. | Juniors | Students |
|---|---|---|---|---|---|
| 1930-31 | 1 | 12 | 13 | 4 | 33 |
| 1931-32 | 1 | 12 | 17 | 6 | 7 |
| 1932-33 | 1 | 13 | 16 | 6 | 16 |

Financial Statement

*Receipts*

| | | |
|---|---|---|
| Balance | $ 88.78 | |
| Rebates | 16.80 | |
| Branch News | 4.88 | |
| Rebates | 8.40 | |
| Rebates | 8.70 | |
| Interest | 1.34 | |
| Rebates | 67.80 | |
| Branch News | 7.87 | |
| Interest | .40 | |
| | | $204.97 |

*Expenditures*

| | | |
|---|---|---|
| Dinners | $ 16.15 | |
| Flowers | 4.00 | |
| Telegrams | 1.28 | |
| Charity | 15.00 | |
| Speakers expenses | 23.38 | |
| Secretary | 45.00 | |
| Rent of room | 4.00 | |
| Chamber of Commerce | 15.00 | |
| Stationery, postage, etc | 17.66 | |
| Balance | 63.50 | |
| | | $204.97 |

Respectfully submitted,
E. J. Schmidlin, m.e.i.c., *Chairman.*
L. F. Grant, m.e.i.c., *Secretary-Treasurer.*

## Lakehead Branch

No report received.

## Lethbridge Branch

The President and Council:—

The following is a report of the operations of the Lethbridge Branch during the past year.

Since January 1st, 1933, eight regular meetings have been held with an average attendance of 47; also six Executive meetings with an average attendance of 7.

The usual procedure has been followed in connection with our regular meetings, i.e., dinner meetings with short musical programmes interspersed with community singing followed by the address.

The Programme committee have been very active this year and as a result some outstanding speakers have addressed the branch on various topics of interest.

Through the efforts of an active Entertainment committee the musical section of our meetings has been excellent.

We have found it necessary through a decreasing membership to reduce the number of our meetings. As our meetings do not follow a set programme for the year as heretofore, it was found advisable to do away with Branch Affiliates until such time as the Branch can afford to follow a set schedule of meetings once again. The Affiliates have access to our meetings however as guests.

The list of speakers and subjects chosen follows:

Jan. 7.—F. H. Ballou, efficiency engineer, B.C. Sugar Refinery Co. Ltd., Raymond, Alberta. Subject: **Operation of a Beet Sugar Refinery.**

Jan. 21.—R. F. P. Bowman, Jr.e.i.c., road master, Canadian Pacific Railway. Subject: **Aligning Railroad Curves.**

Feb. 4.—Joint meeting of the Professional Engineers of Alberta with the Lethbridge Branch of The Engineering Institute of Canada. Dr. H. J. Macleod, M.E.I.C., Professor of Electrical Engineering, University of Alberta. Subject: **The Conquest of Distance.**

Feb. 18.—H. W. Meech, architect, Lethbridge, Alberta. Subject: **Architecture,** illustrated with lantern slides. This meeting was open to the ladies.

Mar. 4.—Annual Meeting. W. D. Armstrong, A.M.E.I.C., Superintendent of the Canada Cement Co. Subject: **Cement.**

April 18.—Dr. O. O. Lefebvre, M.E.I.C., President of The Engineering Institute of Canada. Subject: **Institute Affairs.**

Nov. 8.—Dr. R. C. Wallace, President of the University of Alberta. Subject: **Building a World.** This meeting was open to the ladies and guests of the members.

Nov. 25.—Ladies Night. Musical programme with two motion pictures, **Fire Fighters of the Skies** and **The Arctic Patrol of 1929.** Bridge was played for the balance of the evening.

The Annual Meeting of the Branch was held on March 4th, 1933, when the officers were chosen for the season 1933-1934.

At December 31st, 1933, the membership of the Branch was as follows:—

| | *Resident* | *Non-Resident* | *Total* |
|---|---|---|---|
| Members | 4 | 0 | 4 |
| Associate Members | 14 | 2 | 16 |
| Juniors | 1 | 1 | 2 |
| Students | 4 | 3 | 7 |
| Affiliates | 0 | 0 | 0 |
| | 23 | 6 | 29 |

FINANCIAL STATEMENT
(As at December 31st, 1933)

| | | |
|---|---|---|
| *Revenue* | | |
| Bank balance as at December 31st, 1932 | $ 26.96 | |
| Rebates received from Headquarters, less amount donated to the expense of the Plenary Meeting | 43.70 | |
| Branch News revenue received from Headquarters | 22.00 | |
| Branch Affiliate fees and Journal subscriptions | 44.65 | |
| Special donations for Mr. and Mrs. Geo. Brown (orchestra) | 34.00 | |
| Bank interest | .83 | |
| Rent from motion picture projector | 15.00 | |
| Calgary's share of expense for films, meeting of November 25th, 1933 | 3.75 | |
| | | $190.89 |
| *Expenditures* | | |
| Printing and stationery | $ 27.76 | |
| Meeting expenses: speakers, music, etc | 62.36 | |
| Headquarters: Journal subscriptions | 6.00 | |
| Orchestra, flowers, etc | 54.00 | |
| Postage, exchange, etc | 17.69 | |
| | | $167.81 |
| *Assets* | | |
| Bank balance as at December 31st, 1933 | $ 23.08 | |
| Holmes projector, value $360.25, less 30% deprec. | 252.17 | |
| Rebates of Members fees in arrears | 5.00 | |
| | | $280.25 |

*Liabilities*
Nil

We have examined the books, vouchers, papers and the foregoing statement prepared by the Secretary Treasurer and find the same to be a true and correct account of the standing of the Branch.

C. S. DONALDSON, A.M.E.I.C. }
P. M. SAUDER, M.E.I.C. } Auditors.

Respectfully submitted,
J. HAIMES, A.M.E.I.C., *Chairman.*
E. A. LAWRENCE, S.E.I.C., *Secretary-Treasurer.*

## London Branch

The President and Council:—

During the past year nine meetings were held as follows:—

Jan. 17.—Annual Meeting. Dr. Sherwood Fox, speaker.

Feb. 15.—**Shop Talk.** Speakers W. C. Miller, M.E.I.C., A. O. Wolf, M.E.I.C., S. W. Archibald, A.M.E.I.C.,

Mar. 15.—Talk on **Tax Reduction** by Major Gordon Ingram of the Associated Chambers of Commerce.

April 19.—Films showing construction of the George Washington Bridge and the Empire State Building. Courtesy of the Otis-Fensom Elevator Company.

May 17.—Address on **Town Planning and Landscaping** by Gordon Culham, B.S.A.

June 24.—Annual outing and picnic at country home of the Secretary.

Oct. 18.—Address by J. M. Breen, A.M.E.I.C., of the Canada Cement Company, assisted by L. M. McDonald, plant superintendent.

Nov. 18.—Dinner meeting addressed by O. O. Lefebvre, D.Sc., M.E.I.C., President of The Institute.

Nov. 29.—Address by A. B. Lambe, A.M.E.I.C., President of the Association of Professional Engineers of Ontario.

Owing to the last two meetings being limited to members, the average attendance was reduced to 26.

In addition to the above, six executive meetings were held.

FINANCIAL STATEMENT
(For the year ending December 31st, 1933)

| | | |
|---|---|---|
| *Receipts* | | |
| Balance on hand, January 1st, 1933 | $ 2.10 | |
| Amount due from Headquarters, 1932 | 5.40 | |
| Bank balance | 159.39 | |
| Affiliate fees | 10.00 | |
| Rebates from Headquarters, less $12.00 voted for expenses of Plenary Meeting | 92.69 | |
| Rebates and Branch News due from Headquarters | 15.50 | |
| | | $285.08 |
| *Expenditures* | | |
| Stenographer's services | $ 5.00 | |
| Honorarium to Secretary | 20.00 | |
| Journal subscriptions | 4.00 | |
| Music | 5.00 | |
| Annual dinner expenses | 28.71 | |
| Elevator service and hall rental | 3.75 | |
| Refreshment committee | 5.18 | |
| Hotel expenses for speakers | 10.00 | |
| Stamps and printing | 32.15 | |
| | | $113.79 |
| Bank balance, December 31st, 1933 | | 152.69 |
| Cash on hand | | 3.10 |
| Rebates and Branch News due from Headquarters | | 15.50 |
| | | $285.08 |

W. M. VEITCH, A.M.E.I.C. }
FRANK C. BALL, A.M.E.I.C. } Auditors.

Respectfully submitted,
V. A. MCKILLOP, A.M.E.I.C., *Chairman.*
W. R. SMITH, A.M.E.I.C., *Secretary-Treasurer.*

## Moncton Branch

The President and Council:—

On behalf of the Executive committee we beg to submit the fourteenth annual report of Moncton Branch.

The Executive committee held four meetings. There were seven meetings of the Branch held, one of which was a dinner meeting. All technical meetings were open to the public.

Jan. 24.—A paper on **Detection of Internal Defects in Steel Rails** was read by H. B. Titus, A.M.E.I.C.

Feb. 23.—**The Mining Industry of New Brunswick** was the subject of an address by W. J. Wright, PH.D., F.R.C.S.

Feb. 27.—E. G. Evans, M.E.I.C., read a paper on **The Sphere of Influence of the Engineer.**

May 16.—Nominations made for Branch officers for 1933-1934.

May 31.—The Annual Meeting of the Branch was held on this date.

Oct. 27.—The Branch entertained Dr. O. O. Lefebvre, M.E.I.C., President of The Institute, at a shore dinner at Cocagne, N.B.

Nov. 16.—**Psychological Tests as Used in Industries** was the subject of an address by Professor C. A. Krug, M.A.

Dec. 5.—J. Harold McKinney, A.M.E.I.C., addressed the Branch on **Field Control of Concrete, Saint John Harbour Commissioners Docks,** at West Saint John, N.B.

MEMBERSHIP

Our membership at present consists of seventy-eight members, as follows:—

| | *Resident* | *Non-Resident* |
|---|---|---|
| Members | 6 | 1 |
| Associate Members | 19 | 4 |
| Juniors | 1 | 2 |
| Students | 38 | 5 |
| Affiliates | 2 | 0 |
| | 66 | 12 |

The Annual Meeting of the Branch was held on May 31st, 1933, at which the officers were elected for 1933-34.

Financial Statement
(Year ending December 31st, 1933)

*Receipts*

| | | |
|---|---|---|
| Balance in bank, January 1st, 1933 | $256.08 | |
| Rebates on dues | 82.20 | |
| Affiliate dues | 10.00 | |
| Branch News | 5.76 | |
| Bank interest | 7.22 | |
| Branch News and rebates due from Headquarters | 14.48 | |
| | | $375.74 |

*Expenditures*

| | | |
|---|---|---|
| Expenses of meetings | $ 41.30 | |
| Printing and advertising | 27.09 | |
| Postage | 5.06 | |
| Telegrams and telephones | 2.75 | |
| Miscellaneous | 49.35 | |
| Balance in bank | 232.82 | |
| Cash on hand | 2.89 | |
| Rebates due from Headquarters | 14.48 | |
| | | $375.74 |

*Assets*

| | | |
|---|---|---|
| Balloptican lantern | $ 30.00 | |
| Attache case | 5.00 | |
| Cash in bank | 232.82 | |
| Cash on hand | 2.89 | |
| Branch News and rebates due from Headquarters | 14.48 | |
| | | $285.19 |

*Liabilities*
None

Audited and found correct,
T. H. Dickson, A.M.E.I.C. } Auditors.
H. B. Titus, A.M.E.I.C. }

Respectfully submitted,
H. W. McKiel, M.E.I.C., *Chairman*.
V. C. Blackett, A.M.E.I.C., *Secretary-Treasurer*.

## Montreal Branch

The President and Council:—

We have the privilege of submitting a report of the activities of the Montreal Branch during the past year. We feel that notwithstanding the strenuous times, which we have some reason to expect are now nearing an end, this Branch has concluded what might be considered quite a successful year.

In keeping with the exigencies of the times, we have curtailed our activities in certain directions, but not to a degree, we hope, that has occasioned any halt or backward step in the progress that has for years past marked our operations. Our efforts in the operation of the Branch have been prompted by circumstances towards policies from which it was felt the most good would be derived by all.

Early in the year the Executive gave most serious consideration to such important questions as finance, unemployment, membership, technical meetings, social functions, and the general conduct of Branch activities.

Our financial statement is submitted at the end of this report, and you will note that while a deficit of $76.57 has been incurred in the year's operations, we are, nevertheless, in a sound position. The item of $222.00 which was responsible for the deficit was subscribed towards the expenses of the Plenary Meeting only after very serious consideration and consultation with the resident members of Council.

The subject of unemployment amongst our members was considered of prime importance and occupied the attention of the General committee and of a special committee to a large extent. In order to be assured of a direction from the membership, one of the regular Thursday evening meetings was devoted to a general discussion of it and numerous suggestions were made which were acted upon.

Feeling that existing conditions might re-act adversely for us, it was decided wise to institute at the outset a Membership committee, the purpose of which would be to endeavour to make up for any losses sustained through resignations or deaths, and also to co-operate with Headquarters in inducing members to retain their membership.

Your Executive realized at the beginning of its term that it would be extremely difficult to secure for presentation at the regular weekly meetings any considerable number of papers on works of an outstanding nature, because of general lack of such projects, and furthermore, it felt that lectures of a popular nature would perhaps be more agreeable. With this in mind it endeavoured to secure addresses to be delivered by well known and competent speakers on matters that are very much in the public mind and which would contribute to the general, rather than technical knowledge. This policy we feel has been successful, measured in terms of the large numbers attending our meetings. It was also decided after some study not to hold any social functions, as had been the custom in previous years. It was considered that they would not be justified under present conditions and owing to the holding of the Annual and Professional Meeting in Montreal in 1934 it was believed that this would afford a reasonable compromise in facilitating the renewal of social acquaintance among the members.

Meetings were held on twenty-seven evenings, and the average attendance was 105, which is a slight increase over previous years.

Jan. 5.—Annual Meeting.
Jan. 12.—**Recent Progress in Oxy-Acetylene Welding and Cutting Processes** by D. S. Lloyd, A.M.E.I.C.
Jan. 26.—**Unemployment Problem.**
Feb. 2.—**Power Plants in South America** by J. V. Angus, A.M.E.I.C.
Feb. 9.—**Television: Its Fundamental, Physical and Psychological Principles** by Dr. J. O. Perrine.
Feb. 16.—**Mapping From Aerial Photographs** by A. E. Simpson, B.Sc.
Feb. 23.—**Special Cements** by A. G. Fleming, M.E.I.C.
Mar. 2.—**Fluid Flywheels** by W. T. Reid, F.R.Ae.S., A.M.I.Mech.E.
Mar. 9.—**Wellington Street Subway** by L. J. Leroux, A.M.E.I.C.
Mar. 16.—Junior Meeting:—
**Petroleum Asphalt Paving Material** by Mr. H. R. Holland.
**Etude comparative de chauffage d'une résidence** by Mr. Jean Bastien.
Mar. 23.—**Nipawin Bridge** by Major A. R. Ketterson, A.M.E.I.C.
Mar. 30.—**Electrical Aspects and General Characteristics of Chute-a-Caron Development** by Mr. McNeely DuBose.
April 6.—**Montreal's Traffic Actuated Traffic Control System** by R. B. Dodd, Jr.
April 13.—**Engineering Features of The Location of Hydro-Electric Developments on Upper St. Maurice** by C. R. Lindsey, A.M.E.I.C.
April 20.—**Suspension Bridges** by Mr. Clement E. Chase.
April 27.—**Construction of Hydro-Electric Power Plant at Masson, Que.** by H. V. Serson, A.M.E.I.C.
Oct. 5.—Open Meeting.
Oct. 12.—**International Radio Conference** by Lieut.-Col. A. W. Steel, M.C., A.M.E.I.C.
Oct. 19.—**Refining of Oil** by Mr. F. S. Clulow.
Oct. 26.—**The Sperry Method of Non-Destructive Testing** by J. A. Drain, Jr.
Nov. 2.—**Recent Developments in Switching Equipment** by Mr. L. B. Chubbuck.
Nov. 9.—**Relation of Accounting to The Engineer** by Hon. Gordon W. Scott.
Nov. 16.—**Municipal Law as Applied to Municipal Engineering** by Mr. J. W. Weldon, K.C.
Nov. 23.—Junior Meeting:—
**Aeronautical Research** by Mr. Charles Paton.
**Exploitation d'une carrière** by Mr. J. Benoit, S.E.I.C.
Nov. 30.—**Construction Methods Toronto Water Works Intake** by R. E. Chadwick, M.E.I.C.
Dec. 7.—**Our Friends the Electrons** by Dr. A. S. Eve.
Dec. 14.—**Photography as an Engineering Implement** by Mr. P. J. Croft.

Following our usual custom, out-of-town speakers were tendered a dinner on three different occasions previous to the meeting, and we feel that this is a very important adjunct, as it gives the members and the speaker an opportunity of becoming better acquainted, and of exchanging views more freely on engineering matters.

The customary annual excursion to a distant development was dispensed with and in its stead was arranged, during the summer, a combined visit to the new Caughnawaga bridge and the extensive project of the Beauharnois Power Company. This happy combination was eminently popular as it attracted a very large turnout and our grateful thanks are due to the Janin Construction Company, the Dominion Bridge Company, and the Beauharnois Power Company for enabling us to enjoy the privileges we did at little, if any, cost to ourselves.

The Junior Section, which was organized in 1932, has just completed its first year. This Section comprises the younger members of The Institute, and one of its prime objects is to promote the art of expression in public by members of the engineering profession. They held twelve meetings in all during the past year, and attendance at any of their meetings would disclose a well organized group of promising men, conducting their affairs in a very efficient way, and keen in acquiring and disseminating knowledge of value in the line of their proposed future endeavours. The formation of this section should prove very valuable in securing for The Institute, loyal and interested supporters, thus helping to offset a fear amongst some that the attractions of, and benefits derived from other organizations, did not augur well for it in the future.

The Radio and Wire Communication Section, also organized last year, gives promise of becoming a great asset owing to the developments that appear to be in prospect in this particular line, and the interest and attention that the meetings which it sponsored have aroused. It is worthy also of note that through the agency of associations with the Institution of Electrical Engineers, reciprocal privileges are afforded the members of both Societies in the interchange of knowledge on this increasingly important branch of science.

Your committee, and the Branch as a whole, have co-operated with the Special committee of The Institute in studying the subject of future development and have made recommendations officially as to desirable changes in the constitution of corporate membership—it having been resolved that this should be composed of one grade only.

Suggestions were also made as to modifications in the qualifications for membership. In common with the other branches, this Branch contributed towards the expenses of holding a Plenary Meeting of Council at which this very important subject, amongst others, was given serious study.

A change in the Branch By-laws respecting Affiliate Membership was authorized whereby the dues were reduced, it being the feeling that this would tend to attract more men, having associations with our profession, to The Institute.

There has been held throughout the year a total of twelve meetings of the Executive committee, at which the average attendance has been eleven. In addition to the regular weekly meetings of the Branch and the meetings of the Junior Section, there have been three special Branch meetings called for the purpose of transacting business of a special nature.

MEMBERSHIP

The active list of the members of the Branch remains about equal to what it was in the previous year, as will be noted from a comparison of the figures quoted hereinafter. In addition to the numbers stated there is a number of former members to whom privileges of extension have been accorded in consideration of present conditions and who have been placed upon the non-active list. These would increase the totals by 61 corporate and 18 non-corporate members.

| | *1932* | *1933* |
|---|---|---|
| Corporate members | 720 | 712 |
| Non-Corporate members | 326 | 342 |
| | 1,046 | 1,054 |

We record with deep regret the loss of the following esteemed members who passed away during the course of the year:—

Robert Maitland Hannaford, M.E.I.C.
Allan Campbell MacKenzie, M.E.I.C.
Charles Augustine Mullen, M.E.I.C.
Robert M. Wilson, M.E.I.C.
Henry Maurice Scott, A.M.E.I.C.
David Gemmell Wallace, A.M.E.I.C.

To their families we extend our heartfelt sympathy.

UNEMPLOYMENT

The past year has been a difficult one for those engaged in engineering pursuits, and although it would now appear as if there is every reason to anticipate better conditions, the need for continuation of our effort to assist those in need is as evident as before.

Owing to the limitations of funds made available through the response by the members at large in a special appeal, it was early realized that assistance could only be given to those in actual need. From a report of the committee published in The Journal, December 1933, it will be observed that the fund created in the fall of 1932 has been exhausted, and it was unanimously decided at a meeting of the Branch that the fund be recreated through a further appeal to the members for their generous assistance.

Support of the Technical Service Bureau was withdrawn during the latter part of the year as it then appeared that we could no longer afford to extend our benevolence beyond the ranks of our own members.

Our thanks are due to Mr. Holliday and his aides for the valuable assistance afforded through the Registration Bureau of Office Workers in investigating cases and dispensing the relief which this fund permits.

This committee has co-operated with the main committee of The Institute in compiling statistics on this matter, and has also been successful through the combined efforts in facilitating the temporary or permanent placing of a number of our members.

FINANCIAL STATEMENT

*Revenue*

| | | |
|---|---|---|
| Branch News | $ 4.38 | |
| Affiliate dues | 60.00 | |
| Rebates | 1,522.20 | |
| Bank interest | 29.38 | |
| | | 1,615.96 |
| Balance from 1932 | | 1,297.05 |
| | | $2,913.01 |

*Expenditures*

| | | |
|---|---|---|
| Post cards | $ 580.54 | |
| Printing | 69.56 | |
| Stationery and stamps | 31.52 | |
| Secretary's honorarium | 300.00 | |
| Stenographic service | 120.00 | |
| Telephones | 61.20 | |
| Lantern slides and operator | 73.50 | |
| Subscriptions to *Journal* | 20.00 | |
| Expenses, A. G. and P. Meeting, 1933 | 45.00 | |
| Refreshments, Thursday evenings | 39.15 | |
| Advance A. G. and P. Meeting, 1934 | 30.00 | |
| Loss on dinners to out-of-town speakers | 29.92 | |
| Miscellaneous | 70.14 | |
| Plenary Meeting | 222.00 | |
| | | 1,692.53 |
| Balance, cash in bank | | 1,220.48 |
| | | $2,913.01 |

Respectfully submitted,
E. A. RYAN, M.E.I.C., *Chairman.*
C. K. MCLEOD, A.M.E.I.C., *Secretary-Treasurer.*

## Niagara Peninsula Branch

The President and Council:—

The Executive committee of the Niagara Peninsula Branch presents herein the report for the year 1933.

The Executive held four regular meetings and one electoral meeting with an average attendance of 13.

The meetings are listed as follows:—

Feb. 1.—Dinner meeting, Hotel General Brock, Niagara Falls; speaker, G. W. Lapp, Lapp Insulator Company, LeRoy, N.Y.; topic, **My Trip to Russia.**

Feb. 22.—Annual dinner dance, Welland House, St. Catharines, Ont.

April 22.—Inspection trip, Ontario Paper Company, Thorold. Especially to see electrical installation for boilers. Dinner at Trinity United Church with talk after by W. L. Eliason, electrical engineer, assisted by E. J. Calnan, steam control engineer, of the Ontario Paper Company, giving details of the electrical and steam features of the boilers.

May 18.—Annual meeting at Welland House, St. Catharines. Speaker, Dr. O. O. Lefebvre, M.E.I.C., President of The Engineering Institute of Canada.

Nov. 7.—Joint meeting with Hamilton Branch. Inspection trip in afternoon to the city of Hamilton filtration plant; Dominion Foundries and Steel Company; Porrits and Spencer textile plant. Dinner at the Wentworth Arms hotel. Meeting at McMaster University Science Hall, with moving pictures of the eclipse of the sun, 1932, taken and shown by W. G. Milne, A.M.E.I.C., followed by an address by Dr. O. O. Lefebvre, M.E.I.C., President of The Institute.

Dec. 14.—Dinner meeting at Fox Head Inn, Niagara Falls, Ont.; speaker, Mr. H. Spencer Clark; topic, **An Engineer Looks on Russia.**

MEMBERSHIP

| | |
|---|---|
| Members 1933 | 19 |
| Associate Members | 57 |
| Juniors | 4 |
| Students | 5 |
| Branch Affiliates | 20 |
| | 105 |

This was a loss of 16 from 1932.

FINANCIAL STATEMENT
(January 1st to December 31st, 1933)

*Receipts*

| | | |
|---|---|---|
| Bank balance, January 1st, 1933 | $210.04 | |
| Rebates | 183.60 | |
| Branch News | 12.87 | |
| Proceeds from Meetings | 265.34 | |
| Branch Affiliate fees | 60.00 | |
| Bank interest | 6.39 | |
| | | $738.24 |

*Expenditures*

| | | |
|---|---|---|
| Expenses of meetings | $281.35 | |
| Printing and postage | 34.95 | |
| Exchange on cheques | 0.93 | |
| Refund on dance ticket | 3.00 | |
| W. Simpson, caretaker, Thorold | 10.00 | |
| Secretary's honorarium | 100.00 | |
| Affiliate dues | 42.00 | |
| Plenary meeting of Council | 23.50 | |
| Bank balance, December 31st, 1933 | 242.51 | |
| | | $738.24 |

Respectfully submitted,
W. R. MANOCK, A.M.E.I.C., *Chairman.*
P. A. DEWEY, A.M.E.I.C., *Secretary-Treasurer.*

## Ottawa Branch

The President and Council:—

On behalf of the Managing committee of the Ottawa Branch we beg to submit the following report for the calendar year 1933.

During the year the Managing committee held seven meetings. In addition the Branch held sixteen luncheons, two evening meetings and a dinner dance.

One of the chief activities of the Branch during the year was the holding of the 47th Annual General and Professional Meeting of The Institute in Ottawa in February, at which 423 members registered attendance. This meeting has been fully reported in The Engineering Journal.

It is with deep regret that we report the loss through death of two members, A. M. Grant, M.E.I.C., and Ormond Higman, M.E.I.C., who was a Life Member.

PROCEEDINGS AND PUBLICITY

During the year sixteen luncheon meetings, two evening meetings and a get-together dinner dance were held at the Chateau Laurier. The dates of meetings and speakers are as follows:

Jan. 12.—Annual Meeting, Standish Hall, Hull.
Jan. 12.—Luncheon address, Frank P. McKibben, B.Sc., Black Gap, Pennsylvania, **A Roman Bridge in an American City.**
Jan. 26.—Luncheon address, Dr. Hugh Bostock, M.Sc., Ph.D., Geological Survey, Ottawa, **Mining Industry in the Yukon Territory.**
Feb. 16.—Evening meeting, Gordon McL. Pitts, M.Sc., A.M.E.I.C., Montreal, P.Q., **Transportation in Canada.**
Feb. 23.—Luncheon address, Gordon McIntyre, B.Sc., Sarnia, Ontario, **The General Theoretical Aspects of Lubrication.**
Mar. 9.—Luncheon address, Lieut.-Col. H. J. Lamb, D.S.O., M.E.I.C., Toronto, Ont., **Development of the Great Lakes Waterways System and Harbours Thereon in Canada.**
Mar. 23.—Luncheon address, Dean Eve, C.B.E., D.Sc., McGill University, Montreal, P.Q., **Highs and Lows.**
April 6.—Luncheon address, John Murphy, M.E.I.C., Department of Railways and Canals, Ottawa, **Frazil—from 1883 to 1933.**
April 20.—Luncheon address, H. E. M. Kensit, M.E.I.C., Ottawa, **Water Powers of the World.**
May 11.—Luncheon address, L'abbé Alexandre Vachon, Laval University, Quebec, **Forerunners of Modern Chemistry.**
May 25.—Luncheon address, Frederic R. Speed, Ethyl Gasoline Corp., Detroit, Michigan, **Trends in Gasoline Engine Design and Fuel Design for Optimum Performance.**
May 30.—Luncheon address, J. H. Martin, English explorer, **Seal Fishing in the White Sea, Northern Russia.**
Oct. 5.—Luncheon address, Dr. Olivier O. Lefebvre, M.E.I.C., President of The Engineering Institute of Canada, **Engineering Institute Affairs.**
Oct. 19.—Luncheon address, B. F. Haanel, B.Sc., M.E.I.C., Mines Department, Ottawa, **Fuel Research an Aid to the Solution of Canada's Fuel Problems.**
Oct. 26.—Evening meeting, A. K. Grimmer, M.E.I.C., Town Engineer, Temiskaming, P.Q., **The Development and Operation of Temiskaming, P.Q., as a Company-Owned Industrial Town.**
Nov. 2.—Luncheon address, F. Jaime Gaxiola, B.Sc., Mexican Trade Commissioner, **International Highway, Mexico City, Laredo (American Border).**
Nov. 16.—Luncheon address, Watson Sellar, Comptroller of the Treasury, Department of Finance, Ottawa, **The Treasury and Public Works Expenditure.**
Nov. 30.—Luncheon address, Nouland Cauchon, A.M.E.I.C., Chairman, Ottawa Town Planning Commission, **Elements of Town Planning.**
Dec. 14.—Luncheon address, Alan K. Hay, B.Sc., A.M.E.I.C., Ottawa Suburban Roads Commission, **Progress in Highway Transportation.**
Dec. 15.—Dinner Dance, Chateau Laurier, Ottawa.

The average attendance at these meetings was 82.

### Dinner Dance

With a view to bringing the members of Ottawa Branch of The Engineering Institute into closer touch with one another, an informal dinner dance was held at the Chateau Laurier on December 15th and was attended by 172 members and ladies. During the course of the evening, in addition to the usual dancing, ship's games were provided and this innovation was greatly enjoyed by all. The purpose of the evening to bring the members into closer contact was successfully achieved.

### Membership

Owing to deaths, resignations and members removed from the roll, the membership shows a decrease of ten during the year.

The following table shows in detail the comparative figures of the Branch membership for the year 1932 and 1933:

| | *1932* | *1933* |
|---|---|---|
| Honorary Members | 1 | 1 |
| Members | 88 | 80 |
| Associate Members | 174 | 173 |
| Affiliates of Institute | 4 | 3 |
| Juniors | 13 | 16 |
| Students | 28 | 33 |
| Branch Affiliates | 37 | 36 |
| Resident Members | 345 | 342 |
| District Members | 70 | 63 |
| | 415 | 405 |

### Finances

The attached financial statements show that the Branch had a deficit of $313.43 in expenditure over revenue.

The Branch closed the year with a balance of $579.87 in the bank, $5.97 cash on hand and $1,000 in Victory Bonds; a total balance of $1,585.84. In addition the Branch has assets of $51.60 in rebates due from The Institute; $6.62 due from Branch News in The Engineering Journal, and $21.00 in equipment, etc., making a total of $1,665.06.

### Officers for 1934

The Annual Meeting of the Branch will be held on the 11th of January, when the officers and members of the Managing committee for 1934 will be elected.

### Financial Statement

(For the year ending December 31st, 1933)

*Receipts*

| | | |
|---|---|---|
| Balance in bank January 1st, 1933 | $889.37 | |
| Cash on hand | 9.90 | |
| Interest on Victory Bonds | 52.50 | |
| Bank interest | 16.19 | |
| Rebates from Main Institute, Dec. 1932 | 25.60 | |
| " " " " Jan. to Apr. 1933 | 368.40 | |
| " " " " May to Sept. 1933 | 51.60 | |
| " " " " Branch News, Jan. to Apr. 1933 | 24.67 | |
| " " " " Branch News, May to July 1933 | 18.62 | |
| Advertising 1932 and E.I.C. Journal Commission | 4.20 | |
| Branch Affiliate fees | 60.00 | |
| Proceeds from sale of luncheon tickets | 577.45 | |
| | | $2,098.50 |

*Expenditures*

| | | |
|---|---|---|
| Standish Hall, catering for Annual Meeting, 1933 | $ 37.80 | |
| Chateau Laurier luncheons | 927.15 | |
| Grant to Aeronautical Section | 20.00 | |
| Subscription to Engineering Journal | 6.15 | |
| Grant towards expenses Plenary Meeting in Montreal | 89.00 | |
| Cost of Annual General Meeting, 1933 | 129.27 | |
| Scrims for flowers | 10.00 | |
| Sundries, entertainment, etc | 61.70 | |
| Printing | 85.38 | |
| Petty cash, postage, etc | 113.11 | |
| Cost of Dinner Dance | 33.10 | |
| Balance in bank, December 31st, 1933 | 579.87 | |
| Cash on hand | 5.97 | |
| | | $2,098.50 |

*Assets*

| | | |
|---|---|---|
| Stationery and equipment | $ 20.00 | |
| Library | 1.00 | |
| Rebates due from Main Institute on 1933 fees | 51.60 | |
| Rebates due from Main Institute for Branch News | 6.62 | |
| Victory Bonds due November 1, 1934 | 500.00 | |
| Victory Bonds due October 15, 1943 | 500.00 | |
| Cash in bank | 579.87 | |
| Cash on hand | 5.97 | |
| | | $1,665.06 |

*Liabilities*

| | |
|---|---|
| Surplus | $1,665.06 |
| | $1,665.06 |

Audited and found correct:
G. J. Desbarats, M.E.I.C., Auditor.

Respectfully submitted,
E. W. Stedman, M.E.I.C., *Chairman.*
F. C. C. Lynch, A.M.E.I.C., *Secretary-Treasurer.*

## Peterborough Branch

The President and Council:—

On behalf of the Executive committee of the Peterborough Branch, we have the honour to submit the following report covering the activities of the Branch during the year 1933.

### Meetings and Papers

Jan. 10.—**Erecting Steel Buildings and Strengthening Steel Bridges by Welding** by Mr. Frank P. McKibben, consulting engineer.
Jan. 26.—**The Manufacture of Specialty Rubber Goods in Various Forms** by Mr. O. B. Crowell, chief chemist of the Viceroy Manufacturing Co., Toronto.
Feb. 9.—**Aluminum—Its Production and Utilization** by Mr. Paul S. White, of the Aluminum VI Co. Ltd.
Feb. 23.—**Recent Developments in the Bakelite Industry** by Mr. H. P. Mills, of the Bakelite Corp. of Canada.
Mar. 9.—**Developments in the Great Bear Lake Area** by Major Bernhard Day, consulting engineer for the Bear Exploration and Radium Co. Ltd.
Mar. 23.—**Developments in Topographical Mapping** by J. W. Pierce, D.L.S., O.F.S., M.T.S., M.E.I.C., Peterborough.
April 6.—Students Papers:
1. **Determinism in Natural Science** by J. L. McKeever, S.E.I.C., Canadian General Electric Co.

2. **Building the Backbone of the Nation** by E. J. Davies, Jr.E.I.C., Peterborough Technical School.
3. **A National and International Problem** by W. F. Auld, Jr.E.I.C., Canadian General Electric Co.

April 27.—**Story of Lubrication** by Mr. A. G. Scott of the Imperial Oil Co., Toronto.

May 11.—Annual Meeting, Reports of Committees, Election of Officers.

Oct. 7.—Annual Outing, Trip to Deloro Smelting and Refining Co. plant at Deloro, Ont.

Nov. 9.—**Diesel Engines** by Lieut.-Col. E. J. Schmidlin, M.E.I.C., Royal Military College, Kingston.

Nov. 28.—Annual Dinner, Empress Hotel, Peterborough.

Dec. 14.—**Highways** by W. L. Saunders, A.M.E.I.C., resident engineer, Ontario Department of Highways.

The average attendance at the branch meetings was 34.
Number of Executive meetings held during the year, 7.
Special sub-committees were appointed as follows:—

| | |
|---|---|
| Meetings and Papers | A. B. Gates, A.M.E.I.C. |
| | B. Ottewell, A.M.E.I.C. |
| | E. J. Davies, Jr.E.I.C. |
| Branch News Editor | W. T. Fanjoy, Jr.E.I.C. |
| Membership Committee | B. L. Barns, A.M.E.I.C. |
| | A. A. Richardson, A.M.E.I.C. |
| Unemployment Committee | W. M. Cruthers, A.M.E.I.C. |
| Attendance Committee | D. J. Emery, S.E.I.C. |
| Social and Entertainment | R. L. Dobbin, M.E.I.C. |
| | A. L. Killaly, A.M.E.I.C. |
| | E. J. Davies, Jr.E.I.C. |
| Committee on By-laws and Development | R. L. Dobbin, M.E.I.C. |
| | B. Ottewell, A.M.E.I.C. |
| | A. B. Gates, A.M.E.I.C. |

Membership

| | *Jan. 1, 1930* | *1931* | *1932* | *1933* | *1934* |
|---|---|---|---|---|---|
| Members | 20 | 18 | 15 | 13 | 13 |
| Associate Members | 31 | 30 | 34 | 36 | 35 |
| Juniors | 20 | 20 | 19 | 13 | 11 |
| Students | 30 | 23 | 19 | 16 | 16 |
| Branch Affiliates | 25 | 17 | 15 | 17 | 14 |
| | 126 | 108 | 102 | 95 | 89 |

Financial Statement
(Year ending December 31st, 1933)

*Receipts*

| | | |
|---|---|---|
| Bank balance, January 1st, 1933 | $ 48.64 | |
| Rebates on fees | 108.60 | |
| Journal News | 28.13 | |
| Affiliate fees | 52.00 | |
| Annual dinner | 94.50 | |
| Bank interest | 1.44 | |
| Donation | 4.00 | |
| Rebate from Headquarters | 6.00 | |
| Journal News | 7.88 | |
| | | $351.19 |

*Expenses*

| | | |
|---|---|---|
| Rent | $ 45.00 | |
| Printing | 58.99 | |
| Meetings and speakers | 39.80 | |
| Affiliate Journal subscriptions | 28.30 | |
| Annual dinner | 95.45 | |
| Flowers | 5.00 | |
| Stamps | 1.15 | |
| Treasurer's expense | 1.55 | |
| Insurance | 4.80 | |
| Donation to Headquarters Plenary Meeting | 13.65 | |
| Badges for Student speakers | 4.65 | |
| Bank balance | 38.97 | |
| Accounts receivable, December 31st, 1933 | 13.88 | |
| | | $351.19 |

E. R. Shirley, M.E.I.C., Auditor.

Respectfully submitted,
V. S. Foster, A.M.E.I.C., *Chairman.*
W. T. Fanjoy, Jr.E.I.C., *Treasurer.*
H. R. Sills, Jr.E.I.C., *Secretary.*

## Quebec Branch

The President and Council:—

On behalf of the Executive committee of the Quebec Branch of The Engineering Institute of Canada, we beg to submit the following report covering the activities of the Branch for the calendar year 1933.

Membership

| | *Resident* | *January 1st, 1934* *Non-Resident* | *Total* |
|---|---|---|---|
| Honorary Members (Branch) | 1 | .. | 1 |
| Members | 16 | .. | 16 |
| Associate Members | 54 | 6 | 60 |
| Juniors | 10 | 1 | 11 |
| Students | 9 | 2 | 11 |
| Affiliates | 1 | 1 | 2 |
| | 91 | 10 | 101 |

The following table shows the comparative figures of Branch membership for the years 1931, 1932 and 1933:—

| | *1931* | *January 1st* *1932* | *1933* |
|---|---|---|---|
| Honorary Members (Branch) | 1 | 1 | 1 |
| Members | 16 | 17 | 16 |
| Associate Members | 65 | 66 | 60 |
| Juniors | 12 | 11 | 11 |
| Students | 13 | 15 | 11 |
| Affiliates | 3 | 3 | 2 |
| | 110 | 113 | 101 |

It is with deepest regret that we report the death of one of the founders of our Branch, A. E. Doucet, M.E.I.C., who died on July 16th, 1933.

Report of Activities

During the year 1933, the Branch Executive committee held five regular meetings with an average attendance of seven.

In addition the Branch held meetings as follows:—

Jan. 16.—Luncheon-meeting at Chateau Frontenac. Speaker: Mr. J. E. Gregoire, K.C., Professor of Political Economy at Laval University. Subject: **L'or et son rôle économique.** Attendance, 24.

Feb. 27.—Evening meeting at Chateau Frontenac. Speaker: Lieut.-Col. H. L. Trotter, M.E.I.C., consulting engineer, Montreal. Subject: **The Chats Falls Development, Ottawa River.** Attendance, 25.

Mar. 6.—Luncheon meeting at Chateau Frontenac. Speaker: Augustin Frigon, D.Sc., M.E.I.C., Director of the Montreal Polytechnical School and Director of Technical Education for the Province of Quebec. Subject: **L'ingénieur dans l'industrie.** Attendance, 44.

April 24.—Evening meeting at Palais Montcalm. Speakers: J. U. Archambault, A.M.E.I.C., Quebec Public Service Commission: **Du contrôle des services publics et l'ingénieur;** G. D. Moon, Jr.E.I.C., Bell Telephone Company of Canada: **General Economics on Telephone Business;** Ludger Gagnon, P.E.Q., City of Quebec: **La construction du réservoir des champs de bataille.** Attendance, 42.

May 13.—A visit to the new 30,000,000-gallon reservoir on Battlefields Park. Attendance, 36.

May 25.—**Annual Meeting** and election of officers at Palais Montcalm.

Oct. 13.—Luncheon-meeting at Chateau Frontenac. Dr. O. O. Lefebvre, M.E.I.C., President of The Engineering Institute of Canada, visiting our Branch addressed the members on Institute matters. Attendance, 41.

Dec. 4.—Special meeting at Quebec Drill Hall to visit a display of a modern invention called **Electric Eye.** Attendance, 55.

Financial Statement

*Receipts*

| | | |
|---|---|---|
| Bank balance, January 1st, 1933 | $ 84.59 | |
| Bank interest | .95 | |
| Rebates on fees | 175.50 | |
| Branch News | 20.77 | |
| | | $281.81 |

*Expenditures*

| | | |
|---|---|---|
| Meetings | $ 33.65 | |
| Stamps, postcards, etc | 23.42 | |
| Printing | 49.29 | |
| Flowers | 10.00 | |
| Honorarium to Secretary | 100.00 | |
| Plenary Meeting | 23.20 | |
| | $239.56 | |
| Bank balance, December 31st, 1933 | 42.25 | |
| | | $281.81 |

Respectfully submitted,
Hector Cimon, M.E.I.C., *Chairman.*
Jules Joyal, A.M.E.I.C., *Secretary-Treasurer.*

## Saguenay Branch

The President and Council:—

On behalf of the Executive committee of the Saguenay Branch of The Engineering Institute of Canada, we beg to submit the following report for the calendar year 1933.

### Membership

Our membership this year shows a net loss of one. We are endeavouring to increase our membership and hope to add at least three to the grade of Associate Member.

The following table gives a comparison of our membership as at December 21st for the past four years:—

| | *1930* | *1931* | *1932* | *1933* |
|---|---|---|---|---|
| Members | 6 | 5 | 4 | 3 |
| Associate Members | 25 | 19 | 16 | 18 |
| Junior Members | 7 | 4 | 4 | 3 |
| Student Members | 11 | 7 | 5 | 5 |
| Affiliates | .. | .. | 1 | .. |
| | 49 | 35 | 30 | 29 |

### Branch Meetings

During the year Branch meetings were held as follows:—

June 3.—Meeting was held at St. Joseph d'Alma, preceding which dinner was served. The meeting was addressed by Dr. O. O. Lefebvre, M.E.I.C., who spoke on **Institute Development and Problems.** There were 40 members and guests present.

Aug. 24.—The Annual General Meeting and luncheon was held at Arvida. 16 members were present.

Oct. 12.—A meeting was held at Arvida, addressed by H. B. Pelletier, A.M.E.I.C., on **The Chicoutimi Harbour Development.** 30 members and guests were present.

Nov. 2.—A meeting was held at Arvida, addressed by J. T. Farmer, M.E.I.C., on **The Economics of Steam and Hydro-Electric Generation of Power, with special reference to Process Steam.** 45 members and guests were present.

### Financial Statement

*Receipts*

| | | |
|---|---|---|
| Balance on hand, December 31st, 1932 | $192.88 | |
| Rebates from Headquarters | 55.50 | |
| Branch News | 3.13 | |
| | | $251.51 |

*Disbursements*

| | | |
|---|---|---|
| Printing | $ 11.34 | |
| Exchange | .75 | |
| Postage, telegrams and telephone | 14.81 | |
| Expense of meetings | 80.40 | |
| Stenographic services | 10.00 | |
| Plenary Meeting of Council | 6.00 | |
| | $123.30 | |
| Balance on hand | 128.21 | |
| | | $251.51 |

Respectfully submitted,
A. W. Whitaker, Jr., A.M.E.I.C., *Chairman.*
J. W. Ward, A.M.E.I.C., *Secretary-Treasurer.*

## Saint John Branch

The President and Council:—

On behalf of the Branch Executive committee we have the honour to submit the annual report of the Saint John Branch for the calendar year ending December 31st, 1933.

### Executive Committee

Eleven meetings of the Branch Executive committee were held during the year.

### Standing Committees

The Standing committees of the Branch are as follows:—

| *Committee* | *Chairman* |
|---|---|
| Programmes and Meetings | J. D. Garey, A.M.E.I.C. |
| Entertainment | J. T. Turnbull, A.M.E.I.C. |
| Employment | J. A. W. Waring, A.M.E.I.C. |
| Membership | Branch Executive |
| Salaries | C. C. Kirby, M.E.I.C. |
| Publicity and Branch News | Chas. M. Hare, S.E.I.C. |
| Natural Resources and Engineering Industries | F. P. Vaughan, M.E.I.C. |
| Auditors | D. A. Duffy, A.M.E.I.C.<br>V. S. Chestnut, A.M.E.I.C. |
| Town Planning | J. P. Mooney, A.M.E.I.C. |

### Branch Meetings

During the year six Branch meetings were held as follows:—

Jan. 26.—Joint dinner of The Institute and the Association of Professional Engineers of New Brunswick. Following the meeting M. A. Ravenor, M.E.I.C., read a paper on **Foundations in Clay** illustrated by lantern slides of construction in Georgetown, British Guiana.

Mar. 23.—**Town Planning as Applied to Saint John** was the subject of an address delivered by J. N. Flood, A.M.E.I.C. This address was broadcast by the local radio broadcasting station.

May 4.—Annual Dinner and meeting held at Riverside Golf and Country Club. The present officers of the branch were elected at this meeting.

Aug. 30.—Visit to H.M.S. *Norfolk*, treaty cruiser and flagship of the West Indies Squadron.

Oct. 23.—Dinner tendered Dr. O. O. Lefebvre, M.E.I.C., President of The Institute.

The Maritime Professional Meeting of the E.I.C. and General Meeting of the Association of Professional Engineers held at White Point Beach, N.S., on July 13th, 1933, was sponsored by the Halifax Branch and supported by this Branch, several members attending.

### Membership

The following is a statement of membership as at December 31st, 1933:—

| | *Resident* | *Non-Resident* | *Total* |
|---|---|---|---|
| Members | 10 | 6 | 16 |
| Associate Members | 22 | 12 | 34 |
| Juniors | .. | 5 | 5 |
| Students | 16 | 13 | 29 |
| Affiliates | 1 | .. | 1 |
| | 49 | 36 | 85 |

There are ten members on the non-active list.

### Financial Statement

(Year ending December 31st, 1933)

*Assets*

| | | |
|---|---|---|
| Cash in bank, December 31st, 1933 | $301.96 | |
| Rebates from Headquarters, September to December 31st, 1933 | 25.50 | |
| | | $327.46 |

*Liabilities*

Nil.

*Receipts*

| | | |
|---|---|---|
| Surplus, December 31st, 1932 | $340.74 | |
| Rebates from Headquarters:— | | |
| January to August, 1933 | 99.30 | |
| September to December, 1933 | 25.50 | |
| Branch News, January to August | 11.76 | |
| | | $477.30 |

*Expenditures*

| | | |
|---|---|---|
| Stationery, printing and postage | $ 54.44 | |
| Stenographer | 13.29 | |
| Branch meetings | 20.11 | |
| Lantern slides | 22.00 | |
| Plenary Meeting expenses | 15.00 | |
| Honorarium to Secretary | 25.00 | |
| | $149.84 | |
| Surplus, December 31st, 1933 | 327.46 | |
| | | $477.30 |

Respectfully submitted,
G. A. Vandervoort, A.M.E.I.C., *Chairman.*
S. Hogg, A.M.E.I.C., *Secretary-Treasurer.*

## St. Maurice Valley Branch

The President and Council:—

On behalf of the Executive committee, I beg to submit the following report of the activities of the St. Maurice Valley Branch during the year 1933.

Five general meetings were held; on February 3rd, October 7th, November 4th, when the President of The Institute, Dr. O. O. Lefebvre, M.E.I.C., addressed the meeting, December 4th and December 18th. The Executive committee met twice during the year (on January 25th and April 13th, 1933) to deal with the various questions which arose.

At one of the general meetings a dinner was tendered to Dr. Olivier Lefebvre, M.E.I.C., President of The Engineering Institute, which was attended also by Dr. A. R. Décary, M.E.I.C., Past-President, A. B. Normandin, M.E.I.C., Vice-President, and 40 members of the Branch.

### Financial Statement

*Receipts*

| | | |
|---|---|---|
| In bank, December 31st, 1932 | $ 67.99 | |
| Rebates from Headquarters | 67.50 | |
| Cheque from E. Wardle | 1.10 | |
| Rebates from Headquarters | .60 | |
| | | $137.19 |

*Expenditures*

| | | |
|---|---|---|
| Postage and stationery | $ 28.97 | |
| Branch expenses | 13.84 | |
| Dinner | 56.00 | |
| Plenary Meeting contribution | 9.00 | |
| | | $107.81 |
| Balance in bank | | 29.38 |
| | | $137.19 |

Respectfully submitted,
BRUNO GRANDMONT, A.M.E.I.C., *Chairman*
J. ALBERT HAMEL, A.M.E.I.C., *Secretary-Treasurer.*

## Saskatchewan Branch

The President and Council:—

On behalf of the Executive we submit the following report of the activities of the Saskatchewan Branch for the year 1933.

MEMBERSHIP

The membership of the Branch shows a decrease of twenty-one from last year, the present membership being:—

| | *Resident* | *Non-Resident* | *Total* |
|---|---|---|---|
| Members | 4 | 8 | 12 |
| Associate Members | 28 | 26 | 54 |
| Juniors | 2 | 6 | 8 |
| Students | 3 | 16 | 19 |
| Branch Affiliates | 2 | .. | 2 |
| | 39 | 56 | 95 |

EXECUTIVE COMMITTEE

The Executive committee was elected on March 24th, 1933, and held seven meetings during the year.

COMMITTEES

The standing committees are:—
Papers and Library........S. R. Muirhead, A.M.E.I.C. (Convenor).
Nominating..............H. J. A. Bird, A.M.E.I.C. (Convenor).
Unemployment...........H. R. MacKenzie, A.M.E.I.C. (Convenor).
Membership..............J. J. White, A.M.E.I.C. (Convenor).

MEETINGS

There were one special and six regular meetings of the Branch. The regular meetings in all cases were preceded by a dinner at which the average attendance was thirty-five, a decrease of one from last year. The general interest in the meetings has been good.

We regret to record the loss, by death, of two of our members, C. S. Cameron, A.M.E.I.C., Regina, and J. D. Peters, A.M.E.I.C., Moose Jaw. Mr. Peters was chairman of the Branch last year.

The programme for the year was as follows:—

Jan. 20.—Ladies Night. Address by R. N. Blackburn, M.E.I.C., entitled **A Winter's Wanderings.**

Feb. 17.—Regular meeting held jointly with the Association of Professional Engineers. Address by C. J. Mackenzie, M.E.I.C., Dean of Engineering, University of Saskatchewan, on **The New Saskatoon Bridge.**

Mar. 24.—Sixteenth Annual Meeting. General discussion of Institute affairs.

April 20.—Special meeting. Address by Dr. O. O. Lefebvre, M.E.I.C., on **The Present Status of The Engineering Institute of Canada.**

Oct. 20.—Regular meeting. Address by E. A. Duschak, A.M.E.I.C., on **Developments in Petroleum Refining.**

Nov. 24.—Regular meeting. Address by L. A. Thornton, M.E.I.C., on **Proposed Power Developments on the Saskatchewan River.**

Dec. 15.—Regular meeting. Address by E. B. Webster, A.M.E.I.C., on **The Mineral Possibilities of Northern Saskatchewan.**

FINANCIAL STATEMENT

*Receipts*

| | | |
|---|---|---|
| Bank balance, December 31st, 1932 | $ 52.27 | |
| Rebates from Headquarters | 142.25 | |
| Branch News | 14.77 | |
| Branch dues | 5.00 | |
| Loan | 50.00 | |
| Miscellaneous | 11.00 | |
| | | $275.29 |

*Expenditures*

| | | |
|---|---|---|
| Office | $ 47.63 | |
| Meetings | 54.74 | |
| Loan | 50.00 | |
| Miscellaneous | 22.80 | |
| Bank balance, December 31st, 1933 | 100.12 | |
| | | $275.29 |

Respectfully submitted,
P. C. PERRY, A.M.E.I.C., *Chairman.*
STEWART YOUNG, A.M.E.I.C., *Secretary-Treasurer.*

## Sault Ste. Marie Branch

The President and Council:—

Nine dinner meetings were held during 1933, one at the Country Club, one at the local mill of the Abitibi Power and Paper Company, and seven at the Windsor hotel.

Regular meetings of the Branch were held during the year, and we were especially honoured by a visit from the President of The Institute, Dr. O. O. Lefebvre, M.E.I.C., in June, when a special meeting was arranged at the Country Club.

Attendance at both dinners and meetings was better than during 1932, averaging 26 at dinners and 31 at meetings.

The meetings with the speakers were as follows:—

Feb. 24.—**Monetary Matters** by Jas. Baxter, Royal Bank of Canada.

Mar. 23.—**The Engineering Features of a Sulphite Mill** by C. B. Davies, Abitibi Power and Paper Co. Ltd.

April 28.—**Some Aspects of Forest Protection in Ontario** by Nigel Kensit, Ontario Forestry Department.

May 26.—**Preservation and Use of Canadian Timber** by B. M. Winegar, Canada Creosoting Co. Ltd.

June 14—Visit of President, Dr. O. O. Lefebvre, M.E.I.C.

Sept. 27.—**Development of Great Lakes Waterway System** by Colonel H. J. Lamb, D.S.O., M.E.I.C.

Oct. 27.—**Sisal Industry in Kenya Colony** by C. W. Holman, Sault Technical School.

Nov. 24.—**Examination and Testing of Forging Steels for the Automotive Industry** by W. R. Werther, Algoma Steel Corporation.

Dec. 20.—Annual Meeting. **Northern Ontario Iron Ores** by J. D. Jones, M.E.I.C., Algoma Steel Corporation.

A meeting of the Branch at North Bay was contemplated early last summer but had to be dropped for the time being. Something in this direction may be attempted next year and would be well worth considering.

There were a number of resignations and suspensions during the year but the loss of membership from this has been more than compensated for by members of other branches who have been transferred to this district due to the continued activity in the mining area. There have also been a number of new applications for membership.

The Committee on Unemployment thoroughly canvassed the membership of the Sault Ste. Marie district by letter with regard to unemployment.

Opportunity for employment was offered by The Engineering Institute on construction work being carried out by the Dominion government. Three members of this district availed themselves of the opportunity.

The committee now reports that there is no hardship being experienced by any member of The Institute in this district.

All phases considered 1933 can well be regarded as a very successful year for this Branch, and with increased activity apparent in the industrial field there is every reason for the utmost confidence in its continued success.

FINANCIAL STATEMENT

*Receipts*

| | | |
|---|---|---|
| Interest on savings | $ 6.40 | |
| Rebates from Headquarters | 142.35 | |
| Branch News | 10.38 | |
| Journal subscriptions collected | 6.00 | |
| Affiliates fees | 18.00 | |
| Entertainment receipts | 114.00 | |
| Deficit | 71.84 | |
| | | $368.97 |

*Disbursements*

| | | |
|---|---|---|
| Administrative expenses | $ 27.00 | |
| Contribution to Plenary Meeting | 20.20 | |
| Stationery | 23.41 | |
| Journal subscriptions paid | 8.00 | |
| Postage and telegraph | 14 99 | |
| Entertainment expense | 275.37 | |
| | | $368.97 |

*Assets*

(As at January 1st, 1934)

| | | |
|---|---|---|
| Current account | $128.91 | |
| Savings account | 242.76 | |
| Property—Files, bound volumes, projector, etc. | 1.00 | |
| Accounts receivable | 13.20 | |
| | | $385.87 |

*Liabilities*

(As at January 1st, 1934)

| | | |
|---|---|---|
| Accounts payable | $ 50.00 | |
| Surplus | 335.87 | |
| | | $385.87 |

Respectfully submitted,
K. G. ROSS, M.E.I.C., *Chairman.*
G. H. E. DENNISON, A.M.E.I.C., *Secretary-Treasurer.*

## Toronto Branch

The President and Council:—

The Executive committee of the Toronto Branch respectfully submits the following report on the affairs of the Branch for the year 1933:—

The Annual Meeting was held on March 30th, 1933, and the members of the Executive committee for 1933-34 were elected.

The chairmen of the Standing committees of the Branch are as follows:—

Papers.......Archie B. Crealock, A.M.E.I.C.
Finance.......W. E. Ross, A.M.E.I.C.
Publicity.......A. U. Sanderson, A.M.E.I.C.
Meetings.......W. E. Bonn, A.M.E.I.C.
Membership.......R. E. Smythe, A.M.E.I.C.
Student Relations.......J. Roy Cockburn, M.E.I.C.
Branch Editor.......O. Holden, A.M.E.I.C.

The Executive committee of the Branch has held twelve meetings for the transactions of Branch business during the past year.

Nine regular meetings of the Branch were held, with an average attendance of about sixty-five at each meeting. Two of the meetings were luncheon meetings. The meetings were as follows:—

Jan. 9.—**Erecting Steel Buildings and Strengthening Bridges by Welding** by Mr. Frank P. McKibben, consulting engineer, Black Gap, Pa.

Jan. 26.—**Flow of Water and other Fluids in Pipes** by Professor R. W. Angus, M.E.I.C., Professor of Mechanical Engineering, University of Toronto.

Mar. 16.—**The Construction of the Trans-Canada Highway as an Unemployment Relief Measure** by Jas. Sinton, A.M.E.I.C., chief engineer of the Department of Northern Development, Province of Ontario.

Mar. 30.—Annual Meeting of the Branch.

April 12.—**Tests of Worm Gear Speed Reducers for Power Capacity and Lubrication Data** by Chester B. Hamilton, Jr., M.E.I.C., president and mechanical engineer of the Hamilton Gear and Machine Co.

Oct. 19.—**The Financing of our Highways System** by The Hon. Leopold Macaulay, Minister of Highways, Province of Ontario.

Nov. 2.—**The Chemistry of Portland Cement and its Significance to the Engineer in the Quality of Concrete** by Mr. W. J. D. Reed-Lewis, consulting engineer.

Nov. 16.—**Engineering Institute Affairs** by Dr. O. O. Lefebvre, M.E.I.C., President of The Engineering Institute of Canada.

Dec. 7.—**The Law of Contracts and Bonds of Particular Application to Engineers and Architects** by Mr. H. D. Anger, of Elliott, Hume, McKague, and Anger, barristers. This was a joint meeting with the Toronto Chapter of the Ontario Association of Architects.

During September the Employment committee of the Branch conducted a survey of the condition of unemployment among the membership and the results of the survey were forwarded to Headquarters of The Institute. Further assistance has been given to some members of the Branch from the "Toronto Branch E.I.C. Loan Fund." About one thousand dollars was raised over a year ago for this fund and it is expected that this amount will be sufficient for the present winter, unless very unexpected demands are made upon it.

The Branch is deeply grateful to the Technical Service Council under the direction of Lieut.-Colonel R. E. Smythe, A.M.E.I.C., who has also acted as chairman of the Toronto Branch Unemployment Committee, for the assistance which has been given to members of The Institute in aiding them to find employment. Had it not been for this assistance, the seriousness of the unemployment situation, which we expected following the survey, would have been much greater than it is and it would have been necessary to raise further money for the Loan Fund.

The Toronto Branch has representatives on the Regional Committee of the National Construction Council. A committee has also recently been formed to act in an advisory capacity to the Commissioner of Buildings of the City of Toronto. This committee consists of two members of The Engineering Institute of Canada, two members of the Ontario Association of Architects, and one member of the Contractors Association.

The membership of the Branch on December 31st, 1933, is made up as follows:—

| | *Resident* | *Non-Resident* | *Total* |
|---|---|---|---|
| Members | 108 | 1 | 109 |
| Associate Members | 219 | 15 | 234 |
| Juniors | 56 | 2 | 58 |
| Students | 73 | 21 | 94 |
| Affiliates | 3 | 1 | 4 |
| Branch Affiliates | 2 | .. | 2 |
| Total 1933 | 461 | 40 | 501 |
| Total 1932 | 490 | 38 | 528 |
| | −29 | +2 | −27 |

It is with regret that we record the death of the following members of the Branch during the past year: W. A. Bucke, M.E.I.C., A. R. Davis, M.E.I.C., and W. A. Spence, A.M.E.I.C.

Financial Statement
(For calendar year 1933)

| | | |
|---|---|---|
| *Receipts* | | |
| Bank balance, January 1st, 1933 | $882.33 | |
| A.S.M.E. rebates on printing | 7.24 | |
| Branch Affiliate fee | 10.00 | |
| Proceeds of Councillors dinner | 23.00 | |
| Rebates and Branch News | 515.00 | |
| Bank interest | 20.45 | |
| | | $1,458.02 |
| *Expenditures* | | |
| Affiliate, Journal subscriptions | $ 2.00 | |
| Printing and notices | 149.11 | |
| Room rental | 4.00 | |
| Councillors expenses | 30.50 | |
| Grant toward expense of Plenary Meeting | 103.00 | |
| Entertainment of guests | 39.85 | |
| Gratuities | 10.00 | |
| Speakers expenses | 32.75 | |
| Incidental meeting expenses | 4.60 | |
| Flowers | 10.00 | |
| Clerical assistance, Employment committee | 25.00 | |
| Advertisement in Transactions | 20.00 | |
| Dinner to Members of Council | 34.85 | |
| Stenographic services | 40.00 | |
| Chairman's expenses | 34.35 | |
| Secretary's honorarium and expenses | 152.05 | |
| | $692.06 | |
| Bank balance, January 1st, 1934 | 765.96 | |
| | | $1,458.02 |

Respectfully submitted,
Archie B. Crealock, A.M.E.I.C., *Chairman.*
W. S. Wilson, A.M.E.I.C., *Secretary-Treasurer.*

## Vancouver Branch

The President and Council:—

We beg to submit the following report of the activities of the Vancouver Branch of The Institute during the year 1933.

Meetings

Ten general meetings of the Branch, including one joint meeting each with the Vancouver Section, A.I.E.E., and the Military Institute of Vancouver, were held as follows:—

Feb. 1.—His Honour Judge Howay on **The Royal Engineers and Their Work in British Columbia.** Joint meeting with the Military Institute of Vancouver.

Feb. 11.—Inspection trip to the new Carrall Street gas plant of the British Columbia Electric Power and Gas Co. Ltd.

Feb. 20.—Mr. John Kirkhope on **The New Carrall Street Gas Plant.**

Mar. 4.—Inspection trip to Imperial Oil Refinery at Ioco, B.C.

Mar. 13.—Mr. A. D. Grant on **The Oil Industry.**

April 3.—Professor E. G. Cullwick, Jr.E.I.C., on **Electronic Valves.** Joint Meeting with Vancouver Section A.I.E.E.

April 13.—Dr. O. O. Lefebvre, M.E.I.C., President of The Institute, on **Institute Affairs.**

May 15.—Professor A. H. Finlay on **Erection of Sydney Harbour Bridge.**

Oct. 10.—W. H. Powell, M.E.I.C., on **First Narrows Pressure Tunnel.**

Nov. 8.—Annual Meeting.

The average attendance at meetings was 45.

Executive Meetings

Seven Executive meetings were held during the year to transact the routine business of the Branch and discuss matters of policy.

An informal dinner meeting of the Executive with Dr. O. O. Lefebvre, M.E.I.C., President of The Institute, as the guest of honour, was held in Hotel Georgia on April 13th prior to the General Meeting.

During the past year the Executive committee has carried on an extensive campaign for a policy of development aimed to bring The Institute into closer relations with the provincial associations of professional engineers. Co-operation with the Quebec Branch in particular has resulted in placing clearly before the other executive committees and members of Council the arguments in favour of higher standards of admission than those proposed in the 1932 Report of the Committee on Development. Also we have urged the adoption by Council of a definite plan of development on lines parallel to the membership structure of the provincial associations, which we believe will go far towards harmonizing Institute relations with them and bring the confederation objective into the realm of practical politics. Widespread criticism of the Development Committee's recommendations has caused Council to reconsider the whole question. A. S. Wootton, M.E.I.C., Councillor for Vancouver Branch, represented the Branch at the Plenary Meeting of Council in Montreal on October 30th and 31st. The results of the Council's deliberations on this question were announced in the December Journal.

A contribution of $39.00 was made by the Executive toward the expenses of the Plenary Meeting. This sum is being deducted from moneys due the Branch.

As in 1932, the President and Registrar of the Association of Professional Engineers were appointed honorary members of the Branch Executive, an arrangement which has been very helpful to the Branch and is recommended to the incoming Executive.

The Branch has also been fortunate in being able to carry out arrangements with the local branch of the American Institute of Electrical Engineers similar to those of 1932.

### Visit of President Lefebvre

The Branch was honoured during April by a visit from Dr. O. O. Lefebvre, M.E.I.C., President of The Institute. During the three days he was in Vancouver Dr. Lefebvre spent much time discussing Institute matters, particularly Institute development.

Through the co-operation of the Association of Professional Engineers of British Columbia, Dr. Lefebvre was given a number of opportunities to become familiar with the trend of professional thought here on the subject of closer relations of The Institute with the provincial associations in general.

### Walter Moberly Memorial Prize

The prize for 1933 was awarded to James Wilson MacRae for the best essay submitted by any student in the senior year of the Faculty of Applied Science of the University of British Columbia.

### Membership

| | *Resident* | *Non-Resident* | *Total* | *Suspended List* |
|---|---|---|---|---|
| Members | 45 | 9 | 54 | 1 |
| Associate Members | 53 | 24 | 77 | 4 |
| Juniors | 8 | 4 | 12 | 1 |
| Students | 32 | 6 | 38 | 6 |
| Affiliates | 3 | .. | 3 | .. |
| Branch Affiliates | 1 | .. | 1 | .. |
| | 142 | 43 | 185 | 12 |

A member may go on the suspended list for a limited period, providing he is not in arrears, and may be reinstated to membership on request. While on the suspended list he receives no publications of The Institute but the Branches may, at their own expense, continue to send notices to members on the list and thus keep them in touch with Branch activities. This policy has been pursued by the Vancouver Branch.

At the request of Headquarters the Branch agreed to put on a drive for new members and Dr. E. E. Brydone-Jack, M.E.I.C., was made chairman of the Committee. Recently Dr. Brydone-Jack asked to be relieved of this duty as he was leaving the city, and no action has been taken.

### Elections

For financial reasons the Executive decided to hold the elections by secret ballot at the Annual Meeting subject to the approval of the meeting, nominations signed by two corporate members in good standing and received at the meeting, being accepted on a basis of equality with those of the Nominating committee.

### Financial Statement

The attached financial statement shows a balance on hand of $44.41 as at November 4th, 1933.

*Receipts*

| | | | |
|---|---|---|---|
| Bank balance, December, 1932 | | $ 67.27 | |
| Rebates from Headquarters (Sept. 1932 to April 1933, incl.) | | 224.76 | |
| Branch News | | 9.14 | |
| Bank interest | | .86 | |
| | | | $302.03 |

*Disbursements*

| | | | |
|---|---|---|---|
| *Office expenses:* | | | |
| Rent | $ 75.00 | | |
| Petty cash | 30.60 | | |
| Telegraphs | 3.90 | | |
| Florist (wreath) | 3.00 | | |
| Stenographer | 15.00 | | |
| | | $127.50 | |
| *Meetings:* | | | |
| Notices | 34.12 | | |
| Auditorium rental | 30.00 | | |
| Dinner meeting—April 13th | 16.00 | | |
| | | 80.12 | |
| Honorarium to Secretary (W. O. Scott) | | 50.00 | |
| Balance in bank, November 4th, 1933 | 43.01 | | |
| Cash in hand | 1.40 | | |
| | | 44.41 | |
| | | | $302.03 |

### Walter Moberly Memorial Fund

*Receipts*

| | | |
|---|---|---|
| Bank balance of December, 1932 | $ 87.07 | |
| City of Vancouver Bond interest | 25.00 | |
| Dominion of Canada Bond interest | 5.00 | |
| Bank interest (May, 1933) | 1.34 | |
| | | $118.41 |

*Disbursements*

| | | |
|---|---|---|
| Bank charges | $ 1.00 | |
| Bursar, University of British Columbia | 25.00 | |
| Bank balance, November 4th, 1933 | 92.41 | |
| | | $118.41 |

### Bonds Held in Trust

| | |
|---|---|
| City of Vancouver No. 663—5%—1963 | $500.00 |
| Dominion of Canada No. T.A 065189—5%—1943 | 100.00 |
| | $600.00 |

Audited and certified correct:
A. E. Foreman, M.E.I.C.

Respectfully submitted,
P. H. Buchan, A.M.E.I.C., *Chairman.*
A. E. Gordon, Jr.E.I.C., *Secretary-Treasurer.*

## Victoria Branch

The President and Council:—

The undersigned have the honour to submit the following report on the activities of the Victoria Branch of The Engineering Institute of Canada during the year 1933.

### Membership

An increase of five is reported during the year: two members, six associate members, and one student member were added: one member and one student left Vancouver Island, and two students and one affiliate resigned.

Two senior members were granted life membership. Some success met the efforts of the Branch towards new membership, two applications having been forwarded to Montreal with several applications pending.

At the close of the year the membership of the Branch was as follows:—

| | *Resident* | *Non-Resident* |
|---|---|---|
| Members | 19 | 2 |
| Associate Members | 24* | 9* |
| Junior Members | 2 | .. |
| Students | 7 | 3 |
| Branch Affiliate | 1 | .. |
| | 53 | 14 |

*Includes five Associate Members (three resident and two non-resident) on suspended list on account of inability to pay membership dues.

### Meetings

Seven meetings of the Executive committee were held, the average attendance being seven members, which is considered to be an exceptionally high average and evidence of the interest taken in Institute affairs.

Five general meetings were held, including one social meeting and the Annual General Meeting, the average attendance of 21, or 40 per cent of the resident membership, being considered fairly satisfactory when it is remembered that the official duties of many members require their frequent absence from the city. Reports of technical papers have been duly published in The Journal under the heading of Branch News.

We have adopted the custom of holding our general meetings at a down-town hotel at 7.45 p.m., the meetings being preceded by an inexpensive dinner at 6.15 p.m.; this gives members an opportunity of meeting socially and, it is felt, ensures a better attendance.

### Visit of President

In April, 1933, the Branch was honoured by a visit from Dr. O. O. Lefebvre, M.E.I.C., President of The Institute, who remained two days in the city. The Branch Executive met Dr. Lefebvre on the evening of the first day and views were exchanged on many matters affecting The Institute. On the following evening 27 members met the President at an informal dinner, following which Dr. Lefebvre addressed the Branch. It is felt that Dr. Lefebvre's visit has assisted materially in the promotion of the interests and objects of The Institute.

### Development Committee Report

Members of the Victoria Branch evinced great interest in the Interim Report of The Institute's Committee on Development: every detail of the report was discussed in committee and, finally, by the Branch as a whole. The opinion of the Branch was then put into concise form and sent to all concerned, including secretaries of all Branches.

### Unemployment

The Executive committee of the Branch as a whole continued to act as a committee on unemployment; it is gratifying to be able to report that the situation is certainly no worse than at this time last year and that no cases of destitution are known to the committee.

Through co-operation of officials of the Department of National Defence, all members known to have been unemployed were given an opportunity of employment during the summer on relief projects and six members accepted; three of these members are still so employed. Two members also found employment other than the foregoing; in one case the work was of a permanent nature.

FINANCIAL STATEMENT

The financial statement, attached hereto, shows an improved financial condition at the end of the year, notwithstanding the fact that no branch dues were levied.

ANNUAL GENERAL MEETING 1933

This meeting was held on December 8th, 1933 and the Branch officers for the year 1934 elected.

It is interesting to note that the father of Mr. W. Clarke Gamble, M.E.I.C., who was this year elected a member of Executive committee was the first chairman of the Victoria Branch, which was formed twenty-two years ago.

CONCLUSION

We wish to take this opportunity of expressing our thanks and appreciation of the courtesy and assistance which we have received at all times from Headquarter's staff.

FINANCIAL STATEMENT

*Receipts*

| | | |
|---|---|---|
| Balance in hand, December 6th, 1932 | | $ 71.65 |
| One Branch Affiliate's dues | $ 3.00 | |
| Rebates and Branch News | 138.95 | |
| | | $141.95 |
| | | $213.60 |

*Disbursements*

| | | |
|---|---|---|
| Stationery and repairs to typewriter | $ 3.83 | |
| Stenographer | 19.98 | |
| Mimeographing, addressing and mailing | 23.62 | |
| Cost of five meetings | 27.70 | |
| Telegrams | 8.83 | |
| Telephones | .20 | |
| Wreath and flowers | 6.00 | |
| Preparation and mailing recommendations of Victoria Branch in connection with Development Committee Report | 9.75 | |
| Exchange on cheques | .30 | |
| Present for Secretary of Branch | 10.50 | |
| | | $110.71 |
| Balance in hand, December 1st, 1933 | | 102.89 |
| | | $213.60 |

Audited and found correct:
H. W. GAHAN, A.M.E.I.C., Auditor.

Respectfully submitted,
H. L. SWAN, M.E.I.C., *Chairman.*
I. C. BARLTROP, A.M.E.I.C., *Secretary-Treasurer.*

## Winnipeg Branch

The President and Council:—

The following report of the Winnipeg Branch for the year ending December 31st, 1933, is respectfully submitted.

The Branch membership is as tabulated below:—

| | *Resident* | *Non-Resident* | *Total* |
|---|---|---|---|
| Members | 39 | 5 | 44 |
| Associate Members | 95 | 24 | 119 |
| Juniors | 9 | 4 | 13 |
| Students | 47 | 9 | 56 |
| Affiliates | 2 | 0 | 2 |
| Branch Affiliates | 3 | 0 | 3 |
| | 195 | 42 | 237 |

This tabulation includes members of all classes under suspension.

The membership of the Branch has to our great regret been reduced by death of V. E. Marlatt, Jr.E.I.C.

The Executive committee has held 13 meetings during the year.

There were 13 regular meetings of the Branch during the year, as tabulated below:—

Jan. 5.—D. A. Ross, M.E.I.C., **The Winnipeg Auditorium.** Attendance, 52.

Feb. 2.—Arch. Blackie, **Some Modern Portland Cements.** Attendance, 66.

Feb. 16.—Dr. T. Glenn Hamilton, **Psychical Research—A Belated Branch of Science.** Attendance, 95.

Mar. 2.—J. P. Fraser, A.M.E.I.C., **Operation of the Welland Ship Canal.** Attendance, 40.

Mar. 16.—Professor E. E. Macdonald, A.M.E.I.C., **Granular Materials in Deep Bins.** Attendance, 39.

April 11.—Dean E. P. Fetherstonhaugh, M.E.I.C., **The Photo-Electric Cell.** Attendance, 42.

April 21.—A. B. Cooper, M.E.I.C., **The Ferranti Surge Absorber.** Attendance, 47.

Oct. 5.—Major Geo. Northwood, **Self Liquidating Public Works.** Attendance, 31.

Oct. 19.—Major H. L. Strange, **The Course of the Depression and Recovery—Some Facts; Some Fallacies.** Attendance, 42.

Nov. 2.—Professor J. N. Finlayson, M.E.I.C., **The St. Lawrence Waterway.** Attendance, 128.

Nov. 16.—A. Steventon, **Modern Construction.** Attendance, 165.

Dec. 7.—Wm. D. Hurst, S.E.I.C., **Modern Water Purification.** Attendance, 43.

Dec. 21.—H. C. Beresford, **Great Bear Lake.** Attendance, 52.

It will be seen from this that attendance at Branch meetings has improved greatly, this year's average being 65 while that for last year was 46.

On April 21 the Branch had the good fortune to receive a visit from the President of The Institute Dr. O. O. Lefebvre, M.E.I.C., who addressed the members on Institute affairs. The following day the members met Dr. Lefebvre at luncheon at the Fort Garry hotel, at which time the President made some further remarks on Institute affairs and gave a most interesting address on the activities of the Quebec Streams Commission.

The Joint Committee on Unemployment of the Winnipeg Branch and the Association of Professional Engineers of the Province of Manitoba has, under the able chairmanship of Professor J. N. Finlayson, M.E.I.C., covered much ground and has explored all possible sources of prospective employment for members in need of such, and has had some success in placing men.

The finances of the Branch are not in as strong a condition as could be desired.

FINANCIAL STATEMENT

*Receipts*

| | | |
|---|---|---|
| Rebates due, December, 1932 | $ 6.00 | |
| Rebates for 1933 | 232.14 | |
| Branch News | 16.38 | |
| Dues, Branch Affiliates | 15.00 | |
| Bond interest | 27.50 | |
| | | $297.02 |

*Expenditures*

| | | |
|---|---|---|
| Honorarium to Secretary | $ 75.00 | |
| Deficit, Annual Dance | 24.13 | |
| Students prizes | 80.00 | |
| Joint Committee expenses | 89.32 | |
| Refreshments, Branch meetings | 12.77 | |
| Janitor's services | 28.00 | |
| Printing and postage | 179.91 | |
| Telegraphs | 6.25 | |
| Safety deposit fees | 6.00 | |
| Grant, National Construction Council | 4.00 | |
| | | $505.38 |
| Grant re Plenary Meeting | | 39.70 |
| | | $545.08 |

Thus the bank balance has been reduced by $248.06.

Respectfully submitted,
G. H. HERRIOT, M.E.I.C., *Chairman.*
E. W. M. JAMES, A.M.E.I.C., *Secretary-Treasurer.*

# COMMITTEE of MONTREAL BRANCH

IN CHARGE OF ARRANGEMENTS FOR

## THE ANNUAL GENERAL PROFESSIONAL MEETING

### Montreal, February 8th and 9th, 1934

E. A. Ryan, M.E.I.C., Chairman,
Annual Meeting Committee.

F. S. B. Heward, A.M.E.I.C.,
Chairman,
Entertainment Committee.

Dr. A. Frigon, M.E.I.C.,
Chairman, Montreal Branch.
Vice-Chairman,
Annual Meeting Committee.

J. A. McCrory, M.E.I.C.,
Chairman,
Publicity Committee.

H. W. Lea, Jr.E.I.C.,
Chairman,
Registration Committee.

C. K. McLeod, A.M.E.I.C.,
Secretary Treasurer,
Montreal Branch.
Chairman, Committee in Charge of
Hotel Arrangements.

F. V. Dowd, A.M.E.I.C.,
Chairman,
Papers Committee.

THE
ENGINEERING JOURNAL
THE JOURNAL OF
THE ENGINEERING INSTITUTE
OF CANADA



VOLUME XVII FEBRUARY 1934 No. 2

## A New Canadian Observatory

Much of the recent progress in astronomical knowledge has related to the stars and nebulae, and is the result of patient observation with greatly improved equipment. This has furnished astronomers with a mass of information on such matters as the stars' temperatures, motions, distances and constitutions, all based on the study of the messages which the astronomer deciphers from the light sent to him from the skies. In fact, astronomy has become closely connected with atomic physics and the astronomer and the physicist are working hand in hand. For such investigations the astronomer needs instruments of a capacity and precision undreamt of in the days of Newton and Huygens. Of these, the most important is, of course, the telescope with its photographic and spectroscopic accessories.

The design and construction of a great telescope is now an undertaking which requires the highest skill of the mechanical and electrical engineer, and presents manufacturing and optical problems which very few engineering works are able to solve successfully. As Dr. Young points out in his paper, printed elsewhere in this issue of The Journal, it is necessary to design an instrument which can be moved slowly and with extreme accuracy, although weighing many tons, so as to follow exactly the motion of a celestial object. Further, if the image of the object is to have the necessary clearness of definition, the deformations of the telescope structure and the mirror it carries must be kept within very minute limits, whether such distortions are due to temperature changes or to the weight of the parts of the instrument itself.

The paper describes the way in which these objects have been attained in the construction of the new 74-inch telescope for the David Dunlap Observatory of the University of Toronto. The provision of this instrument and the building which houses it was due to the efforts of Professor C. A. Chant, head of the Department of Astronomy of that University, who for the past twenty-five years has urged the establishment of a research observatory there. In numerous public lectures, in The Journal of the Royal Astronomical Society of Canada, and in the courses in astronomy within the university, the need of an observatory was constantly stressed.

During his life, the late David A. Dunlap took a keen interest in astronomy and in the meetings of the Astronomical Society. When, therefore, some time after his death, Dr. Chant approached Mrs. Dunlap with the proposal that she erect an observatory as a memorial to her husband, the project was very sympathetically received, and as a result plans were made for the observatory, the account of which we are now privileged to publish.

Some of the largest telescopes of the world are listed below:

1. The 100-inch reflector at the Mount Wilson Observatory, California.
2. The 72-inch reflector at the Dominion Astrophysical Observatory, Victoria, B.C.
3. The 69-inch reflector at the Perkins Observatory, Delaware, Ohio.
4. The 60-inch reflector at Harvard College Observatory, Boston.
5. The 60-inch reflector at the Mount Wilson Observatory, California.

The telescope for the new David Dunlap Observatory will have an aperture of 74 inches. It will therefore be the second largest in the world, and its construction gives Canada two reflecting telescopes of the first rank.

The new telescope will be devoted almost entirely to astronomical research. The advantage which it will possess over smaller instruments is due to its great light-gathering power. Taking the light-gathering power of the unaided eye as a unit, that of various sized telescopes may be expressed in terms of this unit. A 2-inch telescope would possess 64 times the light-gathering power of the eye, a 10-inch telescope 1,600 times and a 74-inch telescope 87,616 times. Possibly another and more striking way to illustrate the effectiveness of the large telescope is by a comparison of the number of stars which can be seen in telescopes of various sizes. There are about 4,000 stars visible to the naked eye in the whole celestial sphere on a clear moonless night. A 2-inch telescope will show about 300,000 and with the 74-inch telescope it will probably be possible to photograph over 500 million. Thus the ability of the large telescope to photograph faint stars enables it to reach far out into the depths of space.

When a spectrograph is attached to the telescope the spectra of the stars can be photographed and it is possible to determine their constitution, temperature, distance and speed of motion in the line of sight. To photograph the spectrum of a star at the limit of naked eye visibility requires about two hours with a telescope of 15-inch aperture; with the 74-inch this exposure time can be reduced to ten or fifteen minutes. Thus a great deal more work can be done in a given time with the larger instrument. The actual difference in practice is greater than these numbers indicate, owing to the danger of the long exposures being ruined by clouds and other troubles.

But there is another advantage of the large telescope over the small, and that is the clarity with which it shows detail on any surface. The layman thinks of this as magnifying power; a better term is resolution. In order that detail may be seen on an object it is necessary that the images of two nearby points of the object be seen as two separate images in the telescope. The smaller the angular separation of two points which can be seen apart, the greater the detail which can be made out. This ability to distinguish contiguous points is called resolving power and it varies directly with the aperture of the telescope.

In order that the full resolving power of a telescope be developed it is necessary that the beam of light from the source pass through a perfectly uniform medium and ordinarily even when the sky is clear the atmosphere of the earth is very far from this condition. In looking at the stars through a small telescope of 2-inch aperture the uniform beam of light needs to be two inches in diameter only, but in a 74-inch telescope there must be a uniform beam 74 inches in diameter. The former condition is met with on very many more nights per year than the latter. It therefore happens that the casual visitor to an observatory may be disappointed with the clarity with which he sees the moon or planet through the large telescope, often not better than through a much smaller instrument. The fault does not lie with the telescope but with the atmosphere. When the latter is steady, or, as an astronomer would say, when the "seeing" is good, the full aperture can be utilized to advantage and much more detail seen. The observer must seize these opportunities to do his best work.

The new telescope will be used on every available clear night from sunset to sunrise in photographing the stars or obtaining their spectra. An observatory however would not be fulfilling its complete purpose if used entirely for research. Part of the time must be devoted to those interested in seeing the wonders of the skies and it is planned to set aside one evening per week when the observatory will be open to the public and the telescope available to them. From such a visit some idea may be gained of the patience and skill which the observer needs in order to keep a star image on the slit of his spectroscope, or obtain a clear photographic record in spite of adverse atmospheric conditions and the necessity for prolonged exposure.

## OBITUARIES

### Charles Johnstone Armstrong, C.B., C.M.G., V.D., M.E.I.C.

The membership of The Institute will learn with deep regret of the death at Montreal on January 23rd, 1934, of Major-General Charles Johnstone Armstrong, C.B., C.M.G., V.D., M.E.I.C.

Born at Montreal on August 27th, 1872, General Armstrong graduated from the Royal Military College, Kingston, in 1893.

Following graduation he was until 1899 assistant engineer and later resident engineer on the construction and maintenance of the Atlantic and Lake Superior Railway, and in 1899-1900 served in South Africa with the Royal Canadian Regiment. In 1900-1901 General Armstrong was on the staff of the director of Imperial Military Railways in South Africa, and in 1902-1907 he was divisional engineer in charge of the construction of the Central South African Railways at Harrismith and Krugersdorp. In 1908-1910 he was district engineer in charge of maintenance and new works of the Orange River Colony Railways.

Returning to Canada in 1911, Major-General Armstrong became assistant representative for Sir John Jackson (Canada) Limited, engineers and contractors. During the Great War he held many important posts; he proceeded to England with the 1st Divisional Engineers, C.E.F., and in 1914-1915 commanded the Royal Canadian Engineers, 1st Canadian Division, in England and France. In 1915-1916 he commanded the Royal Canadian Engineers, Canadian Corps, in France, and was engineer-in-chief for Canadian engineer defences in France from February to November 1918. From that time until March 1919, he was chief engineer, VII Army Corps, France. He was mentioned three times in despatches, and besides receiving the 1914-1915 Star, British War Medal and the Victory Medal, was made a Companion of the Bath (C.B.), a Companion of the Order of St. Michael and St. George (C.M.G.). He received the Auxiliary Forces Long Service Decoration (V.D.) and his foreign decorations include the Belgian Ordre de la Couronne and the Portuguese Military Order of Avis (Grand Officer).

C. J. ARMSTRONG, C.B., C.M.G., V.D., M.E.I.C.

Following his return to Canada, Major-General Armstrong was appointed District Officer Commanding Military District No. 4, Montreal, in October 1919, and commanded that district until 1926 when he was appointed to command Military District No. 1, at London, Ont., which appointment he held until 1933, when he retired and made his home at Carillon, Que.

In January, 1933, Major-General Armstrong was promoted to the rank which he held at the time of his death.

He joined The Institute as a Student in 1894 and was transferred to Associate Membership in 1902, becoming a Member in 1912. General Armstrong always took an active part in the affairs of The Institute and was for a number of years chairman of the Honour Roll and War Trophies Committee.

### Hiram Fergusson Donkin, M.E.I.C.

With the death of Hiram Fergusson Donkin, M.E.I.C., at Halifax, N.S., on January 8th, 1934, The Institute loses one of its oldest members.

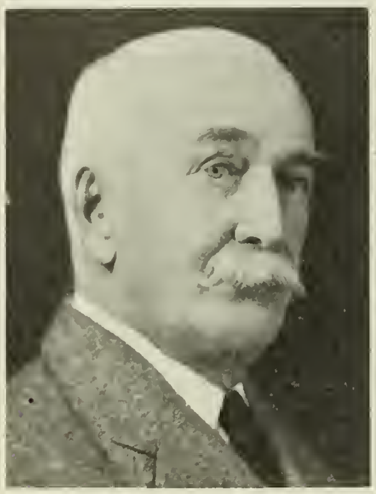
Born at River Philip, N.S., on March 2nd, 1845, Mr. Donkin became a rodman on the Pictou Branch Railway in 1863. From 1867 to 1874 he was assistant engineer with the Intercolonial Railway, and from 1874 to 1876 served in the same capacity with the Kent Southern Railway. During the years 1876-1879, Mr. Donkin was divisional engineer with the Eastern Extension Railway, and in 1879 joined the staff of the Canadian Pacific Railway as divisional engineer. From 1882 to 1883 he was in charge of construction of the Manitoba and Northwestern Railway and from 1883 to 1885 he was contractor with the Canadian Pacific Railway. In the year 1885-1886 Mr. Donkin was in charge of a preliminary survey for the Cape Breton Railway, and in July 1886 was appointed resident chief engineer of that railway. Later on, Mr. Donkin was for some years chief engineer of the Dominion Coal Company, and subsequently was appointed Deputy Commissioner of Public Works and Mines at Halifax, N.S.

Mr. Donkin was one of the original members of the Canadian Society of Civil Engineers, having joined as a Member on June 9th, 1887, the year of its foundation.

### Cyrus Witter Archibald, A.M.E.I.C.

Regret is expressed in recording the death of Cyrus Witter Archibald, A.M.E.I.C., which occurred at Truro, N.S., on January 3rd, 1934.

Mr. Archibald was born at Truro, N.S. on April 27th, 1857, and in 1879 was employed on the Canadian Pacific Railway with the company's engineers on construction at the Lake of the Woods. From 1880 to 1885 he was in the Engineers Department of the Intercolonial Railway, being engaged on surveys and construction work, and from 1885 to 1887 fulfilled the same duties on the Pictou and Oxford branches. In 1887 Mr. Archibald was appointed resident engineer on the Oxford and New Glasgow Railway, which office he held until 1890. During the following year (1891) he was engaged on engineering work of various kinds in New Brunswick and Nova Scotia for the Intercolonial Railway, and from 1891 to 1912 he was roadmaster for the same railway. In 1912 he was appointed resident engineer at New Glasgow, and in the following year became roadmaster on the Halifax division, which position he held until 1931, when he retired.



CYRUS WITTER ARCHIBALD, A.M.E.I.C.

He joined The Institute (then the Canadian Society of Civil Engineers) as a Student on May 17th, 1888, and became an Associate Member on November 21st, 1901. Mr. Archibald became a Life Member on April 11th, 1930.

Mr. Archibald belonged to a well known Nova Scotia family and was held in high esteem by his many friends, especially in railroad circles, having been connected with railway work since the pioneer days in his native province.

### George Edward Wilson Cruttwell, M.E.I.C.

Deep regret is expressed in recording the death in London, England, on November 10th, 1933, of George Edward Wilson Cruttwell, M.E.I.C.

Mr. Cruttwell was born at Frome, Somerset, England, on December 5th, 1857, and received his education at Clifton College and the Applied Science Department of King's College, London. From 1876 to 1879 he was an articled pupil to the late R. P. Brereton, and was employed as assistant resident engineer on Neath harbour improvement works. In November 1879 Mr. Cruttwell entered the service of Mr. (afterwards Sir) John Wolfe Barry, and Mr. H. M. Brunel under whom he acted as resident engineer on St. Paul's station and bridge, and in 1886 he was appointed resident engineer on the construction of the Tower bridge. Since its completion until the time of his death, he has been consulting engineer for the bridge. Following the completion of the Tower bridge, Mr. Cruttwell was in private practice for some years. He held the position of consulting engineer to the Orange Free State Railways until the Boer War and in this capacity was responsible for the new locomotives and rolling stock, large quantities of which were ordered between 1897 and 1900. In 1900 Mr. Cruttwell prepared a scheme for widening London bridge without adding to the weight on the foundations, which was carried out under his supervision without interference with the traffic, and in the same year he obtained the premium of One Thousand Pounds from the New South Wales government for a design, submitted in competition, for Sydney Harbour bridge. In 1901 Mr. Cruttwell joined the firm of Sir John Wolfe Barry and Partners, and during the last thirty years has been connected with a large number of important works covering a very extended range of engineering practice, including dock and harbour works at Barry, Grangemouth, Middlesbrough, Immingham, Newport (Mon.), Grimsby and elsewhere.

In November, 1911, Mr. Cruttwell visited Vancouver in connection with the Second Narrows bridge scheme for which his firm was at that time acting as consulting engineers in conjunction with Messrs. Cleveland and Cameron.

During the Great War Mr. Cruttwell devoted most of his time to work for the Department of Explosives Supply. In 1925 he was appointed honorary consulting engineer to the War Graves Commission, which position he held until the time of his death.

Mr. Cruttwell was a member of the Institution of Civil Engineers and of the Institution of Mechanical Engineers.

He became a Member of The Institute (then the Canadian Society of Civil Engineers) on April 13th, 1912.

### Ernest Harrison McBeath, S.E.I.C.

It is with deep regret that we record the passing, at his home in Moncton, N.B., of Ernest Harrison McBeath, S.E.I.C. Death occurred on December 3rd, 1933, following a long period of illness, the result of an injury received in athletics.

ERNEST HARRISON McBEATH, S.E.I.C.

Mr. McBeath was born at Moncton, N.B., on March 23rd, 1910. He received his elementary education in the Victoria School, afterwards attending Aberdeen High School, in the entrance examinations to which he won the Governor General's medal for Westmorland county. He entered Mount Allison University, Sackville, and graduated with a diploma in engineering. At Mount Allison, Mr. McBeath was president of the Engineering Society. He spent one year at McGill as a student of engineering. Later, failing health compelled him to discontinue his studies.

Mr. McBeath joined The Institute as a Student Member on January 20th, 1931.

## PERSONALS

Charles Connell, A.M.E.I.C., Technical Instructor in the Motive Power Department of the Canadian National Railways, has been transferred from Montreal to Toronto. Mr. Connell, who has been with the Canadian National Railways for many years, was for some time located at Ottawa.

A. R. Currey, Jr.E.I.C., has become connected with Industrial Utilities Limited, Montreal. Mr. Currey obtained the degree of B.A. at Queen's University in 1925, and later studied mechanical engineering at the same institution. In 1927 he entered the engineering department of the Bell Telephone Company, at Montreal, and remained with the same company until the present time, having been appointed general vehicles supervisor in 1931.

M. V. Sauer, M.E.I.C., has been appointed assistant chief engineer of the Beauharnois Light, Heat and Power Company.

Mr. Sauer is a graduate of the University of Toronto of the class of 1901, and took a post graduate course in 1902, receiving a fellowship in 1903.

Following graduation, Mr. Sauer was with the Ontario Power Company at Niagara Falls, first as draughtsman and the next year as assistant to the mechanical engineer. In 1905 he was appointed chief designer of the Niagara Falls Power Company, Niagara Falls, N.Y., and the following year was construction engineer for the Iroquois Construction Company, Buffalo, N.Y. In 1907 he again became associated with the Ontario Power Company as chief designer, then as mechanical assistant to the engineer-in-charge, and subsequently, in 1912, as mechanical engineer in full charge of design, field and inspection department. He later became connected with the Hydro-Electric Power Commission of Ontario, and occupied a prominent position in connection with the design and construction of the Queenston-Chippawa power development. In 1923 Mr. Sauer became hydraulic engineer for Canadian Vickers Limited, with headquarters at Montreal, and in 1925 he was transferred to Toronto, and was chief engineer of the hydraulic department of the then recently incorporated Vickers and Combustion Engineering Ltd., which was a consolidation of the Canadian Vickers Limited, and the Combustion Engineering Corporation Ltd. In 1926, he was appointed vice-president of William Hamilton Limited, at Peterborough, Ont., and was later with the Winnipeg Electric Company, Winnipeg, Man. In 1929 he joined the staff of the Beauharnois Construction Company as hydraulic engineer.

## Addresses Wanted

Mail addressed to the following members has been returned to us by the post office authorities, and any information as to their present addresses will be appreciated:—

*Members*

| | |
|---|---|
| C. W. Dill | C. H. Larson |
| H. Kay | J. C. Tache |

*Associate Members*

| | |
|---|---|
| A. O. Beauchemin | J. C. Mitchell |
| T. R. Cooil | T. M. Montague |
| N. T. Ellis | T. B. Patterson |
| D. H. Fleming | H. E. Thornton |
| W. J. Fraser | L. B. Tillson |
| J. A. Henderson | A. A. Webster |
| F. W. S. Kennedy | J. B. Wilkinson |
| A. J. McFadgen | |

*Juniors*

| | |
|---|---|
| J. E. Archer | J. M. Ehmann |
| T. E. Dwyer | J. E. Kellett |

*Students*

| | |
|---|---|
| R. V. Anderson | A. G. Kay |
| L. C. Gonzalez | A. S. Marshall |
| R. Grossman | L. A. Sherwood |
| B. Heimburger | H. E. Smith |
| P. B. Hughes | W. R. Young |

## RECENT ADDITIONS TO THE LIBRARY

**Proceedings, Transactions, etc.**

American Institute of Electrical Engineers: Quarterly Transactions, September-December, 1933.

Institution of Mechanical Engineers: Proceedings, Volume 124, 1933.

American Society of Mechanical Engineers: Chicago Meeting of Railroad Division, June 26th, 1933; "Contribution of Research to Railway Progress."

**Reports, etc.**

*Quebec Bureau of Mines:*
Annual Report 1932—Part A—Mining Operations and Statistics.

*American Society for Testing Materials:*
Tentative Standards 1933.

*American Institute of Mining and Metallurgical Engineers:*
Year Book 1934.

*Governor of the Panama Canal:*
Annual Report 1933.

*American Society of Mechanical Engineers:*
Research Publication—"Fluid Meters."

*Canada, Department of Labour:*
Report for the year ending March 31st, 1933.

**Technical Books, etc., Received**

Practical Designing in Reinforced Concrete, Part II, by M. T. Cantell. (*E. and F. W. Spon Ltd.*)

Evaporating, Condensing and Cooling Apparatus, by E. Hausbrand. (*Van Nostrand*). Presented by Professor R. W. Angus, M.E.I.C.

Air Conditioning, by Moyer and Fittz. (*McGraw-Hill*). Presented by Professor R. W. Angus, M.E.I.C.

Heat Transmission, by W. H. McAdams. (*McGraw-Hill*). Presented by Professor R. W. Angus, M.E.I.C.

Elements of Engineering Thermodynamics, by Moyer, Calderwood and Potter. (*Wiley*). Presented by Professor R. W. Angus, M.E.I.C.

Canadian Almanac 1934. (*Copp Clark Co. Ltd.*)

George Washington Bridge across the Hudson River at New York, N.Y. (Reprinted from Transactions of the American Society of Civil Engineers, Vol. 97, 1933) (Port of New York Authority.)

## BULLETINS

*Air preheaters.*—An 8-page folder has been received from the Superheater Company, New York, illustrating the various applications of the Ljungstrom air preheater in the public utility and steam power plant fields, and to those interested in industrial heat recovery.

*Concrete*—The Portland Cement Association, Chicago, have issued a 24-page booklet describing monolithic concrete sewers with photographs and design details of types of construction used in eleven leading cities.

*Centrifugal Pumps*—A 4-page folder issued by the Worthington Pump and Machinery Corporation, Harrison, N.J., describes two-stage monobloc centrifugal pump, of high efficiency and low power requirements for services requiring relatively small capacity and medium discharge head.

*Metal treatment*—a 24-page brochure received from The Follsaid Syndicate Limited, of whom the Canadian representative is R. Prefontaine, Montreal, describes the various processes for the treatment of metals of ordinary commercial quality to render them resistant to oxidation at high temperatures, to acid attack, and to give them surface hardness, also the Follsaid agglomeration process for the agglomeration of "fines" flue dust, burned pyrites residues, etc., and the Follsaid volatilization process for the treatment of ores.

*Refuse Collectors*—A 6-page folder received from the Duke Equipment Company, Montreal, describes the various models of truck collector bodies sold by this company. The body mechanism is hydraulically operated, and provides for waist-high loading, thus producing increased speed of collection and disposal.

*Steel Framing*—In their recently issued 20-page booklet the Stran-Steel Corporation, Detroit, Mich., review the use of steel framing for five types of steel house construction. Other possible uses such as roofs, signboards etc., are given. Tables showing dimensions and weights and load possibilities are included, also details of various types of connectors.

*Steel Houses*—In a 28-page booklet issued by the Stran-Steel Corporation, Detroit, Mich., views of actual interiors and exteriors of steel house construction are given.

## CORRESPONDENCE

To The Editor, January 9, 1934
Engineering Journal

In view of the continued serious scarcity of employment among engineers and draughtsmen, we would venture to suggest that an appeal be made to employers to discontinue the loaning of men from one firm to another. By this means it happens that a man who has been unemployed for two or more years is done out of a temporary job, which, however small, would have been of immense financial assistance to him. From a glance at the "Situations Wanted" columns of The Engineering Journal or any list of experienced men available, it is obvious that only in exceptional circumstances can there exist a necessity for borrowing a man at present employed.

Yours very truly,
J. W. March, a.m.e i.c.

The Editor, December 18th, 1933
The Engineering Journal,

Dear Sir,

I read with interest, on page 527 of The Engineering Journal for December, an excerpt from the S.A.E. Journal by C. F. Kettering. Mr. Kettering's statements are enlightening. In this same connection, the opinions of one of the rank and file, who has been fortunate enough to have had responsible charge of the activities of several hundred engineers representing many countries, might not be out of place.

If Mr. Kettering's findings don't coincide with those of the writer, the answer must necessarily lie in the selection and handling of material at hand. The statements are answered in the order in which they are made:

"Engineers as a Class are Too Conceited."

With the possible exception of the recent graduate or a young man, nothing can be further from the truth. We usually find the experienced engineer criticized for being too shy and retiring. Few of them care to make speeches because of this very failing. The conceited man is usually willing to talk on any or all subjects at any time.

"They Think They Known a Lot."

In my own experience, the engineer is the world's greatest pessimist. Engineers lack the confidence of the know-it-all in their own ability. They don't talk very much about what they have done until the work is completed, tested and gives satisfactory service. By experience, the engineer has found that statements which have no basis in fact are liable to be wrong and they will at all times question such statements—not because they think they are right or know a lot, but because they wish to get down to facts before accepting the statement.

"They Don't Mix With Enough Kinds of People."

This is unfortunately only too true. During working hours the engineer has little opportunity for social contact. During his own time a large portion of this must be spent in study if he is to maintain efficiency in his life's work. Engineering methods and processes are in a continual state of flux. The engineer must stay up-to-date or pass out of the picture. When given the opportunity, the engineer is friendly and a good mixer.

"They Lack Imagination."

We must assume Mr. Kettering, in making this statement, feels he has a corner on this valuable process. Why is it, then, that his company with its unlimited financial resources are content to lag five or ten years behind and then copy the developments of European manufacturers of custom built motor cars? I might ask what is wrong with his imagination. However, this is beside the point. All that we have to state is this—every building, bridge or piece of engineering work—machine or what have you, first must take form in the imagination of the engineer before it can be placed on paper.

"They Are Not Emotional Enough."

This is a statement with which it is somewhat difficult to deal. I believe that the average engineer feels emotion just as much as any other individual. However, due to his training and experience, he usually views things as they are and tries to hide his emotions. In other words, he does not capitalize this function as, for instance, is done by the moving picture actor or actress.

"Few of Them Have Broad Mental Perspective."

This statement is probably further from the truth than any of the preceding ones. Let us take, for instance, the typical engineer's work—one who happens to be in charge of machine design and production. In the first place, he must always bear in mind the saleability of the product. He must view the product from the eyes of both the ultimate customer and the salesman. At the same time, he must give due and proper consideration to the economics of the problem with a view to giving the customer a cheap practical product which the sales department will have no difficulty in presenting to the customer and one which can also be manufactured to compete with present machines at a profit to the engineer's employer. Furthermore, he must bear in mind that the product as produced is well within the capabilities of the different branches of manufacture of the company with whom he is employed. In the design and production of the machine he frequently has to deal with eccentricities of his management and different department heads. If this does not constitute a broad perspective within his own field, we are sadly mistaken.

On the other hand, the average engineer has many pursuits outside his own line of endeavour. He usually gives some of his spare time to the study of the various branches of art, theology and politics.

The next two statements must be classified as one:

"Too Many of Them Are Satisfied With Things As They Are."
"They Are Not Dissatisfied Enough."

From my own experience I would say that the average engineer is about the most dissatisfied person in the world. As already stated, they usually are true pessimists. The only individual who can possibly outclass them on a score of dissatisfaction is the Tommy Atkins of the British Regular Army. Dissatisfaction on the part of the engineer frequently causes his dismissal. This, however, is the wrong attitude to take for, as a matter of fact, it is one of the cardinal attributes of the profession, for it is only by dissatisfaction with conditions as they exist that upward progress can be made. Practically every new invention in every field is brought about by the dissatisfaction of the inventor with the methods existing. It is this dissatisfaction, and not the desire for gain which prompts new inventions.

"They Are Inclined to Put Formulae Ahead of Facts."

This statement is absolutely absurd. Mr. Kettering must be out of touch with engineering practice. One would assume from the statement that formulae consist of a conglomeration of hypothetical numbers and signs which bear little or no relation to the subject in hand. In other words, he differentiates between formulae and facts. Formulae, as used by engineers today, are mathematical statements of the relationship of facts which have been proved over and over again by experiment. With the fundamental facts, it is possible to derive a formula with which to work. Formulae are used in order to simplify the work of the engineer. The engineer no longer designs by the cut-and-try method. It would be impossible today to build machinery by this process, inasmuch as we build so much that the cost of producing on this basis would be absolutely prohibitive. He has found that it is much more economical to experiment and find the relationship of the different functions of design and from these basic experiments derive formulae with which it is possible to design machines never before built, with an exactitude which is nothing short of astounding.

For instance, we have the large electrical manufacturers who go out and take contracts for the manufacture of water-wheel generators or steam turbine generators, the capacity of which may be 100 per cent in excess of anything previously built. Before the order is placed they will guarantee all the characteristics of these units. The designs of these machines will be carried out accordingly by formulae and when the tests are made of the final completed unit the results are surprisingly accurate. Inasmuch as this type of machine costs hundreds of thousands of dollars and may weigh several hundred tons, one wonders how long it would take to manufacture these units and what would be the cost if they were produced on the trial-and-error method as suggested by Mr. Kettering's statement.

I might point out that the establishment of formulae from facts established by fundamental experiment would produce infinitely greater results than $7,000,000 of cut-and-try experimentation.

"Most Engineers Lack the Ability to Transfer Their Thoughts in Simple Language to the General Public."

To a certain extent this statement bears some truth. The language of engineering is as different from the ordinary language as is German from English. There exists in engineering, conditions for which it has been found necessary to coin absolutely new words. For this very reason, we have in several good modern dictionaries a glossary of engineering terms. This is usually quite a large section of the work. It is very often quite difficult to explain some of the more complex engineering theories in a manner which can be well understood by the general public. Probably the outstanding engineer of the past generation who was best able to convey his thoughts simply was Charles P. Steinmetz, and he was better able to write his thoughts than to speak them.

In closing, I would like to say that the further up the ladder of success anyone climbs, usually the less able they are to understand the less successful members of their profession, inasmuch as one is apt to lose contact with those more lowly placed. It is only by getting down on the same footing as man to man that one is able to find out the hidden points of a man's character. The man placed on the lower rungs of the ladder is apt to look with some awe at those standing on the topmost rungs. They feel that this man's position must be justified by great ability or learning. This is particularly true in the engineering field. They are, therefore, quite slow in offering suggestions to one whom they feel must know considerably more than they do. Many men will carry out work which they feel is wrong because they have been given strict and uncompromising orders relative to the method of procedure.

There are many types of men in high places who do not give the underling an opportunity to express himself or to voice his opinions. This method can never bring out the best that is in a man.

I am,
Very truly yours,
Boyd Candlish, a.m.e.i.c.

170 Rankin Blvd.,
Sandwich, Ontario.

## Thirty-Fifth Annual Meeting C.I.M. and M.

The Canadian Institute of Mining and Metallurgy will hold its Thirty-Fifth Annual General Meeting on April 3rd to 5th, 1934, in the City of Quebec. Both the General Section and the Industrial Minerals Section will hold sessions, and the technical programme will include the following:—

*Geological*

The Geology of British Columbia Goldfields, by Victor Dolmage.
The Geology of the Vipond Mine, by E. Y. Dougherty.
The Geology of the Beattie Mine, by J. J. O'Neill.
The Geology of the Horne Mine, Noranda, by Peter Price.

*Industrial Minerals*

Recent Developments in the Sodium Sulphate Industry, by L. H. Cole, M.E.I.C.
Mining Methods at the King Mine (an account of the block-caving recently introduced by the Asbestos Corporation), by J. G. Ross.
A Non-Wasting Industrial Mineral, by A. W. G. Wilson.

*Milling and Metallurgy*

Ore Treatment at Falconbridge, by Gill and Mott.
The Trail Leaching Process and Treatment of Fume Produced from Lead Blast Furnace Slag, by Hannay and Bryden.
The Flin Flon Mill, Smelter and Zinc Plant, by The Staff, Hudson Bay Mining and Smelting Co. Ltd.

*Mining*

Sub-level Stoping, by A. Hasselbring.
Guniting at the McIntyre, by D. E. Keeley.
The History, Development and Practice of the Hudson Bay Mine, by The Staff, Hudson Bay Mining and Smelting Co. Ltd.
Power Development for Flin Flon, by The Staff, Hudson Bay Mining and Smelting Co. Ltd.

*Prospecting*

The Organization and Service of a Provincial Prospectors' Association.
The Use of Government Maps and Reports.
The Equipment of a Prospecting Party.
A satisfactory "Grubstaking" agreement.
A Fair Deal for a Prospect.

*General*

The Companies Information Act and Security Frauds Act, Quebec, by W. Amyot.
The Tax Return of a Mining Company, by E. D. Fox.
Blue Sky Laws, by W. E. Segsworth.
Mine Taxation, by The President (Balmer Neilly).

## A.S.T.M. Standards 1933

The American Society for Testing Materials recently issued its triennial Book of Standards containing all of the standard specifications, methods of test, recommended practices and definitions formally adopted by the Society.

The book is published in two parts. Part I, Metals, contains one hundred and four standards on ferrous metals, seventy on non-ferrous, and eleven involving metallography and general testing methods. New specifications adopted in 1933, and revisions are included. Part II, Non-Metallic Materials, contains two hundred and eighty-five standards and methods of test.

In both parts of the book, the specifications for a particular class of material are given first, followed directly by test methods, definitions, etc. A complete subject index is included, together with two tables of contents, one listing the standards under the materials covered, the other listing them in the numeric sequence of their designations.

Copies of either part of the book, in cloth binding, may be obtained for $7.50—both parts $14.00.

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At an "Open Night" and demonstrations given in the Toronto Training Shop of *Dominion Oxygen Company Limited*, Toronto, on January 26th and 27th, 1934, demonstrations were given on bronze welding, pipe welding, aircraft welding, aluminum welding, automatic cutting, hard surfacing, and flame machining. In addition demonstrations were given on metal spraying, weld and welding rod testing, and the results of weld testing, and an illustrated lecture was presented on "Testing Welders and Welding Materials."

*The Bristol Company*, Waterbury, Conn., announces that in order to better serve the Canadian market, a separate company, the Bristol Company of Canada Limited, has been incorporated. Factory and general headquarters will be located at 64 Princess street, Toronto, Ont., where Bristol recording, indicating and control instruments will be made. Mr. J. S. Mayberry, graduate engineer of the University of Toronto, and for ten years with the parent company, has been appointed manager.

# BRANCH NEWS

## Calgary Branch

*J. Dow, M.E.I.C., Secretary-Treasurer.*
*H. W. Tooker, A.M.E.I.C., Branch News Editor*

Arranged for by the Executive Committee, the principal convenors being H. J. McLean, A.M.E.I.C., R. S. Trowsdale, A.M.E.I.C., and G. P. F. Boese, A.M.E.I.C., the members of the Calgary Branch were entertained at a bridge party and dance held at the Renfrew Club on Friday evening December 1st, 1933, which proved to be a most successful affair, and the opinion was voiced by some of the members that a similar event should be held at some future date.

### Reminiscences of Experiences in Africa

The members and their friends of the Calgary Branch of The Institute were entertained at a general meeting on Thursday evening, December 14th, 1933, in the Board of Trade rooms by three short travelogue motion picture reels, following an interesting address by P. J. Jennings, M.E.I.C., superintendent of Banff National Park.

Mr. Jennings spoke on "Reminiscences of Experiences in Africa, South of the Equator," citing many of the hardships that were cheerfully borne by the British soldier during the Boer War.

The pictures "Land of the Nile," "Wild Life on the Veldt" and "Giants of the Jungle" dealt with the daily life of the natives in Egypt, the various kinds of wild animals seen on the veldt and their unceasing watchfulness to protect themselves from unseen dangers, and the elephant which can be trained to perform many useful works.

Following a hearty vote of thanks given the speaker, by M. H. Marshall, M.E.I.C., the meeting adjourned at 10 o'clock p.m.

## Niagara Peninsula Branch

*P. A. Dewey, A.M.E.I.C., Secretary-Treasurer.*

On December 14th, 1933, the Branch held a dinner meeting at the Fox-Head Inn, Niagara Falls, which was addressed by Mr. H. Spencer Clark upon the subject of the "Russian Experiment in Collective Economy." Some forty-five members and guests attended.

Mr. Clark was introduced by Walter Jackson, M.E.I.C., with whom he had been associated during the construction of the Queenston-Chippawa power plant. His trip to Russia in 1931 took him to some of the larger cities, such as Moscow and Leningrad, as well as the surrounding country districts.

### Russian Experiment in Collective Economy

The eventual outcome about Russia, Mr. Clark warned his audience, is probably not determinable at the present stage of affairs, but he had formed the impression that the experiment would eventually succeed to this extent, that a nationality would emerge which would be in advance of anything that could have been achieved under the Tsarist regime.

The name "Russia" is not recognized. It is now "The Union of Socialist Soviet Republics" and comprises a territory larger than North America. The population consists of about 52 per cent pure Russian, 22 per cent Ukrainian and a balance of various racial strains, with one hundred and eighty or more dialects. It is numerically increasing, due largely to two factors, a noted decrease in infant mortality, and a return to the country of exiles or people who have been working in foreign parts, both of which are significant indications of a measure of success.

For sixteen years the U.S.S.R. have had a stable system of government, with policies which have been, on the whole, more consistent than those enjoyed in many other countries, and there is no indication that any counter-revolution is at all possible, or even probable. There is no proof that the government is at present working for, or abetting, any movement for a world revolution; in fact all signs point towards a willingness to recognize the so-called capitalistic nations and to live in peace and amity with them. Therefore no longer does there seem to be any valid reason for refusing to acknowledge this government which will, sooner or later, have such a powerful influence upon world conditions.

Scientific and technical abilities in the U.S.S.R. are receiving a full measure of recognition and, in general, command higher salaries than some of their political superiors. Before the five year plan was announced the details were studied for a period of three years by a commission of 33,000 experts under the leadership of Kubyshev. The plan failed in some respects, notably transportation, but in others the objects were achieved in less than the five years.

Planned economy is the aim of the government, but the machine is not yet functioning smoothly. Most of the energy has been concentrated upon the "heavy industries" in order to provide the necessary power, tools and agricultural implements for the planned productions. Food and clothing have been given a second place temporarily and, in consequence, these articles appear to be less plentiful than at the beginning of the five year plan.

Electrification and aeronautics are well advanced, while, in the cities, education, medical services and social services are much in evidence. Ten thousand new libraries and fifteen hundred scientific institutes convey an indication of their progress.

Mr. Clark visited some of the agricultural districts, five hundred miles south of Moscow, and his lantern slides were quite instructive as to the condition of this basic industry. About 80 per cent of the farmers have joined together in the collective movement and receive government aid by way of scientific earth tests, instructions as to rotation of crops, improved seed and credits for the purchase of farm implements and machinery. Their working and living conditions are comparatively good and the farms are yielding some 50 per cent surplus which goes to the cities. Five hundred grain elevators have been built during the past six years. On the opposite side of the picture are the freehold, or individualistic peasant farmers who, from a fear of losing a new-found liberty, are cultivating their fields as did their forefathers with hoe or wooden plough using hand sickles to garner the grain and hand-flails for threshing. Their land shows every sign of being worked-out, their living conditions are miserable and their yield shows a surplus of but 11 per cent.

In the cities, ration tickets are still employed and consequently much time is wasted in line-ups; many shops, however, carry modern goods which can be purchased by those who have money.

Incentives appear to be somewhat lacking, particularly to the older generation. Propaganda is used freely to raise the spirit of the people, pictures are broadcast showing the faces of men who have done any particularly brilliant piece of work, statues are erected to living heroes and extra holidays are doled out to those who are deemed worthy.

It is of course too early yet to say whether such incentives as these will continue to satisfy ambition and keep the worker fully efficient.

Political prisoners are still treated harshly, but civil misdeeds are punished by banishment to a penal colony where the prisoners live in ordinary surroundings, are taught trades and an endeavour is made at final reform. The restrictions are very slight and inmates have been known to marry and settle in the colony permanently. They are paid nothing at the commencement of their term, but wages are given during the later stages until, at release, they are receiving the common wage.

In conclusion, Mr. Clark remarked that, in his opinion, Russia has now turned the hardest corner and will forge ahead.

A. W. F. McQueen, A.M.E.I.C., in moving a vote of thanks, expressed appreciation of the speaker's address and the interesting lantern slides with which it had been illustrated.

Chairman W. R. Manock, A.M.E.I.C., thanked Mr. Clark on behalf of the Branch and at 10.30 the meeting adjourned.

## Ottawa Branch

*F. C. C. Lynch, A.M.E.I.C., Secretary-Treasurer.*

On Thursday, December 14th, 1933, Alan K. Hay, A.M.E.I.C., highway engineer of the Ottawa Suburban Roads Commission, gave an address on the subject of "Progress in Highway Transportation." Group-Captain E. W. Stedman, M.E.I.C., chairman of the Ottawa Branch, presided, and in addition head table guests included: F. A. Heney, B. Rothwell, J. B. Hunter, Dr. Charles Camsell, M.E.I.C., A. H. Fitzimmons, Bower Henry, H. K. Carruthers, A. Stuart, F. C. Askwith, A.M.E.I.C., E. A. Stephens, F. V. Seibert, M.E.I.C., W. F. M. Bryce, A.M.E.I.C., Colonel A. E. Dubuc, M.E.I.C., F. G. Smith, A.M.E.I.C., and C. McL. Pitts, A.M.E.I.C.

### Progress in Highway Transportation

Mr. Hay traced the development of highway construction from the early days to the present, placing particular stress upon the present-day requirements to meet the ever-extending automobile traffic.

In the design, construction and maintenance of a road the engineer, according to Mr. Hay, must deal with three main problems. There are: wear and tear due to the passage of vehicles; the forces of nature; and obsolescence. Information has been obtained in recent years covering the first two problems, but the third problem, obsolescence, has caused far more concern to highway engineers. It is difficult sometimes to forecast future traffic conditions and the future trend in motor car and motor truck design. The speaker stated that in this country and the United States there are many examples of road improvements which have not given service over their expected tenure of life but which have been rebuilt in a comparatively short time, not because they were worn out but because of changes in traffic and other requirements.

There is an unceasing contest between the motor vehicle designer and the highway builder somewhat analogous to the constant race between gun power and armour plating in naval circles. In the contest between the motor vehicle designer and the highway builder the designer is usually in the lead, that is, the average car or truck has usually reached a higher stage of development than the average road. In this country there are comparatively few stretches of highway adequate to accommodate the latest model car when driven continuously at high speed over a course of some distance. Such stretches of road should have first class alignment, easy grades, long radius curves scientifically banked, wide shoulders, shallow side ditches or none at all, and non-skid surfaces.

Probably considerations of cost will prevent any large portion of highway mileage ever reaching this degree of perfection but at any rate it is an ideal toward which we may aim.

One trouble, however, with setting a standard, is that such a standard is constantly changing. A road which seemed the height of perfection a few years ago might look quite antiquated today.

The speaker made special reference to the development of the motor truck. The truck has been taking an ever-increasing part in the movement of freight and baggage goods and has had its effect upon road construction.

Mr. Hay described some of the more popular types of surface construction giving the advantages and disadvantages of each. He also touched upon the work the road engineer is called upon to do in connection with the building of bridges, culverts, retaining walls, etc. This he characterized as one of the most interesting phases of the highway engineer's activities.

He closed his address with a reference to the highway engineer's necessity for maintaining amicable relationships with the public. This involves endless contact with not only the users of the road but the owners of property frontage, a large number of whom have special little problems of drainage, private entrances, or the fixing of grades. Each of these problems must be given its share of attention having regard to the fact that each owner is a tax payer and also to the fact that the interest of all must be protected.

### Dinner Dance

A dinner dance was held by the local Branch of The Engineering Institute at the Chateau Laurier on December 15th, 1933 at which about one hundred and seventy-five members and their friends were present. This dance was in the nature of a get-together party, the programme consisting of an informal dinner with games and dancing following.

The guests were received by Group-Captain and Mrs. E. W. Stedman and Mr. and Mrs. G. J. Desbarats.

The games were those usually held on board a liner at sea and consisted of horse racing, ship's run, etc. Each person, at the commencement of the evening's programme, was given a fixed sum of fake money and prizes were awarded to those who accumulated the most wealth.

This unique form of entertainment was a pronounced success and everyone present stated that the evening was a most enjoyable one.

## Peterborough Branch

*H. R. Sills, Jr.E.I.C., Secretary.*
*W. T. Fanjoy, Jr.E.I.C., Branch News Editor.*

The last meeting during 1933 of Peterborough Branch took place Thursday evening, December 14th, with Mr. W. L. Saunders, A.M.E.I.C., resident engineer, Ontario Department of Highways, as the speaker.

### Highways

Mr. Saunders gave his paper the general title of "Highways," and dealt particularly with the cost of highways. He stated that the average taxes assessed on an Ontario farmer with a $5,000.00 farm for highways was $8.45 annually. The motorist with a $1,000.00 car pays $40.00 in the same length of time.

Contrary to the popular idea the speaker said that there is more money spent on highways than is taken in. It should be remembered that a huge debt for highways was incurred before the road taxes were instituted. This debt is still drawing interest.

Contrasting Ontario conditions with Great Britain it is found that the license for a Ford car in the latter country costs $112.00.

The speaker was of the opinion that our roads cost us very much less to build and maintain than a similar road in Great Britain and this despite the fact that we have more severe frost and drainage conditions to contend with.

The standard Ontario highway is 20 feet wide of concrete. This is usually laid by contractors and the average rate is 1,000 to 1,200 feet per day. Mr. Saunders said that the world's record for laying this type of highway is held by Ontario when the firm of Clinton & Goderich laid 2,162 feet of 20-foot highway in one day some four years ago.

The average costs on road maintenance per mile in Ontario for all types of roads is $397.00 per year. In Ontario there are about 3,600 miles of highway and on some highways the traffic is as much as 4,500 vehicles per day. The highest type of highway has a maintenance cost per mile year of $441.00. Great Britain's cost on her second class roads with very much lessened frost and drainage conditions is $1,500.00 to $1,600.00 per mile year. Our costs are also less than those in the United States. One of the reasons for this is that no regular road maintenance gangs are maintained. Regular patrol men pick up casual labour along the roads to do the work as required. At the present time, the use of mechanical road equipment is limited so as to benefit hand labour. Grading and paving of course requires the use of machinery.

Mr. Saunders also touched on the work that is being done with regard to widening the shoulders of roads and eliminating ditches. Where feasible the shoulders are being graded down to the ground level at a definite slope, thereby eliminating ditches.

### What Mechanical Tests Are Worthwhile

"Proficiency is the art of designing something which will do the job satisfactorily and not cost too much."

This definition was given by F. A. Nagler, M.A., S.M.E., Chief Engineer of the Canadian Allis-Chalmers Company, Limited, of Toronto, speaking before the Branch, Thursday evening, January 11th, 1934.

To make something which is 100 per cent perfect or which will take care of every possible contingency will in most cases cost too much. In this connection the speaker declared that nothing can replace full scale tests. In a great many cases troubles are encountered in the full scale model that never appear in a reduced model. In many cases of course reduced scale testing must be resorted to but these tests are nearly always checked on the full scale model after it is completed.

There is a wide variation in design. For instance pumps can be designed for a continuous duty of five hundred thousand hours which is equivalent to over fifty years of continuous running. On the other hand ordinary automobiles have a life at full load of only a few hours. Actual tests were made on five cars in the price class of $1,500.00 to $2,000.00, with a brake on the rear wheels to give full load. At full throttle the first car to fail ran one hour, seventeen minutes and the last five hours.

The speaker went on to outline unusual conditions in materials. For instance in transporting helium gas thick walled steel spheres are used with the gas at 1,200 pounds pressure. The spheres are 8 feet in diameter with 2-inch walls. They were tested with water pressure and while under pressure were hammered by six men for two hours with sledges, then six air-hammers were substituted which in three days delivered 20,000 blows. They were finally blown up with heavy water pressure. A section would finally stretch a little and form a pimple. This would relieve the stress at this point and a pimple would form somewhere else on the surface. Finally the sphere had added to its diameter by one foot by stretching all over. The final break was like an orange peel.

The speed of application of a blow is very important. A pipe with internal pressure fails by tearing down one side. Other shapes made from the same material may actually shatter. In general heavy walls shatter and thin walls tear. A rifle bullet was fired at a cylinder of oxygen under 1,200 pounds pressure. Instead of tearing or shattering the heat of impact ignited the steel of the cylinder and the oxygen in the cylinder supported the combustion. Rifle bullets with speeds up to 3,000 or 4,000 feet per second merely spatter against Krupp armour plate but special bullets with a speed of 5,000 feet per second caused hemispheres to drop out of the plate.

New tests are constantly being added to the list of standard tests for steel. At one time tensile strength and elongation was considered sufficient but microphotographs, impact tests, fatigue, reversal of stress, notch effect, etc., are now considered necessary.

In connection with notch effect it has been found that the average strength of a section will be reduced as much as seven or eight times by a notch or sharp corner. Fillets must be used and in some cases particularly punches, these fillets should be polished lengthwise.

## Saskatchewan Branch

*S. Young, A.M.E.I.C., Secretary-Treasurer.*

The regular monthly meeting of the Branch was held in the Hotel Champlain, Regina, being preceded by a dinner at which thirty-two were in attendance. The chair was occupied by P. C. Perry, A.M.E.I.C.

### The Mineral Possibilities of Northern Saskatchewan

After introducing several guests and attending to several items of business, the chairman introduced the speaker of the evening, E. B. Webster, A.M.E.I.C., mining engineer, Department of Natural Resources, Saskatchewan, his subject being "The Mineral Possibilities of Northern Saskatchewan." Pointing out that the capital invested in mineral development in Canada is very largely "outside" capital Mr. Webster proceeded to enlarge on his subject by stating that mineral development in the Saskatchewan-Manitoba area, north of The Pas, has resulted in the establishment of a town, Flin Flon, Manitoba, equal in size and population to several of the smaller cities in southern Saskatchewan. He stated further that, while copper producing mines in other areas had been obliged under existing economic conditions to curtail output to as low as 40 per cent, the mines at Flin Flon have actually increased their output by 50 per cent. He stated further that while Saskatchewan is not listed as a metal producing province, it could and should be so listed if a proper separation of the ore mined in this area were made. If royalties were earned from production a separation of the amount of metals produced in Saskatchewan would be necessary and Saskatchewan would be listed in a small way as a producer of zinc, copper and gold.

The growth in mineral production in Canada has been enormous, the present production being in the ratio:

| | |
|---|---|
| Non-metals | 23.1 per cent |
| Fuels | 29.4 per cent |
| Metals | 47.5 per cent |

Of these one would expect to find metals only in northern Saskatchewan, more especially in the territory west from Flin Flon to Lac La Ronge then north and west to Lake Athabasca and the northernly boundary of the province, latitude 60 degrees N, the latter area extending well into the North West Territory. Here the geological formation, pre cambrian, is the same as in the Flin Flon area.

Northern Saskatchewan has not as yet been properly mapped. Consequently it is impossible to make a proper estimate of the areas favourable to prospecting. There are however several known favourable areas as follows:—

1. The Amisk-Athapapuskow area extending from the eastern boundary of the province west for 35 miles and being about 25 miles in width from north to south.
2. An area from 2 to 10 miles in width extending from the north-east corner of Deschambault Lake north to the Churchill river and beyond, probably fifty miles in length.
3. An area along the west side of Lac La Ronge.
4. The territory surrounding Lake Athabasca and north to the northern boundary of the province.

In concluding his paper Mr. Webster drew attention to the fact that while much of the formation in northern Saskatchewan is considered to be unfavourable it is similar in structure to formation elsewhere in Canada of proved value.

## Sault Ste. Marie Branch

*G. H. E. Dennison, A.M.E.I.C., Secretary-Treasurer.*

The annual meeting of the Sault Ste. Marie Branch was held on Wednesday, December 20th, 1933, at the Windsor hotel at Sault Ste. Marie. The meeting was addressed by J. D. Jones, M.E.I.C., general manager of the Algoma Steel Corporation, whose topic was "Northern Ontario Iron Ores."

### Northern Ontario Iron Ores

In opening, Mr. Jones referred to previous papers read before the Sault Ste. Marie and Peterborough Branches dealing with Canadian iron ores and stated that in this paper he would confine himself to ores of northern Ontario. These deposits are the largest known reserves in Canada and on account of their character and location are sure to be considered in any new developments that may occur. The known and proved deposits are in three locations, namely, the Atikokan ores at the Canadian head of the Great Lakes, the Siderite ores at Michipicoten and the Magnetites of Algoma and Moose Mountain in Sudbury district. Worthy of separate consideration are the iron ores raised in the Sudbury nickel belt incidental to the mining of nickel and copper. All are within easy transportation distance of the Great Lakes and although requiring beneficiation, when beneficiated offer an ideal charge for blast furnaces, superior in every way to the raw ores of the Misabi or Michigan rouges.

There is nothing in our siderite or magnetite ores which presents a metallurgical problem to be contended with in the manufacture of iron or steel and in fact the use of these ores in combination, eliminates many of the daily problems with which steel makers have to contend. The problem, then, is one of preparation. As mined these ores are low in metallic values averaging about 35 per cent for both ores. It is necessary to raise this to at least 50 per cent for economical blast furnace use. In the case of siderite this is done by calcining either by a rotary tube or the use of the Greenawalt or Dwight-Lloyd method. The magnetite ores require fine grinding, magnetite separation and sintering. Both processes have been and are being successfully carried out in Sweden, Eastern Pennsylvania, New Jersey and elsewhere.

On account of the extremely high grade product obtained at Moose Mountain (64 per cent iron) it occurred to the author that it might be possible to extend the beneficiation process to the preparation of sponge iron. This is a very pure product used in the manufacture of very high grade steels.

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Construction Work in Montreal

**Riviere St. Pierre Collector Sewer, Montreal.**

Mr. Jones enlarged on the possibilities of combining these two processes and drew an interesting picture of the unique advantages which could be enjoyed by a steel plant able to derive a wide range of steels from a common source of supply with a consequent saving in inventories.

At the conclusion of Mr. Jones' address, Mr. Jno. A. McPhail, president of the Great Lakes Power Company and one of the receivers for the Algoma Steel Corporation, addressed the meeting, followed by Mr. J. W. Curran. Both dealt with different aspects of the development of the iron ores adjacent to this district and both were confident of early activities in this direction.

K. G. Ross, M.E.I.C., concluded his year of office with the December meeting and at its conclusion retired in favour of E. M. MacQuarrie, A.M.E.I.C., who will occupy that post for 1934. His executive committee consists of H. F. Bennett, A.M.E.I.C., S. B. Clement, M.E.I.C., A. A. Rose, A.M.E.I.C., C. J. Russell, A.M.E.I.C., A. E. Pickering, M.E.I.C., and G. H. E. Dennison, A.M.E.I.C., secretary-treasurer.

## Toronto Branch

*W. S. Wilson, A.M.E.I.C., Secretary-Treasurer.*
*O. Holden, A.M.E.I.C., Branch News Editor.*

On the evening of December 7th, 1933, Mr. H. D. Anger, of the legal firm of Elliott, Hume, McKague and Anger, addressed a joint meeting of the Ontario Association of Architects, Toronto Chapter, and The Engineering Institute of Canada, Toronto Branch, on the subject of "The Law of Contracts and Bonds of Particular Application to Engineers and Architects." The meeting, which was open to guests of the members, was convened in the Debates Room at Hart House, following an informal dinner in the North Common Room.

The speaker pointed out the advisability, in fact the necessity, of engineers and architects having some knowledge of the essentials of contract law, since their work brought them continually in contact with the preparation or interpretation of such documents. A brief outline of what constitutes or is the essence of a contract was given. This may be summarized as follows:

1. An offer and acceptance either verbally, by letter or telegram.
2. Capacity of parties—i.e. they must be competent, and in case of corporations must be within their powers.
3. Consideration—There must be a consideration, but the amount is not considered unless fraud or deceit is shown.
4. Form of Contract—Contracts for more than a year or for the sale of land, among others, must be in writing. Contracts with corporations must be under the seal of the corporation, and in the case of a municipality must be under seal and also be confirmed by by-law, this latter point being of particular interest to engineers acting as consultants on municipal works.

The speaker then dealt with building contracts, and pointed out the distinction as to a contract being one and indivisible or made up of several items to be separately paid for on completion. If of the former type the contractor could not recover any payment until he performs the whole work.

In dealing with sub-contracts, it was pointed out that the sub-contractor cannot sue the owner, nor can the owner sue him, but by virtue of the Mechanics Lien Act a sub-contractor may put a lien on the owner's property, as can the other parties.

The question of extras to a contract was discussed, and attention was called to the fact that any necessary formalities relating to a contract relate also to extras or alterations. If the contract makes no provisions for extras, these form a new contract.

A most interesting portion of the address dealt with the much discussed question of penalties. The speaker pointed out that the courts would not enforce a time penalty whether it was called liquidated damages or not, merely because it was named in the contract. They would, however, allow actual damages. If, however, the evidence shows that the amount named in contract represents estimated actual damages, the courts will enforce it. Such amount, however, must bear a reasonable relation to the time loss or expense to owner, and to the amount of the contract. The enforcement of a penalty does not require the provision for payment of a bonus.

In connection with contract bonds, it was shown that any material variation in the contract without consent of the surety relieves the latter.

A most interesting discussion followed, and the vote of thanks of the members was most heartily given for a very instructive and illuminating address.

## Winnipeg Branch

*E. W. M. James, A.M.E.I.C., Secretary-Treasurer.*
*E. V. Caton, M.E.I.C., Branch News Editor.*

On Thursday evening, December 7th, 1933, at the meeting of the Winnipeg Branch of The Engineering Institute, presided over by Professor G. H. Herriot, M.E.I.C., chairman, a paper was read on "Modern Water Purification" by W. D. Hurst, S.E.I.C., assistant engineer of the City Engineering Department, Winnipeg.

### Modern Water Purification

Mr. Hurst stated that in recent years a higher standard of drinking water has been demanded. The public now demands a water that is not only sterile, but attractive, clear, colourless, odourless and free from excessive quantities of soluble mineral substances. These substances last named are receiving more and more attention as the public becomes aware of the tremendous waste of soaps that occur with a supply of hard water.

Water-borne disease may readily be transmitted through water systems, especially typhoid fever and dysentery. The germs usually find their way into wells drawing from limestone or other porous formations and into lakes or rivers forming a watershed, usually thickly populated and poorly patrolled.

The methods of purification were explained and the type of treatment required by various waters was discussed.

Preliminary sedimentation is now receiving less and less attention although in special cases it may be of service. It can be demonstrated that water which contains particles finer than silt will not become clear by sedimentation even when the particles are relatively heavy and the water perfectly still, unless considerable time is given. For this reason the process may be uneconomical.

The work of Sir Alexander Houston on the treatment of the Thames river water by storage in the Chelsea reservoir was discussed rather fully.

The history of filtration was briefly traced, mention being made of Simpson, Frankland and Hyatt's work in perfecting the general process.

Discussion of proper sand and grading took place and Mr. Hurst emphasized the value of the "effective size and uniformity coefficient" in selecting a proper filtering medium. The effective size averaged about 0.45 mm. but lately sands having a size of 0.5 and 0.6 were becoming common. The uniformity coefficient should run from 1.5 to 1.7.

The paper closed with discussion of softening and filter loadings.

At the conclusion of the address the meeting was thrown open for discussion and a lengthy one followed, during which Mr. A. Blackie, F.I.C., city chemist, gave a short discussion on the chemical requirements of pure water and recognized water standards.

A hearty vote of thanks was proposed to the speaker which was unanimously carried.

On Thursday evening, December 21st, 1933, at the regular meeting of the Winnipeg Branch of The Engineering Institute of Canada, presided over by Professor G. H. Herriot, M.E.I.C., chairman, Mr. H. G. Beresford, D. and M.L.S., gave an address on the "Great Bear Lake Country."

### Great Bear Lake Country

Mr. Beresford, due to his experience in this country during the last two years, where he has been engaged in surveying various properties, is a highly qualified speaker.

This lecture was a joint meeting of the Winnipeg Branch of The Engineering Institute of Canada and the Winnipeg branch of the Canadian Institute of Mining and Metallurgy, and was illustrated by slides made from photographs taken by Mr. Beresford during his residence in the district.

The speaker pointed out that Great Bear lake, the largest lake within the Dominion and having an area of between 12,000 and 13,000 square miles, lies astride of the Arctic circle about 100 miles east of the Mackenzie river. It drains into the latter by the Bear river some 90 miles in length. It was at Echo bay on the east shore of this lake that in 1930 Gilbert LaBine made his wonderful discovery of pitchblende carrying high grade uranium and silver.

Great Bear lake is most easily reached by hydroplane except during freeze-up and break-up. The journey by air from the end of steel at Waterways, Alberta, is usually accomplished in about eight hours, though record trips of six and three-quarter and five and three-quarter hours have been made. Freight has to be shipped in by steamer and barge from Waterways to Fort Fitzgerald on the Slave river, thence across a 16-mile portage to Fort Smith, thence by steamer, gasboat and barge to Fort Norman at the confluence of the Bear and Mackenzie rivers.

Fuel is getting scarce, but deposits of coal have been found on both the western and southern shores of Great Bear lake, and these will be developed in the very near future.

Power at the operating mines is developed from Diesel type engines using fuel oil from the wells at Fort Norman some 300 miles away. The climate is arctic from October to May; the summer is short, though warm and pleasant. Continual daylight occurs from June till August and conversely there are only about three hours of daylight in December and January.

Prospecting is rather difficult as the occurrences of mineralized zones or lodes are hard to find. Nevertheless, numerous discoveries of considerable importance have recently been made and some of them are being developed.

The Dominion government is trying to assist transportation by the construction of a portage around the rapids on the Bear river and it is confidently expected that 1934 will see both reduced freight rates and easier access by the Mackenzie river route.

A very active discussion took place at the end of the meeting, and Mr. Beresford was congratulated on his very interesting address.

# Preliminary Notice

## of Applications for Admission and for Transfer

January 23rd, 1934

The By-laws provide that the Council of The Institute shall approve, classify and elect candidates to membership and transfer from one grade of membership to a higher.

It is also provided that there shall be issued to all corporate members a list of the new applicants for admission and for transfer, containing a concise statement of the record of each applicant and the names of his references.

In order that the Council may determine justly the eligibility of each candidate, every member is asked to read carefully the list submitted herewith and to report promptly to the Secretary any facts which may affect the classification and selection of any of the candidates. In cases where the professional career of an applicant is known to any member, such member is specially invited to make a definite recommendation as to the proper classification of the candidate.*

If to your knowledge facts exist which are derogatory to the personal reputation of any applicant, they should be promptly communicated.

**Communications relating to applicants are considered by the Council as strictly confidential.**

The Council will consider the applications herein described in March, 1934.

R. J. Durley, Secretary.

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* The professional requirements are as follows—

**A Member** shall be at least thirty-five years of age, and shall have been engaged in some branch of engineering for at least twelve years, which period may include apprenticeship or pupilage in a qualified engineer's office, or a term of instruction in a school of engineering recognized by the Council. The term of twelve years may, at the discretion of the Council, be reduced to ten years in the case of a candidate for election who has graduated from a school of engineering recognized by the Council. In every case the candidate shall have held a position in which he had responsible charge for at least five years as an engineer qualified to design, direct or report on engineering projects. The occupancy of a chair as a professor in a faculty of applied science of engineering, after the candidate has attained the age of thirty years, shall be considered as responsible charge.

**An Associate Member** shall be at least twenty-seven years of age, and shall have been engaged in some branch of engineering for at least six years, which period may include apprenticeship or pupilage in a qualified engineer's office or a term of instruction in a school of engineering recognized by the Council. In every case a candidate for election shall have held a position of professional responsibility, in charge of work as principal or assistant, for at least two years. The occupancy of a chair as an assistant professor or associate professor in a faculty of applied science of engineering, after the candidate has attained the age of twenty-seven years, shall be considered as professional responsibility.

Every candidate who has not graduated from a school of engineering recognized by the Council shall be required to pass an examination before a board of examiners appointed by the Council. The candidate shall be examined on the theory and practice of engineering, with special reference to the branch of engineering in which he has been engaged, as set forth in Schedule C of the Rules and Regulations relating to Examinations for Admission. He must also pass the examinations specified in Sections 9 and 10, if not already passed, or else present evidence satisfactory to the examiners that he has attained an equivalent standard. Any or all of these examinations may be waived at the discretion of the Council if the candidate has held a position of professional responsibility for five or more years.

**A Junior** shall be at least twenty-one years of age, and shall have been engaged in some branch of engineering for at least four years. This period may be reduced to one year at the discretion of the Council if the candidate for election has graduated from a school of engineering recognized by the Council. He shall not remain in the class of Junior after he has attained the age of thirty-three years, unless in the opinion of Council special circumstances warrant the extension of this age limit.

Every candidate who has not graduated from a school of engineering recognized by the Council, or has not passed the examinations of the third year in such a course, shall be required to pass an examination in engineering science as set forth in Schedule B of the Rules and Regulations relating to Examinations for Admission. He must also pass the examinations specified in Section 10, if not already passed, or else present evidence satisfactory to the examiners that he has attained an equivalent standard.

**A Student** shall be at least seventeen years of age, and shall present a certificate of having passed an examination equivalent to the final examination of a high school, or the matriculation of an arts or science course in a school of engineering recognized by the Council.

He shall either be pursuing a course of instruction in a school of engineering recognized by the Council, in which case he shall not remain in the class of Student for more than two years after graduation; or he shall be receiving a practical training in the profession, in which case he shall pass an examination in such of the subjects set forth in Schedule A of the Rules and Regulations relating to Examinations for Admission as were not included in the high school or matriculation examination which he has already passed; he shall not remain in the class of Student after he has attained the age of twenty-seven years, unless in the opinion of Council special circumstances warrant the extension of this age limit.

**An Affiliate** shall be one who is not an engineer by profession but whose pursuits, scientific attainments or practical experience qualify him to co-operate with engineers in the advancement of professional knowledge.

**The fact that candidates give the names of certain members as reference does not necessarily mean that their applications are endorsed by such members.**

### FOR ADMISSION

AUSTIN—FRANK DOUGLAS, of 1510 Bathurst St., Toronto, Ont., Born at Brockville, Ont., Sept. 14th, 1890; Educ., B.A.Sc., Univ. of Toronto, 1915; 1925-30, Michigan Land Surveyor; 1910-13 (summers), drainage work, surveying and estimating topog'r.; 1914-19, overseas service, Signal Despatch Rider; 1919-24, asst. engr. with the following: Town of Sault Ste Marie, Algoma Steel Corpn., Dept. Rlys. and Canals, Durant Motors, Leaside; 1924-26, chief of party, surveying and mapping, chief right of way, for R. L. Kerr, Mich.L.S., Vernor, Wilhelm, & Molby; 1926-28, dftsman., Macomb Co. Rd. Commn.; 1928-29, asst. engr., C.N.R. Elec. Rlys., Toronto; 1929-32, computer, C.N.R., Valuation Dept., Toronto; 1932 (Oct.-Dec.), asst. valuation engr., General Steel Wares, Toronto. Not employed at present.

References: A. B. Crealock, R. E. Smythe, A. D. LePan.

BENETT—CHARLES MORGAN, of 22 Chesterfield Ave., Westmount, Que., Born at White Stone, Long Island, N.Y., Nov. 18th, 1894; Educ., B.Sc., McGill Univ., 1923; 1923-26, asst. in cable engrg. lab., Northern Electric Co., Montreal; 1926-27, i/c of dielectric development and tests of materials for a new type of paper power cable; 1927-30, research engr., wire and cable mill, American Steel and Wire Co., Worcester, Mass.; 1930-33, engr. i/c of process control of wire and cable; 1933 to date, inspr. of elect'l equipment, Charles Warnock & Co.; Montreal.

References: W. H. Eastlake, N. L. Morgan, J. M. R. Fairbairn, J. F. Plow, J. M. Fairbairn.

COLLITT—BERNARD, of 1170 Dorchester St. West, Montreal, Que., Born at Lincoln, England, August 31st, 1879; Educ., Municipal Technical College, Sheffield, England, 1900-03; Fellow, Inst. of Chemistry (Great Britain); 1903-04, asst. foundry chemist, Ludwig, Loewe & Co., Berlin, Germany; 1904-09, metallurgist and chemist, in full charge of mech'l. testing and chem'l. labs., Marshalls, Sons & Co. Ltd., Gainsboro, England; 1912-22, metallurgist and chief chemist, Ruston & Hornsby Ltd., Lincoln, England. In full charge of metallographic, mech'l. testing and chem'l. labs., also of two heat treatment depts., built and equipped during the war for treatment of aero engine parts and other parts of munitions of war. Carried through long research on strength and structure of large crank shaft forgings. Have made a special study for many years of the examination of steel and alloys by macro-etching methods; at present, metallurgist, Jenkins Bros., Ltd., Montreal.

References: A. Stansfield, H. J. Roast, A. Laurie, H. W. B. Swabey, C. E. Herd, H. C. Lott.

DEMPSEY—WESTLEY THOMAS, of Dundurn Camp, Dundurn, Sask., Born at Griswold, Man., Sept. 23rd, 1903; Educ., Univ. of Sask., 1923-28; 1925, (summer), rodman, and 1926 (summer), instr'man., Geol. Survey of Canada; 1927 (summer), instr'man. on sewer and pavement constrn., City of Regina; 1928 (summer), instr'man. on concrete sidewalk constrn., City of Saskatoon; 1928-33, sewerage engr., directly in charge, under the city engr., of design and constrn. of sewers and operation of the Regina sewage treatment plant, City of Regina; May 1933 to date, sub-foreman on design of water supply and sewerage facilities for permanent military camp at camp Dundurn, Sask., for Dept. of National Defence.

References: D. A. R. McCannel, J. J. White, R. H. Murray, R. W. Allen.

DUPUIS—PHILIPPE AUGUSTE, of Quebec, Que., Born at St. Roch des Aulnaies, Que., April 6th, 1896; Educ., B.A.Sc., C.E., Ecole Polytechnique, Montreal. Member, Corpn. Prof. Engrs., Quebec; 1921-29, civil engr., Dept. Public Works; 1925-34, consltg. engr., for the Maple Sugar Producers Assn.; 1929 to date, senior engr., Dept. of Public Works, Quebec.

References: I. E. Vallee, O. Desjardins, A. B. Normandin, J. Joyal.

DYER—WALTER GERALD, of Regina, Sask., Born at Balcarres, Sask., July 19th, 1899; Educ., B.Sc. (Civil), Univ. of Sask., 1925; 1923-24 (summers), rodman, C.P.R.; With C.P.R. as follows: 1924-25, bldg. inspr. on re-inforced concrete culverts; 1926-27, bldg. inspr. on new bldgs.; 1927 to date, transitman, mtce. and constrn., and part time bldg. inspr., frame and concrete work. 1931-33 (eleven weeks), relieved divn. engr. during vaction periods.

References: C. J. Mackenzie, J. M. Campbell, D. A. R. McCannel, P. C. Perry, J. J. White.

GOHIER—JOSEPH ARTHUR ERNEST, of Outremont, Que., Born at St. Laurent, Que., Feb. 28th, 1888; Educ., B.Sc., McGill Univ., 1913. Q.L.S.; 1913-16, associated with F. C. Laberge, M.E.I.C., consltg. engr., Montreal; 1914 to date, consultant as follows: 1914-33, water works and drainage system, Town of St. Laurent; 1923-33, drainage system of Town of St. Pierre; 1923-24, water works, l'Abord a Plouffe; 1929-30, water works, Calumet, Laval sur le Lac; 1916-30, water works, Delson and Masson; 1920-32, sewage system for Masson, Mont Rolland and Chambly; 1923-29, filtration plants for St. Jerome and Laval sur le Lac; 1933-34, concrete sheds for harbours of Chicoutimi and Three Rivers; at present, consultant for Three Rivers and Chicoutimi Harbours, towns of St. Laurent, St. Pierre, Chambly, Delson, St. Remi, Masson, Calumet, St. Jerome, Mont Rolland, l'Abord a Plouffe, Laval sur le Lac, and the Metropolitan Commission.

References: O. O. Lefebvre, A. Surveyer, deG. Beaubien, J. E. Blanchard, T. J. Lafreniere, G. R. MacLeod, A. H. Pattenden, P. A. Beique.

LEE—LEONARD ALLDWYN COLE, of Toronto, Ont., Born at Toronto, August 8th, 1892; Educ., B.A.Sc., Univ. of Toronto, 1916; 1911 (5 mos), survey work, Milk River District; 1912-13 (5 mos each), estimator, works dept., Toronto; 1914 (3 mos.), engr. on road constrn. for Ontario Govt.; 1915 (5 mos.), physical tests and reports, Massey Harris Company lab.; 1916-19, overseas, Can. Engrs., Brigade Signal Officer; 1919 (3 mos.), asst. divnl. traffic engr., Bell Telephone Company; 1919-20 (15 mos.), demonstrator in dfting., D.S.C.R.; 1920 (6 mos.), working drawings and design, Truscon Steel Co. of Canada; 1920-24, engr., checking plans, city arch. dept , Toronto; 1924 to date, chief concrete engr., bldg. dept., City Hall, Toronto, Ont.

References: C. R. Young, J. M. Oxley, A. H. Harkness, A. R. Robertson, E. P. Muntz, A. B. Crealock, C. S. L. Hertzberg, R. B. Young, G. L. Wallace, P. M. Thompson, H. A. Babcock, C. J. Madgett, W. W. Gunn, C. A. Scott.

MOXON—GEORGE BURNHAM, of 359 Victoria Ave., Westmount, Que., Born at St. Helens, Lancs., England, May 26th, 1889; Educ., Royal School of Infantry, Aldershot, Halifax, Capt.; 1906-10, articled pupil, County Borough Engr. and Surveyor of St. Helens; Assoc. Member, Inst. C.E., 1921; Reg'd. Prof. Engr. Prov. of Quebec 1911, asst. civil engr. and surveyor, St. Helens and Liverpool City Hall; 1912-14, asst. civil and mech. engr., C.P.R. Angus shops and Dominion Bridge Co. Ltd.; 1916, asst. mech. engr., Imperial Munitions Board, Trenton, Ont.; 1917-19, overseas service, Flying Corps; 1919-21, promotion of civilian flying in England; 1921-25, flying instructor, Spanish Royal Naval Air Service; 1925-32, bridge and mechl. dept., Dominion Bridge Co. Ltd.; 1933, mech. engr., A. Janin & Company Ltd., Montreal, Que.

References: D. C. Tennant, A. Peden, F. H. McHugh, P. G. A. Brault, D. J. Lewis.

McARA—PETER GRAHAM, of 12 Braemer Apts., Regina, Sask., Born at Regina, Aug. 18th, 1902; Educ., B.Sc. (Mech), Univ. of Sask., 1930; Summers: 1920-21, bridge constrn. work, Sask. Prov. Govt. and C.P.R.; 1924, pole line work, Sask. Dept. of Telephones; 1925-28, Regina Water Works Dept., and from 1929 to date, asst. supt., Regina Water Works Dept., Regina, Sask.

References: H. S. Carpenter, J. J. White, H. N. Macpherson, D. A. R. McCannel, J. W. D. Farrell.

McDERMID—GEORGE, of 19 Florence Apts., Winnipeg, Man., Born at Indian Head, Sask., May 18th, 1900; Educ., B.Sc. (E.E.), Univ. of Man., 1927; 1925 (summer), instr'man; 1926 (summer), Royal Signal Corps; 1927-28, sales engr., Western Steel Products; 1928-31, junior engr., electric utility, and 1931 to date, junior engr., way and structure dept., Winnipeg Electric Co., 1930-31, in charge of appraisal of electrical equipment of substations, and 1931 to date, in charge of office of way and structure dept.

References: E. V. Caton, E. P. Fetherstonhaugh, J. N. Finlayson, N. M. Hall, A. E. Macdonald.

McLEOD—SIMON FRASER, of Lethbridge, Alta., Born at Westville, N.S., Oct. 5th, 1889; Educ., Home study. 1st Class Engr's. Cert., Alberta, 1st Class Engr's. Cert., Saskatchewan, 1922; 1904-07, surveying and dfting office, Crows Nest Pass Coal and Coke Co., Michel, B.C.; 1908-09, machine shops, Can. Pac. Mines, Hosmer, B.C.; 1909-23, machine shops, boiler, and power plant, International Coal and Coke Co., Coleman, Alta., West Canadian Collieries, Blairmore, Alta.; 1924-28, master mechanic and chief engr., McLeod River Coal Co., Mercoal, Alta., including design and constrn. of plant; 1928 to date, inspr. of boilers and machinery, Government of Alberta, Lethbridge, Alta.

References: J. T. Watson, J. B. deHart, P. M. Sauder, C. S. Donaldson, R. Livingstone, C. E. Garnett, A. Cox.

### FOR TRANSFER FROM THE CLASS OF JUNIOR

COULTER—HUGH JOHN, of 46 Elmhurst Ave., Detroit, Mich., Born at Windsor, Ont., Feb. 15th, 1900; Educ., B.A.Sc., Univ. of Toronto, 1923; 1921 (summer), dfting and surveying, City of Windsor; With the Detroit City Gas Co., as follows: 1923-27, chem. analyses; routine tests; experimental work on water gas sets, liquid purification and misc. equipment; boiler tests; prep. of mfg. data and cost reports; 1927-32, misc. testing and supervn. on starting up new plants; one year i/c of W.G. plant at Stn. "A"; relief supt. at pumping stations; three years on shift supervn. at River Rouger plant; 1932 to date, supervn. of meter testing and repairs. (*S. 1921, Jr. 1925.*)

References: A. J. M. Bowman, O. Rolfson, J. C. Keith, T. H. Jenkins, H. J. A. Chambers, R. C. Leslie, A. E. West.

GOBY—THOMAS, of 923 East Hunter St., Bloomington, Indiana, Born at London, England, Aug. 13th, 1899; Educ., B.Sc. in C.E., Tri-State Engrg. College, Angola, Indiana, 1925; 1919-20, chainman, rodman, 1920-22, concrete inspn., C.N.R.; 1924-28 (except 5 mos.), project engr. and senior bridge engr., Indiana State Highway; 1928 to date, sales engr., W. Q. O'Neall Company (Amrco Culvert Man. Association), Crawfordsville, Indiana. (*S. 1921, Jr. 1931.*)

References: C. H. N. Connell, W. H. B. Bevan, W. A. Ewing, C. B. R. MacDonald, S. S. McIlwain.

GRAY-DONALD, ERCELDOUNE DONALD, of Quebec, Que., Born at Amoy, China, Dec. 29th, 1900; Educ., B.Sc. (E.E.), McGill Univ., 1926; 1919-21, clerk of works, Govt. of Palestine; 1922 (summer), timekpr. and misc., Lockwood Greene & Co.; 1923-24 and Summer 1925, student, Toronto Hydro-Electric System; 1926-27, apprentice, Shawinigan Water and Power Co.; With Quebec Power Company as follows: 1927-28, asst. engr. on design, mtce., constrn. and operation of hydro-electric power plants, transmission lines, substations and distribution lines; 1928-30, asst. supt., power divn., asst. in charge of above works; 1930 to date, supt., power div., in responsible charge of all work mentioned above. (*S. 1922, Jr. 1926.*)

References: R. B. McDunnough, H. W. B. Swabey, C. V. Christie, A. R. Decary, G. H. Cartwright.

KERRY—ARMINE JOHN, of Quebec, Que., Born at Montreal, Que., Aug. 6th, 1905; Educ., Grad. R.M.C., 1927. B.Sc. (civil), McGill Univ., 1929; 1924-25 (summers), with Canadian Paperboard Co.; 1927-28, Regimental Duty, Halifax, N.S.; 1929-31, School of Military Engrg. and Regimental Duty in England; 1931, Works Officer, Mil. Dist. No. 5, Quebec; 1931, acting as D.E.O., M.D. No. 5, and from 1932 to date, Works Officer, M.D. No. 5, Quebec, Que. (*Jr. 1931.*)

References: J. G. G. Kerry, J. H. L. Bogart, G. R. Chetwynd, J. Weir, R. DeL. French, J. B. P. Dunbar, A. G. Ashford, E. J. C. Schmidlin.

NAISH—SIDNEY GORDON, of Sydney, N.S., Born at Halifax, N.S., Aug. 21st, 1900; Educ., B.Sc., Durham, Univ., 1923; Premium pupil with Sir W. G. Armstrong Whitworth & Co. Ltd., Newcastle-on-Tyne, England. 1919-20, practical work at Walker shipyard of above co., and 1921-24, at Elswick works; 1924-26, asst. production engr., for same company; 1926-29, asst. plant engr., designing, directing and reporting on installn. of telephone plant equipment, Bell Telephone Co. of Canada, Montreal; 1930, practical work at Cleveland Worm & Gear Co. Ltd., Cleveland, Ohio; 1931 to date, eastern district manager, Peacock Bros. Ltd., making recommendations for coal mine mechanization projects, and layouts of power plant equipment. Also in charge of installn. and servicing of above equipment in N.S. and N.B. (*Jr. 1927.*)

References: K. H. Marsh, T. L. McCall, W. H. Slinn, W. S. Wilson, T. E. Naish, A. M. Mackenzie, F. T. Peacock, S. C. Mifflen.

RAPLEY—BLAKE PARKER, of Sarnia, Ont., Born at Strathroy, Ont., Nov. 12th, 1899; Educ., B.Sc., Queen's Univ., 1923; 1923 (summer), mechanic, Canadian Carborundum Co., Shawinigan Falls, Que.; 1923-24, dftsman, 1923-25, checking materials, 1925-26, asst. storekpr. i/c mill stores, Nfld. Power and Paper Co.; 1926-31, dftsman, Imperial Oil Refineries, Limited; and from Aug. 1931 to date, asst. mech'l. supt., with same company at Sarnia, Ont. (*S. 1922, Jr. 1927*)

References: R. L. Weldon, T. Montgomery, G. Noble, D. A. Evans, L. M. Arkley, L. T. Rutledge.

SAMPSON—CYRUS DEXTER, of Westville, N.S., Born at Halifax, N.S., Jan. 1st, 1897; Educ., 1919-20, Acadia Univ.; 1918, Khaki Univ., Epsom, England; 1919, private tutor; 1919 (Feb.-May), course in surveying, N.S.T.C.; 1920-23, home study, civil engrg.; 1924-32, home study, mining engrg.; 1914-19, overseas, C.E.F. (3 Decorations); 1919 (May-Sept.), instr'man., etc., P. H. Board, N.S.; 1920-22, dftsman., instr'man and asst. engr., P. H. Board, N.S.; 1923 (Feb.-Apr.), dftsman., engrg. dept., 1923-25, surveyor and dftsman., mining engrg. dept., Dominion Coal Company, Glace Bay, N.S.; 1925 to date, International Coal Co. Ltd., Westville, N.S., engr. in charge of all work of engrg. nature including surveys, dfting, design, estimating, gas analysis, tunnelling, system of mining, etc. (Provincial Land Surveyor of N.S. by examination.) (*Jr 1923.*)

References: A. L. Hay, S. C. Mifflen, T. L. McCall, J. R. Morrison.

SPOTTON—JOHN GREER, of Guelph, Ont., Born at Harriston, Ont., Feb. 24th, 1900; Educ., B.A.Sc., Univ. of Toronto, 1922; 1918, machine shop, Harriston Furniture Co. Ltd., Harriston; 1919 (5 mos.), machine shop, Gilson Mfg. Co., Guelph, Ont.; 1920 (5 mos.), transformer dept., Canadian Westinghouse Co., Hamilton, Ont.; 1921 (5 mos.), station mtce., H.E.P.C. of Ontario; 1922-31, owner and manager, Spotton Engineering Company, Guelph, Ont. Sales representation, responsibility for service and repair for a number of radio and elect'l. mfgrs. for a territory in central Ontario. Also a number of special radio and sound equipment installations, and special refrigeration installns.; 1932, managing a factory in Guelph for Guelph Excelsior Products, manufacturing from pulpwood-excelsior, excelsior, pads and wrappers, etc.; Jan. 1933 to date, sales engr., Delaney & Pettit Ltd., Toronto and Montreal; (Involves industrial glue, machine labelling and fabric and paper sizing). (*S. 1920, Jr. 1924.*)

References: H. S. Nicklin, A. H. Heatley, J. F. Plow, L. E. Jones.

### FOR TRANSFER FROM THE CLASS OF STUDENT

CLIMO—PERCY LLOYD, of Cobourg, Ont., Born at Cobourg, Ont., Oct. 17th, 1906; Educ., B.Sc., Queen's Univ., 1932; 1928-29 (summers), special ap'tice, machine shop practice, John Bertram & Sons Co. Ltd., Dundas, Ont.; 1930 (summer), surveying and airport constrn., R.C.A.F. Training Station; 1932 (summer), field engr. and timekpr., bldg. constrn., Gardner Constrn. Co., Welland; 1933, occasional employment supervising sewer constrn., Town of Cobourg. (*S. 1928.*)

References: L. M. Arkley, L. T. Rutledge, D. S. Ellis, H. G. Bertram, W. D. Bracken.

KENT—GEORGE EDWARD, of Sarnia, Ont., Born at Truro, N.S., Sept. 25th, 1905; Educ., B.Sc. (Mech.), N.S.T.C., 1928; 1926 (summer), student with Canadian Ingersoll Rand Co., Sherbrooke, Que.; 1927 (summer), compressor operator, Maritime Tel. and Tel. Co., Halifax, N.S.; 1928-29, engr. dial system divn. of gen. traffic dept., Bell Telephone Co. of Canada; With Imperial Oil Refineries Limited, Sarnia, Ont., as follows: 1929-30, engr., dfting dept., on design of oil refinery equipment; 1930-32, asst. mech'l. supt., and from July 1932 to date, asst. to refinery supt. at plant No. 2, assisting in the operation of plant 2 refinery and looking after all repairs. (*S. 1926.*)

References: T. Montgomery, C. B. Leaver, J. W. MacDonald, W. A. Winfield, W. P. Copp, F. R. Faulkner.

LAING—ADDISON KERR, of Ottawa, Ont., Born at Hamilton, Ont., Feb. 20th, 1905; Educ., B.Sc. (Civil), McGill Univ., 1930; Summers: 1927, i/c car loading, Canada Crushed Stone Corpn., Hagersville, Ont.; 1928, computer and asst. instr'man., topog'l. survey, Dept. of Mines, Ottawa; 1929, gen. dfting., Dominion Bridge Co., Lachine; 1930 to date, hydrographer, Grade I, Can. Hydrographic Service, Dept. of Marine, Ottawa. (*S. 1926.*)

References: F. Anderson, H. W. Jones, M. A. MacKinnon, C. A. Price, J. V. Butterworth, R. DeL. French, W. Hollingworth.

NICKERSON—ALLAN DOUGLAS, of Halifax, N.S., Born at Shag Harbour, N.S., Sept. 13th, 1906; Educ., B.Sc., (E.E.), N.S.T.C., 1929; 1928 (summer), rodman, survey party, N.S. Power Commn.; 1929-31, asst. engr. (equipment and transmission), and 1931 to date, transmission engr. (under supervision of equipment engr.), responsible for layout and specifications for both toll and local telephone plant, also for inductive relations work, including co-ordinated design of signal and supply systems, Maritime Telegraph and Telephone Co. Ltd., Halifax, N.S. (*S. 1929.*)

References: W. A. Winfield, F. R. Faulkner, C. M. Crooks, F. A. Bowman, H. Fellows.

WEIR—RONALD ALBERT STANLEY, of 4868 Cote des Neiges Road, Montreal, Que., Born at Montreal, Aug. 2nd, 1901; Educ., 1924-25, Fac. of App. Sci., McGill Univ., completing 1st and 2nd years; Automotive Course at Montreal Technical School; 1929, six weeks instruction in aerial mapping at Ottawa; 1921 (summer), gen. bldg. constrn., Newport, Vt.; 1922 (summer), timekpr. and subforeman on road constrn., for St. George Constrn. Co.; 1923-24 (summers), care and operation of marine engine and yacht; 1925-26, with Duke-Price Power Company, Lake St. John, 6 mos. gen. electl. installn. work in power house; switchboard; station auxiliary; lighting, etc.; also 6 mos. on transmission line, Isle Maligne-Port Alfred; 1926-32, with the Shawinigan Water and Power Company and subsidiary companies, in field engrg. dept., prelim. investigations and final surveys of rivers; storage reservoirs; power house and dam sites; railways, highways; transmission lines; telephone lines; estimates and constrn., organization and management of field parties; 1930-32, in charge of all aerial mapping work for Shawinigan companies; at present, asst. industrial lubricating engr., Imperial Oil Limited, Montreal, Que. (*S. 1924.*)

References: C. R. Lindsey, S. Svenningson, J. A. McCrory, A. S. Runciman.

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## A.S.T.M. Tentative Standards

The book of A.S.T.M. Standards issued annually has just been received for 1933. This contains two hundred and twenty-three standards which are issued by the Society for trial before final adoption. These are classified under the head of: A—Ferrous Metals, B—Non-Ferrous Metals, C—Cement, Lime, Gypsum, Refractories, Concrete and Masonry Materials, D—Miscellaneous Materials, E—General Testing Methods.

This book is available to other than members of the Society at a cost of $7.00, in paper binding, or $8.00 in cloth. Individual tentative standards are available separately.

## Annual Meeting, Association of Professional Engineers of the Province of B.C.

At the annual meeting of the Association of Professional Engineers of the Province of British Columbia, held recently in Vancouver, the retiring President, Mr. J. D. Galloway, Provincial Mineralogist, in his address drew attention to the satisfactory progress which the Association had been able to make in spite of a year of uncertainty and depression. Although unemployment at the present time exists in nearly all branches of the profession in British Columbia, the mining engineers had been the least affected; and the Association's propaganda and educational activities had been carried on under these adverse conditions with comparatively little interruption. The speaker drew attention to the benefits arising from the Dominion Government Relief Camps for single unemployed men, and the efficient manner in which the Vancouver Engineers Relief Committee had raised and distributed a fund for unemployed professional engineers.

The following officers were elected for 1934: President, A. S. Gentles, M.E.I.C.; Vice-President, G. S. Eldridge; Councillors, Sidney Anderson, C. V. Brennan, L. A. Campbell and H. F. G. Letson.

At the annual dinner the principal speaker was the Hon. George S. Pearson, Minister of Mines and Labour, who stated that the fundamental policy of the provincial government was based on the need of more employment and a fairer spread of the employment available. It was proposed to investigate possible means for the stimulation of industry in the province, and take action accordingly.

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The Topographical and Air Survey Bureau of the Department of the Interior, Ottawa, has issued a new topographical map of the Sudbury district. The map has a scale of 2 miles to one inch, and shows an area of about 1,650 square miles, including Sudbury, Copper-Cliff, Coniston, Capreol, Chelmsford and Cartier. Copies may be obtained at the nominal price of twenty-five cents.

# EMPLOYMENT SERVICE BUREAU

The Service is operated for the benefit of members of The Engineering Institute of Canada, and for industrial and other organizations employing technically trained men—without charge to either party.

*All correspondence should be addressed to*

**The Employment Service Bureau, The Engineering Institute of Canada**
**2050 Mansfield Street, Montreal**

## Situations Wanted

ELECTRICAL ENGINEER. Age 33. Canadian University graduate. Ten years experience in design and construction of power and substations network calculations-illumination design and industrial layouts. Seven years as design engineer. Available for position at home or abroad. Apply to Box No. 7-W.

ELECTRICAL AND RADIO ENGINEER, B.Sc., '28. Experience in the design and testing of broadcast radio receivers, including latest superheterodyne practice, and capable of constructing apparatus for testing same. Also familiar with telephone and telephone repeater engineering. Thorough experience in design, and construction and inspection of municipal power conduits. Apply to Box No. 12-W.

MECHANICAL ENGINEER, Canadian, with technical training and executive experience in both Canadian and American industries, particularly plant layout, equipment, planning and production control methods, is open for employment with company desirous of improving manufacturing methods, lowering costs and preparing for business expansion. Apply to Box No. 35-W.

MECHANICAL ENGINEER, A.M.E.I.C. Married. Experience in machine shops, erection and maintenance of industrial plant mechanical and structural design. Reads German, French, Dutch and Spanish. Seeks any suitable position. Apply to Box No. 84-W.

YOUNG ENGINEER, B.A., B.Sc., A.M.E.I.C., R.P.E., Ont. Competent draughtsman and surveyor. Eight years experience including design, superintendence and layout of pulp and paper mills, hydro-electric projects and general construction. Limited experience in mechanical design and industrial plant maintenance. Apply to Box No. 150-W.

PURCHASING ENGINEER, graduate mechanical engineer, Canadian, married, 34 years of age, with 13 years' experience in the industrial field, including design, construction and operation, 8 years of which had to do with the development of specifications and ordering of equipment and materials for plant extensions and maintenance; one year engaged on sale of surplus construction equipment. Full details upon request. Apply to Box No. 161-W.

CIVIL ENGINEER, age 44, open for employment anywhere, experience covers about 20 years' active work, including 7 years on municipal engineering, 2 years as Town Manager, 3 years on railway construction, 3 years on the staff of a provincial highway department, 2 years as contractor's superintendent on pavement construction. Apply to Box No. 216-W.

REINFORCED CONCRETE ENGINEER, B.Sc., P.E.Q., eight years experience in construction design of industrial buildings, office buildings, apartment houses, etc. Age 30. Married. Apply to Box No. 257-W.

MECHANICAL ENGINEER, B.Sc., McGill '19, A.M.E.I.C. Married. Twelve years experience including oil refinery power plant, structural and reinforced concrete design, factory maintenance, steam generation and distribution problems, heating and ventilating. Available at once. Location immaterial. Apply to Box No. 265-W.

ELECTRICAL ENGINEER, B.Sc., '28, Canadian. Age 25. Experience includes two summers with power company; thirteen months test course with C.G.E. Co.; telephone engineering, and the past thirty months with a large power company in operation and maintenance engineering. Location immaterial and available immediately. Apply to Box No. 266-W.

MECHANICAL ENGINEER, age 28, nine years all round experience, Grad. Inst. of Mech. Engs. England, S.E.I.C. Technical and practical training with first class English firm of general engineers; shop, foundry and drawing office experience in steam and Diesel engines, asphalt, concrete machinery, boilers, power plants, road rollers, etc. Experience in heating and ventilation design and equipment; 18 months designing draughtsman with Montreal consulting engineers. 2½ years sales experience, steam and hot water heating systems, power plant equipment, machinery, oil-burning apparatus. Canadian 4th class Marine Engineers Certificate; C.N.S. experience. Available at short notice. Apply to Box No. 270-W.

DESIGNING DRAUGHTSMAN, experience in layout of steam power house equipment and piping. Wide experience in mechanical drive and details of machinery, gearing, and hoists. Accustomed to layout of small mill buildings of steel and timber, structural design and details. Good references. Present location Montreal. Apply to Box No. 329-W.

PLANE-TABLE TOPOGRAPHER, B.Sc., in C.E. Thoroughly experienced in modern field mapping methods including ground control for aerial surveys. Fast and efficient in surveys for construction, hydro-electric and geological investigations. Apply to Box No. 431-W.

ELECTRICAL ENGINEER, B.Sc., A.M.E.I.C., AM.A.I.E.E., age 30, single. Eight years experience H.E. and steam power plants, substations, etc., shop layouts, steel and concrete design. Location immaterial. Available immediately. Apply to Box No. 435-W.

## Situations Wanted

CIVIL ENGINEER, B.A.Sc., and C.E., A.M.E.I.C., age 30, married. Experience over the last ten years covers construction on hydro-electric and railway work as instrumentman and resident engineer. Also office work on teaching and design, investigations and hydraulic works, reinforced concrete, bridge foundations and caissons. Location immaterial. Available at once. Apply to Box No. 447-W.

SALES ENGINEER, M.A.Sc. Univ. of Toronto, wishes to represent firm selling building products or other engineering commodities, as their representative in Western Canada. Located in Winnipeg. Apply to Box No. 467-W.

CIVIL ENGINEER, B.Sc., A.M.E.I.C., with six years experience in paper mill and hydro-electric work, desires position in western Canada. Capable of handling reinforced concrete and steel design, paper mill equipment and piping layout, estimates, field surveys, or acting as resident engineer on construction. Now on west coast and available at once. Apply to Box No. 482-W.

MECHANICAL ENGINEER, B.Sc. Age 28, married. Four and a half years on industrial plant maintenance and construction, including shop production work and pulp and paper mill control. Also two and a half years on structural steel and reinforced concrete design. Available at once. Apply to Box No. 521-W.

CIVIL ENGINEER, Canadian, married, twenty-five years' technical and executive experience, specialized knowledge of industrial housing problems and the administration of industrial towns, also town planning and municipal engineering, desires new connection. Available on reasonable notice. Personal interview sought. Apply to Box No. 544-W.

ELECTRICAL AND MECHANICAL ENGINEER, B.Sc., A.M.E.I.C. Experience includes C.G.E. Students Test Course and six years in engrg. dept. of same company on design of electrical equipment. Four summers as instrumentman on surveying and highway construction. Recently completed course in mechanical engineering. Available at once. Location preferred Ontario, Quebec, or Maritimes. Apply to Box No. 564-W.

CIVIL ENGINEER, age 25, single, graduate. Creditable record on responsible hydro and railroad work in both Eastern and Western Canada. Apply to Box No. 567-W.

MECHANICAL ENGINEER, A.M.E.I.C., with twenty years experience on mechanical and structural design, desires connection. Available at once. Apply to Box No. 571-W.

MECHANICAL ENGINEER, B.A.Sc., '30, desires position to gain experience, and which offers opportunity for advancement. Experience in pulp and paper mill and one year in mechanical department of large electrical company. Location immaterial. Available immediately Apply to Box No. 577-W.

DOMINION LAND SURVEYOR, and graduate engineer with extensive experience on legal, topographic and plane-table surveys and field and office use of aero-photographs, desires employment either in Canada or abroad. Available at once. Apply to Box No. 589-W.

MECHANICAL ENGINEER, Canadian, technically trained; eighteen years experience as foreman, superintendent and engineer in manufacturing, repair work of all kinds, maintenance and special machinery building. Location immaterial. Available at once. Apply to Box No. 601-W.

CHEMICAL ENGINEER, S.E.I.C., B.Sc., University of Alberta, '30. Age 31. Single. Six seasons' practical laboratory experience, three as chief chemist and three as assistant chemist in cement plant; one year's p.g. work in physical chemistry; three years' experience teaching. Desires position in any industry with chemical control. Available immediately. Apply to Box No. 609-W.

DESIGNING ENGINEER AND ESTIMATOR, grad. Univ. of Toronto in C.E., A.M.E.I.C., twenty years experience in structural steel, construction and municipal work. Available at once. Apply to Box No. 613-W.

CIVIL ENGINEER, A.M.E.I.C., R.P.E., Ontario; three years construction engineer on industrial plants; fourteen years in charge of construction of hydraulic power developments, tower lines, sub-stations, etc.; four years as executive in charge of construction and development of harbours, including railways, docks, warehouses, hydraulic dredging, land reclamation, etc. Apply to Box No. 647-W.

## Situations Wanted

MECHANICAL ENGINEER, A.M.E.I.C., Canadian, technically trained; six years drawing office. Office experience, including general design and plant layout. Also two years general shop work, including machine, pattern and foundry experience, desires position with industrial firm in capacity of production engineer or estimator. Available on short notice. Apply to Box No. 676-W.

ELECTRICAL AND CIVIL ENGINEER, B.Sc., Elec., '29, B.Sc., Civil '33. Age 27. Jr.E.I.C. Undergraduate experience in surveying and concrete foundations; also four months with Canadian General Electric Co. Thirty-three months in engineering office of a large electrical manufacturing company since graduation. Good experience in layouts, switching diagrams, specifications and pricing. Best of references. Available immediately. Apply to Box No. 693-W.

MECHANICAL ENGINEER, B.Sc., '27, Jr.E.I.C. Four years maintenance of high speed Diesel engines units, 200 to 1,300 h.p. Also maintenance of D.C. and A.C. electrical systems and machinery. Draughting experience. Westinghouse apprenticeship course. Practical mechanical and electrical engineer with a special study of high speed Diesel engine design, application and operation. Location in western or eastern Canada immaterial. Apply to Box No. 703-W.

COMBUSTION ENGINEER, R.P.E., Manitoba, A.M.E.I.C. Wide experience with all classes of fuels. Expert designer and draughtsman on modern steam power plants. Experienced in publicity work. Well known throughout the west. Location, Winnipeg or the west. Available at once. Apply to Box No. 713-W.

ELECTRICAL ENGINEER, B.Sc., University of N.B., '31. Experiences includes three months field work with Saint John Harbour Reconstruction. Apply to Box No. 722-W.

MECHANICAL ENGINEER, age 41, married. Eleven years designing experience with project of outstanding magnitude. Machinery layouts, checking, estimating and inspecting. Twelve years previous engineering, including draughting, machine shop and two years chemical laboratory. Highest references. Apply to Box No. 723-W.

CIVIL ENGINEER, B.Sc. (Alta. '31), S.E.I.C. Experience includes three seasons in charge of survey party. Transitman on railway maintenance, and concrete bridge designing Nature of work and location immaterial. Apply to Box No. 724-W.

YOUNG CIVIL ENGINEER, B.Sc. (Univ. of N.B. '31), with experience as rodman and checker on railroad construction, is open for a position. Apply to Box No. 728-W.

DESIGNING ENGINEER, M.Sc. (McGill Univ.), D.L.S., A.M.E.I.C., P.E.Q. Experience in design and construction of water power plants, transmission lines, field investigations of storage, hydraulic calculations and reports. Also paper mill construction, railways, highways, and in design and construction of bridges and buildings. Available at once. Apply to Box No. 729-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.Sc., Univ. of B.C. '30. Single, age 24. Sixteen months with the Allis-Chalmers Mfg. Co. as student engineer. Experience includes foundry production, erection and operation of steam turbines, erection of hydraulic machinery, and testing texropes and centrifugal pumps. Location immaterial. Available at once. Apply to Box No. 735-W.

CIVIL ENGINEER, M.Sc., A.M.E.I.C., R.P.E. (Ont.), ten years experience in municipal and highway engineering. Read, write and talk French. Married. Served in France. Will go anywhere at any time. Experienced journalist. Apply to Box No. 737-W.

ELECTRICAL AND RADIO ENGINEER, B.Sc. '31, S.E.I.C. Age 25. Nine months experience on installation of power and lighting equipment. Eight months on extensive survey layouts. Two summers installing telephone equipment. Specialized in radio servicing and merchandising. Available at once. Location immaterial. Apply to Box No. 740-W.

CIVIL ENGINEER, graduate '29. Married One year building construction, one year hydro-electric construction in South America, fourteen months resident engineer on road construction Working knowledge of Spanish. Apply to Box No. 744-W.

SALES ENGINEER, B.Sc., McGill, 1923, A.M.E.I.C. Age 33. Married. Extensive experience in building construction. Thoroughly familiar with steel building products; last five years in charge of structural and reinforcing steel sales for company in New York state. Available at once. Located in Canada. Apply to Box No. 749-W.

DESIGNING ENGINEER, graduate Univ. Toronto '26. Thoroughly experienced in the design of a broad range of structures. desires responsible position. Apply to Box No. 761-W

MECHANICAL ENGINEER, graduate, '23, A.M.E.I.C., P.E.Q., age 32, married. (English and French.) Two years shop, foundry and draughting experience; one year mechanical supt. on construction; six years designing draughtsman in consulting engineers' offices (mechanical equipment of buildings, heating, sanitation, ventilation, power plant equipment, etc.). Present location Montreal. Available immediately. Montreal or Toronto preferred. Apply to Box No. 766-W.

ELECTRICAL ENGINEER, B.Sc. (McGill Univ. '29), S.E.I.C. Married. Experience in pulp and paper mill mechanical maintenance, estimates and costs and machine shop practice. Desires position with industrial or manufacturing concern. Location immaterial. Available on short notice. References. Apply to Box No. 770-W.

## Situations Wanted

CIVIL ENGINEER, S.E.I.C., B.Sc. Queen's Univ '29. Age 25. Married. Three years experience as construction supt. and estimator for contracting firm. Experience includes general building, bridges, sewer work, concrete, boiler settings, sand blasting of bridges and spray painting. Available at once. Apply to Box No. 776-W.

CIVIL ENGINEER, B.Sc., '25, Jr.E.I.C., P.E.Q., married. Desires position, preferably with construction firm. Experience includes railway, monument and mill building construction. Available immediately. Apply to Box No. 780-W.

DRAUGHTSMAN, experience in civil engineering, forestry engineering, land surveying and house construction. Good references. Apply to Box No. 781-W.

ELECTRICAL AND SALES ENGINEER, S.E.I.C., grad. '28. Experience includes one year test course, one year switchboard design and two years switchboard and switching equipment sales with large electrical manufacturing company. Three summers Pilot Officer with R.C.A.F. Available at once. Apply to Box No. 788-W.

ELECTRICAL ENGINEER. Specializing in power and illumination reports, estimates, appraisals, contracts and rates, plans and specifications for buildings. Available on interesting terms. Apply to Box No. 795-W.

CIVIL ENGINEER, S.E.I.C., graduate '30, age 23, single. Experience includes mining surveys, assistant on highway location and construction, and assistant on large construction work. Steel and concrete layout and design. Apply to Box No. 809-W.

CIVIL ENGINEER, college graduate, age 27, single. Experience includes surveying, draughting concrete construction and design, street paving both asphalt and concrete. Available at once; will consider anything and go anywhere. Apply to Box No. 816-W.

CIVIL ENGINEER, B.E. (Sask. Univ. '32), S.E.I.C. Single. Experience in city street improvements; sewer and water extensions. Good draughtsman. References. Available at once. Location immaterial. Apply to Box No. 818-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. (Queen's '32), age 21. Three summers surveying in northern Quebec. Interested in hydraulics and reinforced concrete. Available at once. Location immaterial. Apply to Box No. 822-W.

CIVIL ENGINEER, B.Sc., A.M.E.I.C., with fifteen years experience mostly in pulp and paper mill work, reinforced concrete and structural steel design, field surveys, layout of mechanical equipment, piping. Available at once. Apply to Box No. 825-W.

ELECTRICAL ENGINEER, S.E.I.C., grad. '29, age 24, married; experience includes one year Students Test Course, sixteen months in distribution transformer design and eight months as assistant foreman in charge of industrial control and switchgear tests. Location immaterial. Available at once. Apply to Box No. 828-W.

CIVIL ENGINEER, B.A.Sc., D.L.S., O.L.S., A.M.E.I.C., age 46, married. Twelve years experience in charge of legal field surveys. Owns own surveying equipment. Eight years on technical, administrative, and editorial office work. Experienced in writing. Desires position on survey work, assisting in or in charge of preparation of house organ, on staff of technical or semi-technical magazine, or on publicity, editorial or administrative office work. Available at once. Will consider any salary, and any location. Apply to Box No. 831-W.

CIVIL ENGINEER, M.Sc., R.P.E. (Sask.). Age 27. Experience in location and drainage surveys, highways and paving, bridge design and construction city and municipal developments, power and telephone construction work. Available on short notice. Apply to Box No. 839-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. '32 (Univ. of N.B.). Age 25, married. Two years experience in power line construction and maintenance; one year of highway construction; one summer surveying for power plant site, location and spur railway line construction. Available at once. Location immaterial. Apply to Box No. 840-W.

CIVIL ENGINEER, B.Sc. '15, A.M.E.I.C., married, extensive experience in responsible position on railway construction, also highways, bridges and water supplies. Position desired as engineer or superintendent. Available at once. Apply to Box No. 841-W.

CIVIL ENGINEER, B.Sc. (Alta. '31), S.E.I.C., age 24. Experience, three summers on railroad maintenance, and seven months on highway location as instrumentman. Willing to do anything, anywhere, but would prefer connection with designing or construction firm on structural works. Available immediately. Apply to Box No. 846-W.

MECHANICAL ENGINEER, Jr.E.I.C., technical graduate, bilingual, age 30. Two years as designing heating draughtsman with one of the largest firms of its kind on this continent handling heating materials; three years designing draughtsman in consulting engineers' office, mechanical equipment of buildings, heating, ventilation, sanitation, power plant equipment, writing of specifications, etc. Present location Montreal. Available at once. Apply to Box Nn. 850-W.

BRIDGE AND STRUCTURAL ENGINEER, A.M.E.I.C., McGill. Twenty-five years' experience on bridge and structural staffs. Until recently employed. Familiar with all late designs, construction, and practices in all Canadian fabricating plants. Desirous of employment in any responsible position, sales, fabrication or construction. Apply to Box No. 851-W.

STRUCTURAL ENGINEER, B.A.Sc., A.M.E.I.C. Twenty-two years experience in design of bridges and all types of buildings in structural steel and reinforced concrete. Three years experience in railway construction and land surveying. Apply to Box No. 856-W.

MECHANICAL ENGINEER, B.Sc. '32, S.E.I.C. Good draughtsman. Undergraduate experience:—One year moulding shop practice; two years pipe fitting and sheet metal work; one year draughting and tracing on paper mill layout; six months machine shop practice; and eight months fuel investigation and power heating plant testing. Desires position offering experience in steam power plants or heating and ventilating design. Will go anywhere. Apply to Box No. 858-W.

MECHANICAL ENGINEER, age 31, graduate Sheffield (England) 1921; apprenticeship with firm manufacturing steam turbine generators and auxiliaries and subsequent experience in design, erection, operation and inspection of same. Marine experience B.O.T. certificate thoroughly conversant with Canadian plants and equipment. Available on short notice. Any location. Box No. 860-W.

CHEMICAL ENGINEER, B.Sc. (McGill '21), A.M.E.I.C., age 36, married; three years since graduation with pulp and paper mills; eight years in shops, estimating and sales divisions of well-known gas engineering and construction companies in the United States. Excellent references. Available on short notice. Apply to Box No. 866-W.

CONSTRUCTION ENGINEER (Toronto Univ. of '07). Experience includes hydro-electric, municipal and railroad work. Available immediately. Location immaterial. Apply to Box No. 886-W.

ELECTRICAL ENGINEER, graduate 1929, S.E.I.C. Single. Experience includes two years with electrical manufacturing concern and one on highway construction work. Available at once. Will go anywhere. Apply to Box No. 887-W.

CIVIL ENGINEER, B.Sc., Montreal 1930, age 26, single, French and English, desires position technical or non-technical in engineering, industrial or commercial fields, sales or promotion work. Experience includes three years in municipal engineering on paving, sewage, waterworks, filter plant equipment, layout of buildings, etc. Available immediately. Apply to Box No. 891-W.

ELECTRICAL ENGINEER, grad. Univ. of N.B. '31. Experienced in surveying and draughting, requires position. Available at once. Will go anywhere. Apply to Box No. 893-W.

CIVIL ENGINEER, B.A.Sc., Jr.E.I.C., age 29, single. Experience includes two years in pulp mill as draughtsman and designer on additions, maintenance and plant layout. Three and a half years in the Toronto Buildings Department checking steel, reinforced concrete, and architectural plans. Available at once. Location immaterial. At present in Toronto. Apply to Box No. 899-W.

ENGINEER, Jr.E.I.C., specializing in reconnaissance and preliminary surveys in connection with hydro-electric and storage projects Expert on location and construction of transmission lines, railways and highways. Capable of taking charge. Location immaterial. Apply to Box No. 901-W.

MECHANICAL ENGINEER, Canadian, age 25, B.Sc. (Queen's '32). Since graduation on supervision of large building construction. Undergraduate experience in electrical, plumbing and heating, and locomotive trades. Available at once. Apply to Box No. 903-W.

DESIGNING ENGINEER, A.M.E.I.C. Permanent and executive position preferred but not essential. Fifteen years experience in designing power plants, engine and fan rooms, kitchens and laundries. Thoroughly familiar with plumbing and ventilating work, pneumatic tubes, and refrigeration, also heating, electrical work, and specifications. Apply to Box No. 913-W.

YOUNG CIVIL ENGINEER, Jr.E.I.C. Six years as instrumentman on subway work. Two years as timekeeper cost clerk on building construction. Four years as job engineer on buildings, tunnels, dams, power houses. Location immaterial. Available at once. Apply to Box No. 916-W.

INDUSTRIAL ENGINEER, B.Sc. in M.E., age 25, married, is open for a position of a permanent nature with an industrial concern. Experience includes three years in various divisions of a paper mill and two years in an electrical company. Apply to Box No. 917-W.

ENGINEER, B.Sc., A.M.E.I.C., R.P.E. (N.B.), age 35, married. Seven years' mining experience as sampler, assayer, surveyor, field work, and foreman in charge of underground development; two years as assistant engineer on highway construction and maintenance Available on short notice. Apply to Box No. 932-W.

CIVIL ENGINEER, B.Sc., '25, McGill Univ., Jr.E.I.C., P.E.Q., age 32, married. Experience as rodman and instrumentman on track maintenance. Seven and one-half years with Canadian paper company, as assistant office engineer handling all classes of engineering problems in connection with woods operations, i.e., road buildings, piers, booms, timber bridges, depots, dams, etc. Apply to Box No. 933-W.

ELECTRICAL ENGINEER, Dipl. of Eng., B.Sc. (Dalhousie Univ.), S.B. and S.M. in E.E. (Mass. Inst. of Tech.), Canadian. Married. Seven and a half years' experience in design, construction and operation of hydro, steam and industrial plants. For past sixteen months field office electrical engineer on 510,000 h.p. hydro-electric project. Available at once. Apply to Box No. 936-W.

CIVIL ENGINEER, B.Sc., O.P.E. Experience includes several years on municipal work-design and construction of sewers, steel and concrete bridges, watermains and pavements. Available at once. Apply to Box No. 950-W

ELECTRICAL ENGINEER, twenty years experience, desires position, either temporary or permanent. Experienced in design, construction, and operation of power and industrial plants, and supt. of construction. Apply to Box No. 974-W.

INDUSTRIAL ENGINEER, B.Sc., in C.E. (McGill Univ. '30), graduate student in industrial engineering '33 session, age 27, single, available for a position of temporary or permanent nature with industrial concern. Has theoretical knowledge of latest methods of market analysis, production control, management and cost accounting. Also experience in the design and construction of industrial buildings. Location immaterial. Apply to Box No. 981-W.

CIVIL ENGINEER, B.Sc. (Univ. of Sask. '33), S.E.I.C., age 28, single. Experience in testing hydro-electric equipment, draughting, surveying, city street, improvements, technical photography. Available at once. Location immaterial. Apply to Box No. 986-W.

ELECTRICAL ENGINEER, B.A.Sc., '27, Jr.E.I.C., A.A.I.E.E. Married. Age 31. One and a half years G. E. Test Course, Schenectady; four and a half years motor and generator design including induction motors, D.C. and A.C. motors and generators. Willing to do anything, design or sales preferred. Available at once. Present location Toronto. Apply to Box No. 993-W.

MECHANICAL ENGINEER, S.E.I.C., B.Sc., Queen's University '33. Age 24, desires position on power plant and power distribution problems, factory maintenance, heating and ventilation or refrigeration design. Willing to work for living expenses in order to gain experience. Apply to Box No. 999-W.

ENGINEER SUPERINTENDENT, age 44. Engineering and business training, executive ability, tactful, energetic. Had charge of several large projects. Intimate knowledge of costs and prices, reports and estimates. Available immediately. Any location. Apply to Box No. 1021-W.

CIVIL ENGINEER, B.Sc. (Queen's 14), A.M.E.I.C., Dominion Land Surveyor, 5 months' special course at the University of London, England, in municipal hygiene and reinforced concrete construction. Experience covers legal and topographic surveys, plane tabling and stadia surveying, railway and highway construction, drainage and excavation work. Available at once. Apply Box No. 1035-W.

ELECTRICAL ENGINEER AND GEOPHYSICIST. Age 36. Married. Seven years experience in geophysical exploration using seismic, magnetic and electrical methods. Two years experience with the Western Electric Company of Chicago, working on equipment and magnetic materials research. Experienced in radio and telephone work, also specializing in precise electrical measurements, resistance determinations, ground potentials and similar problems of ground current distribution. Apply to Box No. 1063-W.

ELECTRICAL ENGINEER, B.A.Sc. Univ. Toronto '28. Experience includes Can. Gen. Elec. Co. Test Course. Also more than two years in the engineering dept. of the same company. Available on short notice. Preferred location central or eastern Canada. Apply to Box No. 1075-W.

ELECTRICAL ENGINEER, B.Sc. Married. Eight years electrical experience, including operation, maintenance and construction work, electrical design work on large power development, mechanical ability, experienced photographer, employed in electrical capacity at present. Available on reasonable notice. Apply to Box No. 1076-W.

GRADUATE IN MECHANICAL ENGINEERING, 1927, desires opportunity in Diesel engine field, preferably in design and development work. Skilled draughtsman and clever in design. Familiar with basic theories of the Diesel engine and in touch with recent developments and applications. Anxious to obtain a foothold with up-to-date company. No objection to shopwork or other duties as a start but would prefer shopwork and assembly if possible. Apply to Box No. 1081-W.

INDUSTRIAL ENGINEER, B.A.Sc. in Chem. Eng. (Tor. '31), S.B in Indust. Eng. (Mass. Inst. of Tech. '32), S.E.I.C. Age 25 years. Northern Electric Training Course. Construction and sales experience Rockefeller Research Associate at McGill University in industrial engineering for past year and to date. Desire work in production or financial departments of a manufacturing plant. Apply to Box No. 1098-W.

CIVIL ENGINEER, age 27, graduate 1930, single. Experience includes detailing, designing and estimating structural steel, plate work and pressure vessels; also hydrographic surveying. Available at once. Apply to Box No. 1111-W.

CIVIL ENGINEER, B.Sc. Sask. '30. S.E.I.C. Age 24 years. Experience in municipal engineering, including sewer and water construction, sidewalk construction, paving, storm sewer design, draughting, precise levelling, and reinforced concrete bridge construction. Unmarried. Available at once. Will go anywhere. Apply to Box No. 1115-W.

## Wanted to Purchase

Second-hand or used Land Surveying Compass with tripod. Must be in good condition. Describe fully and state price wanted. Apply to Box P-15.

BUY COGHLIN SPRINGS
FOR QUALITY AND SATISFACTION
With sixty-five years Canadian reputation and experience, you can safely specify COGHLIN'S for all your spring requirements.
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Filer Smith Machinery Co., Ltd., Winnipeg Gordon & Belyea, Ltd., Vancouver

# Purchasers' Classified Directory

## *A Selected List of Equipment, Apparatus and Supplies*

**For Alphabetical List of Advertisers see page 18.**

### A

**Acids:**
- Canadian Industries Limited.

**Aerial Survey:**
- Canadian Airways Ltd.

**Ammeters and Voltmeters:**
- Bepco Canada Ltd.
- Crompton Parkinson (Canada) Ltd.

**Angles, Steel:**
- Bethlehem Steel Export Corp.

**Ash Handling Equipment:**
- Babcock-Wilcox & Goldie McCulloch Ltd.
- Combustion Engineering Corp. Ltd.
- E. Long Ltd.

**Axles, Steel, Forged:**
- Dominion Foundries & Steel Ltd.

### B

**Ball Mills:**
- Dominion Engineering Works Limited.
- Wm. Hamilton Div. Canadian Vickers Ltd.

**Balls, Steel and Bronze:**
- Can. S.K.F. Co. Ltd.

**Barking Drums:**
- Canadian Ingersoll-Rand Company, Limited.

**Bars, Steel and Iron:**
- Bethlehem Steel Export Corp.
- Dominion Foundries & Steel Ltd.

**Bearings, Ball and Roller:**
- Can. S.K.F. Co. Ltd.

**Billets, Blooms, Slabs:**
- Bethlehem Steel Export Corp.
- Dominion Foundries & Steel Ltd.

**Bins:**
- Canada Cement Co. Ltd.

**Blasting Materials:**
- Canadian Industries Limited.

**Blowers, Centrifugal:**
- Can. Ingersoll-Rand Co. Ltd.

**Blue Print Machinery:**
- Montreal Blue Print Co.

**Boilers:**
- Babcock-Wilcox & Goldie-McCulloch Ltd.
- Canadian Vickers Ltd.
- Combustion Engineering Corp. Ltd.
- Foster Wheeler Limited.
- E. Leonard & Sons Ltd.
- Vulcan Iron Wks. Ltd.

**Boilers, Electric:**
- Can. General Electric Co. Ltd
- Dominion Engineering Works Limited.
- Northern Electric Co. Ltd.

**Boilers, Portable:**
- E. Leonard & Sons Ltd.

**Boxes, Cable Junction:**
- Northern Electric Co. Ltd.

**Braces, Cross Arm, Steel, Plain or Galvanized:**
- Northern Electric Co. Ltd.

**Brackets, Ball Bearing:**
- Can. S.K.F. Co. Ltd.

**Brakes, Air:**
- Can. General Elec. Co. Ltd.

**Brakes, Magnetic Clutch:**
- Northern Electric Co. Ltd.

**Bridge-Meggers:**
- Northern Electric Co. Ltd.

**Bridges:**
- Canada Cement Co. Ltd.
- Canadian Vickers Ltd.
- Dominion Bridge Co. Ltd.

**Bucket Elevators:**
- Jeffrey Mfg. Co. Ltd.
- Plessisville Foundry.

**Buildings, Steel:**
- Dominion Bridge Co. Ltd.

### C

**Cables, Copper and Galvanized:**
- Northern Electric Co. Ltd.

**Cables, Electric, Bare and Insulated:**
- Can. Westinghouse Co. Ltd.
- Can. General Electric Co. Ltd.
- Northern Electric Co. Ltd.

**Caissons, Barges:**
- Dominion Bridge Co. Ltd.

**Cameras:**
- Associated Screen News Ltd.

**Capacitors:**
- Bepco Canada Ltd.
- Can. Westinghouse Co. Ltd.
- Lancashire Dynamo & Crypto Co. of Can. Ltd.

**Cars, Dump:**
- E. Long Ltd.

**Castings, Brass:**
- The Superheater Co. Ltd.

**Castings, Iron:**
- Babcock-Wilcox & Goldie-McCulloch Ltd.
- Dominion Engineering Works.
- E. Leonard & Sons Ltd.
- E. Long Ltd.
- The Superheater Co. Ltd.
- Vulcan Iron Wks. Ltd.

**Castings, Alloy Steel:**
- Dominion Foundries & Steel Ltd.

**Castings, Steel:**
- Dominion Foundries & Steel Ltd.
- Vulcan Iron Wks. Ltd.

**Catenary Materials:**
- Can. Ohio Brass Co. Ltd.

**Cement Manufacturers:**
- Canada Cement Co. Ltd.

**Chains, Silent and Roller:**
- The Hamilton Gear & Machine Co. Ltd.
- Jeffrey Mfg. Co. Ltd.

**Channels:**
- Bethlehem Steel Export Corp.

**Chemicals:**
- Canadian Industries Limited.

**Chemists:**
- Milton Hersey Co. Ltd.
- Roast Laboratories Reg'd.

**Chippers, Pneumatic:**
- Canadian Ingersoll-Rand Company, Limited.

**Choke Coils:**
- Ferranti Electric Co.

**Circuit Breakers:**
- Can. General Elec. Co. Ltd.
- Can. Westinghouse Co. Ltd.
- Northern Electric Co. Ltd.

**Clarifiers, Filter:**
- Bepco Canada Ltd.
- Crompton Parkinson (Canada) Ltd.

**Clutches, Ball Bearing Friction:**
- Can. S.K.F. Co. Ltd.

**Clutches, Magnetic**
- Northern Electric Co. Ltd.

**Coal Handling Equipment:**
- Babcock-Wilcox & Goldie-McCulloch Ltd.
- Combustion Engineering Corp. Ltd.
- E. Long Ltd.

**Combustion Control Equipment:**
- Bailey Meter Co. Ltd.

**Compressors, Air and Gas:**
- Babcock-Wilcox & Goldie-McCulloch Ltd.
- Canadian Ingersoll-Rand Company, Limited.
- Foster Wheeler Co.

**Concrete:**
- Canada Cement Co. Ltd.

**Condensers, Steam:**
- Babcock-Wilcox & Goldie-McCulloch Ltd.
- Canadian Ingersoll-Rand Company, Limited.
- Foster Wheeler Limited.

**Condensers, Synchronous and Static:**
- Bepco Canada Ltd.
- Can. General Elec. Co. Ltd.
- Can. Westinghouse Co. Ltd.
- Crompton Parkinson (Canada) Ltd.
- Harland Eng. Co. of Can. Ltd.
- Lancashire Dynamo & Crypto Co. of Can. Ltd.
- Northern Electric Co. Ltd.
- Bruce Peebles (Canada) Ltd.

**Conduit:**
- Can. General Elec. Co. Ltd.
- Can. Westinghouse Co. Ltd.
- Northern Electric Co Ltd.

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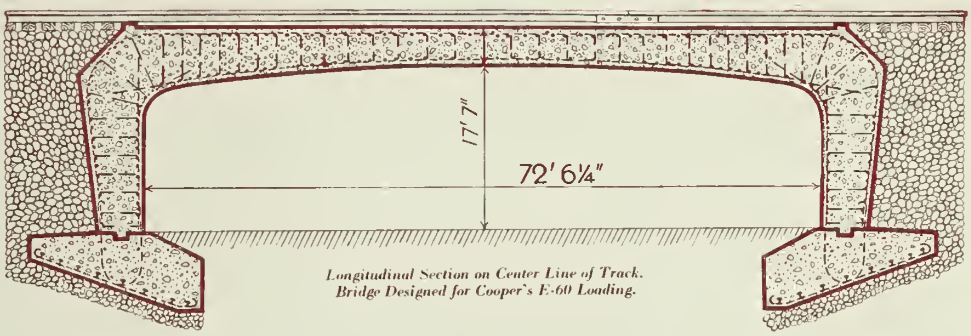
## CONCRETE RAILWAY BRIDGE

*at Vaudreuil, Que.*




*Longitudinal Section on Center Line of Track.*
*Bridge Designed for Cooper's E-60 Loading.*

Owner, Dept. of Highways, Quebec.
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Lieut.-Col. J. L. Boulanger, Deputy Minister.
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Rigid frame concrete bridges offer remarkable economies for grade crossing elimination jobs. Thin crown sections: reduced embankment or excavation: longer spans: more headroom: no intermediate columns: no structural projections: low first cost: are a few of their many advantages.

Canadian National Railways double-track bridge at Vaudreuil over the new Montreal - Hull - Ottawa Highway is a typical application of the rigid-frame principle. No ballast or ties are used, the rails being fastened to the concrete deck with a cushion block of oak beneath them.

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CANADA CEMENT COMPANY BUILDING
PHILLIPS SQUARE MONTREAL

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Included here are outstanding Canadian bridges using members built up of plates and angles.

Left to Right — Victoria Bridge, Montreal, South Shore Bridge, Montreal, Kaministiquia Bridge, Fort William. Lower views show Bathurst St. Bridge, Toronto, and Alexandria Bridge, Ottawa.

# THE ENGINEERING JOURNAL

VOL. XVII
No. 3

MARCH
1934

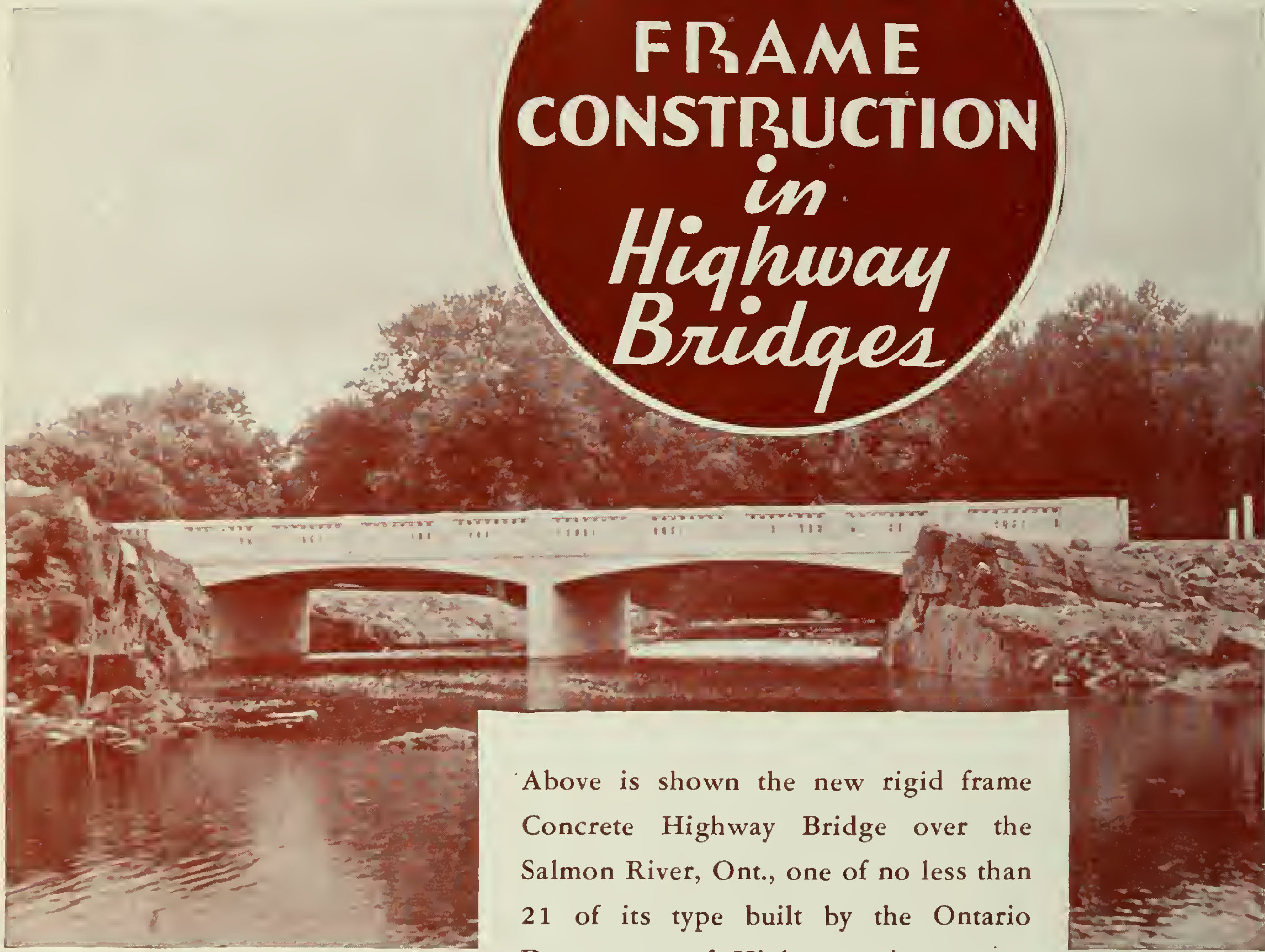
## *In this issue*



PUBLISHED MONTHLY BY

THE ENGINEERING INSTITUTE *of* CANADA

# RIGID FRAME CONSTRUCTION *in* Highway Bridges



*Salmon River Bridge:*
*Leopold McCauley, Minister of Public Works and Highways, Ontario.*
*R. M. Smith, Deputy Minister of Highways.*
*A. A. Smith, Chief Engineer, Dept. of Highways.*
*Arthur Sedgwick, Engineer of Bridges, Dept. of Highways.*
*Angus & Taylor Ltd., North Bay, Contractors.*

Above is shown the new rigid frame Concrete Highway Bridge over the Salmon River, Ont., one of no less than 21 of its type built by the Ontario Department of Highways since 1931. This modern type of construction offers unusual economies such as: reduced embankment or excavation, thin crown sections, longer spans, no intermediate columns or structural projections and many other advantages. Write our Service Department for full information.

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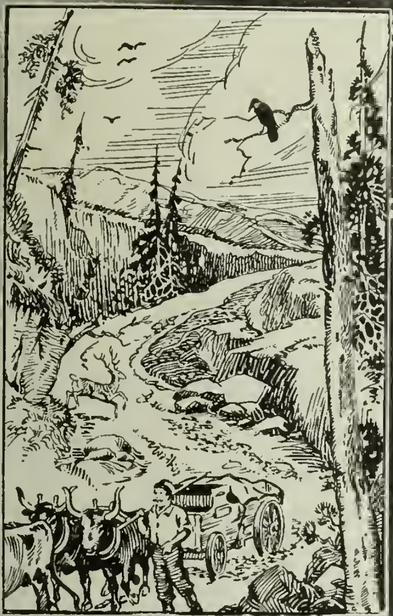
# The Romance of Road Building in Canada



THE early crude roads not only served the needs of the settlers, but also those of the British, French and American armies during the numerous campaigns.

The first important highway in Canada extended along the north shore of the St. Lawrence from Quebec to Montreal, being gradually completed with the growth of the French settlements. In 1794, the first governor of Upper Canada, Colonel John Graves Simcoe, completed one of the great arteries of traffic known as Grovernor's Road, Yonge Street, Toronto, to Lake Simcoe. The work was done by the Queen's Rangers. In 1817 Toronto was joined to Montreal and in 1827 a through road was available between Halifax and Amherstburg. The cost of construction of these roads was high, and travel by stage coach was tedious and costly. Today, over 378,094 miles of all types of roads are in use throughout Canada. Explosives played a large part in this construction work and NOW a new, economical and efficient method of building highways across swamps and marshy ground can be carried out by the use of C-I-L Explosives.

ET. 134

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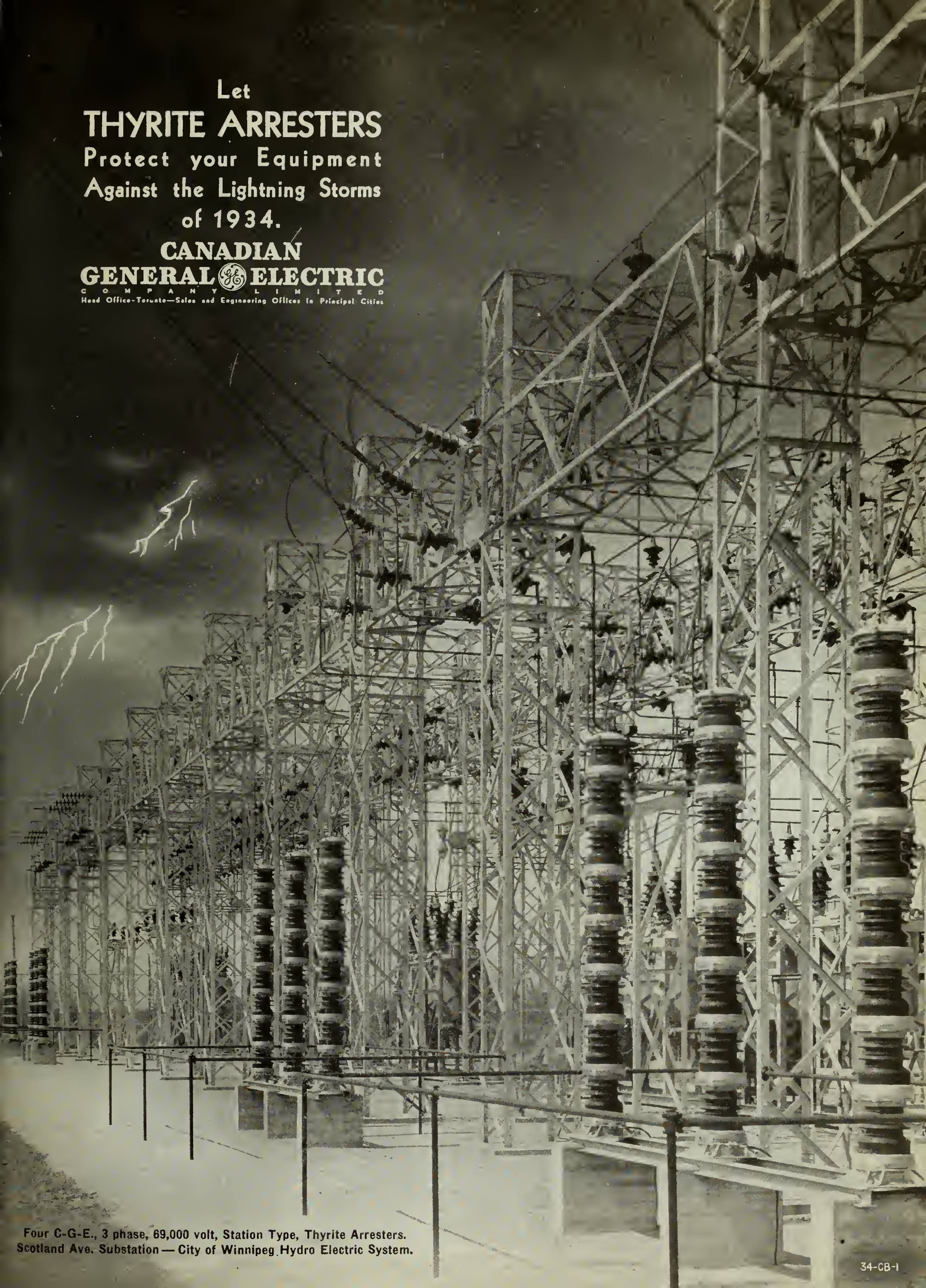
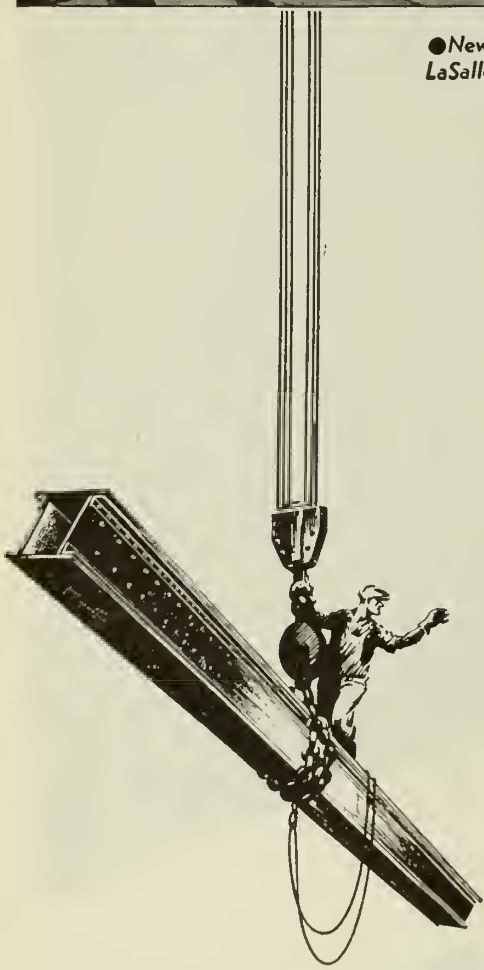
*"Everything for Blasting"*




Four C-G-E., 3 phase, 69,000 volt, Station Type, Thyrite Arresters.
Scotland Ave. Substation — City of Winnipeg Hydro Electric System.

34-CB-1

New steel highway bridge now being constructed over the St. Lawrence River, between Ville LaSalle and Caughnawaga, just west of Montreal. Length 2919 feet, Roadway 27 feet wide.



— THE —

# ENGINEERING JOURNAL

## THE JOURNAL OF THE ENGINEERING INSTITUTE OF CANADA

*"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"*

**March 1934** **Volume XVII, No. 3**

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## Survey Work for the Lake St. Louis Bridge

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**Paper presented at the General Professional Meeting of The Engineering Institute of Canada, Montreal, Que. February 8th and 9th, 1934.**

SUMMARY.—The paper first discusses the preliminary soundings, borings and current measurements for the 4500-foot highway bridge, which is now approaching completion, over the St. Lawrence river near Lachine, Que. The author then deals with the survey work including levelling, triangulation, and direct check measurements for the location of the centre lines of the fourteen piers.

Preliminary surveys to determine the location and levels for the new highway bridge to cross the St. Lawrence river in the neighbourhood of Ville LaSalle and Caughnawaga were made during the summer of 1931.

After the contracts were placed, the work of checking the preliminary triangulation was put in hand and carried out early in 1933.

The bridge is situated about eight miles from Montreal at the outlet of Lake St. Louis, and will provide direct access to provincial route No. 4, one of the main roads from the province of Quebec into New York state.

Starting from the north or LaSalle end, it consists of an embankment with a graded surface of 4.7 per cent about 440 feet long. This connects with a reinforced concrete

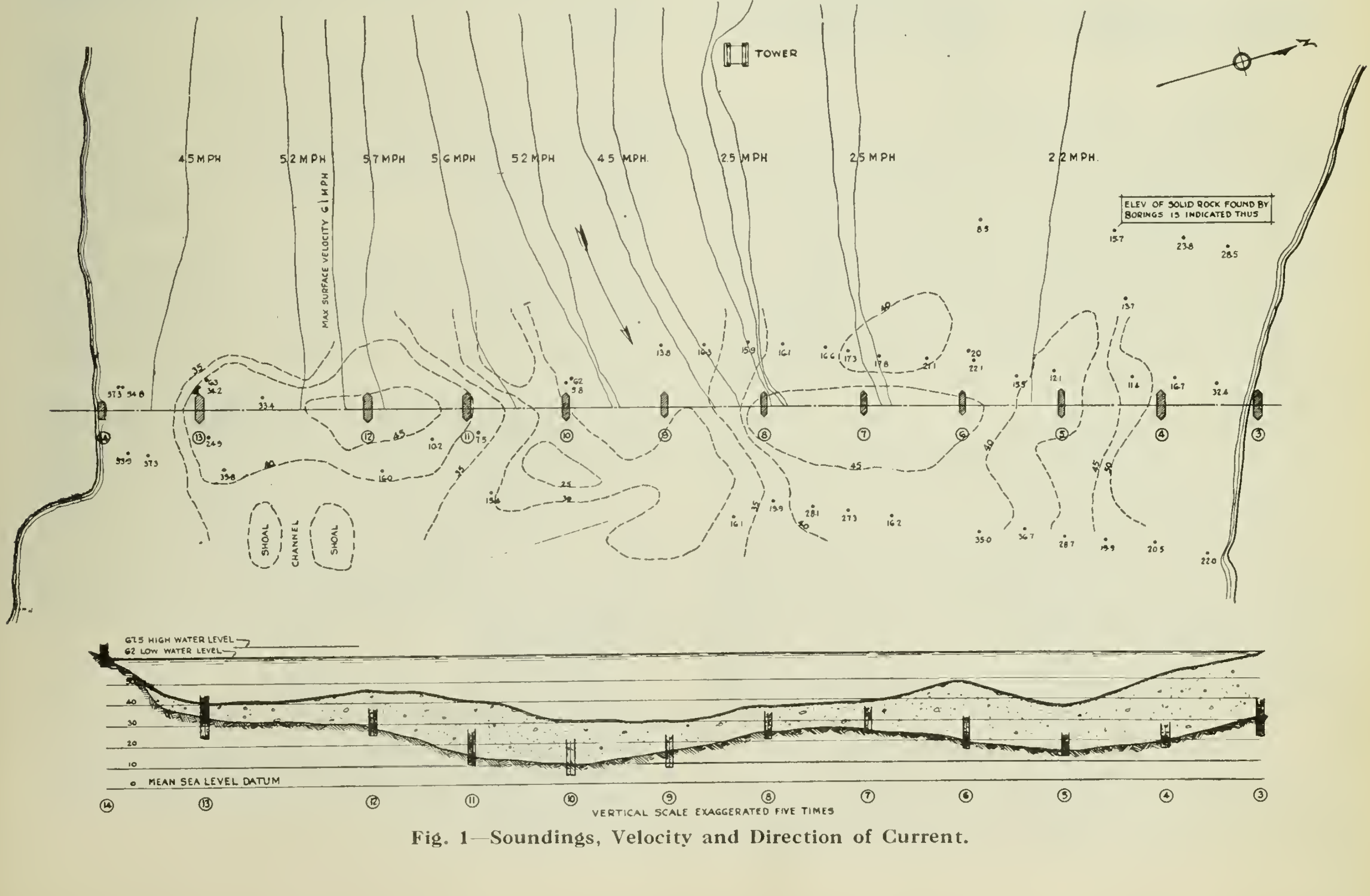



Fig. 1—Soundings, Velocity and Direction of Current.

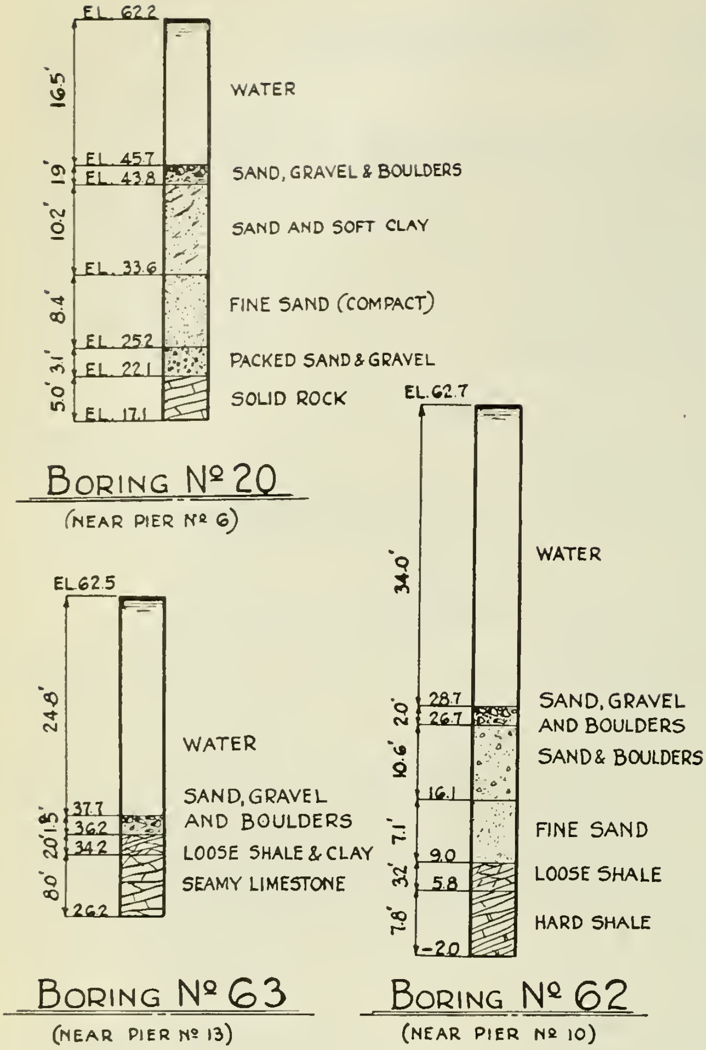



Fig. 2—Borings.

viaduct 300 feet in length, with level grade, containing six spans of 50 feet ending at pier No. 1 of the river crossing.

The total length of the river crossing measured between the faces of the extreme piers, Nos. 1 and 14, is 2,918.3 feet.

From pier 14 the highway is carried southward on a reinforced concrete viaduct containing twenty-five spans of 50 feet each, the grade falling 2.5 per cent.

The total length between faces of the ballast walls of the north and south abutments is 4,469 feet 4 inches.

An embankment about 1,300 feet in length falling on a 2.5 per cent grade, connects with the highway on the south shore.

The second pier of the river crossing was located originally on the south side of LaSalle boulevard, and close to it. For construction reasons this pier was eliminated, and a single span 172 feet long of a deck truss type with curved lower chord to provide clearance over the highway was substituted for the two shorter spans between piers 1 and 3. The next span, that between piers 3 and 4, is of a special length, 231 feet between pier centres, to conform with the requirements of the proposed St. Lawrence Deep Waterway channel.

With the exception of these two spans and that of the 400-foot river channel span, the remaining nine spans are each 235 feet between pier centres.

### Soundings, Borings and Current Measurements

Soundings were taken during the summer of 1931 and these, together with information obtained from the Department of Railways and Canals, covered an area of about 700 feet downstream from the bridge and upstream as far as the Canadian Pacific Railway bridge. Taking a section on the centre line, these show a maximum depth of water of about 32 feet with the water level at 62 above mean sea level datum. This depth occurs between piers 9 and 10 and is the deepest portion of the river for the area considered, with the exception of several pockets about 5 feet deeper, adjoining the two 400-foot spans of the railway bridge. The remainder of the latter crossing is however in shallower water than is found lower down, while some 400 feet longer than the new highway bridge crossing.

The sectional area of the waterway on the centre line is 54,500 square feet at low water, the width being 2,700 feet, giving an average depth of 20.2 feet.

Results of the measurements giving velocity and direction of current, soundings, and borings are given on the accompanying plans (Figs. 1 and 2).

The material in the river bed overlying the rock consists of clay, sand, gravel and boulders, in varying combinations, and the depth of the overlying material varies from 13 and 14 feet between piers 7 and 9, to 28 feet at pier 6 and 31 feet at pier 3. From pier 13 to the south shore the rock rises rapidly and is outcropping at pier 14. The smaller boulders were found to be largely of material foreign to the bed rock, having been carried by water or ice, and occurred at varying levels, whereas the larger boulders were almost entirely of eroded black shale, which was the material on which the piers have been founded, with, to a limited extent, intrusions of a hard grey limestone.

This shale, which is badly broken up and eroded on the surface, shows regular bedding where cut into, and gives a dip which is of irregular amount, but generally changes from a westward dip for the northern half of the river to a dip eastward for the southern half. The erosion of such a deposit, therefore, results in the breaking off of successive steps, and giving fall to the channel, while presenting rock of a very broken character when first encountered in excavation.

The central profile shows that this rock is roughly level as far south as pier 8, with an elevation of 25 over datum, and has a fairly regular depression from piers 3 and 7 towards pier 5, where it was met with 11 feet deeper. From pier 8 to the south shore there is a depression, culminating at pier 10, where the lowest rock was found at elevation 8.4, the foundation of this pier being carried down 4 feet further.

From pier 11 the rock rises abruptly to pier 12 whence it gradually rises southward. The depth of sinking at pier 10, while it is the deepest of the piers, was exceeded in the case of pier 6, which was 33 feet, and piers 3 and 4, where the foundations were carried through 41 feet and 35 feet respectively.

The borings were partly wash-borings and partly taken with diamond drill. They were taken over a band of from 30 to 80 feet in width, and were supplemented later with some additional borings taken on the actual pier sites.

The direction and velocity of the surface currents in the river were measured in December 1932 and in November 1933 at intervals across the channel. They show the velocity to vary from a minimum along the north shore, where it is approximately 2.2 miles per hour, to a maximum of 6.1 miles per hour in the channel span, water level being 63.5 over datum.

### Triangulation

The general outline of the triangulation is given on the accompanying diagram (Fig. 3). The figure used in the survey is roughly of quadrilateral form, with its longer east and west sides slightly tapering towards the south, and the distance between these sides of about two thirds of the longer dimension.

The bridge centre line crosses this figure longitudinally and subdivides it in an approximate ratio of three to two.

The resulting figure between the two bridges has a width of 1,400 feet, which is about 40 per cent of its longest side, the base line.

This figure was admirably suited for transference of points measured along the base line, on to the new bridge centre line.

The original circumscribing figure contained nine sides, the longest of which was the original base line. The tower station near the centre of the river and closer to the railway bridge was used as a check on the outer figure. A new base line was substituted for the original, since it was impossible to measure the latter directly with sufficient accuracy. This virtually added two sides to an already crowded polygon, but was a necessary complication. Once, however, the figure was calculated and adjusted, little use was made of it, beyond the new base line with its pier substations. The tower station was used to check a few of the adjoining piers.

The angles were read throughout by a single observer to eliminate as far as possible variation in personal error. Each angle with its explement* was read three times in one direction, the telescope reversed and the same readings taken in the opposite direction. Each angle was therefore read twelve times and the average was then recorded.

The angles so adjusted were again checked for closure around each station. They were further adjusted in each quadrilateral into which the triangulation figure was divisible, by the angle equation, and were finally adjusted by the quadrilateral side equation:—

$$\frac{\sin 1 \ . \ \sin 3 \ . \ \sin 5 \ . \ \sin 7}{\sin 2 \ . \ \sin 4 \ . \ \sin 6 \ . \ \sin 8} = 1$$

in which the figures in order of sequence represent the eight angles at the apices of the quadrilateral.

*The explement of an angle is equal to 360 degrees minus the angle.

From the angles so adjusted the latitude and departure of each point was calculated, and a working plan made for use in the field, with only the essential angles shown thereon.

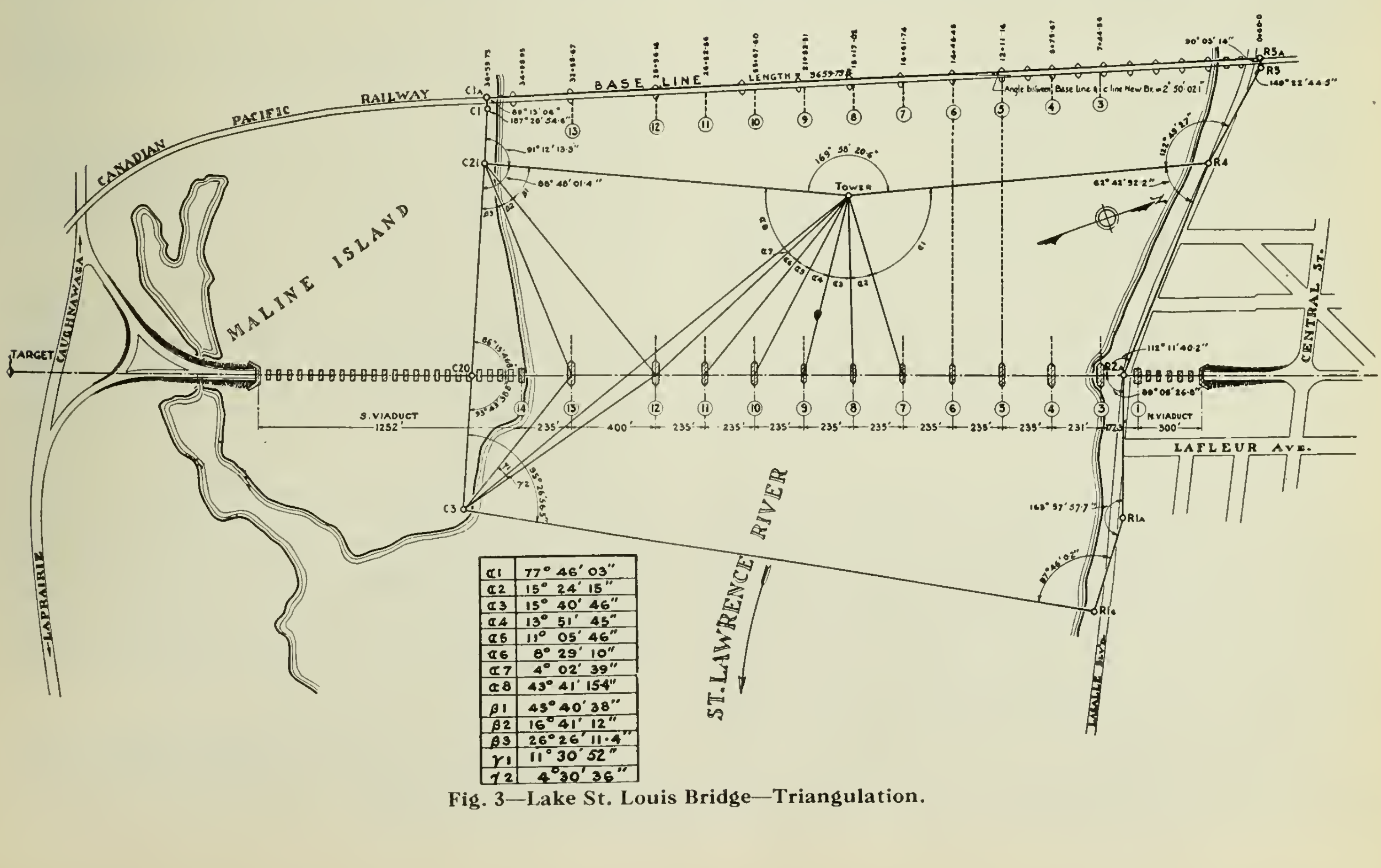
### Tape Measurements

The tapes used for precise measurements, 500 feet and 300 feet long, were first of all checked with those used in the Dominion Bridge Company's shops, where the steel work was being fabricated. All measurements were corrected for a temperature of 70 degrees. Checks of the suspended-tape measurements were made, and for this purpose two small steel supports were made as shown in the accompanying illustration (Fig. 4). These provided a convenient method of fixing a point plumb over the plugs at either end, also a smooth pulley, with dead weights for measuring the pull. A small correction for friction was made by taking the mean reading between those given by releasing the weight after slightly increasing and relieving it.

For the measuring point, a small adjustable brass plate was fitted at the top of the stand, with a line engraved on its centre, the plate being adjusted plumb over the hub by transit, and fixed by two butterfly nuts when correct.

For the purpose of checking the suspended-tape measurements, two steel plugs were set in the level concrete floor of the Dominion Bridge Company's machine shop. These were 235 feet apart, and the steel standards described above were placed with their measuring points plumbed by transit directly over the plugs. The 300-foot tape was used, with pulley weights varying by five pounds each from 20 pounds up to 40 pounds and from 40 pounds back to 20 pounds, the sags being measured and the temperatures noted. The corrections for sag agreed very closely with the catenary calculated from the known weight of the tape and the tensions applied.

It may be pointed out that the greatest difficulty in carrying out such measurements in the field lies in obtaining suitable climatic conditions, namely, absence of wind and uniformity of temperature. This applies particularly in




| | |
|---|---|
| α1 | 77° 46′ 03″ |
| α2 | 15° 24′ 15″ |
| α3 | 15° 40′ 46″ |
| α4 | 13° 51′ 45″ |
| α5 | 11° 05′ 46″ |
| α6 | 8° 29′ 10″ |
| α7 | 4° 02′ 39″ |
| α8 | 43° 41′ 154″ |
| β1 | 45° 40′ 38″ |
| β2 | 16° 41′ 12″ |
| β3 | 26° 26′ 11·4″ |
| γ1 | 11° 30′ 52″ |
| γ2 | 4° 30′ 36″ |

Fig. 3—Lake St. Louis Bridge—Triangulation.

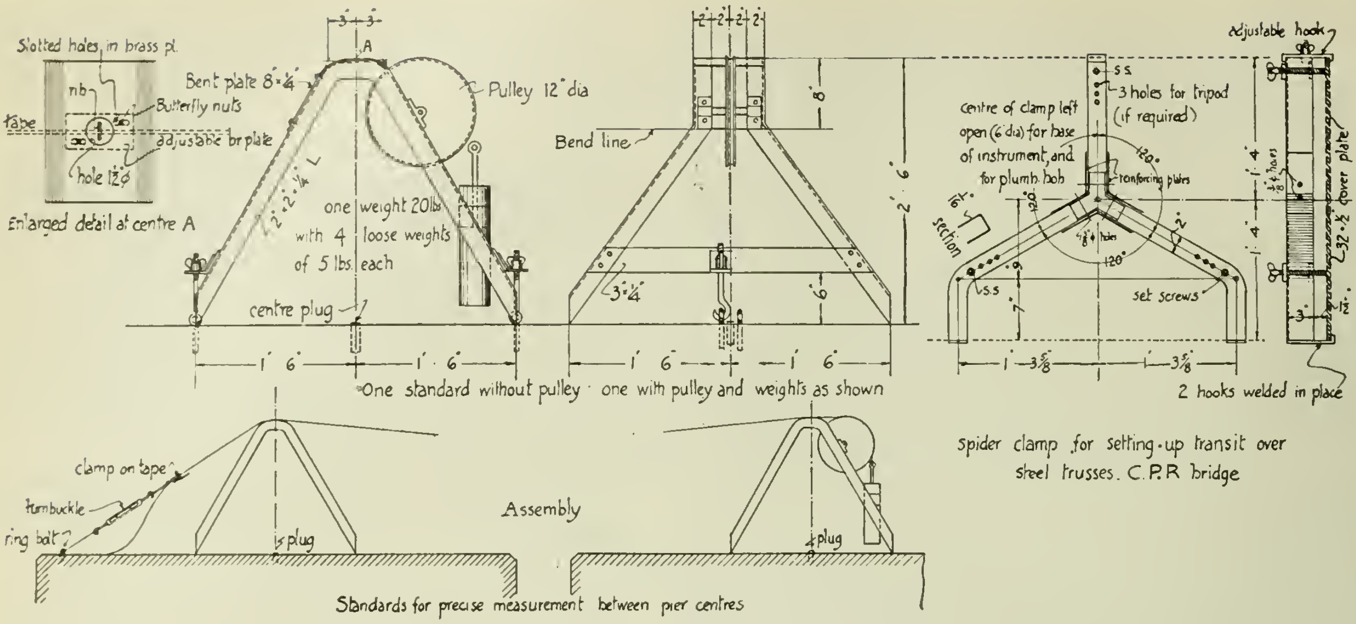



Fig. 4—Steel Supports for Checking Suspended-Tape Measurements.

the case of a wide and exposed river such as the St. Lawrence at Lake St. Louis, where a windless day is a rarity. Generally, the early morning is the most favourable time for this work, as well as for taking long sights, and is usually preferable to the evening. In the morning the atmospheric conditions have remained equable over a long period. This is particularly noticeable in sighting over a long stretch of steel work or even of railway track. The reason is that during the night the temperature of the steel has approached a condition of equilibrium which is not greatly disturbed even by an early sun, whereas in the evening the heat absorbed by the steel structure during the day, particularly if the sun has been strong, begins to radiate into the surrounding atmosphere as soon as the sun approaches setting, with consequent quivering of the air which renders accurate sights impossible.

During the progress of the work on the sub-structure, and after its completion, suspended-tape check measurements were made as described above from pier to pier across the river, and the centre lines for the pier members of the steel trusses laid out therefrom.

For the measurement of the base, a line was chosen on the deck of the west track of the railway bridge, giving a space clear of all obstructions from rail or deck fastenings. A metal plug was set in the masonry of the abutment ballast wall at either end of the line C1A-R5A (Fig. 3). Small zinc plates engraved with two fine lines at right angles, were placed on centre, and nailed to the first anchored bridge tie on the fixed end of the corresponding span. The 500-foot tape was used, and the zinc plates set at a distance apart not exceeding the length of the tape. These plates were subsequently used to lay out the adjoining pier intersections.

The base line C1A-R5A was measured on April 28th, 1933, a cloudy day being chosen, and a period between trains. Measurements were taken to the zinc plates, and the total length obtained by aggregating the separate distances, whatever they happened to be. The temperature, at intervals, of the tape was also recorded, and the necessary corrections made. By this method time was saved, and the measurements were reversed and taken a second time. Pulls of 30 pounds and 40 pounds were used for each measurement, and the length finally corrected to the standard used throughout.

A shorter side C3-C20 on the south shore was also measured by levelling stakes every 20 feet and checked in well with the rest of the work.

### Locations of Piers

The triangulation figure gave with the established shore stations a system whereby the piers could have been located entirely from these shore stations.

Owing to the accessibility of the railway bridge, however, through the courtesy of the Canadian Pacific Railway Company, it was used almost entirely for the location of the new piers, with the added advantage that from the base line on that bridge, not only could the centres of the piers be established, but also the pier centre lines themselves. Full advantage was taken of this, as well as for the location of the breakwaters or deflectors, which were placed in position by floating equipment, as nearly as possible symmetrical with the pier centre lines.

These deflectors were located also, as well as the construction trestle, by means of a 50-foot offset line which was laid out for this purpose, with hubs and targets at either end.

The intersections of each pier were marked on the base line and the pier centre lines transferred across the width of the railway bridge to its east face where targets were placed, three to each pier. The two side targets were placed for the side lines which were used on the construction trestle to control the sinking of the caissons.

Where the trusses of the railway bridge permitted, from the intersection of pier 5 southward, the pier intersections were also transferred to the cover plate of the top chords, and a special clamp made for setting up the tripod of the transit, as shown in Fig. 3. In this way the work could be carried out with a minimum of inconvenience from passing trains.

After the checking of the triangulation, work was commenced on the viaduct on the south shore and on pier 14, which was constructed from the shore by the same gang. The setting out of this 1,250-foot viaduct presented nothing out of the ordinary. The centre line of each pier was extended to a hub 100 feet on each side of the centre line. After the completion of pier 14, a target was placed on its summit, on the centre line, and used subsequently for the viaduct on one side and the river piers on the other.

### Levelling, etc.

For the levels, the government bench marks were used until a check was made across by levelling over the railway bridge, also by connecting the levels from an instrument placed at the tower station.

A small correction was made to the reduced levels of the bench marks on the south side of the river which were not favourably situated, or in good condition for accuracy. All levels were co-ordinated with the bench mark placed at the north end of the railway bridge, which was in good condition.

It may be pointed out that in setting the lines for the location of the pier members of the steel spans on their bridge seats, the span lengths centre to centre of bearings were corrected to a temperature of 40 degrees. The latter would be approximately the mean temperature, and give the mean position of the expansion end of the span.

By making this correction the cycloidal pintles set in the upper and lower expansion members which control the rollers will lie one vertically over the other at the mean temperature. The amount of this correction is about 9/16 inch for the 235-foot spans. It may be noted that if this correction had been made throughout, the entire bridge would have been about 10½ inches shorter.

It is of interest to consider what degree of precision is necessary in work of this kind. Actually an error of 8 inches was found in the length of the river crossing as determined by the preliminary survey. This is about one in four thousand. Had even this amount been known in time, it might have been taken care of by judicious distribution. The difficulty lies in the fact that the error would probably not have been discovered until it had either been concentrated in one span, or until a stage had been reached in the erection of steel when it would have been equally unfortunate.

An error of one sixth of the above, however, or one in twenty five thousand, would have been reasonable and of little moment from the nature of this particular structure.

To reduce errors in measurements to such a proportion absolute precision should therefore be aimed at. That it was possible to reduce the total of errors to considerably less even than the above, to less than one in one hundred and fifty thousand, was due to the enthusiastic co-operation on the part of the entire engineering staff in an attempt to obtain as nearly absolute precision as possible.

# The Substructure and Approaches of the Lake St. Louis Bridge

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SUMMARY.—Twelve of the piers for the Lake St. Louis bridge across the St. Lawrence stand in a strong current and in depths of water up to 32 feet. The paper discusses the construction methods adopted, some of the pneumatic caissons having been placed from a specially designed sectional trestle, and others from powerful floating equipment. Notes are given on the construction of the approach viaducts.

The Lake St. Louis bridge, now approaching completion, will carry the traffic of a main highway across the St. Lawrence river at a point near Lachine, west of Montreal. The bridge is about 4,500 feet long from abutment to abutment. The north shore approach consists of a 440-foot earth fill and a 300-foot concrete viaduct, and the south of a 1,300-foot earth fill and a 1,250-foot concrete viaduct.

The steel superstructure is supported by thirteen piers, eleven of which have been carried to bedrock by the pneumatic method. The north shore pier was built in an open sheeted cofferdam, and that on the south shore in a puddle cofferdam.

The following interesting features characterized the construction of the substructure of this bridge:—

1. The development of a practical and economical combination steel-tube and timber trestle for construction in swift water.
2. The use of welded steel caissons.
3. The methods employed for building and guiding caissons and forming breakwaters.
4. Accurate methods of sinking.
5. The use of a specially designed deflector in combination with a powerful shear-leg boat designed for handling and sinking pneumatic caissons.

### General River Conditions

The river conditions had to be studied very carefully before any final method of construction could be adopted. The St. Lawrence river, at the bridge site, is 2,800 feet wide. At low water, its depth varies up to a maximum of 30 feet. It has a current velocity of 2 miles per hour near the north shore, increasing to a maximum of 6 miles per hour at pier No. 10, and 3 miles per hour at the south shore. At high water, the velocity reaches a maximum of 8 miles per hour in the channel. A rate of 4 miles per hour has actually been measured near the north shore during construction last spring.

The river is not navigable, with the exception of a narrow and tortuous channel near the south shore, and contains many shoals and rocky reefs. The extreme low water (elevation 61.3) which prevailed during the greater part of the summer and fall of 1933 increased the difficulties of navigation to such an extent that it became risky.

The behaviour of the river between December 1932 and May 1933 was observed closely. This section of the river is open all winter, but considerable field and frazil ice floats down; the maximum proportion of ice to water surface last winter was approximately 90 per cent with an average of 50 per cent of rapidly moving ice.

The spring break-up took place on April 4th, 1933, the river being entirely clear of ice by April 15th, with the water at elevation 66. This definitely fixed the average working season between April 15th and December 1st.

The bridge site is subject at times to strong westerly winds from Lake St. Louis, creating such conditions that during many days construction operations are difficult, if not impossible.

Test borings taken from 200 to 300 feet upstream and downstream from the final site of the bridge were made in

Fig. 1—General View Downstream of Bridge under Construction.

1931, to determine the best location. These borings were remote from the pier sites and the elevations of the base of each pier as shown on the contract plans had been interpolated between these borings. The nearest other available information regarding river bottom conditions was at the C.P.R. bridge located 1,500 feet upstream; the bottom there being practically bare rock and generally about 3 feet below low water, with a maximum of 35 feet of water at the channel.

### Construction Methods

The contract for the substructure was awarded on November 14th, 1932, to be completed on November 1st, 1934. Guided by the studies of the river conditions and the available borings, the general contractor decided that the most advantageous way to construct the river piers was to find an economical system of getting at as many piers as possible from the land, by using a system of trestle especially fitted to these river conditions; the number of piers to be built this way to be determined by soundings, current velocity readings and borings made at the pier site, just as soon as the river would permit. There was then enough information on hand to allow of making the final plans and ordering the necessary materials up to pier No. 6.

A trestle design was studied, and a system of trestle, side cribs and breakwater developed, permitting: (*a*) pile spuds to be driven in swift running water regardless of river conditions, (*b*) minimum stream obstruction, (*c*) adaptability for use on other work, (*d*) considerable economy by speedy construction and dismantling.

This combination steel tube and timber trestle was developed by Mr. Englander. the general contractor's resident engineer in charge of the river work, to whom the writer is greatly indebted for assistance in the preparation of this paper.

The trestle was designed of sufficient strength and size to support a 35-ton crane. The bents were 20 feet centre to centre, braced to act as four-legged towers, the corner posts being square tubes made of ⅛-inch plate, and electrically welded at the junction, with welded gusset plates to receive the lateral and sway bracing. These tubes and frames were fabricated at the Dominion Bridge Company's shops, and assembled at the bridge site with bolted field connections. A typical tower ready to be placed in position is shown in Fig. 2.

Soundings were made at the bent locations and 12-inch by 12-inch square timber spuds, steel shod and of proper length, were prepared in advance of placing the bents.

The four corner spuds were first placed in the tubes, with the points projecting the proper distance below the bottoms of the tubes and held in place by dowels through the tops of the tubes. The tower was then lifted from the trestle by the crane and swung into line with the trestle; ¾-inch wire rope cables were then attached to the bottom struts of the tower and carried through two sets of three-part blocks to a small scow equipped with two 15-ton hand winches. This scow was located about 100 to 150 feet up-

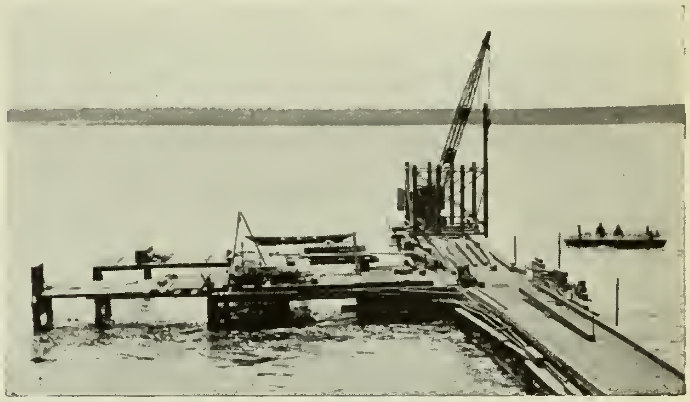


Fig. 2—Trestle under Construction.

stream from the tower to be placed, and by means of lines from one of the winches, leading to upstream anchors, could be warped into position. The cables attached to the tower resisted the current action and permitted the tower to be placed in its correct up and downstream position.

The tower was then lowered to rest on the four spuds. The winches were tightened up to withstand current action, and the crane boomed out until proper distance between towers was obtained. With the tower in position, the intermediate spuds were placed in the tubes, driven to refusal and dowelled. Then the corner spuds were driven home. Although the penetration at times was as little as nine inches, the steel tubes prevented the current from swaying the spuds and also provided lateral and sway bracing far below water level without any additional labour, and without any underwater work.

Spuds were then cut off, capped, and the stringers and deck placed. The caps and stringers were 12 inches by 16 inches, and 10 inches by 16 inches, drift bolted. The deck was 3-inch plank.

All lumber was of standard length, which speeded up the work considerably.

The final operation was to attach anchor cables to the top of the tower. These consisted of two ¾-inch wire rope cables tied to two one-ton pre-cast concrete blocks, which had been previously placed about 50 to 75 feet upstream from the trestle. This completed 40 lineal feet of trestle and the crane was now ready to move ahead for the next tower.

The work was arranged so that materials required for a 40-foot section of trestle were directly behind the crane and ready for distribution. The tower bents were assembled and bolted at the land end and rolled out on 6-inch rollers on top of the guard rails of the trestle, as shown in Fig. 2.

Figure 3 shows the arrangement and construction of the trestle at a pier, and Fig. 4 shows a typical caisson in position.

### Caisson Cribs

To create a dead water basin at the caisson site, the tower directly on the centre line of, and upstream from the caisson was designed to act as a combination breakwater and trestle tower. This was accomplished by providing steel channel grooves for 4-inch wooden stop logs on the north and south sides of the frames.

To deflect the current, the upstream and downstream corner tubes were fitted with half sections of steel sheet piling to permit driving steel sheeting across the upstream and downstream sides of the towers. The side stop logs were first placed, as they would not obstruct the current, spuds were cut off, capped and deck placed as in the case of the standard bents. Clearance was allowed in the deck to permit the driving of the steel sheeting when ready to deflect the current.

The next operation was to place the tower bents which functioned as side guides for the caisson, supported working platforms, and acted as buttresses to the main trestle; the upstream towers on the north and south sides also functioning as part of the breakwater. Three towers were placed on each side of the caisson berth; the north consisting of two 15- by 20-foot towers with four spud bents, the downstream one of one 12- by 12-foot tower with two spud bents. Those on the south were similar to the north downstream tower. All frames in the guide towers were fitted with 5-inch channel grooves for wood stop logs as has been previously described. These towers were carefully located and a clearance of three feet on each side of the caisson allowed. The north platform was 20 feet wide, enabling the crane to erect caisson, steel shafting and locks. On the south side it was 12 feet wide providing a working platform and support for the concrete tower.

After the stop logs were in place, the cribs were filled from 10 to 15 feet deep with rip-rap providing lateral stability for the cribs while sinking and guiding the caisson.

With the side cribs in place and rip-rapped, the gap in the upstream breakwater was closed with steel sheet piling, and when required, sheeting placed at the downstream end of tower, and a rip-rap fill made.

This combination of breakwater, trestle and working platform created an effective dead water basin; in fact, the downstream eddy caused a slight upstream current in the basin. The closure between the breakwater and two adjoining side cribs was made with steel sheeting.

It was not found necessary to carry all of the stop logs to the water surface as the upstream logs deflected the current sufficiently.

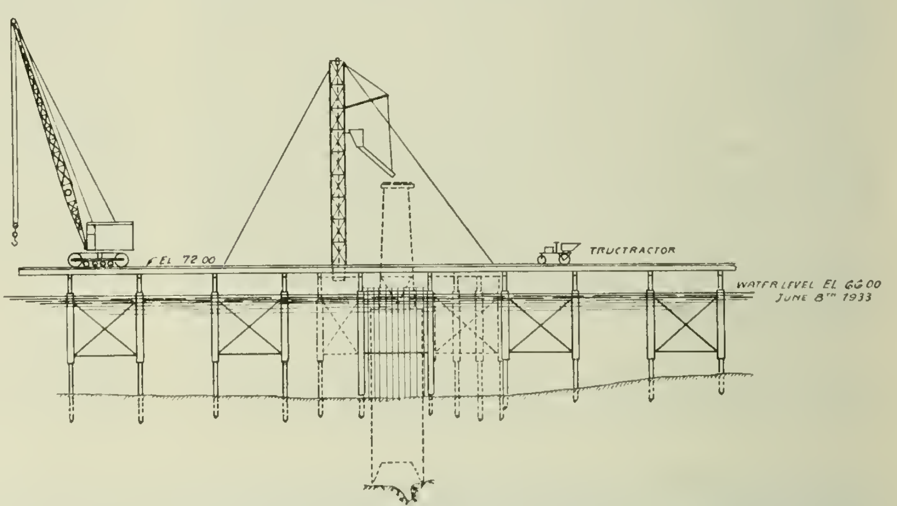
To resist the pressure of the sheeting against the tower, the lower horizontal waler was reinforced with a channel and the top one stiffened by an 8-inch by 8-inch timber.

The caisson area was now ready for accurate soundings and inspection to determine the character of the river bottom and prepare it to receive the caisson.

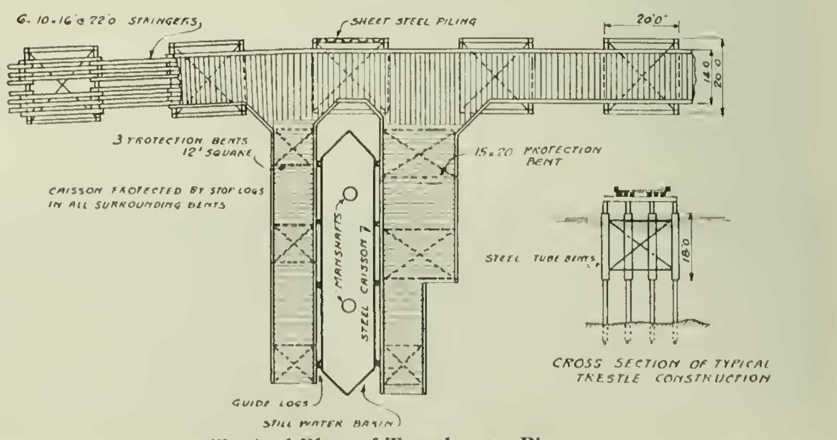
In this manner the trestle and berths were built without difficulty to pier No. 6, during the high water period, in a current varying from 3 to 5 miles per hour, and in water from 12 to 26 feet deep.

The elevation of the trestle deck was fixed at 72.0 to provide clearance for maximum high water.

The trestle construction commenced as soon as river conditions permitted and the major portion of ice had passed the bridge site. The first tower was placed on April 19th, and the trestle built, including side cribs, etc., to pier No. 6, a total length of 1,200 feet, by June 1st, averaging 60 feet per day taking into consideration the fact that during three weeks the crane did not erect trestle but handled material for caisson build-up, erected gantry frame used for lowering, placed shafting, and air locks.



Typical Elevation of Trestle at a Pier.



Typical Plan of Trestle at a Pier.
Fig. 3.

In computing the stability of the towers against the current, the formula used for current pressure was

$$P = K \frac{wv^2}{2g}$$

where $w$ = 62.5 pounds per cubic foot, $v$ is the velocity in feet per second. $K$ was taken as 1.5 for a square tower. The current pressure was considered as acting on the upstream faces of all columns in each tower. Actually, the current is deflected by the upstream column, and when the columns are

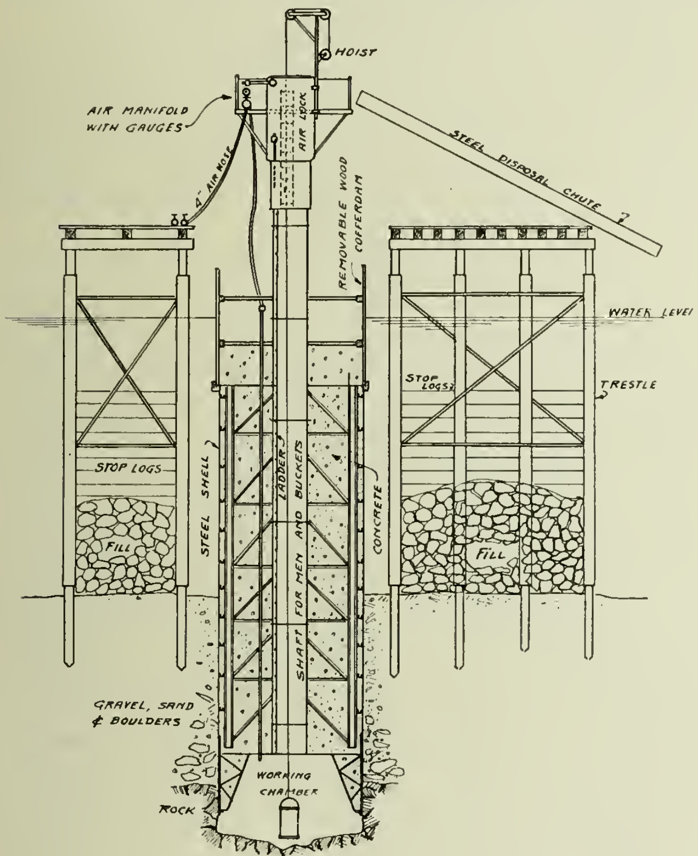



**Fig. 4—Typical Caisson for Piers.**

in line with the current the factor $K$ taken as 1.5 is probably larger than necessary. At two miles per hour, figured from the above formula, the current pressure is 12.9 pounds per square foot; at 3 m.p.h. 28.8; at 4 m.p.h., 51.5; and at 5 miles per hour, 80.4, the pressure increasing as the square of the current velocity.

This current pressure was assumed as acting one third of the depth below the surface of the water, the moment arm increasing with the depth of the water. Resisting the current is the moment of the weight less the buoyancy of the tower, the piling, the steel sheet piling and stop logs if used, the weight of the stringers, caps and decking. To this may be added excess weight from dead loads, such as rip-rap fill, or upstream anchorages.

It was found that the trestle in itself was stable at the current velocities and river depths encountered, but as a factor of safety, and a precaution against storms, anchorages of one ton block were placed upstream from each tower.

### Construction Equipment for Trestle and Cribs

The equipment used for the trestle and crib construction was one 60-foot boom North-West crane, one No. 7 McKiernan Terry air-operated hammer, one 14- by 30-foot scow (built on the job), equipped with two 15-ton hand winches, three tructractors and three lorries, an unusually small amount of equipment for such work.

The area available for the contractor's use on the north shore was very small, therefore it was decided to so co-ordinate the work and deliveries of materials, that little storage would be necessary. All materials being truck delivered, a stiff-leg derrick was erected on the north shore and so placed that it could unload directly from trucks on the highway to lorries on the trestle. These lorries were hauled by three three-wheeled tructractors along the trestle. Schedules of deliveries were drawn up weekly, sent to the vendors and revised as progress demanded. Thus, through this bottle neck, 120 tons of steel for the towers, 580,000 board feet of lumber, 14,000 cubic yards of concrete, steel for the caissons, air locks, shafting, and reinforcing were delivered with practically no storage of materials, and at no time was the job either blocked or held up because of supply of materials.

The tructractors, being very flexible, entirely eliminated the need for industrial track, handling all materials for trestle construction, caisson build-up, shafting, locks and concrete, and accelerated construction a great deal.

### Caisson Design

*Caisson No. 3*

This caisson was designed of reinforced concrete with a steel cutting edge. This cutting edge (Fig. 5) was made up of a 24-inch by ¾-inch outside plate, one 8-inch by 6-inch by 1-inch angle, and a 12-inch at 25-pound channel, the inner flange of the channel bent to conform to the slope of the inner working chamber wall, and riveted to a 22-inch by ⅜-inch continuous plate. Reinforcing, threaded and fitted with two nuts, passed through the channel to provide anchorage for the steel edge. The 2-inch wood sheeting forming the outside was fastened to the outer plate with countersunk bolts. As this sheeting was to remain in place, 6-inch nails at 2-foot centres were driven to provide a bond between the caisson concrete and sheeting, thus eliminating any tendency to displacement due to skin friction while sinking. Horizontal walers at 4-foot centres, and tie rods, held the sheeting in place while concrete was poured, and were removed as the caisson was sunk. The character of the sub-soil justified the heavy cutting edge used. The deck of the working chamber was sloped longitudinally upwards towards each shaft and thence downwards to the centre. This precaution was taken to insure complete filling of working chamber concrete against the deck. Directly above the roof, jet nozzles

**Fig. 5—Cutting Edge, Caisson No. 3.**

pointing upwards were placed at 5-foot centres with the outer ends flush with the outside of the sheeting. These nozzles, connected to a header and riser, were placed on each side of the caisson, and formed the jetting system used to reduce the skin friction. It was arranged to have each side operate independently. As the caisson concrete stopped at elevation 60, 4 to 5 feet below the water level, a light cofferdam, braced by flanged pipe, was provided to permit the building of the pier shaft in the dry.

*Caissons 4 to 13*

The borings indicated the probability of difficult sinking through gravel, boulders and shale, and therefore all cutting edges were proportioned to withstand severe conditions. The only riveted steel was in the cutting edge. The skin plates, deck, channels and angles were all electrically welded. The working chamber roof was 6 feet above the cutting edge; hooks were welded to the deck for electric light wires, and U-bolts placed at various points for snatch blocks to pull snags, boulders, etc., from under the cutting edge. To permit the connection to the working chamber of air lines, vents, whistle and other pipes, pipe couplings of proper size were welded to the top side of the deck plates, and nipples were screwed into these couplings from below for any piping required inside. This arrangement left all openings flush with the roof when nipples were removed and all pipes could be used as vents when sealing the working chamber. The manshafts were 42 inches in diameter, the bottom sections were welded to the deck with the underside flush so as to permit bottom doors to be placed without difficulty when raising the locks. Two shafts were provided for each caisson, and located at the centre of area of the material to be removed.

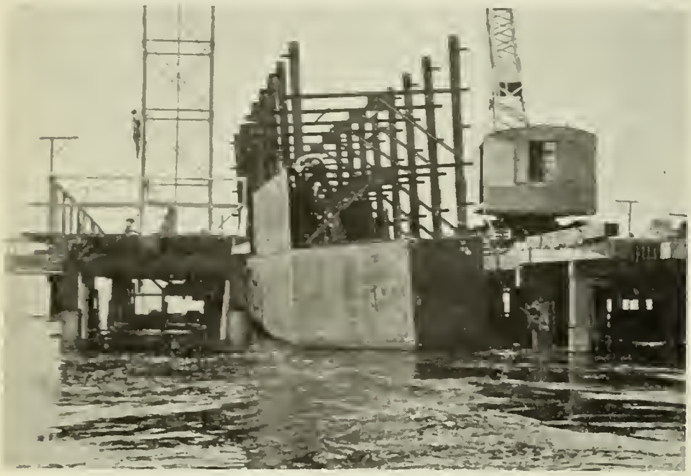


Fig. 6—Erecting Caisson Steel.

The skin plates and bracing above the deck level were designed to withstand the water head imposed under sinking conditions at the different caissons. All skin plates and bracing were electrically welded at junction points. (Fig. 6.)

As the outside shell was specified to be built entirely of steel to elevation 60, due to the uncertainty as to the actual elevation of rock and the corresponding final cutting edge elevation, the caisson steel was built up to within 4 or 5 feet of the designed height, assuming contract rock elevations to be correct, and flanged steel panels provided to complete the steel skin to elevation 60. A wooden cofferdam was provided to withstand the water head above the top of the steel caisson.

For each caisson, flotation and sinking diagrams were made to determine the height to which the caisson plates should be carried, the cofferdam requirements and the concreting schedule.

### Preparation of River Bottom

At pier No. 3, located at the water's edge, the site of the caisson was first dredged to a depth of 4 feet so as to remove all snags and boulders, and then backfilled to elevation 65 with sand, the water being then at elevation 64.

At the other pier sites, careful soundings were taken to determine the general profile of the bottom and where necessary the high points were either clammed off or sand bag walls built up to the high level to enable the caisson to land plumb and in position. Where the river bottom was found to be practically level, no preliminary preparations were made. As soon as sufficient concrete weight was on the caisson, air was applied; the sand hogs placed bags under the cutting edge and removed the high points under the side walls.

### Erection and Lowering of Caissons

The caisson steel for piers 4, 5 and 6 was fabricated at the Lachine shops of the Dominion Bridge Company Limited. Trucks and trailers transported it to the job in sections that could be handled by the job derrick, which transferred it to lorries on the trestle, and by means of the tructractors it was hauled to the caisson site. The crane assembled the steel at each pier site on ten 12-inch by 12-inch timbers spanning across the caisson berth. The first build-up was about 14 feet; all field welding being done with four General Electric welding machines. The "high air" for riveting the cutting edge was supplied by the air plant north of Lasalle boulevard.

The method employed to lower the caissons is shown in Fig. 7 and was as follows:—

Twelve-inch H-beams 60 feet long were placed on the side platforms parallel to the caisson. Five 12-inch by 12-inch posts, capped longitudinally by 12-inch by 12-inch timber and braced to the platforn s, provided support for ten I-beams (15 inches at 42 pounds) placed at right angles to the timbers and spanning over the caisson. These I-beams were paired, bolted together with wooden clamps and separated a sufficient distance to allow eyebar straps to pass between the flanges. A pin across the tops of the I-beams held the straps in place. Two triple blocks with shackles and becket reeved with 1¼-inch manilla rope were attached to these straps and to a similar arrangement which held an 8-inch H-beam under the cutting edge of the caisson, this H-beam being securely blocked under the 12-inch channel of the cutting edge. The lead from each top block led to a 15-ton hand winch. Five winches were used on each side. The caisson was then raised until clear of the timbers, which were removed, and the caisson lowered until floating. The load on each winch was about 6 tons, the maximum weight to be handled being 60 tons on ten winches.

This operation took from one to two hours. After the caisson floated the lowering frame was removed to be re-

Fig. 7—Lowering Caisson.

used on the next caisson. Generally, the lowering was started in the afternoon and the night crew had removed all lowering apparatus by the following morning, permitting the erection crew to start on the second build-up on the morning shift.

In some cases, after lowering, and before the third build-up, it was necessary to concrete to increase the stability.

### Landing Caissons on River Bottom

A 60-foot tubular frame steel concrete tower and hoist, air operated, was erected on the 12-foot platform opposite the centre of the caisson; the platform, cut away under the tower, permitted the bucket to drop below platform level, and concrete to be dumped directly into the tower bucket.

The concrete was delivered ready mixed to the job on Lasalle boulevard, chuted to a ten-yard hopper at the trestle level, then transported to the concrete tower by the tructractors, which were equipped with a one-yard automatic dumping bucket. Three trucks were used, handling an average of 30 cubic yards an hour. This output required the use of ten to twelve four-yard trucks, the haul from the Montreal plant being 6 miles.

From the tower the concrete was chuted directly into a central hopper on the caisson, and chutes distributed the concrete where desired, so as to keep the caisson floating level. (See Fig. 8.)

Before sinking, five 12-inch by 12-inch vertical greased guides were placed along each side of the caisson for lateral support, and the up and downstream position was controlled by tackles.

Great care was taken to land the cutting edge on the river bottom in its proper position. With the caisson thus properly "landed," it was fitted up for air; and as air was put on, enough weight of concrete was placed to overcome the air pressure. As soon as the water in the working chamber was lowered to a workable depth, the gang was sent in, to place the clapper valves, high air manifolds, and level the high and low spots preparatory to actual sinking. These precautions in landing have been justified, as the caissons were narrow and very little tolerance had been allowed in the design between caisson and shaft sizes.

Rod soundings were made in the working chamber under air, to determine the existence of obstructions and when it was evident that the bottom was clear, sufficient concrete was added for sinking.

### Air Plant

The air plant erected on a leased property north of Lasalle boulevard consisted of one 831-cubic foot and one 1,196-cubic foot low pressure compressor, one of these being intended as emergency equipment. A 600-cubic foot high pressure compressor supplied the high air requirements. These machines were all electrically driven, with two independent sources of electrical energy. Cooling water for the compressors was supplied by a motor-driven pump located at the river, which raised the water to a gravity tank in the compressor room. The water main on Lasalle boulevard was also tapped for an emergency supply. The high and low air compressors were arranged to pass the air through after-coolers before entering the three receivers in the compressor house, and the valves arranged so that the high air could pass into the low air receivers in emergencies. The low air was carried through two 6-inch lines from the compressor house to the foot of the river bank and from there through two 4-inch lines along the trestle to the caissons. The high air line was a 4-inch pipe and during the sinking of pier No. 3, which was done in cold weather, the air was passed through a pre-heater, to prevent freezing at the exhausts of jack hammers, tugger hoists, paving busters and other air tools.

**Fig. 8—Caisson No. 4 under Air.**

At each caisson the two low air lines were manifolded to enable the use of either line in case of breakage of pipes. A 4-inch air hose tapped the main line and led to a manifold placed on each lock platform. These manifolds supplied air to two 4-inch air hose, one leading to the main caisson supply pipe, and the other to a 4-inch connection under the bottom door of the lock. Gauges on this manifold, watched by the locktender's helper, controlled the pressure in the working chamber. Telephone connections were provided from the working chamber to the outside on the lock platform, and also from the trestle directly to the compressor room and field office. In this manner, complete control of air requirements was possible.

Two locks of the Moran type were used on each caisson. These locks were fitted with jib-boom derricks and the material buckets hoisted with "Little Tugger" air hoists. The buckets were tipped into steel chutes which dumped the muck where desired. When mucking sticky material, water supplied to the chutes prevented any stoppage due to piling up of material.

This method of equipping caissons for river work is a distinct departure from the standard practice. Usually, the dirt buckets are handled by derrick boats and the materials deposited with a boom either on scows or directly into the river, and the derrick boats are also used to raise locks, build-up and concrete caissons, etc. On this work, the locks were raised and shafting extended by means of the crane, using the usual bottom door at the deck of the working chamber and removing one lock at a time; the gang mucking through the other lock in the meanwhile.

### Sinking Caissons to Final Positions

A record chart of sinking caisson No. 3 is shown in Fig. 9. This particular caisson proved to be one of the most difficult to sink. As noted on the chart, the caisson was carried down through 30 feet of boulders and rock, and skin friction as high as 800 pounds per square foot was developed. The boulders were mostly under half cubic yard size, being too large to be placed directly in the 30-inch diameter muck bucket.

To make sure that the caisson would not become boulder bound, the cutting edge was blocked up before each drop by 12-inch by 12-inch timbers, mudded up, boulders removed; then the blocks were "shot." A slight movement would follow removal of the blocking. The caisson was then "blown" by reducing the air pressure until sinking movement started. When the caisson failed to move after blowing, the water jets were started, air raised about 5 pounds above theoretical requirements, shut off and reduced to 5 pounds above atmosphere. In all cases movement started after this procedure and the full drop was made.

During the blowing operations the gang was taken out of the caissons. As said before very little tolerance in

Table I

| Pier No. | Size of Caissons | Water Level During Construction | Elevation of River Bottom | Depth of River | Average Elevation-Bottom of Piers | Depth Sunk Below River Bed | Total Height of Piers |
|---|---|---|---|---|---|---|---|
| 1 | 32′ 1½×13′ 1½ | .... | .... | .... | 89.0 | .... | 30.9 |
| 3 | 20×74 | 63.0 | 64.4 | .... | 21.1 | 43.3 | 72.9 |
| 4 | 20×74 | 66.1 | 54.2 | 11.9 | 17.0 | 37.2 | 77.0 |
| 5 | 14×72 | 64.0 | 38.4 | 25.6 | 12.7 | 25.7 | 81.3 |
| 6 | 14×60 | 63.6 | 50.9 | 12.7 | 16.3 | 34.6 | 77.7 |
| 7 | 14×60 | 63.6 | 38.9 | 24.7 | 23.2 | 15.7 | 70.8 |
| 8 | 14×60 | 63.1 | 39.7 | 23.4 | 20.2 | 19.5 | 73.8 |
| 9 | 14×60 | 62.7 | 31.9 | 30.8 | 7.3 | 24.6 | 86.7 |
| 10 | 18×72 | 62.7 | 34.1 | 28.6 | 4.3 | 29.8 | 89.7 |
| 11 | 18×72 | 61.5 | 41.0 | 20.5 | 10.0 | 31.0 | 84.0 |
| 12 | 20×74 | 61.7 | 48.3 | 13.4 | 24.0 | 24.3 | 67.0 |
| 13 | 20×74 | 62.4 | 42.8 | 19.6 | 23.1 | 19.7 | 67.9 |
| 14 | 42′3×14′11 | 63.5 | 63.5 | .... | 60.0 | 3.5 | 59.9 |

Note:—Pier No. 1—On shore. Piers Nos. 3 to 13—Pneumatic caissons. Pier No. 14—Open cofferdam.

location had been allowed for the caissons, and extreme precautions were required to hold all caissons plumb and in position. The caisson's cutting edge, as a rule, was carried down a few feet into the rock and excavation continued until a satisfactory rock bottom was reached. Ten-foot by 10-foot test pits were excavated 4 feet deep into the rock and 5- to 6-foot holes drilled to make certain that no mud seams or cavities existed below the level of the excavation. Figure 10 is from a photograph showing actual conditions in the working chamber.

Figure 11 shows a cross section of the river with the depths to which the various caissons were sunk and the nature of the material encountered. Particulars are given in Table I.

Considering the narrow widths of the caissons and the depths sunk, the final locations were remarkably good. This was due to the precautions taken in landing on the river bottom, the daily checking of caisson locations, the side guides and cribs and, most of all, to the expertness of the pressure foremen on the job.

After the bed rock had been cleaned off, test pits and drill holes made, the bottom was inspected and passed by the engineers of the Lake St. Louis Bridge Corporation.

The rock generally lay in strata dipping upstream. In some of the caissons, alternate layers of shale and limestone were found. In pier 6, for instance, the bed rock consisted of a 4-foot layer of hard limestone underlain by shale. Due to a crevice running diagonally across the caisson and extending to the shale, it was necessary to clean out the loose material. The limestone being very blocky, a great deal of air was required due to losses through the crevices. The bottom of the excavation was 9 feet 6 inches below the cutting edge. In caisson No. 5, a 4-foot layer of hardpan was encountered in the river bottom, necessitating the use of air tools and mudding up under the cutting edge as soon as sinking operations started. Before each drop, due to insufficient cover outside the caisson, a blow would occur, flooding the caison to the cutting edge.

In the case of pier No. 10, after the deflector and side cribs had been installed (as described later in the paper), a test boring was taken 23 feet upstream from the nose of the caisson. This boring struck rock at elevation 3.7, about 18 feet lower than expected. The boring further disclosed that the river bottom was covered with about 2 feet of gravel and boulders with 27 feet of sand extending to rock. Considerable indication of scour was noted around the south side of the deflector, and there was also the possibility that the gravel and boulder surface did not extend over the whole area, as there had been little difficulty in driving the piles for the side cribs to a penetration of 8 to 13 feet. Pier No. 10 as designed, was 14 feet wide by 60 feet long at the base, with a height from rock of 72 feet and 80 feet from the bottom. The above boring made the height from rock 90 feet giving this pier a slenderness ratio of nearly 7. The river bottom around the pier might scour to a greater depth, therefore aggravating the situation, the velocity of the current at this point being at least 6 miles an hour. Regarding these conditions, it was finally

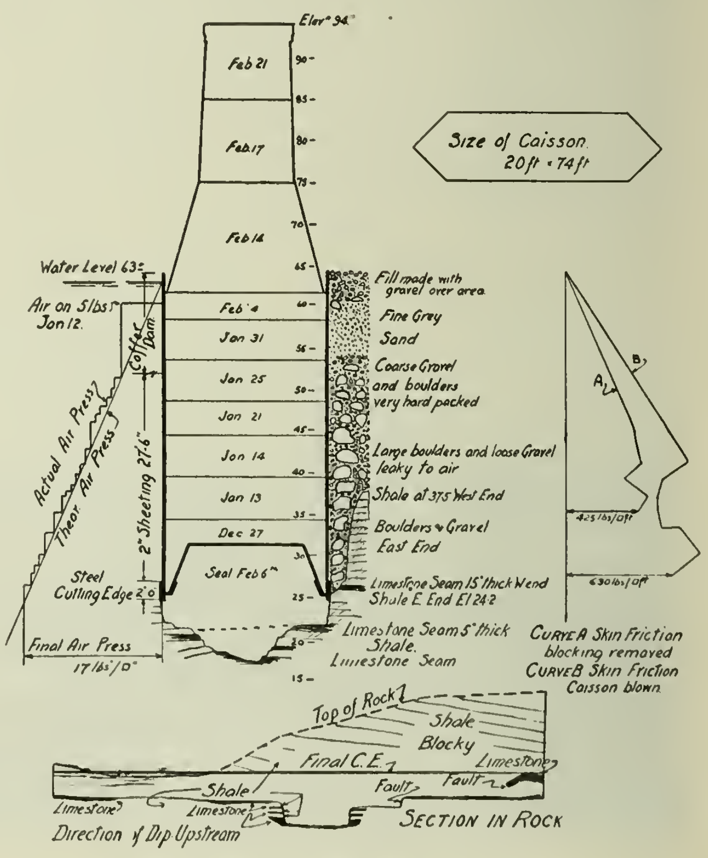


Fig. 9—Record Chart, Caisson Pier No. 3.

decided to increase the size of this caisson to 18 feet by 72 feet at the base to a height of 46 feet above the cutting edge, and from this point build a cofferdam, stepping the concrete to 14 feet by 60 feet using ⅛-inch liner plates up to elevation 60.0. The distance between side cribs permitted this increase without change of location.

Pier No. 2 was located near the edge of a high bank underlain by a 14-foot bed of blue clay, part of which was soft and plastic. As a street exists just to the north of this pier there was also a possibility of endangering, either during construction or later, the water, sewer and gas mains. There was also the possibility that the pier might be disturbed or moved laterally after its completion. It was therefore decided to abandon this pier and construct the steel span from No. 3 to No. 1. Pier No. 3 being carried to rock did not require any increase in size, whilst pier No. 1 was enlarged sufficiently to carry the increased load.

**Fig. 10—Working Chamber of Caisson No. 3.**

### Sealing the Working Chamber

A 19-inch diameter by 2-foot high tube, fitted at the bottom with a ½-inch rubber gasket and supported by timber, was placed on the bottom door of the lock. Above this tube, a conical wooden hopper, lined with sheet iron, was built within the lock. Ladder rungs were provided to enable the sand hogs to pass through the hopper to the main shaft. This hopper was made removable to be re-used in other locks. The concrete was chuted to the hopper, 2 cubic yards constituting a batch; top door closed, air applied, and the mass allowed to drop to the working chamber where it was shovelled into place by sand hogs. This operation continued until the concrete reached to within 3 feet of the deck, care being taken that it was level and well packed under the cutting edges. Concreting was then stopped until lights, fittings, valves and nipples were removed, and all men out of the working chamber, and then continued, using a ¾-inch gravel concrete with a 7- to 8-inch slump (adding cement to maintain the cement water ratio), until it rose in the shafts 20 to 30 feet above the deck. The gate valves controlling the air lines leading to the locks were then opened and those leading to the working chamber closed. All of the pipes leading into the working chamber were fitted on the open air end with stop cocks and, as the concreting continued, were opened from time to time until any accumulated water in the working chamber was forced out, the water spouting from the pipes until they were plugged by concrete reaching the working chamber roof level. When the concrete reached 10 to 20 feet above the deck, the air on one shaft was raised 10 pounds above the theoretical and lowered on the other shaft, inducing a flow from shaft to shaft and filling any cavity that may have existed under the working chamber roof. The concreting in the shafts was continued for a height of 30 feet above the deck, thus creating a pressure head equivalent to the weight of a 30-foot column of concrete on the semi-fluid mass in the caisson. To insure absolute contact between the working chamber concrete mass and the deck, neat cement grout under 100 pounds pressure was applied to each vent pipe with the remaining pipes open to atmospheric pressure. In most cases, no grout was forced into the chamber. Fifty bags of cement was the maximum used on any one caisson in this grouting operation. In the caisson of pier No. 5, the shafts were filled to about 44 feet above the cutting edge, creating a pressure of 30 pounds per square inch on the plastic mass in the working chamber. In addition 34 pounds per square inch of pressure were maintained on the locks and 100 pounds applied to the neat cement in the grouting machine, the grout being applied immediately after the sealing. Thus there was approximately 164 pounds pressure acting on a confined fluid mass in the working chamber. All vent pipes were opened and no grout could be forced in the chamber. Properly placed and properly grouted, it is believed that this method of sealing the working chamber is preferable to the old benching method.

### Pier Shafts

The shafts and caissons for piers 3 and 4 were designed for a future lift span intended to replace the present span should the St. Lawrence waterways project become an actuality. All piers were built with standard ice breaker noses. The up and downstream noses and corners are protected from ice damage by ¾-inch steel plates anchored securely into the concrete pier mass.

Each pier shaft was concreted in three lifts, using the steel concrete tower erected alongside on the working platform. The bearing areas of the bridge seats were left ¼ inch high and afterwards bush hammered to the proper level surface.

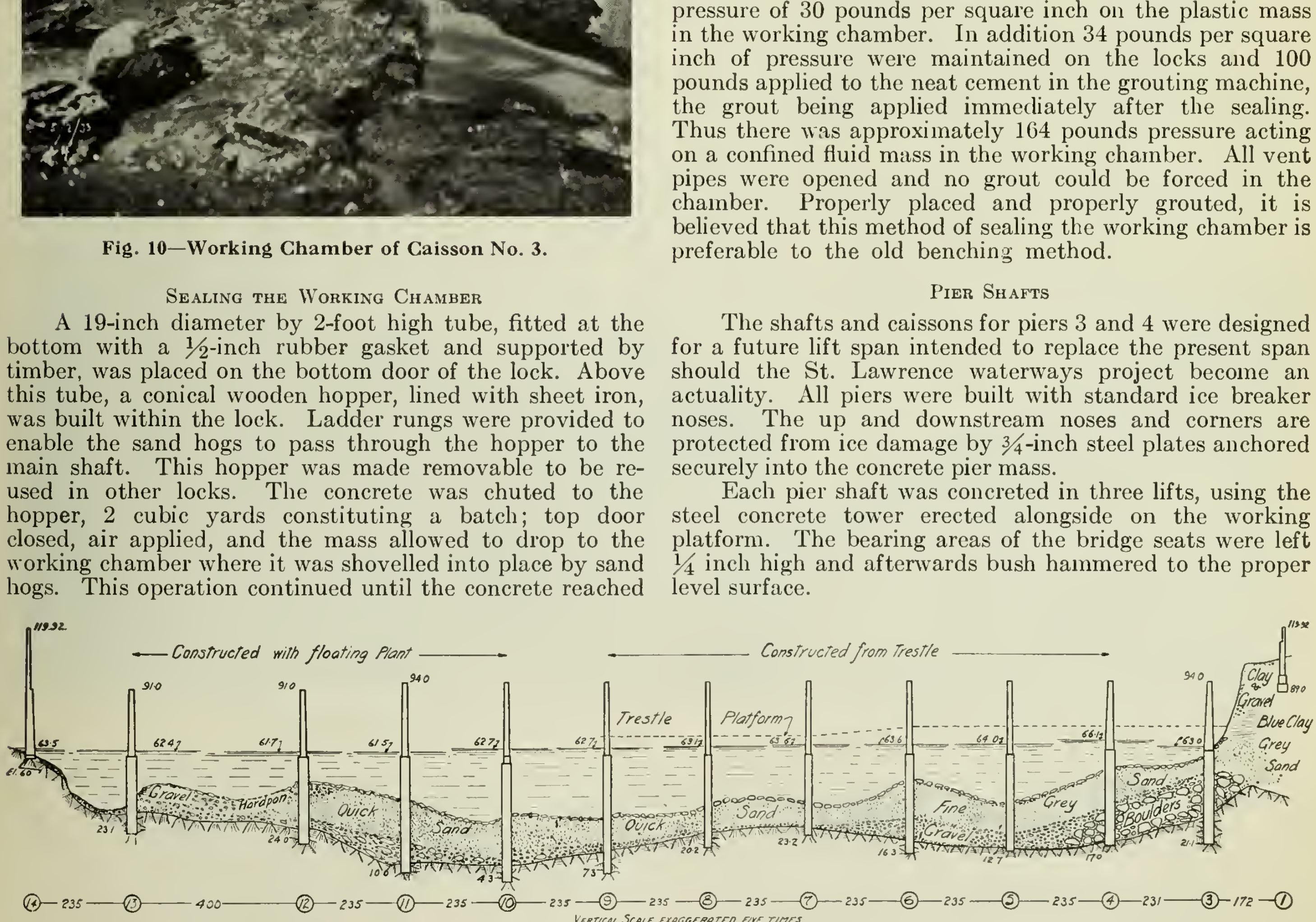



**Fig. 11—Cross Section of River.**

### Concrete for Piers

The coarse aggregate was crushed stone graded in size from ¼ inch to 1½ inch having a fineness modulus of 8.1; and ¼ inch to ¾ inch having a fineness modulus of 7.6. The coarse aggregate of the concrete used for the sealing of the working chamber was ¾-inch washed gravel. The fine aggregate was either washed pit sand having a fineness modulus of 2.8 or Lake of Two Mountains sand having a fineness modulus of 2.6.

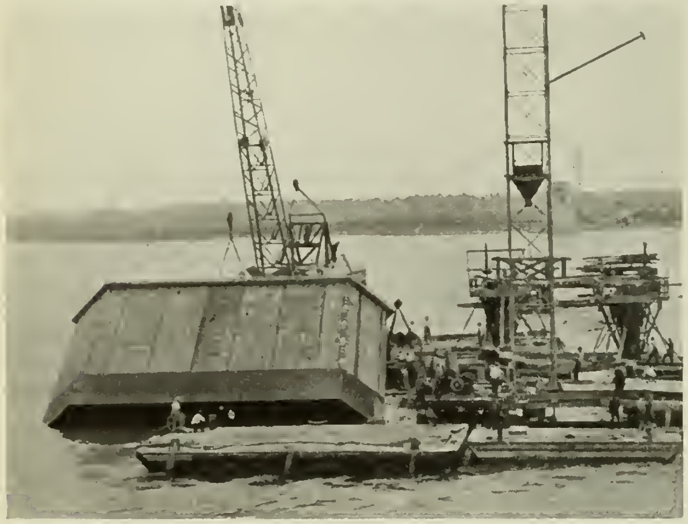


Fig. 12 *Masson* lifting Caisson No. 9 at Pier Site.

Cylinder tests were made on approximately every 100 cubic yards of concrete poured. Cylinders were made from concrete taken at trucks, in the hoppers, and in the forms. Tests were made at seven and twenty-eight days, and averages for the different classes of concrete were as in Table II.

Table II

| | 7 days | 28 days | 3 months | Average Slump |
|---|---|---|---|---|
| 2,000 pounds | 1,950 pounds | 2,600 pounds | .... | 4 inches |
| 2,500 " | 2,380 " | 3,030 " | .... | 4 " |
| 2,000 " (¾-inch gravel) | 1,956 " | 2,564 " | 3,036 pounds | 7 and 8 inches |

### Progress of Work

Before the spring of 1933, a sub-contract had been let for the construction in the river of piers No. 7 to 13 inclusive. Early in March, a schedule of progress had been submitted by the sub-contractor and approved by the general contractor, in which provision was made for the completion during the month of December 1933 of piers No. 7, 8, 9 and 10, the three remaining piers, Nos. 11, 12 and 13, to be completed by September 1st, 1934. The steel tube combination trestle and breakwater had been developed by the general contractor as a consequence of his decision not to use his own floating equipment, which was at the same time the object of sub-letting piers No. 7 to 13 to the sub-contractor, who, on the contrary, was anxious to use on that work the large floating equipment which he had available.

During the month of May, the sub-contractor began preparations to start work; his first move being the construction of a wharf, 1,500 feet downstream from the bridge site, to accommodate his floating equipment and receive materials. At that time, the general contractor's work had reached the point where the success of the steel tube combination trestle had become evident and progress was becoming so rapid that an opportunity was seen to advance considerably the date of completion of the entire river work if the use of the trestle could be extended further than originally intended, so that three of the four piers which were to be completed during the first season could be completed by that method early in the summer, allowing the sub-contractor to concentrate the work of his fleet on the four remaining piers three of which were to be completed only the following year. Accordingly, the general contractor submitted this plan to the sub-contractor who, in the meantime, had succeeded in bringing his floating equipment to the site somewhat earlier than originally expected. It appeared to both the general contractor and the sub-contractor that a very substantial saving in time might be effected by a virtual pooling of the two plants and organizations and by extending the trestle and concentrating the floating plant on the south side of the river. A combination along these lines was agreed upon with exceedingly satisfactory results and, with the exception of minor details on the approaches, the entire substructure was completed before the end of November 1933 or exactly twelve months ahead of schedule.

This agreement was completed before the end of May, and as a consequence, all work beyond pier No. 6 was continued up to pier No. 9, by means of the steel tube combination trestle and breakwater in the same manner as the general contractor had proceeded up to then, but with the difference that from then on the general contractor's plant and organization passed under the supervision of the sub-contractor, who then abandoned the wharf downstream, and used the trestle as his dock, to anchor his fleet and receive his material. Between piers No. 6 and 9, the floor construction of this trestle was made lighter, since it had only to carry the tructractors and the lorries. The deck was also lowered by 3 feet, the water level at the time of construction having gone down that much. The trestle was erected with a derrick boat. The caissons for piers No. 7, 8 and 9 were built on the banks of the Lachine canal at the Dominion Bridge Company's docks, and floated on their sides to the pier sites and righted and placed in their berths by a 25-ton derrick boat. (Fig. 12.) These three caissons being only 14 feet wide were too unstable to be floated in an upright position.

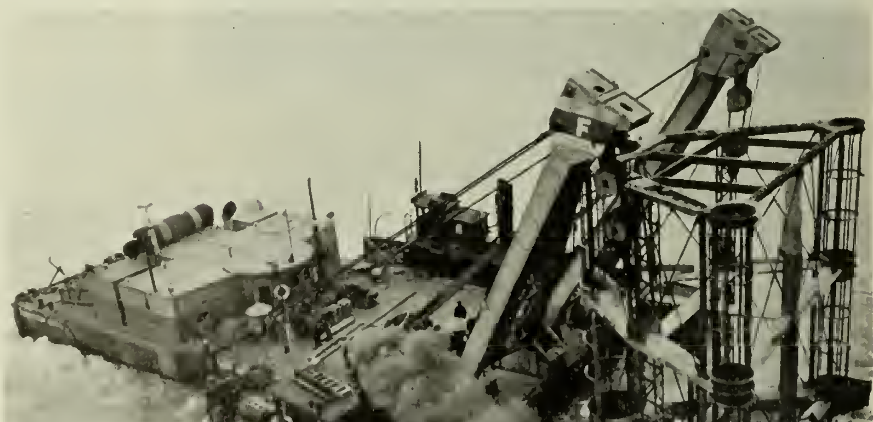
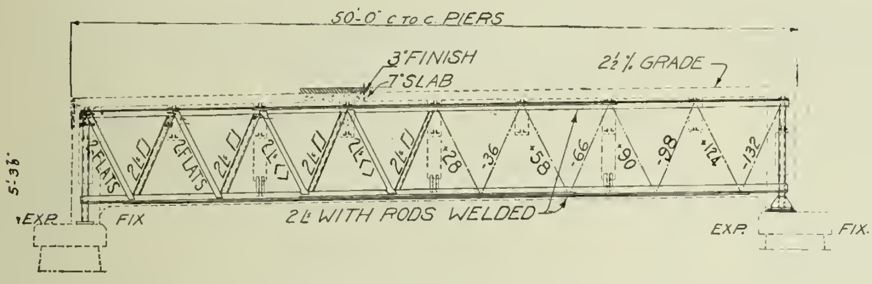


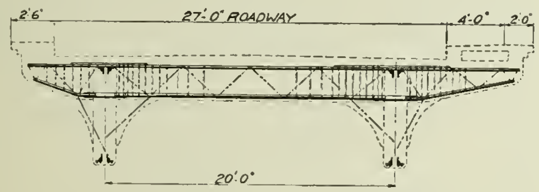
Fig. 13—*Scarboro* and Deflector.

### Floating Equipment and Deflectors

Piers Nos. 10 to 13 inclusive were constructed by the sub-contractor exclusively with floating equipment, the most important piece of which was the 250-ton work-boat *Foundation Scarboro,* especially designed for the handling and sinking of pneumatic caissons, and fitted with powerful shear legs for this purpose. This boat is equipped to furnish 2,000 c.f.m. of low pressure air and 750 c.f.m. of high pressure air.




**Elevation of Main Truss.**




**Section Showing Cross Beam.**

**Fig. 14—Viaduct—Light Structural Steel Kane Truss.**

Primary power is derived from twin Diesel electric generators complying with the usual requirements of two independent sources of power, both high and low pressure air are furnished from electrically driven compressors to give complete duplication back to the source of primary power. High and low pressure air for tools and divers are furnished from separate systems. Water, electric light and power are furnished from the ship's pumps and generators. The vessel is manoeuvred from two anchor winches which have a capacity of 18,000 pounds pull on a single line, and able to handle anchors for a 7,000-ton ship. Lateral lines and stern anchors, when required, are handled from two warping winches each having two drums and one warping head. The bo t is equipped with a decompression lock, and all requirements for handling pressure workers. On this particular work, the *Scarboro* placed the "deflector" (as shown in Fig. 13), which ultimately formed the anchorage for the caissons and furnished air for sinking; the current deflector forms part of the *Scarboro* equipment, the shear legs on the vessel being designed so that a deflector of the maximum width practical for navigating through the St. Lawrence canal could be held between the legs, and the ship navigated in inland waters with the deflector in place. The purpose of this deflector is to form an anchorage and to break the current. It is arranged in triangular form to adapt itself to fairly uneven surfaces with all three legs bearing. The triangular form also lends itself to efficient streamlining. Means are provided for forming a foundation for the legs of the deflector so that the whole structure may be held level within the degree of accuracy required. After the deflector is set in position, heavy steel and concrete sheet piles are placed along the two upstream sides of the triangle and tied into the structural framework, thus adding to the weight and relieving the device to a great extent of its tendency to slide on the bottom. When thus sheeted the deflector forms a very substantial and solid anchorage and does not require additional support, although as a matter of precaution in the swifter water anchor lines were run from the nose, exerting a more or less uniform pull due to the sag in the anchor cables. The downstream legs are also arranged for spuds if required. A deflector in position for pier No. 12 may be seen in Fig. 1.

From these 150-ton current deflectors, lines were led to tandem steel pontoons anchored with 4-ton ship anchors and seen in Fig. 1 near pier No. 12. Each pair of pontoons was equipped with a double drum hoist and boiler, thus affording means to adjust its position with block and tackle. This arrangement of anchors provides for the strain of any given line to be distributed to at least two anchors, and permits of the proper distribution of load between any pair of anchors compensating for any dragging. Other various items of floating plant were conveniently moored to these pontoons. Side cribs consisting of tower bents similar to those used for the trestle construction were constructed at each of these piers, and were found absolutely necessary for the guiding of the caissons. Caissons 10 to 13 were launched similarly to 7, 8, and 9, lashed alongside a scow and floated to the job in an upright position.

The combination of the two methods above described enabled the contractors to obtain the greatest possible economy, eliminated much hazard, and speeded work to such an extent that all river piers were completed, and the river cleared by November 1st, 1933. This was very fortunate, considering the zero weather which was experienced early in November and the premature winter which followed.

### Safety Precautions

Every known precaution was taken to prevent accidents and sickness, and it is gratifying to state that the entire job was carried through without a single major accident. There were no permanent disabilities and no real case of bends resulting from the air operations. The time of decompression established by good practice was followed and recorded on an automatic gauge attached to the lock.

**Fig. 15—South Viaduct, Deck under Construction.**

A well equipped first-aid room in charge of competent day and night nurses, and under the supervision of a physician, attended to all injuries, and the fine work of this staff contributed very largely to the low casualty record of this job.

The sand hog houses were located next to the compressor plant and were built around the hospital lock, with clothes lockers along the walls. They were heated, provided with showers and tubs, and in charge of an experienced sand hog whose duties were to provide the regulation coffee, keep the place clean, and decompress such men as required treatment in the hospital lock.

### Approach Viaducts and Embankments

The work on the south shore consisted of a large earth fill (137,000 cubic yards), an abutment wall and a concrete viaduct 1,250 feet long.

The south abutment and viaduct and river pier No. 14 are built on an island, Isle Maligne, with water about four feet deep separating it from the mainland. The approach fill extends from the present provincial highway No. 3 across a shallow creek to the abutment on this island, a 7-foot by 8-foot concrete culvert being built to take care of the water from this creek.

The distinguishing feature of the viaduct was the use of a system of light structural steel for reinforcing and form supports and special viaduct form work. The viaduct is supported on 24 piers varying in height from 24 to 54 feet above the rock on which they are founded. The deck is carried on two longitudinal concrete girders 7 feet 6 inches deep with nine cross girders, 2 feet 6 inches deep, the sidewalk being carried on cantilever brackets. The system of light structural steel members utilized (Fig. 14) is strong enough to carry the forms and green concrete, and then becomes a permanent reinforcement for the concrete itself. This design was detailed and the material furnished by the Dominion Bridge Company. The steel trusses were entirely shop welded. Stirrups were used on the floorbeams to resist shear. Vertical and longitudinal reinforcing rods and angle braces were used on the main girders. They were intended as surface reinforcing rather than for strength.

The steel trusses and floorbeams were shipped by rail from the Lachine shops to the Adirondack siding on the south side of the river. They were then trucked to the site and erected with a caterpillar crane; the twenty-five spans were put in place ready for concrete in ten working days. All field connections were bolted. The forms for the bottom of the main girders were built on double 2-inch by 12-inch cross stringers, hung close to the bottoms of the girders by means of specially designed U-shaped hangers with removable bolts. The stringers were 36 feet long extending under the complete width of the slab. Scaffold planks were laid on these to provide a safe working platform for erecting and stripping forms, and finishing the surface of the concrete. After the platform was prepared, the forms for the beam sides and bottoms were placed and suspended from the steel work. Metal forms were used for the curved bottoms of the brackets. This method eliminated completely the usual falsework to the ground level, this feature alone being an economy of time and expense. Figure 15 shows the south viaduct under construction by this method.

In each span of the deck there are 111 cubic yards of concrete, 5,247 square feet of forms, 12.0 tons of structural steel and 4.75 tons of reinforcing steel. Expansion joints were provided every 50 feet under each main beam. At each expansion joint there is a sliding bearing plate, a copper strip in the concrete, and asphalt expansion material across the deck. Cast iron drain scuppers are placed at intervals of 25 feet, dowels set for the stone balustrade, and conduit pipe for the lighting of the bridge. The balustrade is artificial stone of four members, sill, balusters, rail and posts.

Excavation was started June 13th. Concreting of the columns started July 14th and was completed on September 1st. The pouring of the twenty-five spans of the deck started on September 13th and finished on October 19th, from five to six spans being poured each week.

The concrete plant consisted of a one cubic yard paving mixer on caterpillar tractor, a tubular frame steel tower 90 feet high and a three-compartment material bin, fed by a clam shell bucket, each size of aggregates being weighed on a separate scale. In concreting, all the footings were poured first, then the mixer travelled back pouring columns and finally travelled back for the third time

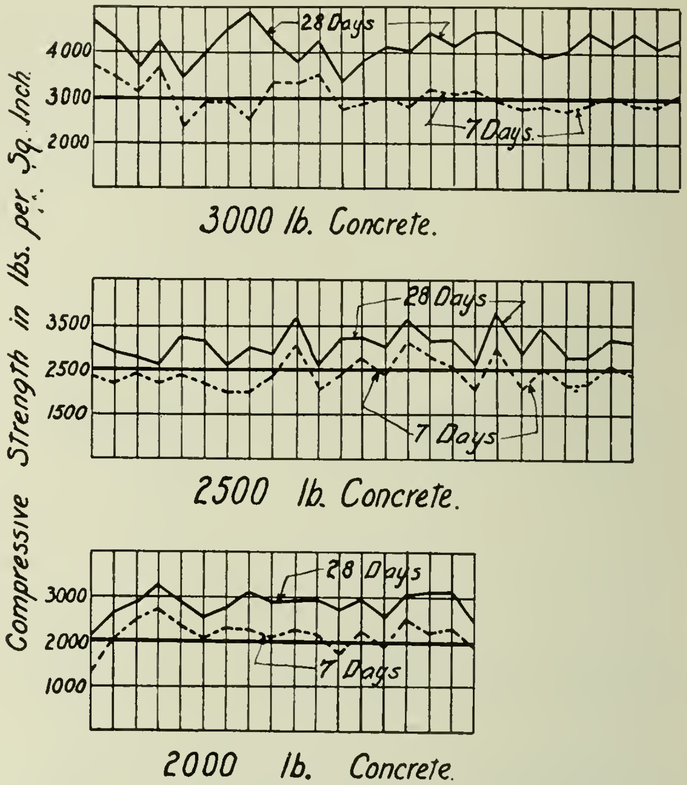



**Fig. 16—Concrete Tests, South Viaduct.**

pouring the deck. A 35-ton caterpillar crane with 65-foot boom was used for handling form material, steel, and aggregates to the bin.

The aggregates used were classified as follows:—

Coarse: Crushed stone ¼ to 1½ inch; fineness modulus 7.9
Crushed stone ¼ to ¾ inch; fineness modulus 6.9.
Fine: Washed pit sand having a fineness modulus of 2.8.

Figure 16 shows the results of compression tests made on the different classes of this concrete.

River pier No. 14 at the south edge of the river was also built from this plant. A timber cofferdam was built for the excavation of the footing of this pier, which was carried into solid rock.

The north viaduct is similar in design to the south viaduct, but is only 300 feet long, with columns having a maximum height of but 16 feet.

The bridge is built for the Lake St. Louis Bridge Corporation under the supervision of Dr. O. O. Lefebvre, M.E.I.C., chief engineer, with Jules A. Beauchemin, A.M.E.I.C., as resident engineer. A. Janin & Company Limited of Montreal are the contractors for the substructure and approaches, with Harry Englander as their resident engineer in charge of river work, and C. J. E. Maxwell as general superintendent. The Foundation Company of Canada Limited were the sub-contractors for the river piers No. 7 to 13 inclusive, the work being in charge of R. Holland, vice-president, and W. U. Smick as their superintendent. The Dominion Bridge Company are the contractors for the superstructure.

# The Steel Superstructure for the Lake St. Louis Bridge

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**Paper presented at the General Professional Meeting of The Engineering Institute of Canada, Montreal, Que., February 8th and 9th, 1934.**

SUMMARY.—The steel spans for the new highway bridge over the St. Lawrence river near Lachine have a total length of nearly three thousand feet, and include a number of simple deck spans, with a continuous tied arch over the present navigation channel. Provision has been made for the replacement of one of the deck spans by a lift span when the projected St. Lawrence Waterway is completed. The paper discusses the design and erection of the steel superstructure, with particular reference to the problems connected with the continuous tied arch.

## General Description

The steel superstructure for the Lake St. Louis bridge is mostly of deck type, but modified to conform to the navigation requirements of the Federal government. It supports a roadway 27 feet wide between kerbs, thus providing for three lines of traffic; and a 4-foot sidewalk, on the upstream side. The roadway is level throughout, with crown at elevation 129.0. The total length of the steel spans is 2,918 feet. Tenders for the superstructure were requested on two alternative designs, A and B, differing in the treatment of spans 11, 12 and 13 at the south end. General elevations of the two designs are shown in Figs. 2 and 3.

In design A, spans 11 and 13 are of simple deck type; but span 12, though simple, is of through type, in order to provide the required overhead clearance at the navigation channel. In design B, which was adopted, spans 11 to 13 inclusive are continuous over four supports, with vertical reactions only, the thrust of the arch ribs being resisted by the bottom tie at the floor level. Furthermore, the top chords of the arch are continuous with those of the anchor spans; thus, in consequence, the structure is called a "continuous tied arch," and may be considered to represent a new type of design.

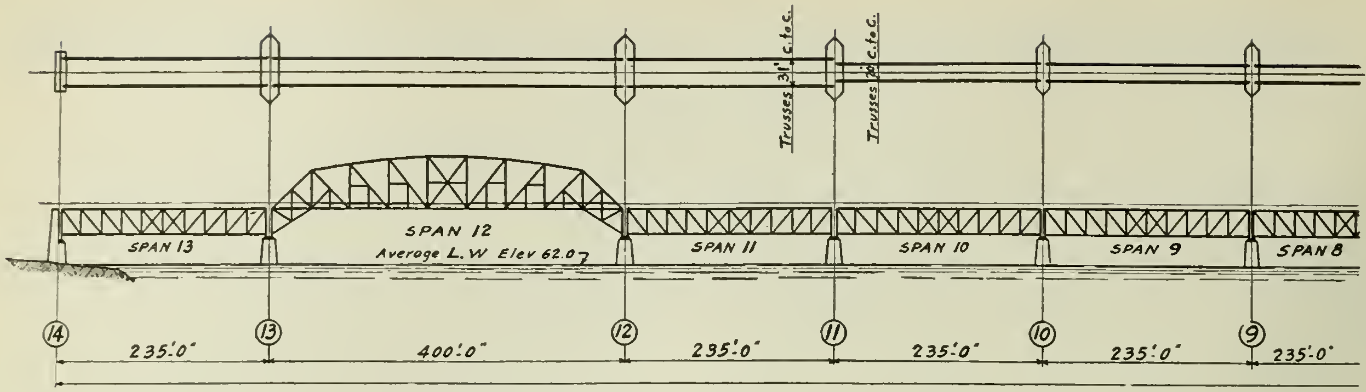
Tenders with estimated weights and unit prices were received on both designs; in which tenders the estimated weight for the three continuous spans in design B was considerably less than that for the corresponding simple spans in design A; but, owing to higher unit prices for the former, the resulting total estimated cost for B was about $5,000 greater than that for A. However, the Lake St. Louis Bridge Corporation was of the opinion that design B, owing to its superior æsthetic value, was well worth the additional cost, and adopted it accordingly.

Hitherto, too little attention has been given to æsthetics when designing steel bridges, particularly in countries of this western hemisphere. In consequence, many persons are convinced that a steel bridge must necessarily be an ugly structure. But no bridge need be ugly, and some may be made beautiful, simply by careful attention to general lines and proportions, and without additional expense. In the present instance, the final lines and proportions for the continuous tied arch were adopted only after much thought and many trials.

In other parts of the steel superstructure, care was exercised to avoid sudden breaks in general outline, particularly in the revised span 2, which was required to conform to somewhat unusual conditions. It is hoped that the resulting bridge will be found pleasing to the eye, as well as satisfactory in other respects. Unfortunately, it is too early to see the completed structure; but a good idea of it may be obtained from the artist's drawing, shown in Fig. 1.

An unusual feature in the design as built, is the use of splayed trusses for spans 5 and 10, in order to facilitate continuous cantilever erection from the north shore to the channel, which method of construction was considered highly desirable on account of the swift current and floating ice. Now the trusses for spans 2, 3 and 4 are spaced 31 feet centre to centre, to provide sufficient clear width for the roadway to pass through the future lift span which may eventually replace the present span 3, as well as to pass through the counterweight towers on the adjacent spans 2 and 4. The trusses for spans 6 to 9 inclusive are spaced 20 feet centre to centre, for economy; and the trusses for the continuous tied arch, or spans 11, 12 and 13, are 31 feet centre to centre, to provide the necessary clear width for the roadway which passes through these trusses, also to

**Fig. 1—Sketch Showing Bridge when Completed.**



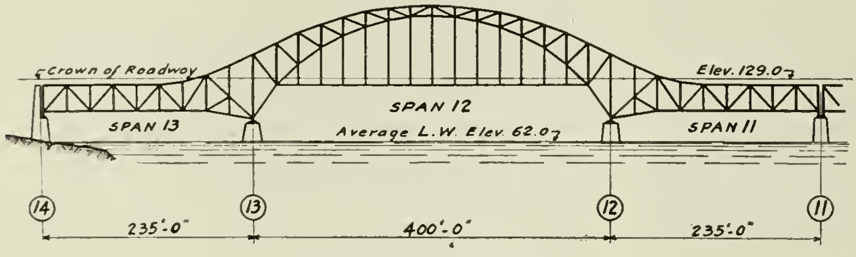




**Fig. 3—Adopted Design B.**

give adequate lateral stability for the 400-foot channel span. In consequence, spans 5 and 10 have been designed with trusses inclined to one another horizontally, to conform at each end to the truss spacing of the adjacent span. In addition to their usefulness during erection, these splayed spans also obviate unsightly breaks in the alignment of the trusses, which would otherwise occur at piers 5 and 11. Moreover, the slight bends in the alignment are scarcely perceptible, even to one familiar with the design, and could not be detected by others unless viewed from the water immediately below the splayed spans.

### Future Lift Span

One of the requirements of the Federal government was that provision should be made for installing a lift span when required, on the line of the projected St. Lawrence Waterway, which is close to the north shore of the river at this point, or between piers 3 and 4. Owing to the uncertainty when the lift span will be required (if ever) and the great cost of this type of structure, the Corporation decided to substitute, as a temporary measure, an ordinary deck span; but to construct the piers and the two adjacent spans so that they will be capable of carrying the future lift span and counterweight towers.

Before the designs for spans 2 and 4 could be completed, it was necessary to develop a design for the future lift span and towers in sufficient detail to determine their weight and the applied wind loads, and thus to obtain the reactions at the front and rear legs of the towers, for dead load, live load, impact and wind. An elevation of this design, including that of the revised span 2 is given in Fig. 4. The span is of through type and provides, when down, a minimum clearance above high water of 50 feet, which will be sufficient to accommodate much of the traffic. With the span up, the clearance will be 120 feet above the highest water in Lake St. Louis (elev. 74.1), as required. The clear distance between piers at the coping is 220 feet. The dead weight of the span will be supported by counterweights inside of the towers, and connected with the ends of the trusses by cables passing over sheaves at the top of the towers. The bridge will be raised or lowered by uphaul and downhaul ropes, operated by winding engines in the machinery house, placed at the top chords and at the centre of the span. The operator's cabin will be immediately below and suspended from the floor of the machinery house. Safety gates for highway traffic will be provided on the adjacent approach spans, located about 75 feet from the ends of the lift span, and interlocked with the bridge mechanism so that the span cannot be raised until the gates are closed.

### Span No. 2

The outline of revised span 2 calls for some explanation. Both of the general designs A and B, upon which tenders were submitted, included a pier (No. 2) located at the edge of the river bank and about 82 feet from pier 1. With this length of span it was practicable to use comparatively shallow girders over Lasalle road, thus providing ample headroom. Later on, it was decided to eliminate pier 2, owing to the unsatisfactory nature of foundation materials, interference with the roadway while excavating and the possibility of considerable lateral thrust on the pier in the event of land slides. The problem then was to provide a structure, spanning the distance between piers 1 and 3 (more than double the length of the original span 1) and without encroaching on the standard clearance of 14 feet over Lasalle road. A design was first submitted, in which the top chords of the trusses were placed above the roadway, in order to obtain sufficient depth for this longer span. Æsthetic considerations were chiefly responsible for the rejection of this design by the Corporation.

In the design as built, the top chords are set as high as possible, without interfering with the space reserved under the sidewalk slab for future telephone or telegraph conduits, and a minimum practicable depth of 13 feet centre to centre of chords is used from pier 1 to the outer edge of the roadway, from which point the bottom chords are curved downwards to a suitable height above the bridge seats on pier 3. The panels are of varying lengths, being longer where the trusses are deeper. The trusses are spaced 31 feet centre to centre, to accommodate the north tower for the future lift span; and the second panel-point in the top chords (counting from pier 3), which will support the back legs, is located so that the inclination of these members will be the same as for corresponding parts on span 4. Although the top chords are higher than those on other sections of the bridge, the break in alignment, due thereto, is scarcely noticeable, due to the proximity of the floor system. At present the height from the roadway to the under side of the steelwork is only 12 feet; but the full clearance of 14 feet will be provided by lowering the roadway. In order to maintain consecutive numbering throughout, this section of the structure is called span 2. The saving due to the elimination of pier 2 was more than sufficient to offset the increased cost of the single span over the two shorter spans of the original design.

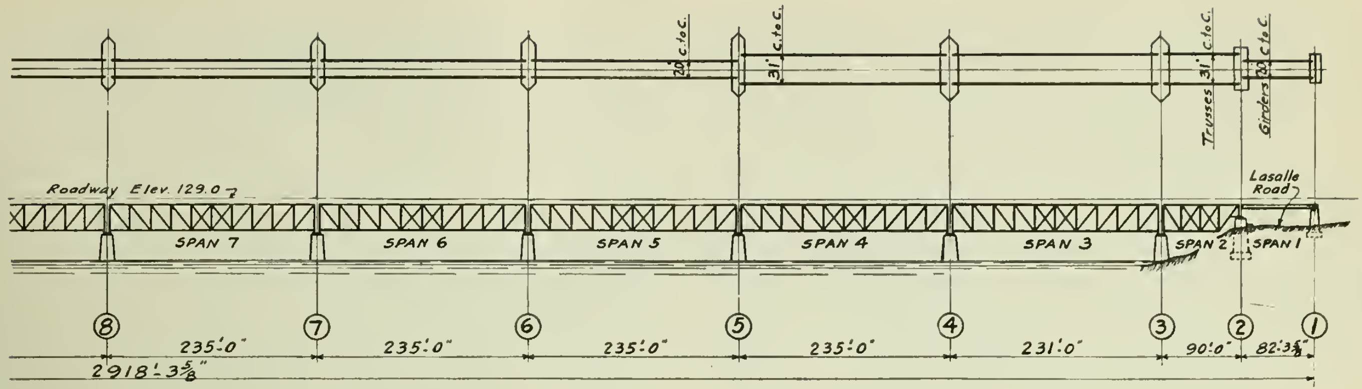



Fig. 2—Design A.

### Span No. 4

Span 4 is designed to support the south tower for the future lift span, and thus the trusses are spaced 31 feet centres, as are those of span 2.

### Spans 6 to 9

Spans 6 to 9 inclusive are of ordinary deck type, with trusses spaced 20 feet centre to centre. The floorbeams are supported on the top chords of the trusses, overhanging upstream and downstream to carry the roadway and sidewalk.

### Splayed Spans 5 and 10

Spans 5 and 10 are similar to spans 6 to 9, but the trusses are spaced 31 feet centre to centre at one end and 20 feet at the other, to align with those of adjacent spans and thus facilitate cantilever erection, as stated previously. Resulting from this unusual spacing of the trusses, the floorbeams are all different from one another; moreover, the dead loads on the heavy or upstream truss, which carries the sidewalk, increase from the wide to the narrow end, whilst the dead loads on the downstream truss decrease; thus involving much tedious labour in working out this part of the design. The resulting sections for the truss members of the splayed spans are only slightly different from those of spans 6 to 9; in consequence, it was found convenient to include on the same shop drawings all similar members for six spans, 6 to 9 inclusive, noting differences where they occurred.

### Continuous Tied Arch

The distinguishing feature of the bridge is the continuous tied arch, comprising spans 11, 12 and 13. In the development of its general design, as well as in detailing, many interesting problems have arisen and have been successfully solved; thus an entire paper should be devoted to its description. It is understood that such a paper will be presented to The Institute at a later date. In consequence, only a few points will be touched upon at this time.

The tied arch is more generally used either as a complete bridge in itself, supported on abutments, or as a suspended span, supported on the ends of the cantilever arms of two anchor spans. In the latter case, top-chord members are provided, for erection purposes, in the panel immediately landward of the points of support for the arch. After erection these members are cut at one end and provided with a sliding joint, to break the continuity; they thus become idle members, but are left in place to conform to æsthetic requirements.

The continuous tied arch resembles the simple tied arch, supported on the cantilevered arms of anchor spans; but the top chords at the ends of the arch are not cut after erection, and thus continue to be effective members of the structure, resulting in economy of materials and greater rigidity. In this design, an articulated joint at the point where the bottom tie meets the arch rib becomes unnecessary, which is a great advantage in view of the complicated details at this point, where provision must also be made for transverse bending moments of considerable magnitude due to wind loads. For calculation of stresses, the arch is assumed to be hinged at the crown, although the joint at this point is actually riveted. The lower chord

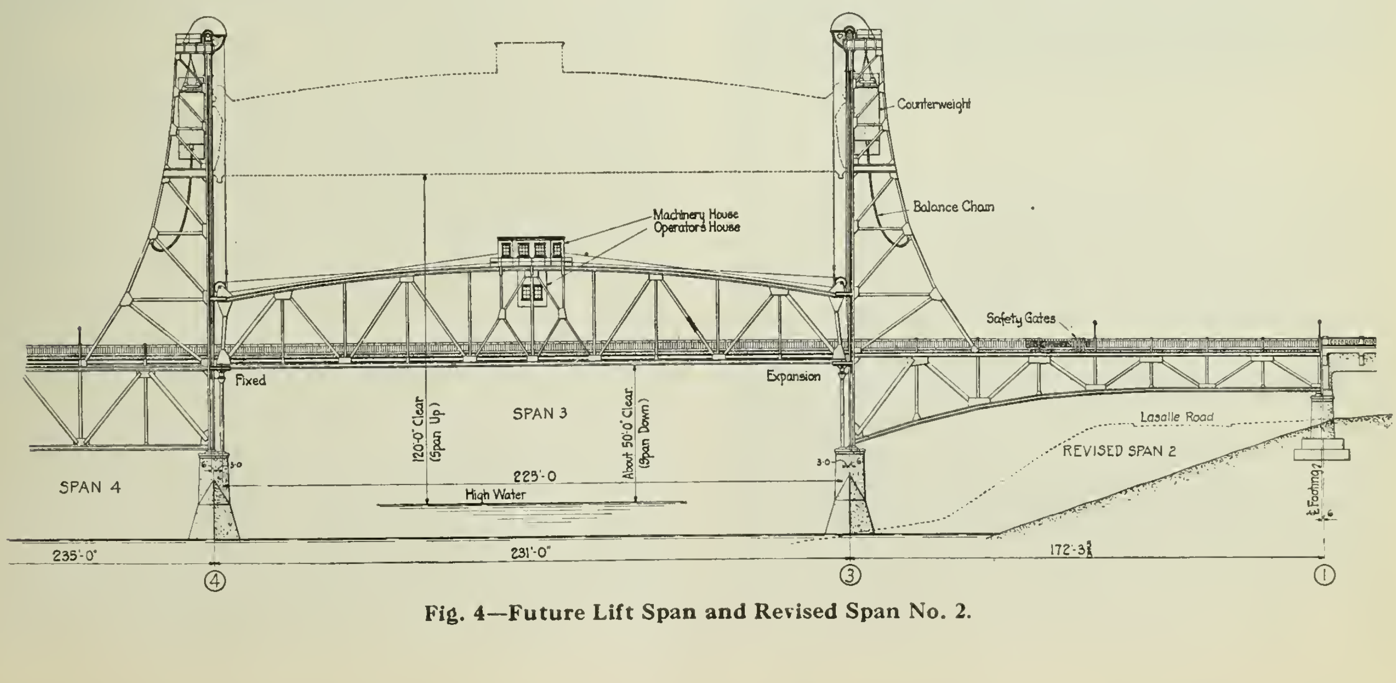



Fig. 4—Future Lift Span and Revised Span No. 2.

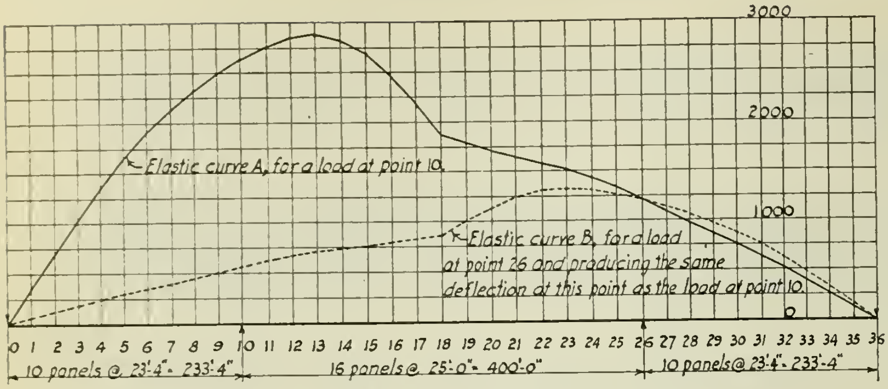



Fig. 5—Elastic Curves for Loads at Points 10 and 26.

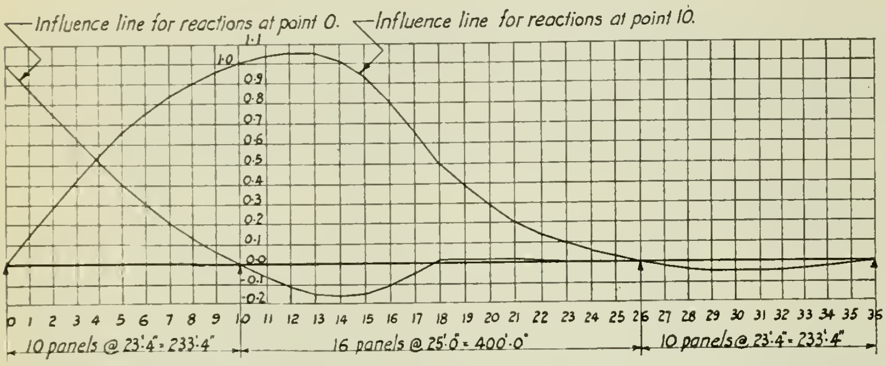



Fig. 6—Influence Lines for Reactions at Points 0 and 10 (I Variable).

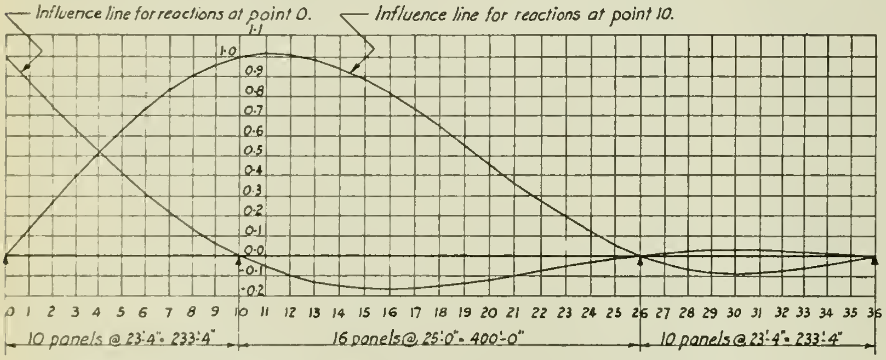



Fig. 7—Influence Lines for Reactions at Points 0 and 10 (I Constant).

of the arch rib in the two panels adjacent to the centre line, which is of the lightest practicable section, is designed as an idle member, thus removing one redundancy and greatly facilitating the stress calculations. By assuming a hinge at the top, and by making the lower rib at the centre of the span incapable of transmitting stress, the effective depth of the arch is increased, resulting in a considerable saving in the bottom tie, which is probably sufficient to compensate for the lack of continuity at the crown.

For the calculation of reactions, the structure has been treated as a girder of variable moment of inertia, continuous over four supports. The influence lines for the reactions have been obtained by the elastic-curve method, which is clearly demonstrated by D. B. Steinman, in the section dealing with continuous bridges in "Movable and Long-Span Bridges" by Hool and Kinne. Due to the unusual framing of this continuous girder and the consequent great and sudden changes in its moment of inertia, the curves are decidedly irregular and somewhat surprising. In Fig. 5, the elastic curve *A* represents the deflections of the girder when supported at its extreme ends only and subject to a concentrated load of any intensity at one of the inner piers (panel point 10). These deflections were obtained by a Williot diagram, using sectional areas of members derived from earlier designs. Elastic curve *B* is for a load at the other inner pier (panel point 26), giving the same deflection at that point as the load at panel point 10. Elastic curves *A* and *B* are similar but opposite to one another.

The reaction at point 10, for a load at any point on the girder is proportional to the intercept at that point between elastic curves *A* and *B*. In Fig. 6, these intercepts are reduced in scale and plotted with reference to a horizontal line, with the ordinate at point 10 made equal to unity. Thus the reaction at point 10 for a load of unity at any point on the girder is equal to the ordinate at that point, and the line circumscribing the ordinates for all points considered is the influence line for reactions at point 10, due to a load of unity at every point on the girder. Since the end spans are alike, this one influence line serves to obtain the reactions at both of the inner piers. Having obtained the unit reactions at the two inner piers, as above, the reactions at the two end piers were easily computed by moments, from which the influence line for reactions at point 0 was constructed.

For comparison, the influence lines for reactions for a continuous girder, having the same panel lengths and spans, but with constant moment of inertia, are given in Fig. 7.

## Floor Design

The roadway has a clear width of 27 feet, and is designed with a curved surface, being two inches higher at the crown than at the kerbs. The roadway slab is of reinforced concrete, having a uniform thickness of 6½ inches; and it is supported by longitudinal stringers, about 3 feet centre to centre, the stringers being set so that the top flange of each conforms to the bottom surface of the slab. The wearing surface for the roadway is of asphalt, 2½ inches thick. The roadway kerbs are 9 inches high and are protected by a 5 by 3½ by ⅜-inch angle. These protection angles are anchored to the concrete by bent clips welded to the angles. Thus anchor bolts, which are very troublesome to maintain in their proper position during the placing of concrete, are eliminated.

Except on the continuous tied arch, the sidewalk slab, which is on the upstream side, is 4 feet 3 inches wide, measured from kerb to outer edge, and 4 inches thick. It is supported on and is integral with the kerb, and is also supported upon a longitudinal stringer near its outer edge. On the continuous channel structure, between panel points U5 (north and south) the sidewalk is 3 feet wider, in order to maintain the same clear width outside of the trusses as on the purely deck part of the structure; and an additional supporting stringer is provided, immediately outside of the adjacent truss. Around the truss members which extend through the slab, rectangular openings are provided, with a minimum clearance of two inches between concrete and steel work. The outer edge of the sidewalk, throughout, is one inch higher than the kerb; thus the splayed connecting sections, between panel points U3 and U5 (Fig. 14) which are 46 feet 8 inches long, are slightly warped. This alternative was considered preferable to an irregularity in the vertical alignment of the handrailing. Under the sidewalk slab, throughout, a clear space, not less than 30 inches wide and 9 inches high, is reserved for future telegraph and telephone ducts. On spans 2 and 4, provision is made for widening the sidewalk, when required, to provide the necessary width outside of the towers for the lift span.

Principally for permanence rather than for present strength, the concrete in the slabs is required to have an ultimate crushing strength of 3,000 pounds per square inch at age of twenty-eight days. It is also required to conform to the Canadian Engineering Standards Association specification for reinforced concrete.

Fig. 8—First Stage of Cantilever Erection.

### Drainage

For drainage of the roadway and sidewalk, cast-iron scuppers are provided on both sides of the bridge, at the middle point of every panel. At the kerb, the scupper castings have a rectangular opening 8 inches wide and 3 inches high, and they are tapered to a 3-inch circular section at the outlet; they are supported on and rigidly connected to the top flange of the outer roadway stringers, thus insuring correct position and alignment with the kerbs, also preventing displacement during the placing of the concrete. At the outlet of the scupper castings, a 3-inch standard galvanized pipe is provided, to conduct the drainage clear of the steelwork. On span 2, which crosses Lasalle road, the drain pipes empty into an open trough of structural steel, on each side of the bridge, which discharges into the river, thus protecting the roadway, as well as the river bank.

### Lighting

Provision has been made for lighting standards, in line with the handrailings, and spaced alternately. upstream and downstream, four panels apart, or 100 feet on the channel span and about 93 feet elsewhere. The lower section of the standards is of structural steel, to facilitate connections with the floorbeams and with the handrailings; it is 10 inches square inside to accommodate a transformer, and will be provided with an ornamental cast-iron door, bearing the arms of the province of Quebec. The upper section of the standards will be of cast iron, with ornamental capital and globe holder, similar to those used in modern city street lighting. On the tied arch, where the trusses extend above the roadway, the lamps on the downstream side will be supported by cast-iron brackets, connected to the steelwork and located, transversely, two feet from the centre line of the near truss. The light centre for all lamps, whether supported on standards or brackets, will be 16 feet above the kerb or sidewalk.

Low voltage lamps of 400 c.p. will be used with reflectors. They will be operated on the series system, and with reduced current provided by a transformer at the base of each standard. The main current will be supplied by a two-conductor insulated and weatherproofed cable, on each side of the bridge. That on the upstream side will be supported on the bottom flange of the outer sidewalk stringer, and clamped thereto. On the downstream side, the cable will be carried on the bottom flange of the outer roadway stringer. On the steel portion of the bridge there will be thirty-two lights; but the total number, including those on the concrete viaducts and on the approach roadways, will be about seventy. The complete lighting system will extend over a distance of about 6,000 feet.

### Erection, Spans 2 to 11 Inclusive

Erection was begun at the north end on September 6th, 1933. Span 2, which is principally over land, and span 3, which is over shallow water, were erected on falsework. From pier 4, however, the structure has been erected by cantilevering from pier to pier, using the last-finished span as an anchor arm for the span under construction. Thus, during the erection of span 4, span 3 was the anchor arm, and the order of procedure was as follows: First, thrust blocks were placed over pier 4, and in line with the bottom chords, to transmit the thrust at this point between the two adjacent spans; and temporary ties were provided to connect the top chords. From these starting points, cantilever erection was carried forward to the fourth panel point at the bottom chord, and to the third panel point at the top chord. For handling materials and for placing them in the structure, stiff-leg derricks, provided with bull wheel and hoisting engine, were used. Figure 8 represents this first stage of cantilever erection using temporary ties to connect the top chords of anchor arm and cantilever, and shows the type of derrick used.

Owing to the uneconomical length of span (as a cantilever) in proportion to its depth, it would have been impracticable to proceed in this manner to a landing on pier 5, because the chord stresses, near the supported end, would have been excessive, requiring greatly increased sections. It was therefore necessary to increase the effective depth of the trusses over pier 4; to accomplish which, a

Fig. 9—Saddle Fully Erected.

Fig. 10—Second Stage of Cantilever Erection with Saddle Functioning.

temporary saddle, shown in Figs. 9 and 10, has been used. This saddle structure consists essentially of portal-braced verticals, supported on the top chords at the first panel points of the anchor arm and of the span being erected; together with a horizontal tie at the top, and inclined ties, connected to the top chords of the two adjacent spans by temporary pins at the third panel points. The saddle functions only after the removal of the temporary ties at the top chords of the adjacent spans, before mentioned.

**Fig. 11—Span 13 Supported on Pier 14 and on the First Temporary Pier.**

In Fig. 9, the completely-erected saddle is shown; and the top-chord ties are being removed. In this operation, the toggle-joint principle was employed, in which a downward force, applied by block-and-tackle at pin-connected joints in the top horizontal ties, shortens the distance between the pins at the top of the posts, thus eliminating the tension in the temporary top-chord ties and permitting of their removal. The bend in the top horizontal ties, produced by the block-and-tackle, can readily be seen in the illustration.

With the saddle in place, and subjected to stresses produced by that portion of the overhanging structure already erected, the second stage of cantilever erection began, and was proceeded with in the same manner as for the first stage, until pier 5 had been reached. Here the span was jacked up sufficiently to slacken the tension bars of the saddle, and thus to permit of its removal. This saddle structure was designed and fabricated for use in the erection of the South Shore bridge, and has since been used on several other bridges. The second stage of cantilever erection is illustrated by Fig. 10, in which the bottom chords of the overhanging arm have just reached the forward pier.

The procedure, described above for the erection of span 4, applies equally to spans 5 to 11 inclusive.

In all spans erected by the cantilever method, field riveting of main joints has followed closely behind the erector.

### Erection of Span No. 13

It may be explained in this place that the contract with the Dominion Bridge Company called for completion of erection by March 1st, 1935; but, owing to the rapid progress made in the construction of the piers (which were completed during the month of October, 1933), it was found practicable to finish the entire bridge a full year ahead of the specified date. Accordingly, arrangements were made with the contractor for the steel superstructure to complete his part of the work early in the year 1934.

In order to conform to the advanced date for completion, it was necessary that span 13, the south anchor arm for the continuous tied arch, should be erected during 1933, and sufficiently early to avoid risks from floating ice. Judging by previous records, no danger from this source could have been expected earlier than the middle of December; but, to be on the safe side, the contractor planned to finish this part of the erection not later than December 1st, which was a wise precaution; for the available records, covering the past ninety years and more, contain no precedent for the severe winter conditions throughout the month of November 1933.

Erection of span 13 began on October 2nd, which was the earliest practicable date, due to the time required for the completion of the final stress sheets for the continuous structure; their checking and approval by the Corporation's engineers; together with the detailing and fabrication of this span.

The first operation was the construction of a tower alongside of the bridge site and close to pier 14, with a platform on top, level with the bridge floor, on which was erected a stiff-leg derrick. This tower and derrick served to deliver bridge materials, to erect a temporary pier in the river at panel point L2 (see Fig. 14), and to erect the first two panels of the span.

The temporary pier at panel point L2 was of substantial construction, well braced in all directions, the posts being heavy steel-encased timbers, previously used in a working platform by the contractor for the substructure. The construction of the upper part of this pier is clearly shown in Fig. 11.

The first two panels of the span were then erected, resting on the temporary pier at L2 and on the bridge seats of pier 14. To prevent uplift during subsequent operations, the structure was securely anchored at pier 14 by substantial bolts, previously built into the concrete. From the temporary pier at L2, cantilever erection was carried forward far enough to facilitate the construction of another temporary pier, for the support of the structure at panel point L6. This second temporary pier was similar to that at L2, but located in much deeper and much swifter water. On reaching this second temporary pier, the structure was jacked up sufficiently to remove its load from the earlier support provided at L2, which then became inactive. Cantilever erection now proceeded to pier 13, reaching that point on November 21st, 1933. On the following day, riveting of the span was completed; it was jacked up on pier 13, and securely blocked. There was then no load on either of the temporary piers, the span being supported entirely on permanent piers 13 and 14.

In the erection of span 13, the hazard was greater than for other sections of the superstructure, due to the necessity of using falsework in swift and deep water, the risks from floating ice and the lateness of the season. Notwithstanding these obstacles and the loss of time on days when it was impossible to work, the structure was completed well in advance of the date contemplated by the contractor, and without fatality or serious accident of any kind.

The erection conducted from the north shore has been equally without accident to date. As a precautionary measure, the contractor has maintained a man in a boat, constantly on the lookout, in case any one should lose his footing and fall from the bridge.

### Erection of Span No. 12

The erection of span 12 will begin as early in the year 1934 as practicable, considering weather conditions. Each half of the span will be erected as a cantilever, with spans 11 and 13 as anchor arms; and the work will proceed simultaneously from piers 12 and 13 towards the centre of the span. The first two panels at the ends, in which the heaviest members are found, and where the height of the top chords above the roadway is not too great, will be erected by stiff-leg derricks, supported on the floor of the bridge, as before. For the remainder of the erection, a different type of derrick will be used, designed to travel on the top chords of the arch ribs; one such derrick will be provided for each cantilever arm. Materials will be delivered by runways at the roadway level, and will be hoisted into place by the derricks overhead.

During cantilever erection, it is highly desirable to omit all superfluous weight. In this instance, parts so omitted will include the idle members of the middle chords, near the crown of the arch (referred to previously), six lines of roadway stringers, two lines of sidewalk stringers, all sidewalk brackets and both lines of handrailing.

Closure will first be made at panel point L18 in the bottom tie. In order to do so, the free ends of the anchor arms will be lowered sufficiently to counteract deflections under cantilever conditions, and to raise the ends of the cantilevered arms slightly above their geometrical position, as shown in Fig. 12. The south half of the structure, which is provided with roller bearings at pier 13, will then be jacked towards the other half until they meet. At this stage, the two sections of the bottom tie will be in contact, whereas there will be a small gap at the crown of the arch, as shown in Fig. 13. In this position, the joint in the bottom tie will be securely bolted. The anchor arms will now be jacked up sufficiently at piers 11 and 14 to bring the adjacent ends of the arch ribs into firm contact at U18, as shown in Fig. 14. Having securely bolted the joint at this point, the anchor arms will be raised further, by hydraulic jacks, until the reactions at L0, as indicated by the gauges, agree with the calculated amounts. After which field riveting will be completed.

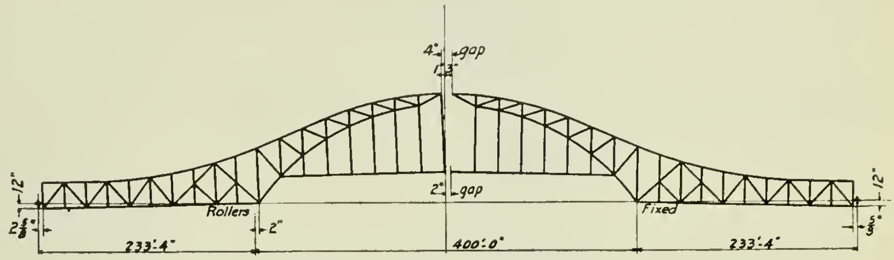


Fig. 12—Closure. First Position.

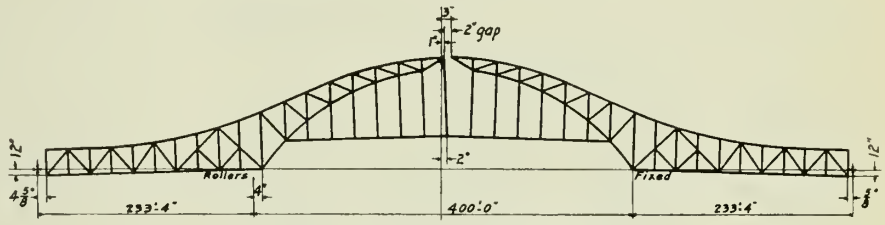


Fig. 13—Closure. Second Position.

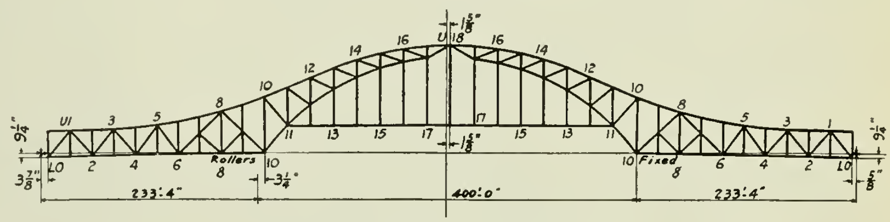


Fig. 14—Closure. Third Position.

### Plans and Specifications

The general plans and specifications for the steel superstructure were prepared under the direction of the chief engineer for the Corporation, Dr. O. O. Lefebvre, M.E.I.C. The general specifications include, modifying where necessary, those of the Department of Public Works for the province of Quebec; and the Standard Specification for Steel Highway Bridges, A6-1929, published by the Canadian Engineering Standards Association.

The details of the design (including the stress sheets) have been worked out by the contractor for the superstructure, in consultation with and subject to the approval of the corporation's engineer.

The specified live loads are as follows:—

For proportioning the reinforced concrete slab for the roadway, its supporting stringers and the floorbeams, also for truss members deriving their entire load from a single floorbeam, 120 pounds per square foot; or two 20-ton motor trucks, plus 30 per cent impact.

For sidewalk slabs, stringers and brackets, 120 pounds per square foot.

For main trusses, 100 pounds per square foot over the entire width of the roadway, for spans of 100 feet or less (reduced to 80 pounds per square foot, for spans of 200 feet and over, as per Canadian Engineering Standards Association specification), or two 20-ton motor trucks plus 30 per cent impact; together with a uniform load on the sidewalk, equal in intensity to 50 per cent of that on the roadway.

The specified material for the bridge is structural carbon steel for bridges, complying with the requirements of the Canadian Engineering Standards Association specification; and it is worthy of note that every pound of this steel has been rolled in Canadian mills.

### Concluding Remarks

The contractor for the steel superstructure, the Dominion Bridge Company Limited, has carried on his part of the work in the most satisfactory manner; and the contractor's engineers have given every attention to details, both great and small, in order that the completed structure may represent the best in modern practice.

The author desires to thank every one who has assisted him in the preparation of this paper, especially the Dominion Bridge Company, for drawings and photographs; and Mr. H. Lavoie, C.E., the author's assistant, for his valuable help in arranging the drawings for publication.

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## The Construction Industry's Problems

Just twelve months ago the organization and aims of the National Construction Council were brought to the attention of the readers of The Journal. The formation of that Council was the result of joint action by the Canadian Construction Association, the Royal Architectural Institute of Canada, The Engineering Institute of Canada, and a number of other organizations vitally interested in the welfare of the construction industry, its object being the revival of that industry in Canada.

One of the outstanding features of the discussions which took place at the Annual General Meeting of The Institute on February 8th was the presentation of an interesting summary of the year's activities of the National Construction Council, in a report submitted by J. B. Carswell, M.E.I.C., one of The Institute's representatives upon that Council.

At the commencement of its activities, the Council established three working committees, the Research committee, under the chairmanship of W. L. Somerville, architect, Toronto, the Publicity committee, under the chairmanship of H. P. Frid, general contractor, Hamilton, and the Survey committee, under the chairmanship of Mr. Carswell.

The first named of these committees has been occupied in gathering data for the Council on the distribution of construction costs and other allied matters, and it is also engaged in investigating housing conditions in Canada.

The duty of the Publicity committee has been to put the needs of the construction industry before the Canadian public, and as a result, the idea of a planned construction programme as a proper economic step in Canada has been effectively presented to the public and to legislative authorities.

On its formation the Survey committee immediately commenced an enquiry into the present conditions and possibilities of the construction industry throughout Canada, for which purpose twenty regional committees have been established, on which architects, engineers, contractors, manufacturers and labour are represented. As a result of their work, a survey of all deferred construction since January 1st, 1930, has been completed, and indicates that the value of such construction approaches the startling figure of $500,000,000. A large proportion of this total represents undertakings which would have been carried out by private enterprise if conditions had been more favourable, the remainder consisting of much needed Federal, provincial and municipal works which have been deferred for very obvious reasons during the period of depression.

During the past year the Survey committee has been in constant touch with the Federal government, and has been able to comply with a request from the Prime Minister to furnish a list of proposed Federal, provincial and municipal works which might be proceeded with at the present time. This list was in the Prime Minister's hands shortly before the recent conference of provincial prime ministers, and it included undertakings to the amount of some $50,000,000. Shortly after the conclusion of that conference, the Council was permitted by Mr. Bennett to announce that a moderate programme of widespread public works would be instituted during the present session of Parliament. It is believed that this satisfactory result is due in great measure to the work of the National Construction Council in which the representatives of The Engineering Institute of Canada, Messrs. J. B. Carswell, M.E.I.C., and A. H. Harkness, M.E.I.C., have been privileged to take an active part.

As regards provincial and municipal schemes, Mr. Carswell pointed out that these will present a more serious problem. It is obvious also that the restoration of confidence to private enterprise has still to be dealt with. The great bulk of suspended construction work lies in this field rather than in the field of public expenditure, and private initiative is still hindered by such obstacles as the moratorium situation in Ontario and other provinces and by the high interest rates demanded for commercial loans.

In its recommendations, the National Construction Council has consistently urged that if a revival of the construction industry is to take place, any construction work backed by public authorities, whether Federal, provincial or municipal, must be carried out on a competitive basis, employing qualified architects and engineers in private practice and with regular contractors employing labour remunerated at standard rates. In other words, the wages paid must be fully earned by competent workers, none of the expenditure must be on a charitable or relief basis, and the public must receive full value for the outlay.

Emphasis has also been laid on the necessity for the proper control of the financial features of the scheme, the Council having suggested that a board or commission should be formed, under the auspices of the Dominion government, for the purpose of passing on the merits or necessity of proposed construction projects, and assisting them in arranging for banking services or direct financing. The activities of this commission would be directed primarily to the fostering of construction by private enterprise.

Following Mr. Carswell's report, the construction situation received further consideration during the technical sessions of the Annual Professional Meeting, when W. D. Black, M.E.I.C., spoke on "Construction, the Joint in the Armour of Depression."

In this address, originally prepared for the Canadian Construction Association, Mr. Black took a point of view somewhat different from that of Mr. Carswell's presentation, and dealt more particularly with the problem of stabilising the industry. His chart, showing the gross value of building contracts awarded in Canada in recent years, indicated that starting from a figure of $150,000,000 in 1906, the estimated value of building contracts awarded yearly grew to $463,000,000 in 1912. During the war years a considerable shrinkage took place, and the value of contracts awarded remained at less than $100,000,000 per annum. At the close of the war, however, an upward movement began again, and in 1926 (now generally regarded as a normal year) the total was $372,000,000. The activity of the industry reached its peak in 1929, with a value of $576,000,000. This was followed by a rapid decline, until in 1933 the total was less than $100,000,000. Thus the history of the industry during the past thirty years simply records a series of violent fluctuations without any appreciable period of stable activity. As the speaker pointed out, the effect of this is that at the close of each period of stagnation a large amount of delayed construction has accumulated, such accumulation being estimated by Dr. Marvin, economist of the Royal Bank of Canada, to be now proceeding at the rate of $100,000,000 to $150,000,000 per annum, with the result that unless effective steps are taken the industry will be subject to another period of feverish production followed by credit contraction and unemployment as before.

In Mr. Black's view, this situation, which affects directly or indirectly some eight hundred thousand men, can only be controlled by some authoritative body possessing power over the financial agencies through which credit is extended, as well as over the construction industry itself.

In advocating the establishment of such a board or commission he arrives at a conclusion which is practically the same as that of the National Construction Council, although the Council perhaps lays more stress on the financial duties of the proposed board than on its planning activities. In any case, such an authority, after considering the results of such a survey as the Council has made, would first have to determine the level of activity or mean line which would be justified as a uniform standard, and secondly would be confronted by the problem of the raising of construction activity to this determined level.

Thus the board would evidently have to be equipped for planning as well as for control, and should be empowered to deal with such economic factors as working hours and other factors affecting employment in the industry. It would seem quite possible for a board possessing powers such as those outlined above to smooth out the peaks and valleys of the total construction curve, by deferring public works construction in times of commercial activity and proceeding with such work during periods of depression.

The figures available indicate that if all public works expenditure had been cut to the bone during the early years of the peak period, until in 1929 such works had virtually disappeared, total construction would then only have exceeded a mean economic line by $80,000,000. In this event, during the period considered, the operation of a system of prosperity reserves for all public works construction would have resulted in the operation of the construction industry within economically justified bounds.

The publicity already given to these proposals has called forth a good deal of comment in all parts of the country. The majority of the critics agreed that some scheme of stabilization for the construction industry is inevitable. The opposition has come principally from those who consider that the ups and downs in business are caused largely by governmental and political interference with private initiative and that the ideal condition is one of laissez-faire. Those who hold this view seem to oppose any form of planned economy and have apparently no practicable remedy to offer for the present condition of affairs. Such ideas are in marked contrast to those which are now being tried in the United States, where the code control of industry is being followed up by an effort to develop a comprehensive scheme of industrial planning.

The proposals sketched by the National Construction Council's committees and by Mr. Black have awakened general attention and may well form the first step in the adoption of a definite plan of campaign to develop industry in Canada.

In presenting the subject for discussion at the Annual Meeting, The Institute's representatives on the National Construction Council and Mr. Black have earned the thanks of their fellow members. The interest aroused should encourage all those who like to see The Institute taking its rightful part in considering the economic problems of the day, particularly those which are of vital concern to all members of the engineering profession.

## Western Professional Meeting 1934

Arrangements are now being completed for the 1934 Western Professional Meeting of The Institute, which has been authorized by Council and will take place in Vancouver under the auspices of the Vancouver and Victoria branches of The Institute during the week of July 8th.

This meeting is of particular interest because it will be held at the same time and place as the Western Summer Convention of the American Society of Civil Engineers. Representatives of the two organizations are collaborating so as to make these two simultaneous meetings outstanding in all respects.

It is intended that the first technical session shall be held jointly by the two societies, the ensuing business and technical sessions taking place independently, while members of both societies will join in the various social functions.

The Headquarters of both societies will be at the Hotel Vancouver, and a local committee under the chairmanship of E. A. Cleveland, M.E.I.C., M.Am.Soc.C.E., and composed of members of both organizations, is at work on the details of the programmes, particulars of which will be published as soon as available.

## Meetings of Council

A meeting of Council was held at Headquarters on January 16th, 1934, at eight o'clock p.m., with President O. O. Lefebvre, M.E.I.C., in the chair, and four other members of Council present.

The annual report of the Finance committee was submitted for approval and Council discussed the financial situation and approved the auditors' report for presentation at the Annual Meeting.

After discussion of the case of members in arrears for 1933, it was thought desirable in their case to suspend for the present the operation of the provisions of Section 37 of the By-laws and the Secretary was directed to send a circular letter to a number of Members, Associate Members and Juniors who have not replied to communications, informing them that they are being placed on the non-active list in order to avoid the accumulation of further indebtedness on their part.

Discussion took place as to the desirability of discontinuing the payment for branch news for The Journal, this being recommended by the Finance committee as a measure of economy. After consideration this course was approved by Council.

The Report of Council for the year 1933 and the reports of the various Institute committees were approved for presentation to the Annual Meeting.

The membership of the Nominating committee for the year 1934 was noted, and the reports of the various medal and prize committees were accepted for presentation to the Annual Meeting.

A suggestion was submitted by F. S. B. Heward, A.M.E.I.C., that The Institute might possibly be of assistance in the movement which is being promoted by the Canadian Chamber of Commerce in connection with the formation of provincial committees to discuss and make recommendations as to the present economic situation. The Secretary was directed to write to the Secretary of the Canadian Chamber of Commerce indicating Council's willingness to render such assistance in this movement as may be within its power.

The Secretary presented letters from the Winnipeg and Saskatchewan branches with reference to local organizations of graduate engineers which have been formed in Manitoba and Saskatchewan for mutual aid in obtaining employment and discussion of the industrial problems of the day. It was thought that The Institute might perhaps be of assistance to these young engineers, and a reply from the Secretary was approved suggesting that the associations in question might with advantage to themselves function as Junior Sections of Institute branches.

Council gave sympathetic consideration to a request from the Saskatchewan Branch asking for support in making representations to the government of the province of Saskatchewan in connection with a classification scheme for provincial civil servants which has recently been proposed, in connection with which there has been some criticism as regards engineering appointments. The Council appointed a committee under the chairmanship of Fraser S. Keith, M.E.I.C., to study and report upon the matter.

Six resignations were accepted, a number of members were placed on the non-active list, and certain special cases were dealt with.

A number of applications for admission and for transfer were considered, and the following elections and transfers were effected:

| *Elections* | | *Transfer* | |
|---|---|---|---|
| Member | 1 | Student to Junior | 1 |
| Associate Members | 2 | | |
| Students admitted | 5 | | |

The Council rose at eleven forty p.m.

A meeting of Council was held at the Windsor hotel, Montreal, on Friday, February 9th, 1934, at five o'clock p.m., with President F. P. Shearwood in the chair, and sixteen other members of Council present.

R. J. Durley, M.E.I.C., was re-appointed Secretary of The Institute, and J. B. Challies, M.E.I.C., was re-appointed Treasurer.

The Finance committee was re-appointed for the year 1934 under the chairmanship of P. L. Pratley, M.E.I.C., the membership being as follows:

P. L. Pratley, M.E.I.C., *Chairman*
J. L. Busfield, M.E.I.C.
J. B. Challies, M.E.I.C.
A. Duperron, M.E.I.C.
F. Newell, M.E.I.C.

The chairmen of the following committees were appointed, with a request to submit the names of the remaining members of their committees to the next meeting of Council:

Library and House Committee.....A. Cousineau, A.M.E.I.C.
Papers Committee.....C. S. L. Hertzberg, M.E.I.C.

The following committees were re-appointed for the year 1934:

Publication Committee..... H. Cimon, M.E.I.C., *Chairman*
J. A. Duchastel, M.E.I.C.
A. A. MacDiarmid, M.E.I.C.
P. L. Pratley, M.E.I.C.
H. L. Trotter, M.E.I.C.

Legislation Committee.....F. Newell, M.E.I.C., *Chairman.*
C. A. Bowman, M.E.I.C.
A. S. Gentles, M.E.I.C.

Following the discussion at the Annual General Meeting of Council's proposals for the amendment of the By-laws, it was noted that an amendment to Section 1 of the proposals had been moved. Accordingly, in regard to the pro and con committees required by the by-laws to state the arguments for and against this amendment Past-President Lefebvre, as chairman of the Annual General Meeting at which the proposals were discussed, appointed Messrs. J. L. Busfield, M.E.I.C., and W. C. Adams, M.E.I.C., to state the case for Council's proposals, and Messrs. Gordon M. Pitts, A.M.E.I.C., and R. F. Legget, A.M.E.I.C., for the contrary arguments.

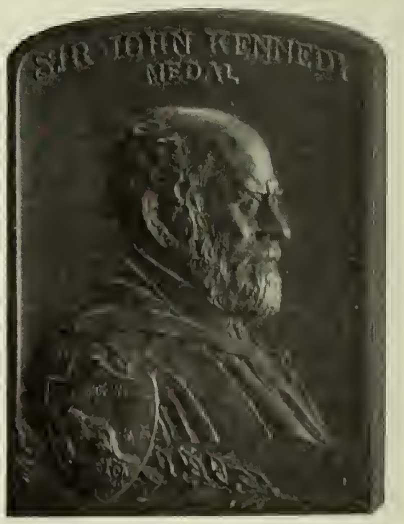
Correspondence with Vancouver and New York was presented regarding the Western Professional Meeting 1934 outlining a general plan for the meeting, which was approved by Council subject to later modification in detail if found necessary. It was decided that the meeting should be held during the week of July 8th, and this period being satisfactory to the American Society of Civil Engineers it was understood that The Institute and the Society will each conduct its own functions, while certain arrangements common to both will be in the hands of a local General committee composed of members of both bodies. Certain joint technical sessions will be held but other technical and business sessions will be held separately. Social functions will be held jointly.

The Secretary was directed to express Council's appreciation of the success attending the efforts of the Montreal Branch committees in connection with the Annual General and General Professional Meeting which had just concluded.

The Secretary was also directed to address letters of thanks to the Rt. Hon. R. B. Bennett, Sir William Clark, and to the Canadian Marconi Company for the broadcasting facilities they afforded, also to write to H. P. Eddy, M.E.I.C., President, American Society of Civil Engineers, expressing the pleasure given by his attendance at the Annual Meeting.

Six Students were admitted.

The Council rose at six fifteen p.m.




**Sir John Kennedy Medal**

## Annual Fees

Members are reminded that a reduction of One Dollar is allowed on their annual fees if paid on or before March 31st of the current year. The date of mailing, as shown by the postmark on the envelope, is taken as the date of payment. This gives equal opportunity to members residing in all parts of the country.

# Frederick Perry Shearwood, M.E.I.C.

## President of The Engineering Institute of Canada

Election to the office of President of The Engineering Institute of Canada, the highest honour in The Institute's gift, is generally considered as a fitting recognition of professional eminence and of long and active work in the interests of The Institute. The membership has made no departure from this principle in choosing Frederick Perry Shearwood, M.E.I.C., as President for 1934.

Born in 1866 in London, England, he received his education by private tuition in England, and in 1884 proceeded to Brazil, where he entered the service of the São Paulo Railway. After three years of railway work, he came to Canada and became connected with the firm with which the greater portion of his professional career has since been spent.

Starting in a junior position in the Engineering Department of the Dominion Bridge Company, Montreal, Mr. Shearwood rose rapidly, holding successively the appointments of designing engineer and assistant chief engineer, until in 1921 he became chief engineer, the position which he now holds.

A list of the important structures for whose design or erection Mr. Shearwood has been wholly or largely responsible, would be a list of the principal work carried out during the last thirty years by that organization. Apart from the design of many of the structures they have built, his company, as a contracting firm, has had in many cases to develop such erection methods as were required to meet special needs. In work of this kind Mr. Shearwood has always been greatly interested, and structural engineers will appreciate the engineering skill and experience required to devise and apply such methods in the case of structures like the Interprovincial bridge at Ottawa, the Montreal Harbour bridge, or large roof structures like that of the Maple Leaf Arena, Toronto. It may in fact be said that examples of the results of Mr. Shearwood's engineering ability may be seen right across the continent, starting fron the ferry landing-stages on the Straits of Canso and terminating at the bridge over the Fraser river at New Westminster, B.C. In all of these undertakings his part in connection with the erection or design, or both, has been a principal one, and his reputation as a bridge engineer is based on this Dominion-wide experience.

FREDERICK PERRY SHEARWOOD, M.E.I.C.

An enthusiastic yachtsman and yacht designer, Mr. Shearwood was for ten years associated with his then chief, G. H. Duggan, M.E.I.C., in building and racing the boats which brought the Seawanhaka cup to Canada and for a long period during the nineties successfully defended that trophy against American challengers. The many successes of boats whose designs came from Mr. Shearwood's board have proved that his skill as an amateur yacht designer equals his ability to handle a racing boat under sail.

Throughout his career he has been an active member of The Institute, joining the Canadian Society of Civil Engineers as an Associate Member on April 8th, 1892, and transferring to Member on November 17th 1904. He was elected to Council in 1909 and again in 1921 and the two succeeding years. In 1923, when the late Walter J. Francis, M.E.I.C., was called upon to assume the office of President, Mr. Shearwood was a Vice-President of The Institute, which office he held until 1925. He has been active in committee work, having been chairman of the Finance Committee for three years from 1923 to 1925. In 1926 he undertook the responsible duties of Treasurer of The Institute, in succession to the late Sir Alexander Bertram, M.E.I.C., and retired from that office in 1930.

Mr. Shearwood is a member of the American Society of Civil Engineers, an Associate Member of the American Railroad Engineering Association, and a member of the Corporation of Professional Engineers of the Province of Quebec. He has also served on various committees of the Canadian Engineering Standards Association including those for Structural Steel, Railway and Highway Bridges and Buildings.

The selection of Mr. Shearwood as The Institute's President for 1934 will give real pleasure to all who have been associated with him, either in professional work, in the service of The Institute, or in any other activity.

# Address of the Retiring President

*O. Lefebvre, D.Sc., M.E.I.C.*

**Delivered before the Forty-Eighth Annual General Meeting of The Engineering Institute of Canada, Montreal, Que., February 8th, 1934.**

During my term as President of The Institute, which will terminate with the conclusion of the present brief address, it has been my privilege to pay a visit to all of the twenty-five branches of The Institute. This has given me the opportunity of acquiring a broader conception of the affairs of The Institute and the different problems inherent to local conditions.

There is no need to mention that I was received royally on all occasions, except that I should take this opportunity to express my appreciation and my gratitude for the welcome accorded to me.

My visits brought me into contact with a large portion of our membership,—men of character and ability who have played a great part in the development of the country, and are determined to help in every possible way to bring an end to the present financial and industrial depression.

There are in Canada, eleven schools of engineering recognized by Council. From these engineering schools or faculties of applied science, graduates numbering three hundred or so are given degrees every year, and these young men should join our Institute. Why do they not all do it? It is perhaps due to our lack of interest in them. It seems to me that the members of those branches located at the seat of a university, or engineering school, should make special efforts to awaken the interest of these young graduates. I do not want to imply that no efforts have been made in that direction. I know what good work is done by some of the teachers and some of our members outside of the teaching profession, but the effort from the outside members is not sufficiently organized and is too spasmodic to give efficient results.

The Institute is awarding to each engineering school, each year, a prize of $25.00 which is remitted to the most deserving student. The presentation of that prize should be made an outstanding event and a prominent member of The Institute should make the presentation. Advantage could be taken of this occasion to impress upon the students the advantages of membership in our Institute.

Some of our branches have established contact with the students. Meetings are held to which the students are invited. Sometimes they are held in the university. This should be more generally practised. After all, the students of to-day will be the engineers of to-morrow, and all of them should be induced to become members of The Institute.

Another remark which I want to make concerning the profession is a warning against the tendency to sectionalize engineering. Engineering covers a very wide field and necessarily lends itself to specialization. We should be careful, however, to resist that tendency to divide the profession into its different branches, each with its own organization, and holding its own meetings.

Glancing at one of our publications, one finds more than a dozen different classes of engineers. Not so very long ago, the engineering profession recognized two classes, namely: the military engineer and the civil engineer. There is a tendency to distinguish between the latter and the mechanical engineer, the electrical engineer, the hydraulic engineer, the structural engineer, the municipal engineer, the highway engineer, the railway engineer, the mining engineer, and others,—even the sales engineer, the promotion engineer. This practice should be discouraged in every possible way. Let us designate ourselves as civil engineers specialized in such and such a branch.

The policy followed by the Montreal Branch of The Institute is to be recommended to other branches. That Branch has a civil section, a mechanical section, a railway section, a municipal section, and so on, but all these divisions form part of one single body.

Another feature which I have noted has been occasional misunderstanding as to the relations between The Engineering Institute and the Provincial Corporations of Professional Engineers. Many of our members do not yet realize that the two bodies are complementary to each other, and that their activities are essentially different.

The Engineering Institute was organized principally to facilitate the interchange of engineering knowledge and experience between its members. The Institute has rendered great service to the profession, both to the individual members and to the group. However, The Institute could not exercise the legal control of the practice of the profession. This control is a matter of provincial jurisdiction. Hence the reason for the organization of the Provincial Corporations. These provincial bodies can perform what The Engineering Institute cannot perform. It is fair to say that their existence has been brought about mainly by the initiative of The Institute. In 1918, a committee of The Institute drafted a model act which The Institute submitted to its members in the different provinces, with the advice that legislation be obtained along the lines recommended. Legislation was passed in eight of the nine provinces,—the only exception being Prince Edward Island where no act was presented to the legislature for reasons that are obvious.

The model legislation requested was not acceptable to all of the legislatures, but nevertheless the acts are quite satisfactory, except in one or two cases. Under the acts that are satisfactory, the practice of the engineering profession is legally controlled to the benefit of the public and of the members of the profession.

The Institute has gone a step further and has taken the initiative to bring about uniformity in legislation between the different provincial acts and uniformity in the requirements for admission to the Provincial Associations. As a result, a committee representative of the eight Provincial Associations, namely, the "Committee of Eight," is at work and is making good progress.

When we have reached the goal of uniformity in provincial legislation and uniformity in requirements for admission, it will be a simple matter to bring about a complete co-operation between The Institute and the Provincial Associations,—the associations exercising the legal control of the practice of engineering, and The Institute devoting all its time, activities and resources to facilitating the interchange of engineering knowledge and professional experience amongst its members. Such a complete co-operation between the two bodies will result in great benefit to the profession as a whole and to its individual members in particular.

# The Forty-Eighth Annual General and General Professional Meeting

**Convened at Headquarters, Montreal, January 25th, 1934, and adjourned to the Windsor Hotel, Montreal, on February 8th, 1934**

The Forty-Eighth Annual General Meeting of The Engineering Institute of Canada was held at Headquarters on Thursday, January twenty-fifth, nineteen hundred and thirty-four, at eight fifteen o'clock p.m., with President O. O. Lefebvre, M.E.I.C., in the chair.

The Secretary having read the notice convening the meeting, the minutes of the Forty-Seventh Annual General Meeting were submitted, and on the motion of J. T. Farmer, M.E.I.C., seconded by E. C. Kirkpatrick, M.E.I.C., were taken as read and confirmed.

Appointment of Scrutineers

On the motion of G. B. Mitchell, M.E.I.C., seconded by H. W. B. Swabey, M.E.I.C., Messrs. deGaspe Beaubien, M.E.I.C., and J. M. Fairbairn, A.M.E.I.C., were appointed scrutineers to canvass the Officers' Ballot and report the result.

There being no other formal business, it was resolved, on the motion of H. Milliken, M.E.I.C., seconded by G. Kearney, M.E.I.C., that the meeting do adjourn to reconvene at the Windsor hotel, Montreal, at ten o'clock a.m., on the eighth day of February, nineteen hundred and thirty-four.

## Adjourned General and General Professional Meeting at the Windsor Hotel, Montreal

The adjourned meeting was called to order by President O. O. Lefebvre, M.E.I.C., at ten a.m. on Thursday, February 8th, 1934. After messages of regret had been submitted from members and guests unable to be present, the Secretary announced the membership of the Nominating Committee appointed to nominate the officers of The Institute for 1935 as follows:

Nominating Committee 1934

*Chairman:* H. W. B. Swabey, M.E.I.C.

| *Branch* | *Representative* |
|---|---|
| Cape Breton | R. R. Moffatt, A.M.E.I.C. |
| Halifax | J. B. Hayes, A.M.E.I.C. |
| Saint John | G. G. Murdoch, M.E.I.C. |
| Moncton | G. E. Smith, A.M.E.I.C. |
| Saguenay | N. F. McCaghey, A.M.E.I.C. |
| Quebec | P. Methe, A.M.E.I.C. |
| St. Maurice Valley | J. H. Fregeau, A.M.E.I.C. |
| Montreal | F. S. B. Heward, A.M.E.I.C. |
| Kingston | W. Casey, M.E.I.C. |
| Ottawa | F. H. Peters, M.E.I.C. |
| Peterborough | A. L. Killaly, A.M.E.I.C. |
| Toronto | J. J. Spence, A.M.E.I.C. |
| Hamilton | J. R. Dunbar, A.M.E.I.C. |
| London | F. C. Ball, A.M.E.I.C. |
| Niagara Peninsula | C. G. Moon, A.M.E.I.C. |
| Sault Ste. Marie | C. Stenbol, M.E.I.C. |
| Lakehead | H. G. O'Leary, A.M.E.I.C. |
| Border Cities | W. J. Fletcher, A.M.E.I.C. |
| Winnipeg | T. C. Main, A.M.E.I.C. |
| Saskatchewan | L. A. Thornton, M.E.I.C. |
| Lethbridge | R. Livingstone, M.E.I.C. |
| Edmonton | R. J. Gibb, M.E.I.C. |
| Calgary | B. L. Thorne, M.E.I.C. |
| Vancouver | T. E. Price, A.M.E.I.C. |
| Victoria | H. F. Bourne, A.M.E.I.C. |

Awards of Medals and Prizes

Before asking the Secretary to announce the winners of the various prizes and medals of The Institute, the President stated that the formal presentation of these would take place at the Annual Dinner of The Institute. The following awards were then announced:

The Sir John Kennedy Medal to Alexander Joseph Grant, M.E.I.C., Engineer in Charge, Welland Ship Canal, St. Catharines, Ont., Past-President of The Institute.

The Past-Presidents' Prize to Eric G. Adams, S.E.I.C., Cockfield Brown & Co., Montreal, Que., for paper on "The Relations of Economics to Engineering."

The Gzowski Medal to Milton Eaton, A.M.E.I.C., Electrical Engineer, Shawinigan Chemicals Ltd., Shawinigan Falls, Que., for his paper "Automatic Operation of Electric Boilers."

The Plummer Medal to A. G. Fleming, M.E.I.C., Chief Chemist, Canada Cement Company, Montreal, for his paper "The Development of Special Portland Cements in Canada."

The Leonard Medal to C. H. Hitchcock, Vice-President, Smith and Travers Limited, Sudbury, Ont., for his paper "Diamond Drilling Practice."

*Students' and Juniors' Prizes*

The John Galbraith Prize (Province of Ontario) to C. W. Crossland, S.E.I.C., now with Hawker Aircrafts Limited, England, for his paper "The Rationalization of Load Factors for Aeroplane Wings."

The Phelps Johnson Prize (Province of Quebec—English) to L. A. Duchastel, Jr.E.I.C., Designer, Power Engineering Company, Montreal, for his paper "The Rapide Blanc Development."

The Ernest Marceau Prize (Province of Quebec—French) to Raymond Boucher, S.E.I.C., now at the Massachusetts Institute of Technology, Cambridge, Mass., for his paper "Projet d'aménagement hydro-électrique."

Report of Council and Report of Finance Committee

The Report of Council for 1933 was read by the Secretary, and on the motion of H. B. Stuart, A.M.E.I.C., seconded by W. H. Wardwell, M.E.I.C., the report was approved. The report of the Finance Committee was presented by the committee's chairman, Mr. Busfield, who pointed out that although the expenditures had been kept within the budget, the year's operations of The Institute had resulted in a deficit, a result principally due to the unforeseen drop in members' fees. General C. H. Mitchell, M.E.I.C., was of the opinion that the Finance Committee's report was more favourable than might have been expected, having regard to the difficult circumstances obtaining during the past year, and moved the adoption of the report. In seconding General Mitchell's motion, J. H. Hunter, M.E.I.C., supported General Mitchell's views. F. W. Paulin, M.E.I.C., drew attention to the desirability of according lenient treatment to members in arrears, and Mr. Busfield, in reply, explained the procedure adopted by Council, in which the utmost consideration was given to the circumstances of individual cases wherever members have stated their circumstances, and after further discussion the report was unanimously adopted.

Reports of Committees

After presentation by the Secretary, on the motion of W. McG. Gardner, A.M.E.I.C., seconded by J. B. Macphail, A.M.E.I.C., the reports of the following committees were taken as read and adopted:—Past-Presidents' Prize Committee, Gzowski Medal Committee, Plummer Medal Committee, Leonard Medal Committee, Students' and Juniors' Prizes, Membership Committee, Papers Committee, Publication Committee, Library and House Committee, Report of E.I.C. Members of the Main Committee of the Canadian Engineering Standards Association, Committee on Biographies, Honour Roll and War Trophies Committee, Board of Examiners and Education, Unemployment Committee and Employment Service Bureau.

### Reports of Branches

On the motion of L. F. Grant, M.E.I.C., seconded by H. A. Lumsden, M.E.I.C., it was resolved that the reports of the branches be taken as read and accepted.

### National Construction Council of Canada

J. B. Carswell, M.E.I.C., one of The Institute's representatives on the National Construction Council of Canada, presented a report on that Council's activities, which outlined the origin and proceedings of the Council, with particular reference to the study it had made of the economic situation as affecting the construction industry. Its recommendations, sent early in the year to Mr. Bennett and to the Provincial Prime Ministers in Canada, had suggested a reasonable construction programme to be carried out under normal working conditions in an effort to reduce relief. Since that time the Council had formed twenty regional committees all over Canada and had completed a survey of all construction deferred since January 1st, 1930, amounting to some 500 million dollars, much of this consisting of Federal, provincial and municipal work. A list selected from this had recently been placed in the Prime Minister's hands, and an assurance had been received from Mr. Bennett that a certain amount of long-deferred and much needed public works construction will be undertaken this year. The question of municipal undertakings still presented a very serious problem, to the solution of which attention was now being given. Mr. Carswell pointed out that for the first time the construction industry had a coherent voice, and congratulated The Engineering Institute as having given much needed and active support in the work of this organization. It was moved by F. W. Paulin, M.E.I.C., seconded by C. M. McKergow, M.E.I.C., and carried unanimously, that a hearty vote of thanks be accorded to J. B. Carswell, M.E.I.C., and A. H. Harkness, M.E.I.C., the members representing The Institute on the National Construction Council of Canada.

### Reduction in Entrance Fees

The President drew attention to the action taken by the Council of The Institute on October 6th, 1933, in taking upon itself to order a reduction of the entrance fee for all classes of membership to $5.00, this to hold good until June 30th, 1934. The Council now asked the members present at the Annual General Meeting to approve this action, which had been undertaken with a view of facilitating the recruitment of new members. It was perhaps too soon to say whether this reduction, which had now been effective for four months, had produced any definite effect. The action of the Council in changing the entrance fee was unanimously approved, on the motion of deG. Beaubien, M.E.I.C., seconded by J. H. Hunter, M.E.I.C.

### Council's Proposals for the Amendments to By-laws

The Secretary presented a letter from the Executive Committee of the Vancouver Branch pledging its support to the draft of by-laws as now proposed by Council provided that no move was made to substitute the term "Associate" for "Affiliate" in the wording of these by-laws. That Branch Executive committee was of opinion that the draft of by-laws should be accepted as they stand. A letter was also read from the Secretary of the Moncton Branch stating that that Branch strongly opposed any change being made in the present grading of Institute members, and urged that the time had come when admission to corporate membership in The Institute should be limited to those who are graduates in engineering of some recognized university, or who possess the equivalent of this.

The President pointed out that the draft by-laws now submitted by the Council for discussion were the result of work which had extended over two years, culminating in the consideration and approval of the proposals in detail at the Plenary Meeting of Council held on October 31st and November 1st and 2nd last.

The discussion was opened by Mr. Busfield, formerly chairman of the Committee on Development, who briefly described the considerations and activities which had led to the present proposals. The most important of these were the adoption of one class of corporate membership in place of two, and the modification of membership qualifications to give a measure of recognition to membership in a provincial association. He urged the adoption of the present proposals by the membership on ballot, and felt that if this were done there would be a secure foundation on which to build up The Institute during the next few years.

Professor H. E. T. Haultain, M.E.I.C., inquired what were the conditions of urgency which had called for the considerable effort and expenditure undertaken in connection with these proposed changes in the by-laws, and asked how the proposed changes met this condition of urgency. Mr. Busfield in reply indicated that the activities of the Committee on Development had been set on foot as a result of criticisms from members of The Institute that it was not fulfilling its functions in the best possible way. Many members were dissatisfied with what they considered apathy and lack of activity within The Institute. The course that had been taken was not started so much as a measure of urgency as in order to hasten the process of development of The Institute, which it was felt was proceeding at too slow a pace.

R. F. Legget, A.M.E.I.C., observed that while the proposals now before the meeting had met with the unanimous approval of the Plenary Meeting of Council, he did not think the Council in this respect was truly representative of all branches of The Institute members, particularly the younger members of The Institute, who were especially concerned in the path which The Institute was going to take. Mr. Legget had discussed the proposed changes with a number of members of The Institute under the age of thirty-five, and he believed that the majority of these younger men would be definitely opposed to the changes suggested. This position was based on disagreement with the motive underlying the activities of the committee, as they did not consider that the objects of The Institute would be best served by changing the requirements for admission so as to secure a larger but less highly qualified membership. He criticized the new by-laws as containing no definition of what an engineer is, and felt that the changes in the objects of The Institute in Section 1 were such as to place first the functions of The Institute as a clearing house for technical knowledge, whereas it should be fundamentally a professional body. He felt also that a mistake was being made in abandoning the existing code of ethics and replacing it by a clause which was so general as not to meet the case. He, and those who thought with him, believed that the proposed by-laws made no progress whatever towards approaching the professional associations with a view of the fundamental co-ordination of the profession. He hoped to see eventually a scheme similar to that which was working so admirably in the case of the sister profession of architecture in Canada.

Mr. Legget felt that the present status of the professional engineer in Canada was unsatisfactory. The opinion of him held by the general public could be judged, for instance, by articles appearing in the leading papers of Canada, an example of which he gave, in which the work and status of the engineer were systematically belittled. He felt that The Engineering Institute of Canada should be organized as a definite professional body, and should be so constituted as to be able to take action in cases of this kind. He hoped that the opinions he had expressed, which were, he thought, largely the views of the younger men, could be given consideration.

The meeting adjourned at twelve fifty p.m.

In resuming the discussion at two fifty-five p.m., the Secretary, in reply to a question of Gordon M. Pitts, A.M.E.I.C., pointed out that there was no need for a motion for the adoption of the proposed changes in the by-laws, as, in accordance with Section 75 of the present by-laws, these were before the Annual General Meeting for discussion and thereafter must go to a ballot.

Mr. Pitts expressed appreciation of Mr. Legget's contribution to the discussion, which indicated that he had given serious and thorough study to the proposals. Such action on the part of the younger members was badly needed by The Institute. Mr. Pitts drew attention to the first section of Council's proposals, and particularly to the object which was stated as "to enhance the usefulness of the profession to the public." He felt that one of the most important functions of The Institute would be to convince the public that engineers are an asset to the community, and he believed that The Institute as now constituted was not in a position to do that to the fullest degree. Mr. Pitts read a letter which he had addressed to the Council under date of October 4th, 1933, in which he had advocated the consolidation of the engineering profession throughout Canada into one representative organization, somewhat along the lines of the present organization of the profession of architecture, the Dominion organization forming a liaison between the legally constituted provincial bodies and the engineers of the Dominion. The reply he had received indicated that Council had been considering this question for nine years, but that practically nothing had been accomplished. Under these circumstances he urged that action on the proposed amendments to the by-laws be deferred until a full and proper study had been made by all parties concerned as to the possibility of a broader organization of the profession in Canada.

During the discussion which followed, Major L. F. Grant, M.E.I.C., pointed out that the condition desired by Mr. Pitts must be the result of action by the eight provincial associations themselves, and he drew the attention of Mr. Pitts to the fact that the Council of The Institute had for years been doing all in its power to further the movement of co-ordination.

D. G. Elliott, S.E.I.C., was in agreement with Mr. Legget in opposing the present proposals of the Council, as he felt that they lacked the factors which had given the Institution of Civil Engineers in Britain and the American Society of Civil Engineers in the United States the general respect of the community. These were, high qualifications for membership, a high code of ethics, and rigorous enforcement of that code. He was of the opinion that if a change were necessary, which was debatable, consideration should rather be given to a move towards the raising of the standard of membership, making it something to be prized. He felt that instead of doing this The Institute was proposing to open the doors still wider in the hope of increasing its membership.

Dr. L. F. Goodwin, M.E.I.C., in commenting on Mr. Elliot's remarks, felt that the Plenary Meeting of Council, at which more than thirty members were present from all over the Dominion, representing branches with widely divergent views, was really more representative of the membership at large than the present Annual General Meeting. Dr. Goodwin pointed out that in addition to the consideration of opinions expressed by the members of Council present at that meeting, a mass of written communications from branches and members had been considered, embodying all kinds of suggestions. He felt that Mr. Legget's position was difficult to understand, as on the one hand he criticized the standard of admission to The Institute as not being sufficiently high, while on the other he wished at once to co-ordinate The Institute's activities with those of the provincial associations of professional engineers. Apparently Mr. Legget was not aware that this was the difficulty, as the requirements of the professional associations were by no means uniform, and some, at least, had a distinctly lower standard than The Institute. He felt that many of the points brought forward by Mr. Legget had been carefully considered and the Council had tried to recognize the different points of view. Dr. Goodwin believed that if the by-laws as proposed were adopted on ballot the solution of the larger problem of co-ordination with the professional bodies would be facilitated, particularly if the full co-operation of the younger members of the profession could be secured.

J. H. Hunter, M.E.I.C., compared the present requirements for corporate membership with those embodied in the Council's proposals, and believed that those proposals prescribed qualifications which should be acceptable to every member of The Institute. He was of opinion that the adoption of the new by-laws would do exactly what they were intended for—put The Institute on a sound foundation.

F. W. Paulin, M.E.I.C., drew attention to the difficulty experienced, particularly in some of the outlying branches of The Institute, in obtaining the co-operation of these various branches with the sections of foreign engineering societies which had been established in Canada, and also with the mining engineers. He thought that the representatives of these organizations should be asked to a committee meeting to see what could be done to provide a common ground for the members of every branch of engineering to discuss their problems.

Professor Haultain, as an old member of The Institute, recalled that he had been chairman of the committee whose work resulted in the change from the Canadian Society of Civil Engineers to The Engineering Institute of Canada. This important change was, however, made on the advice of a committee all of whose members had taken an active part in the work. He felt that in the case of Mr. Busfield's Committee on Development, which had included a galaxy of past-presidents, this policy had not been followed, and the actual work of the committee had been done by a very small proportion of its members. In any case, the Committee on Development was soon superseded by another, and finally it was decided to have a Plenary Meeting of Council, at which but little time seemed to have been given to the detailed consideration of the proposals now put forward by the Council. Professor Haultain was not in agreement with a number of the changes which were now proposed, particularly the alteration in the objects of The Institute, and the change in the allocation of vice-presidents. He urged that the code of ethics should not be abandoned. Such a code was of great educational value, and the clause now proposed by Council was a poor substitute for a complete code. As regards the change in the classes of membership, Professor Haultain criticized the proposed requirements for corporate membership, which he regarded as unsatisfactory, since it was impossible to assign a precise meaning to some of the phrases used. The standing of The Institute to-day was not due to any by-laws but to the men like Sir John Kennedy, Phelps Johnson, G. H. Duggan, R. A. Ross, J. M. R. Fairbairn and Julian Smith, who in the past had contributed so much to the prestige and influence of the profession, and had unhesitatingly given their time and ability to build up The Institute. He had looked in vain for the presence of these distinguished men at the last Annual Meeting, when the report of their committee was presented by Mr. Busfield.

Mr. Paulin desired to correct a wrong impression he seemed to have given to Professor Haultain, namely, that at the Plenary Meeting of Council but little time was given to the discussion of the new by-laws. Nearly all of the time of that meeting was taken up in a full, broad discussion of every item concerning these by-laws, and then a comparatively short time was spent in going over the different clauses in order to conform with the views that had been presented in the general discussion.

S. R. Banks, Jr.E.I.C., desired to express his agreement with Mr. Legget's criticisms of the proposed by-laws, the adoption of which he believed would be a retrograde step. The prestige of a society depended on the standing of its individual members and the requirements exacted of them. He felt that the qualifications now proposed were of a lower standard and believed that the status of The Institute under the proposed by-laws would compare very unfavourably with that of older institutions with more rigid requirements for membership. Many of the clauses in the proposed by-laws were vague and depended on the discretion of the Council. He believed that if the proposed by-laws were accepted the result would be equivalent to an invitation to foreign societies to come in and start branches in Canada.

John M. Fairbairn, A.M.E.I.C., considered that the proposed changes brought up the question as to whether The Engineering Institute was to be a purely professional body or whether it was to be largely a commercial one. Was The Institute to be a broad-minded organization covering the whole field of engineering, or would some of the best known engineers who are engaged in competitive industry have to withdraw from The Institute?

A. B. Lambe, A.M.E.I.C., drew attention to the difficulties which had been encountered by the professional associations in obtaining satisfactory legislation and remarked that while the present situation was by no means satisfactory, particularly as regards the relations between The Institute and the professional bodies, it was the best possible under present conditions, and for the time being it would be necessary to carry on with the two sets of organizations. Mr. Lambe outlined the discussions which had taken place between The Institute's committee and those of the professional associations, and explained that a committee representing the professional associations was at work, and as soon as some initial difficulties had been overcome, would endeavour to compose the difficulties among the associations.

Mr. Carswell felt that the discussion had so far been somewhat unsatisfactory as being unlikely to lead to any definite result. He questioned whether an Annual General Meeting, at which slightly over two per cent of the total membership were present, could be regarded as being very representative, and he thought that the discussion could with advantage be closed at this point. In this he was supported by Dr. Goodwin.

After further discussion, in which Messrs. Pitts, Busfield, Lambe, Hunter and General Mitchell took part, Mr. Gordon Pitts presented a motion that the decision on the by-laws now proposed by Council be delayed for the time being. This motion was ruled out of order by the President, as the course to be followed in connection with Council's proposals was definitely laid down in the by-laws, the motions with which the Annual General Meeting was empowered to deal being those for amendments to the proposed by-laws as submitted by Council. The motion of Mr. Pitts did not fall within this category.

Mr. Legget drew attention to the provisions of the present by-laws to which the chairman had referred, and moved, as an amendment to Section 1 of the Council's proposals, that the words of Section 1 of the existing by-laws be substituted for those of Section 1 of the new by-laws as now proposed by Council. H. M. Scott, M.E.I.C., having seconded this amendment, the President announced that in accordance with the by-laws it would go out to ballot with Council's proposals, and that he would appoint the necessary committee to state the arguments for and against, as required by Section 75 of the by-laws.

The President then declared the discussion closed, and delivered his retiring address, which appears in another column of this issue of The Journal.

The Secretary was then asked to read the report of the scrutineers appointed to canvass the Officers' Ballot for 1934, and the officers named therein were declared duly elected as follows:

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| President | F. P. Shearwood |
| Vice-Presidents: | |
| Zone B | E. G. Cameron |
| Zone C | A. B. Normandin |
| Zone D | A. Gray |
| Councillors: | |
| Cape Breton Branch | C. M. Smyth |
| Moncton Branch | H. J. Crudge |
| Saguenay Branch | G. F. Layne |
| Quebec Branch | H. Cimon |
| Montreal Branch | C. B. Brown |
| | A. Cousineau |
| Ottawa Branch | C. M. Pitts |
| Peterborough Branch | R. L. Dobbin |
| Toronto Branch | J. R. Cockburn |
| Hamilton Branch | F. W. Paulin |
| Niagara Peninsula Branch | W. Jackson |
| Sault Ste. Marie | A. E. Pickering |
| Winnipeg Branch | F. G. Goodspeed |
| Lethbridge Branch | C. S. Clendening |
| Calgary Branch | F. M. Steel |
| Victoria Branch | H. L. Swan |

On the motion of A. B. Normandin, M.E.I.C., seconded by A. B. Crealock, A.M.E.I.C., it was unanimously resolved that a vote of thanks be tendered to the scrutineers for their services and that the ballot papers be destroyed.

Dr. Lefebvre then asked Past-President C. H. Mitchell, M.E.I.C., and Past Vice-President J. H. Hunter, M.E.I.C., to conduct the newly elected President to the chair, and after a brief expression of appreciation from President Shearwood of the honour done him, the following votes of thanks were unanimously passed.

On the motion of W. H. Wardwell, M.E.I.C., seconded by W. C. Adams, M.E.I.C., it was unanimously resolved that the hearty thanks of The Institute be accorded to the retiring President and the retiring members of Council in appreciation of their services during the past year.

On the motion of E. W. Stedman, M.E.I.C., seconded by F. W. Paulin, M.E.I.C., it was unanimously resolved that the thanks of The Institute be conveyed to the Montreal Branch in recognition of their hospitality and activity in connection with the holding of the Forty-Eighth Annual General and General Professional Meeting.

Following announcements by the Secretary, the meeting adjourned at five oc'ock p.m.

### Social Functions

At the luncheon held on Thursday, February 7th, the Chairman of the Montreal Branch, Dr. A. Frigon, M.E.I.C., took the chair, and the members and ladies present were addressed by the Hon. Fernand Rinfret, M.P., Mayor of Montreal, who extended the city's welcome. He was followed by Sir William Clark, K.C.S.I., K.C.M.G., High Commissioner for the United Kingdom, who spoke of recent economic changes in Britain, tracing the history of events there since the war. He discussed the effect of the various measures taken for recovery, referring particularly to the conversion loan, the effect of the introduction of tariffs and the undoubted recovery in basic industries.

The Annual Dinner of The Institute took place in the evening of the same day, President F. P. Shearwood, M.E.I.C., in the chair. The function was honoured by the presence of the Prime Minister, The Right Hon. R. B. Bennett, K.C., P.C., LL.D., who presented the prizes and medals of The Institute and delivered an inspiring address. Mr. Bennett pointed out that the engineering profession was essentially one of wide vision, and that to the engineer material things seemed of less importance than the realization of hope and belief. He concluded with a message of encouragement to the younger men.

Following the dinner a reception and dance took place which was largely attended, the members and guests being received by the President and Mrs. Shearwood, the chairman of the Montreal Branch, Dr. Frigon, and Mrs. Frigon, and the chairman of the Annual Meeting Committee, Mr. E. A. Ryan, and Mrs. Ryan.

On Friday the 9th, the ladies were entertained at tea at the Cercle Universitaire and in the evening a ladies' bridge at the Windsor hotel proved very popular. On the same evening the smoker held in the Windsor Hall was a great success, the attractions provided including some very acceptable musical numbers by the McGill University Glee Club and a boxing tournament held under the sanction of the Amateur Athletic Union of Canada. The nine bouts were refereed by the bantam and welter-weight champions of Canada, and the excellent display was greatly appreciated.

Technical Sessions

The professional sessions were held on Friday, February 9th, the papers presented and discussed in the morning being the following:

In the York Room, under the chairmanship of P. B. Motley, M.E.I.C.:

"The Broadway Bridge, Saskatoon, Sask.," by Dean C. J. MacKenzie, M.C.E., M.E.I.C.

"Survey Work for the Lake St. Louis Bridge, Lachine," by C. F. Draper, A.M.Inst.C.E.

In the Prince of Wales Salon, under the chairmanship of Dr. A. Frigon, M.E.I.C.,

"Stresses in Stiffened Circular Tubes under External Pressure," by R. D. Johnson, M.Am.Soc.C.E.

"The Reflecting Telescope for the David Dunlap Observatory," by R. K. Young, Ph.D.

"The Utilization of Magnesian Carbonates," by F. E. Lathe.

In the afternoon papers were presented and discussed as follows:

In the York Room, under the chairmanship of P. B. Motley, M.E.I.C.,

"Substructure and Approaches of the Lake St. Louis Bridge," by J. A. Lalonde, A.M.E.I.C.

"Superstructure of the Lake St. Louis Bridge," by W. Chase Thomson, M.E.I.C.

In the Prince of Wales Salon, under the chairmanship of Dean Ernest Brown, M.E.I.C.,

"Department of National Defence Relief Camps and Projects," by Major G. R. Turner, M.C., D.C.M., A.M.E.I.C.

"Construction, the Joint in the Armour of Depression," by W. D. Black, M.E.I.C.

The Committee of the Montreal Branch, which was responsible for the detailed arrangements, is to be heartily congratulated on the success of the meeting, the organization of which was carried out under E. A. Ryan, M.E.I.C., as chairman of the Montreal Branch committee, with Dr. A. Frigon, M.E.I.C., as vice-chairman. H. W. Lea, Jr.E.I.C., was responsible for the registration, F. V. Dowd, A.M.E.I.C., for the papers and meetings, F. S. B. Heward, A.M.E.I.C., for the entertainment and smoker, and J. A. McCrory, M.E.I.C., for the publicity. Mrs. E. A. Ryan was chairman of the Ladies' Committee.

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## Address of the Right Hon. R. B. Bennett, K.C., P.C., LL.D.,

*Prime Minister of Canada*

**Delivered at the Annual Dinner of The Engineering Institute of Canada, Montreal, February 8th, 1934**

After a few words of congratulation to the newly elected President of The Institute, Mr. F. P. Shearwood, M.E.I.C., the Prime Minister continued as follows:—

Ladies and Gentlemen, I did not come here to make a speech, but rather to do honour to myself by being permitted to associate with a group of men who play such a great part in our modern civilization.

I suppose there are few countries in the world where greater opportunities have been offered for the development of engineering in the greatest and widest sense than in Canada. Take our highways winding over mountain and stream; the splendid steel structures that cross our great rivers; our mines and the winning of minerals; irrigation systems, canals and railways; I wonder if you ever pause to think where our civilization would be if it were not for the engineers. If one reads the history of the past, we realize how large a part they play.

Here in Canada, where we have such a variety of natural resources, where there are such great difficulties to overcome, the engineer has indeed found the widest scope for his activities.

I believe, Sir, that the bridge I see every morning that spans the river between Ottawa and Quebec is one of the first you built in this country. I was looking at it the other day, and realized the sense of pride men must have as their creative genius, first of all conceives, and then works out the designs for such a work, until finally every detail takes shape and form and a bridge is the result.

Then there are the irrigation canals. We have extensive irrigation works in the western country and twenty-three or four or five years ago, I was actively engaged in work which had to do with irrigation canals. I well remember my duty was to complete the water agreements and the then President of the Canadian Pacific was having some difficulty with those in "the benighted east" as we in the west would say, as to the extent of responsibility involved in the water agreements. Lord Shaughnessy, then Sir Thomas Shaughnessy, asked "What are our obligations under this contract?" I said, "Your obligations are to deliver water in the canals to be available for the farmers if there is water in the Bow river. That is all we ask."

Lord Shaughnessy remarked "As we are under contract to deliver mail across this continent, and we frequently have disasters in the mountains, I cannot think that our obligation is any greater in the one instance than in the other, and there is no reason why we should not rely on our engineers as much in one case as the other" and they did.

We have spanned streams, we have built irrigation works, sewers, water works; gas, electric light and power have been developed and they are truly a monument of progress in this country. We have, indeed, experienced with all the world a great setback, and passed through a period of great depression, but as you look about in city and town and country, you realize that the engineer has been abroad in the land. Though a depression is upon us, in the month of November last, I think, we consumed more kilowatts of electric energy than in any month in the history of this Dominion, and so, you see, the engineer of water power, electric plants and matters of that kind has still work to do.

But I did not come here for the purpose of reminding you of the great contribution you have made to the welfare of the Dominion. That, of course, some of you younger men would readily admit. It might be a little difficult to get the older men to consent to such an admission, but remembering my own youth and the willingness with which I would undertake to give an explanation of a legal difficulty more easily than the more experienced men, I feel quite certain that the younger men will admit that they have made a great contribution to the life of this country. I can only hope that the steady resistant courage that enabled the Welland canal to be completed and resulted tonight in the presentation to Mr. Grant of the Sir John Kennedy Medal which is indicative of the high regard in which he is held by his confreres, will encourage the youth of this country as they go forward with their enterprises, so that when they have attained a similar age they will have been the recipients of similar honours.

I do not know that I could usefully do more tonight, after having paid tribute to your worth, than to express my sense of obligation on behalf of the nation to those who belong to the engineering profession, for I conceive it to be not only a high honour but a great privilege and pleasure to bear my tribute of respect and esteem and regard to the great profession to which you belong in all its various branches. I do so, not only on my own behalf, but gladly on behalf of the nation and the government of which I happen to be the head, for I am quite certain that the contributions which engineering has made to the Dominion of Canada in every branch of its activity, have done more to bring about the material progress and advancement than any other single factor to which I could refer.

When I say that, I explain at once my reason for being here and my excuse for not indulging in any lengthy observations. To make any address would be like painting the lily. Has not one young man won a prize because he talked about "Economics and Engineering"? I think that during the last three years I must have listened to more economic advice than any man in this room. Take for example the development of electric energy on the St. Lawrence. If the advice was not tendered by individuals, at least I received it through the columns of the newspapers.

So, not being desirous of indicating my own unfamiliarity with problems with which you are so familiar, I would just like to say these words of encouragement: Few professions have offered the same opportunity as yours for wide vision, for no great engineer can be a small man. It is impossible. He can't be; he might like to be a small politician, but he couldn't be if he wanted to; it is impossible. It is quite impossible, for he deals with problems that are not small, he struggles with the forces of nature in their wildest forms; he looks at a great chasm and sees a dam, water power, towns, communities, factories. He sees in his mind's eye, all those things which go with the orderly development of great industry. He sees a great railway or a great terminal or a great system of water works, a great canal or a great irrigation system, bringing fertility to the dry and sterile land through which water is being led. How could he be small? To-day, if you want to get a large view of anything, you go to the engineer. He always has it. It can't be otherwise. I am sure none of the wives of the engineers present have ever found their husbands niggardly with their monthly allowance. (Laughter.)

Young men, with such examples as you have before you in this country, I hope you are shaping your course along the line of their example. When I was a youth I remember reading Samuel Smiles' "Lives of the Engineers." It is a little old fashioned now, but I suppose most of you have read it. I remember the impression it made on my mind as I read of Telford, the great engineer. The electrical engineer hadn't then come into being. We hadn't heard of him and the consultant and the specialist. People had to take chances in those days and they became their own consultants and their own engineers and their own initiators.

But you boys feel very pessimistic these days. You say there isn't much doing. "What is the hope for us? We haven't got anything to do. We have education. Didn't we listen to Dean Brown for the last four years? We know all there is to know about these abstruse and difficult things. What are we going to do to-day?"

Well, my friends, the other night I picked up the 1830 Quarterly Review—an article written only one hundred and four years ago—and they had exactly the same difficulties in those days that we have now, only they thought they were worse. We know they are worse in our day because you radio and electrical engineers have created a situation where it is possible to have all the troubles of all the world on our doorstep every morning. It is the price we pay for your achievements.

But I come with a message of hope to you younger men. This country is only on the threshold of its development. It may be true that we have been over-ambitious in some directions and that ten and a half million of people have, perhaps, accomplished more than ten and a half million people should have accomplished so quickly, but we are on the threshold of great development. All the world shows signs of progress. The insecurity of the past is leaving us; the uncertainty is giving place to certainty. In every nation, whether the United States or France or Germany or Great Britain, or Canada or Japan, employment is greater, production is increasing and men are looking with more hopefulness upon the future.

Even though you may sometimes recall the phrase "hope deferred makes the heart sick"—I think those are the words—nevertheless, have a strong and abiding faith in your country, with pride in what has been accomplished, with certainty as to your equipment which has been secured for you by the sacrifices of those who have gone before. Have an intelligent appreciation of what the future holds for Canada, be of good hope, be of high courage, for you will find your niche and your place and your work to do. Of that I feel confident.

If at times you are depressed, as I sometimes am myself, study the history of the great engineers of the past in our country and in other countries, learn of the difficulties they overcame, the struggles they had, their willingness to endure sacrifices that they might vindicate sometimes a principle, at other times a struggle for livelihood —you will take courage and despair no longer. The clouds break, the future is brighter.

I would not say that if it were confined to my own country, but in all the world it is so. Who shall say that in a young country such as this, after passing through the struggle we have, and enduring what we have, we may not produce better men, because they have not too easily attained prosperity.

You engineers know something of stress and strain. Sometimes you have to make costly experiments in order to satisfy yourselves as to the correctness of what you are doing. Well, you young men are being tried in the laboratory of experience. The work may be hard, the compensation may be small, but don't shorten your vision because of that.

When I talk to my friend, the President, here, I realize that here is a man to whom material things were much less important than the realization of hopes and visions and understanding. If, in this material age, you sometimes wonder whether there is room for aught but material thoughts, I would like to say to you younger men, what helped me when I was your age, for unless a man's reach exceeds his grasp what's a Heaven for? So hope beyond what you may attain; believe what you may not see and, reach, reach, reach, reach far beyond your grasp. That is all I have to say to you.

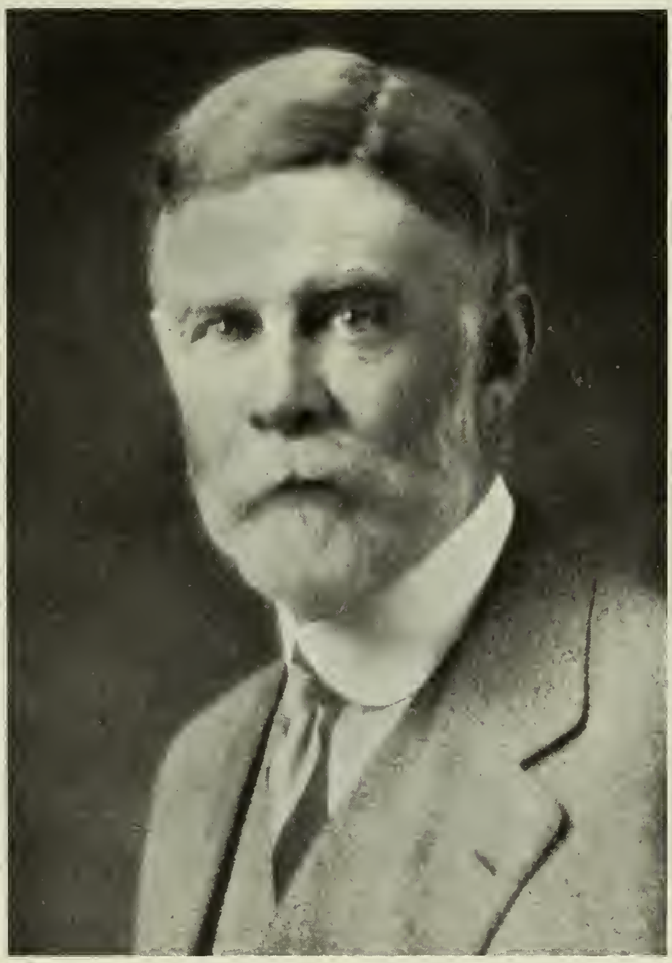
It is worth coming here tonight to see your faces, to shake you by the hand and for the moment to see men who have done things, who have wrestled with the forces of nature and won from her her treasures. It is not easy to overcome her; Nature is hard to beat. Wrestling with her, overcoming her, struggling with her, you attain victory and success. I came here tonight to get inspiration from the thought of what you have done, that I may take up the burden of my responsibilities the better for having seen you. (Prolonged applause.)

# The Sir John Kennedy Medal Awarded to Alexander Joseph Grant, M.E.I.C.

In order that The Engineering Institute of Canada might give fitting recognition from time to time to engineers of outstanding merit in the profession, and to those who have made noteworthy contributions to the science of engineering or to the benefit of The Institute, the Sir John Kennedy Medal was established in 1928. The rules governing its award provide that in making its decision as to this medal, the Council of The Institute shall take into consideration the life, activities and standing in the community and profession of the late Sir John Kennedy. It is one of the greatest honours in the gift of The Institute.

At its Plenary Meeting on October 30th, 1933, the Council unanimously named Past-President A. J. Grant, M.E.I.C., as a recipient of this distinction, and accordingly the medal was presented to him at the Annual Dinner of The Institute on February 8th.

Two previous awards of this gold medal have been made, the first, in 1929, to the late Lieut.-Colonel R. W. Leonard, M.E.I.C., Past-President of The Institute, and the second to Past-President G. H. Duggan, M.E.I.C., in 1930.



A. J. GRANT, M.E.I.C.

Mr. Grant, who now becomes the third Sir John Kennedy medallist, was born in Scotland on May 10th, 1863, at Dufftown, Banffshire, and came to Canada in 1872. He was educated at the University of Ottawa and St. Mary's College, Montreal.

His professional career began in 1880 on a survey party under H. D. Lumsden, for the Canadian Pacific Railway, west of Winnipeg. In 1883 he worked on the Baie des Chaleurs Railway, and in July 1886 he entered the outside service of the Department of Railways and Canals by joining the engineering staff of the Cape Breton Railway, under Hiram Donkin, M.E.I.C., where he was assistant engineer on the construction of the railway from 1887 to 1891. In the latter year he was transferred to the engineering staff of the Soulanges canal under Thomas Monro, remaining as an assistant engineer until the completion of the canal in January 1903, when he was appointed to the position of engineer in charge of the Port Colborne improvements. Here he remained until April 1906, when he was promoted by the department to the position of superintending engineer of the Trent canal.

During his tenure of this appointment, the construction of the Ontario-Rice Lake Division of the waterways was carried out, and the surveys and plans made for the Severn River Division of the canal. The works for improving the navigation of the Severn river were begun under his supervision, but, owing to war conditions, were suspended in 1916-17.

Since January 1st, 1919, Mr. Grant has been engineer in charge of the construction of the Welland Ship canal.

Mr. Grant joined The Institute before its change of name, having been elected an Associate Member on October 8th, 1891, and a Member on November 21st, 1901. Throughout his connection with The Institute he has been an unfailing supporter of its work and aims, and he took an active part in the formation of the Niagara Peninsula Branch in 1919. He served on Council as Vice-President in 1928-1929, and was elected President in 1930, a year which was particularly appropriate, since it saw the official opening to traffic of the important waterway whose construction he had directed for more than ten years.

This great work, with its terminal harbours and flight locks, is an outstanding engineering achievement, and its sound design and substantial construction forms an enduring evidence of Mr. Grant's professional capacity, ripe experience, and ability as an engineer and administrator.

# Award of Medals and Prizes

PAST-PRESIDENTS' PRIZE

The Past-Presidents' Prize for the year 1932-1933 has been awarded to Eric G. Adams, S.E.I.C., Montreal, the subject, "The Relation of Economics to Engineering" having been prescribed by Council for this competition. The committee also accorded honourable mention to the paper contributed by C. G. Cline, A.M.E.I.C., Niagara Falls, Ont.

Mr. Adams is a graduate of McGill University, having obtained the degree of B.Sc. in 1929. He is at the present time with Messrs. Cockfield, Brown and Company, Montreal. This is the second time that Mr. Adams has been the recipient of one of The Institute's prizes, having been awarded the Phelps Johnson Prize for Students and Juniors in the province of Quebec for the year 1930-1931, for his paper entitled "Some Economic Problems Confronting the Wider Application of Railroad Electrification in America."

Eric G. Adams, S.E.I.C.

M. Eaton, A.M.E.I.C.

A. G. Fleming, M.E.I.C.

C. G. Cline, A.M.E.I.C.

C. H. Hitchcock

Mr. Cline is senior assistant engineer with the Water Power and Hydrometric Bureau, Department of the Interior, Ontario Power Plant, Niagara Falls, Ont. He graduated from the University of Toronto in 1911 with the degree of B.A.Sc.

GZOWSKI MEDAL

The Gzowski Medal Committee has awarded that medal for the year 1932-1933 to M. Eaton, A.M.E.I.C., for his paper entitled "Automatic Operation of Electric Boilers." Mr. Eaton graduated from McGill University in 1921, with the degree of B.Sc., and following graduation was on the engineering staff of the Shawinigan Engineering Co. Ltd. In 1922 he was appointed electrical engineer for the Canadian Electro Products Company Ltd., and at the present time he is connected with Shawinigan Chemicals Limited, at Shawinigan Falls, Que.

PLUMMER MEDAL

The Plummer Medal for the year ending June 1933 was awarded to A. G. Fleming, M.E.I.C., for his paper on "The Development of Special Portland Cements in Canada."

Mr. Fleming graduated from Queen's University in 1904, with the degree of B.A. and later attended the School of Mines of the same university. In 1907 he joined the staff of the International Cement Company (later the Canada Cement Company) at Hull, as operating chemist, and in 1913 received the appointment which he now holds, that of chief chemist of the Canada Cement Company, Montreal.

LEONARD MEDAL

C. H. Hitchcock, vice-president, Smith and Travers Limited, Sudbury, Ont., is the recipient of the Leonard Medal for this year, the award being for his paper on "Diamond Drilling Practice" which was published in the June, 1933, issue of the Bulletin of the Canadian Institute of Mining and Metallurgy. Leonard medallists must be members either of The Engineering Institute of Canada or of the Canadian Institute of Mining and Metallurgy.

STUDENTS' AND JUNIORS PRIZES

Three of these prizes were awarded this year as follows:

The John Galbraith Prize (province of Ontario) to C. W. Crossland, S.E.I.C., of the Hawker Aircraft Limited, England, for his paper on "The Rationalization of Load Factors for Aeroplane Wings."

C. W. Crossland, S.E.I.C.

L. A. Duchastel, Jr.E.I.C.

R. Boucher, S.E.I.C.

The Phelps Johnson Prize (Province of Quebec, English) to L. A. Duchastel, Jr.E.I.C., designer, with the Power Engineering Company, Montreal, for his paper on "The Rapide Blanc Development."

The Ernest Marceau Prize (Province of Quebec, French) to R. Boucher, S.E.I.C., Massachusetts Institute of Technology, Cambridge, Mass., for his paper entitled "Projet d'Aménagement Hydro-Electrique."

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## ELECTIONS AND TRANSFERS

At the meeting of Council held on January 16th, 1934, the following elections and transfers were effected:

*Member*

MAILHIOT, Adhemar, Civil, Mining and Chem. Engr., (Ecole Polytechnique), professor of mining, geology and metallurgy, Ecole Polytechnique, Montreal, Que.

*Associate Members*

BRIDGE, John Franklin, B.A.Sc., (Univ. of Toronto), elect'l. engr., Canadian Industries, Limited, Sandwich, Ont.

GOODWIN, Edward Arthur, (St. Helens Tech. Sch.), chief engr., Silent Glow Oil Burner Corpn. Ltd. (Canada), Montreal, Que.

*Transferred from the class of Student to that of Junior*

BLACK, Frank Leslie, B.Sc., (N.S. Tech. Coll.), asst. professor, engrg. dept., Mount Allison University, Sackville, N.B.

*Students Admitted*

HARDING, Sidney Howard, (Univ. of N.B.), Apohaqui, N.B.

HOUGHTON, Walter Craig, (Grad., R.M.C.), (Queen's Univ.), 223 Albert St., Kingston, Ont.

HUNT, William Murray, B.Sc., (N.S.Tech.Coll.), North Sydney, N.S.

MACDONALD, Colin, (Univ. of Toronto), North House, Univ. of Toronto, Toronto, Ont.

SHORT, H. Douglass, B.Sc., (Queen's Univ.), 3032 Maplewood Ave., Montreal, Que.

At the meeting of Council held on February 9th, 1934, the following Students were admitted:

BLAINE, Donald Smith, (Grad. R.M.C.), (Queen's Univ.), Kingston, Ont.

GRAHAM, Charles Allison, (McGill Univ.), Chesterville, Ont.

KESTER, William Hudson, (Univ. of Wisconsin), 162 Windermere Road, Walkerville, Ont.

McCANN, Edward Howard, (McGill Univ.), 2064 Mansfield St., Montreal, Que.

TASSE, Yvon Roma, (Ecole Polytechnique), 4683 Christophe Colomb, Montreal, Que.

TREMBLAY, Charles, B.A.Sc., C.E., (Ecole Polytechnique), junior engr., Lake St. Louis Bridge, Montreal, Que.

## ANNUAL REPORT

*Received too late to publish with Branch Reports in February, 1934 issue of The Journal*

### Lakehead Branch

The President and Council:—

On behalf of the Executive committee, the following Annual Report of the Lakehead Branch of The Engineering Institute of Canada is submitted.

MEMBERSHIP

On January 1st, 1933, there were 41 Corporate Members and 12 Non-Corporate Members. On December 31st, 1933, there were 34 Corporate Members and 10 Non-Corporate Members.

MEETINGS

Two meetings were held during the past year. The first meeting was held in the Officers' Mess, Port Arthur Armoury, on April 24th. Dr. O. O. Lefebvre, M.E.I.C., President of The Institute, was the guest of honour. The meeting was preceded by a dinner, after which the meeting was called to order by the Branch Chairman, J. Antonisen, M.E.I.C. Dr. Lefebvre addressed the meeting on Institute affairs. After discussing the affairs Dr. Lefebvre answered all questions that were asked by the members present. A hearty vote of thanks was tendered the President.

The second meeting was held in the same place and was addressed by G. H. Burbidge, M.E.I.C., who gave a resume of his attendance at the Plenary Meeting. Then P. E. Doncaster, M.E.I.C., addressed the meeting on the subject of The International Joint Commission re International Waters along the Boundary. Mr. Doncaster had just returned from a meeting of the above body at Winnipeg and St. Paul, Minn.

Both addresses were greatly enjoyed and a vote of thanks was tendered both gentlemen.

H. G. O'Leary, A.M.E.I.C., was appointed the Lakehead Branch Representative on the Nominating Committee.

FINANCIAL STATEMENT

| | | |
|---|---|---|
| *Revenue* | | |
| Balance in Bank, December 31st, 1932 | $447.17 | |
| Rebate of Fees | 61.50 | |
| Rebate of Fees, 1932, deposited January 1933 | 3.90 | |
| Bank Interest | 10.59 | |
| Refund, Travelling Expenses to Plenary Meeting | 145.80 | |
| Rebates due from Headquarters | 6.00 | |
| | | $674.96 |
| *Expenditure* | | |
| Telegrams | $ 3.18 | |
| Entertainment | 66.15 | |
| Dues, Secretary-Treasurer | 40.15 | |
| Advance, Travelling Expenses to Plenary Meeting | 145.80 | |
| Branch Share, Plenary Meeting | 4.20 | |
| Accounts Receivable, Rebates due from Headquarters | 6.00 | |
| Balance in Bank, December 31st, 1933 | 409.48 | |
| | | $674.96 |

Respectfully submitted,
J. ANTONISEN, M.E.I.C., *Chairman.*
GEO. P. BROPHY, A.M.E.I.C., *Secretary-Treasurer.*

## Publications of Other Engineering Societies

From time to time announcements have appeared in The Engineering Journal regarding the exchange arrangements which exist between The Engineering Institute of Canada and the founder engineering societies of the United States, whereby members of The Institute may secure the publications of the American societies at special rates which in most instances are the same as charged to their own members. A list of these publications with the amounts charged is given below, and subscriptions may either be sent direct to New York or through Headquarters of The Institute.

| | *Rate to E.I.C. Members* | *Rate to Non-Members* |
|---|---|---|
| AMERICAN SOCIETY OF CIVIL ENGINEERS | | |
| Proceedings, single copies | $ 0.50 | $ 1.00 |
| Per year | 4.00 | 8.00* |
| Civil Engineering, single copies | .50 | .50 |
| Per year | 4.00 | 5.00 |
| (Plus $.75 to cover Canadian postage.) | | |
| Transactions, per year | 6.00 | 12.00† |
| Year Book | 1.00 | 2.00 |
| (Other publications 50 per cent reduction on catalogue price to E.I.C. members). | | |
| * *If subscription is received before January 1st, otherwise $10.00.* | | |
| † *If subscription is received before February 1st, otherwise $16.00.* | | |
| AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS | | |
| Electrical Engineering, single copies | $ 0.75 | $ 1.50 |
| Per year | 6.00* | 12.00* |
| (*Plus postage $1.00.) | | |
| Transactions—annual, bound | 6.00* | 12.00* |
| (*Plus postage $1.00.) | | |
| (The single copy price for Electrical Engineering includes postage charge.) | | |
| THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS | | |
| Mechanical Engineering, single copies | $ 0.50 | $ 0.60 |
| Per year | 4.00* | 5.00 |
| (*Additional Postage to Canada $.75, Outside United States and Canada, $1.50.) | | |
| Transactions, bound, published annually, about May 15 (price of current volume) | 10.00 | 20.00 |
| (Other publications, same rate to E.I.C. members as to A.S.M.E. members.) | | |
| AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS | | |
| Mining and Metallurgy, single copies | $ 0.50 | ....... |
| Per year | 3.00* | ...... |
| (*Plus $1.00 for foreign postage.) | | |
| Metals Technology, single copies | 1.00 | ...... |
| Per year | 7.00* | ....... |
| (*Plus $.50 for foreign postage.) | | |
| Transactions, per volume | 5.00* | ...... |
| (*Plus $.60 for foreign postage.) | | |
| Technical publications: Supplied at $.01 per page, with a minimum charge of $.25 for single copies, or at a subscription rate per year of | 7.00* | ...... |
| (*Plus $1.00 for foreign postage.) | | |

# OBITUARIES

### Narcisse Belleau Gauvreau, M.E.I.C.

It is with regret that we place on record the death on December 29th, 1933, at North Vancouver, B.C., of Narcisse Belleau Gauvreau, M.E.I.C.

Mr. Gauvreau was born at Isle Verte, Que., in 1855. He studied mathematics at Laval University, and was an articled apprentice to Mr. C. Baillarge, city engineer of Quebec, and Mr. Bignell, Provincial Land Surveyor of Quebec. From 1871 to 1875 he was leveller and transitman on Dominion government surveys for the Canadian Pacific Railway, and in 1876-1879 was employed on railway location and the construction of the North Shore Railway. From 1880 to 1885 Mr. Gauvreau was engaged on Dominion government Canadian Pacific Railway work in British Columbia, and has since that time resided in British Columbia.

Mr. Gauvreau was one of the oldest members of The Institute, having joined the Canadian Society of Civil Engineers on November 11th, 1887. He became a life member on March 25th, 1925.

### Pierre Michel Helbronner, M.E.I.C.

Regret is expressed in placing on record the death at Montreal on January 23rd, 1934, of Pierre Michel Helbronner, M.E.I.C.

Born at Montreal on October 22nd, 1876, Mr. Helbronner studied architecture in the offices of Taylor and Gordon, and in 1896-1897 took an architectural course at McGill University. In 1899 he joined the staff of T. Pringle and Son Limited, and in 1907 became a member of the firm, which association was retained until the time of his death.

Mr. Helbronner served with the French Army from 1914 to 1919, receiving three decorations, and being cited in British despatches. From 1917 until the armistice he was attached to Sir Douglas Haig's headquarters staff as interpreter, and was the author of a technical bilingual dictionary used by the British Ministry of War.

Under the pen name of Jacques Savane, Mr. Helbronner enjoyed a considerable reputation in France and in Montreal as a poet and writer, and for his poetry gained a mention and then a first prize in the annual poetic competitions of Les Annales, Paris, in 1906 and 1907 respectively.

He was president in Montreal of the Société Française de Secours Mutuels, vice-president of the Union Nationale Française, vice-president of the Vétérans des Armées de Terre et de Mer, and of the Soldats de la Grande Guerre, also vice-president of the Société Alsacienne-Lorraine and of the Association des Sphynx, and member of the Ville-Marie section of the Association des Vétérans de la Grande Guerre. Mr. Helbronner was a member of the Association of Architects of the Province of Quebec, a founder-member of the Royal Architectural Institute of Canada, a member of the Société des Architectes de France, and a licentiate in architecture of the Royal Institute of British Architects of London.

Mr. Helbronner joined The Institute as a Member on August 12th, 1921.

### James Benjamin Philipps, A.M.E.I.C.

Regret is expressed in recording the death at Winnipeg, Man., on January 11th, 1934, of James Benjamin Philipps, A.M.E.I.C.

Mr. Phillips was born in South Wales on June 24th, 1874, and from 1897 to 1901 was employed as chainman and instrumentman on Dominion Land Surveys. In 1901-1903 he was with the Public Works Department of Manitoba as instrumentman on bridge and drainage works, and later was with the Canadian Northwest Irrigation Company. In January, 1904, Mr. Phillips joined the staff of the Grand Trunk Pacific Railway and later in the same year was assistant engineer on the construction of the main line of the Canadian Northern Railway. In January, 1905, he was assistant engineer with the National Transcontinental Railway, and in 1906 was connected with the Grand Trunk Pacific Railway as resident engineer on construction at Saskatoon. Later he became resident engineer for the Transcontinental Railway at St. Boniface, Man., and was subsequently in the construction department of the Canadian Pacific Railway Company. In 1924 Mr. Philipps went to Winnipeg as division engineer with the Canadian National Railways.

He became an Associate Member of The Institute on February 7th, 1907.

### Cyril Henry Ernest Rounthwaite, A.M.E.I.C.

It is with very deep regret that we place on record the sudden death at Sault Ste. Marie, Ont., on February 5th, 1934, of Cyril Henry Ernest Rounthwaite, A.M.E.I.C.

Born at Hartford, Cheshire, England, on February 27th, 1876, Mr. Rounthwaite came to this country as a child and was educated here, graduating from the School of Practical Science, University of Toronto, in 1900.

For three years he was assistant superintendent with the Canadian Electro-chemical Company, Sault Ste. Marie, and in 1904-1909 was draughtsman with the Grand Trunk Pacific Railway at Fort William. In 1910 Mr. Rounthwaite was located at Winnipeg as draughtsman for the chief engineer of the same railway, and in the same year returned to Sault Ste. Marie as chief draughtsman and later as office engineer of the Algoma Central Railway, which positions he held up to the time of his death.

Joining The Institute (then the Canadian Society of Civil Engineers) as an Associate Member on September 21st, 1914, Mr. Rounthwaite always took a very active part in its affairs, being a charter member of the Sault Ste. Marie Branch. From 1922 to 1927 he represented that Branch on the Council of The Institute and in 1930 was Chairman of the Branch.

## PERSONALS

A. L. Farnsworth, A.M.E.I.C., is, for a time with the Northern Foundry and Machine Co., at Sault Ste. Marie. Mr. Farnsworth was formerly with the engineering staff of Abitibi Power and Paper Co. at Sault Ste. Marie.

J. L. Rannie, M.E.I.C., chief of the triangulation division of the Geodetic Survey, Department of the Interior, Ottawa, was elected president of the Dominion Land Surveyors Association for 1934, at the Association's annual meeting held at Ottawa recently.

J. A. Reid, M.E.I.C., formerly consulting mining engineer and geologist of Toronto, Ont., is now associated with the Panama Corporation (Canada) Limited, at Panama, R. de P.

John Hole, M.E.I.C., architect and engineer, has opened an office in the Harbour Commissioners Building, Toronto, Ontario.

At the Forty-third Annual Meeting of the Province of Quebec Association of Architects held recently, L. A. Amos, M.E.I.C., of L. A. and P. C. Amos, Montreal, was elected President, and G. McL. Pitts, A.M.E.I.C., of Maxwell and Pitts, Montreal, became Vice-President.

W. F. Auld, Jr.E.I.C., is now on the staff of the Lincoln Electric Company of Canada Limited, at Toronto, Ont. Mr. Auld, who graduated from the University of Toronto in 1927 with the degree of B.A.Sc., was for a time in the Induction Motor Engineering Department of the Canadian General Electric Company at Peterborough, Ont.

Among the officers elected at the Sixteenth Annual Meeting of the Canadian Construction Association held at Toronto recently were F. G. Rutley, A.M.E.I.C., vice-president, The Foundation Company of Canada, Limited, Montreal, who became a Vice-President, and W. L. R. Stewart, A.M.E.I.C., managing director, Stewart Construction Company Limited, Sherbrooke, Que., who was re-elected eastern Vice-President.

Alan K. Hay, A.M.E.I.C., Engineer of the Ottawa Suburban Roads Commission, has been elected Chairman of the Ottawa Branch of The Institute for the year 1934. Mr. Hay graduated from McGill University in 1914 with the degree of B.Sc., and following graduation was until 1916 assistant engineer on the city engineer's staff of Ottawa. In 1917 he was inspector in the gauge-testing laboratory of the Imperial Ministry of Munitions, and in 1918 and 1919 served with the Canadian Engineers, having the rank of lieutenant. Later Mr. Hay became resident engineer for the Department of Public Highways and subsequently received his present appointment.

H. M. White, A.M.E.I.C., was recently elected President of the Association of Professional Engineers of the Province of Manitoba for 1934. Mr. White, who has served on the Executive of the Winnipeg Branch and has been a Member of the Association Council for the last three years, graduated from the Faculty of Applied Science of the University of Toronto in 1910 and in the fall of the same year joined the Engineering Staff of the Dominion Bridge Company Limited, Montreal. In 1919 he was transferred to Winnipeg as designing engineer, appointed engineer in 1923 and for the last several years has been chief engineer of the Western Division, Dominion Bridge Company Limited, which includes plants in Winnipeg, Calgary and Edmonton.

#### S. J. Hungerford, M.E.I.C., Appointed President of C.N.R.

S. J. Hungerford, M.E.I.C., acting president of the Canadian National Railways since July 1932, was recently appointed President by the Board of Trustees recently named to administer the railway's affairs.

Mr. Hungerford's first railway work was as machinist apprentice with the Southeastern Railway and Canadian Pacific Railway at Farnham, Que., in 1886-1891; from then until 1910 he was with the Canadian Pacific Railway in various capacities at a number of points throughout the system, and at that time he joined the engineering staff of the Canadian Northern Railway as superintendent of rolling stock with headquarters at Winnipeg. Following the organization of the Canadian National Railways, Mr. Hungerford was appointed, in November 1917, general manager of the eastern lines, and in the following year became vice-president and general manager. In 1923 he assumed the office of vice-president in charge of operation and maintenance.

#### Harrison P. Eddy, M.E.I.C., President of the American Society of Civil Engineers

Harrison P. Eddy, M.E.I.C., partner in the firm of Metcalf and Eddy, Boston, Mass., has been elected President of the American Society of Civil Engineers for the year 1934.

Born at Millbury, Mass., on April 29th, 1870, Mr. Eddy graduated from the Worcester Polytechnic Institute in 1891 with the degree of B.S. in chemistry. Subsequently he was until 1892 superintendent of the Sewage Treatment Works of Worcester, Mass., and during the years 1892-1907 was superintendent of the Worcester Sewer Department.

Beginning in 1907 there followed a life-long partnership with the late Leonard Metcalf, M.Am.Soc.C.E., under the firm name of Metcalf and Eddy, by which it is still officially known. A list of the large and important works on which the firm has served during its twenty-six years existence would sound like the roster of most of the important sanitation and water supply projects in America. The firm's practice has not only extended widely but has gone deeply into many allied fields, including water works, sewerage and drainage systems, water, sewage and industrial wastes treatment plants and municipal refuse incinerators.

As an outcome of his intimate acquaintance with these technical questions, Mr. Eddy has been retained on many

Harrison P. Eddy, M.E.I.C.

important court cases and his services have been in demand on many engineer commissions, including the Engineering Board of Review of Chicago, working on the lake-lowering controversy and the programme of remedial measures. Still another commission on which he served had to do with the general plan, design, construction and operation of the sewage treatment plant of the North Toronto District, and on the sewage disposal problem of the entire city of Toronto. Among the projects on which he is now engaged are the sewerage problems for the District of Columbia in the east and for the city of Portland, Ore., in the west. At the present time he is a member of the Technical Board of Review which is advising the Public Works Administration in Washington with respect to applications for Federal aid in carrying out those of its projects which are unusual and of a controversial nature.

In spite of his otherwise busy life Mr. Eddy has found time to devote to technical writing, and is widely known as the co-author of a standard work on American Sewerage Practice and on Sewerage and Sewage Disposal. Many technical papers and reports also have appeared under his name. The quality of this work is attested by the award of the Desmond FitzGerald Medal from the Boston Society of Civil Engineers, and that of the Rudolph Hering Medal and the Norman Medal from the American Society of Civil Engineers, the latter the highest literary distinction in the profession.

### Committee on Low Water Level in St. Lawrence River

A committee of engineers to inquire into the cause of the low water level that has existed in the St. Lawrence river channel from Montreal downstream in recent years, and to report upon action necessary in order to correct the situation, has been appointed by the Canadian government. The low level during the late fall in 1933 seriously hampered navigation in Montreal harbour.

The committee composed entirely of engineers in the federal government service is as follows: N. B. McLean, M.E.I.C., chief engineer of the St. Lawrence Ship Channel division of the Department of Marine, Ottawa (chairman); A. Laflèche, A.M.E.I.C., assistant chief engineer of the division; F. Anderson, M.E.I.C., director, hydrographic survey; K. M. Cameron, M.E.I.C., chief engineer, Department of Public Works, Ottawa; J. L. Dansereau, A.M.E.I.C., district engineer, Montreal; J. T. Johnston, M.E.I.C., director, Dominion Water Power and Hydrometric Bureau, Ottawa, and D. W. McLachlan, M.E.I.C., chief engineer, St. Lawrence Waterways and Hudson Bay Terminals, Department of Railways and Canals, Ottawa.

## RECENT ADDITIONS TO THE LIBRARY

### Proceedings, Transactions, etc.

Liverpool Engineering Society: Transactions, 1933.
American Society of Mechanical Engineers: Transactions, Record and Index December 30th, 1933.
American Society for Testing Materials: Proceedings 36th Annual Meeting. Vol. 33, 1933.

### Reports, etc.

*American Railway Association:* Signal Section—
Electric Interlocking.
Principles and Economic Phase of Signalling.
*Can. Pulp and Paper Association:*
Technical Section—21st Annual Meeting.
*Canada, Department of Marine:*
66th Annual Report, 1932-1933.
*Canada, Department of Mines:*
Report for the Year Ending March 31st, 1933.
Economic Geology Series No. 5—2nd edition, Oil and Gas in Western Canada, by G. S. Hume.
*Canada, Department of Labour:*
22nd Annual Report on Labour Organization in Canada for the Year 1932.
*Canada, Geological Survey:*
Memoir 154, Geology of Anticosti Island, by W. H. Twenhofel.
*Institution of Civil Engineers:*
List of Members 1934.
*Boston Public Works Department:*
Annual Report for the Year 1932.
*Air Ministry, Aeronautical Research Committee, Great Britain:*
No. 1551—The Radially Braced Airship Ring.
No. 1521—An Application of Prandtl Theory to an Airscrew.
No. 1539—Flow Past Circular Cylinders at Low Speeds.
No. 1554—Buckling of Thin Plates in Compression.
No. 1540—Convection of Heat from Isolated Plates and Cylinders in an Inviscid Stream.
No. 1553—Summary of the Present State of Knowledge Regarding Sheet Metal Construction.
No. 1556—Pitching Moment due to Rotation in Pitch.
No. 1552—Methods of Visualizing Air Flow.

### Technical Books, etc., Received

Arc-Welded Steel Frame Structures by G. D. Fish. (*McGraw-Hill Book Co.*)
Basic English, by C. K. Ogden.
The Basic Dictionary, by C. K. Ogden.
Industrial Radiography, by Ancel St. John and Herbert R. Isenburger. (*John Wiley and Sons.*)
Tables of Integrals and Other Mathematical Data, by H. B. Dwight. (*MacMillan Company of Canada Ltd.*)

## BOOK REVIEWS

### Air Conditioning

*By J. A. Moyer and R. U. Fitz, McGraw-Hill Book Company Inc., New York, 1933. 6 by 9¼ inches, 390 pp. Figs., tables. $4.00. Cloth.*

Reviewed by G. Lorne Wiggs, A.M.E.I.C.*

In this book the authors have covered clearly and comprehensively the broad subject of air conditioning for industrial processes and human comfort. The work is replete with design data, charts, illustrations and examples of design calculations.

The first portion of the book is devoted to the underlying principles of air conditioning and ventilation. As the authors point out in the preface, a great deal of the data from the research work of the American Society of Heating and Ventilating Engineers and from other sources has been drawn on and included in this portion of their book.

The subject of air filters and dust removal has been well treated in a chapter devoted to that subject.

A large portion of the book covers the use of refrigeration in connection with air conditioning. This includes not only the properties of refrigerants and the different types of refrigerating equipment, including the new steam-jet type, but it also covers air-cooling by means of ice and such adsorption substances as silica-gel, activated alumina and calcium chloride.

Temperature and humidity control equipment is clearly described, while the design of temperature and humidity control systems is well covered.

The illustrative design calculations of an air conditioning system for twelve floors and the basement of a bank and office building are given. The calculations for a theatre, having a seating capacity of three thousand people, are shown in the same way, while an example of the air conditioning of a restaurant seating about seven hundred people is also included.

The details of the application of air conditioning to food factories and textile mills are given. The different methods of air conditioning railway passenger cars are also described.

Finally, the author deals with the subjects of air conditioning for residences and residence heating with refrigeration equipment.

The book is recommended to those interested in air conditioning and especially to those engineers engaged in the design of air conditioning systems.

*Consulting engineer, Montreal.*

## Practical Designing in Reinforced Concrete

*By M. T. Cantell, E. and F. N. Spon Ltd., London, England, 1933. Part II. 5½ by 8¾ inches, figs., tables, photos. 12/6 net. Cloth.*
Reviewed by VERNON R. DAVIES, A.M.E.I.C.*

This is the second volume to appear of what is to be a three-volume work on reinforced concrete designing. The book is printed in very excellent type on high grade paper. It is well printed and illustrated, containing two hundred and nineteen figures, of which only fifty are photographs. The book is arranged in headings and sub-headings without any chapter or section numbers. The index is not as comprehensive as one would wish.

A short notice of Part I states it to be a description of reinforced concrete and its suitability for various kinds of structures, together with examples worked out in detail for all types of beams, floors and columns. Part II appears to be a further development of some of the topics treated in Part I, together with some new items, such as retaining walls, safety vaults, roofs, water tanks, bins, silos, conduits, underground reservoirs, foundations and combined footings.

In the preface it is stated that Part III will contain articles in earthquake resistance, tall chimneys, dams, arches, bridges, conduits and domes.

In the preface the author points out that advanced mathematics are avoided, and graphical solutions are included in many examples to assist in elucidation and simplification of the problems.

One may raise the objection that the treatment of the various topics is rather too elementary. In many of the subjects treated a more generalized treatment could quite easily have been given without the use of advanced mathematics. It may be noted that fifteen examples are worked out for continuous beams, but in every one a constant moment of inertia has been assumed throughout all the spans. This is not usually the case in practice. In another example, when discussing a hollow circular column, the author states that, as the load is within the middle third of the diameter, there will be no tension at the section. For the particular ratio of outer and inner radii in his examples, he is right, but he should have informed his readers that for a solid circular section the kern diameter is one quarter of the outer diameter and for a thin cylindrical shell the kern diameter is one half of the outer diameter. He might also have stated that the kern radius is equal to one third the outer radius only when the ratio of outer and inner radii is equal to 3 and that the middle third rule is for solid rectangles and squares only.

The author has evidently kept in mind the needs of the beginner, as for example, when he devotes half a page to the discussion of elementary hydrostatic principles. His discussion of the wind stresses in tall buildings is empirical, but probably quite adequate for most ordinary situations. A larger number of charts or tables might with advantage have been provided in the book as aids in calculations.

The book can be recommended as a collection of examples for the use of beginners in the study of reinforced concrete structures.

*Structural and hydraulic engineer, Montreal.*

## BULLETINS*

*Steel Scaffolding*—A 16-page booklet received from the Steel Scaffolding Company Limited, London, England, illustrates the use of, and details of construction of tubular steel scaffolding which is recommended as having greater strength, safety, durability, efficiency, and is cheaper than anything of its kind on the market.

*Centrifugal Pumps*—The Worthington Pump and Machinery Corporation, Harrison, N.J., have issued a 4-page folder describing the Worthington Type U.B., two-stage volute centrifugal pumps, and including details of specifications and a list of parts.

*Compressors*—An 8-page bulletin published by the Worthington Pump and Machinery Corporation, Harrison, N.J., describes and illustrates the Worthington single horizontal, single stage, steam and motor driven compressors. Diagrams show the details of construction and advantageous features of the units, also specifications of the various sizes made are included.

*Couplings*—A 2-page leaflet issued by the Dominion Engineering Company, Ltd., Montreal, illustrates Dominion gearflex couplings, small series, shaft sizes 1, 1½ and 2 inches.

*Rotary Pumps*—Roots-Connersville Blower Corporation, Connersville, Ind., have issued a 4-page folder on their cycloidal rotary pumps which are built on the two-impeller principle, with two or three lobe impellers depending on the type of service to which they are to be applied. They are principally for heavy duty service.

*Sheet Piling*—A 2-page leaflet received from the Canadian Sheet Piling Company Ltd., Montreal, illustrates the use of steel sheet piling in the reconstruction of the Fish Quay, Torquay, England.

*Pavements*—The Portland Cement Association have issued a 20-page booklet containing particulars based on a survey of concrete resurface projects. It includes table giving recommended thickness and design for varying conditions of traffic and support.

*Cementation*—A 122-page book received from the François Cementation Company Ltd., Bentley Works, Doncaster, England, gives particulars and examples of work carried on by this company in the injection of a liquid mixture of cement, sometimes spoken of as grouting, into cavities, fissures, etc., thereby strengthening and consolidating the strata of structures so treated. A number of special features are claimed for this process such as, the mixture being moved directly by a pump piston and not through the use of compressed air; the pressure of injection is recorded on hydraulic pressure gauges and is kept under strict observation, the position of the cement tanks and pumps may be hundreds of feet away from the point of application.

** Copies of the bulletins listed above are usually available upon request to the companies concerned.*

## A.S.T.M. Regional Meeting in Washington, D.C.

A symposium on the Outdoor Weathering of Metals and Metallic Coatings will be the technical feature of the 1934 A.S.T.M. Regional Meeting, to be held on March 7th, in Washington, D.C.

The A.S.T.M. committees are sponsoring a number of important test programmes, involving atmospheric corrosion, liquid corrosion, galvanic and electrolytic corrosion, etc., and their standardization work on specifications and test methods has met definite needs on the part of industry.

This problem of outdoor weathering is one of the most difficult ones with which technical men and engineers must contend.

## Business Training for Engineers at McGill University

The Corporation of McGill University at a recent meeting received a memorandum from Dean E. Brown, M.E.I.C., of the Faculty of Engineering, who discussed the problem faced by his faculty in correlating the studies of engineering students with the more practical aspects of their work with which they are faced after graduation. He explained that engineering law and general economics had been a regular part of the engineering course for many years, but that recently an attempt had been made to extend the general training.

A course of lectures on the general history of science is now included in the first year curriculum, which is designed mainly to show that all the sciences are interrelated and interdependent. In the second year a similar course, called "Engineering Reports," is given, this being mainly a general training in English; and public speaking and a general course on economic aspects of engineering have been included in the third year, but are optional. In the fourth year, the most recent innovation is an optional course of weekly lectures by practising engineers and business men, which, as will be noted from the following programme, is diverse, and the results are being followed with great interest: October 16th-23rd—Engineering and the Social Sciences, Professor L. C. Marsh, The Social Research Council; October 30th—Engineering and Banking, Major S. C. Norsworthy, Bank of Montreal; November 6th, 13th—Engineering and Insurance, George B. Foster, K.C., Travelers Insurance Company; November 20th-27th—Engineering and Labour, Mr. Tom Moore, Trades and Labour Congress of Canada; December 4th-11th—Engineering and Trade, Mr. W. H. Munro, M.E.I.C., Ottawa Light, Heat and Power Company; January 25th-February 1st—Engineering and Safety, Mr. W. G. H. Cam, M.E.I.C., Canada Cement Company; February 8th,—Engineering and the Federal Departments, Mr. J. B. Challies, M.E.I.C., Shawinigan Water and Power Company; February 15th—Engineering and Public Health, Mr. T. J. Lafreniere, M.E.I.C., Provincial Board of Health; February 22nd-March 1st—Engineering and Architecture, Professor Ramsay Traquair, School of Architecture, McGill University; March 8th-15th—Engineering and Economics, Mr. S. W. Fairweather, Bureau of Economics, Canadian National Railways; March 22nd-29th—Engineering and the Professional Societies, Mr. R. J. Durley, M.E.I.C., Engineering Institute of Canada.

In January, 1934, the *Dominion Engineering Company Limited* presented the first issue of The Dominion Engineer, which is to be published each month. It is to contain articles of general interest regarding mechanical equipment for various purposes, and articles of a technical nature indicating modern engineering trends, and will also include items concerning the products and shop facilities of both the company and its associates. The first issue is a 12-page booklet, which contains a number of excellent illustrations, and short informative articles.

*The Hamilton Gear and Machine Company* of Toronto is now represented in British Columbia by the B.C. Conveying Machinery Company, 422 Shelly Building, Vancouver.

# BRANCH NEWS

## Border Cities Branch

*C. F. Davison, A.M.E.I.C., Secretary-Treasurer.*

"The Diesel and High Speed Engines" was the subject of an address given by Boyd Candlish, A.M.E.I.C., to the members of the Border Cities Branch and their friends at a dinner meeting held in the Prince Edward hotel, on Friday evening, January 12th, 1934.

### The Diesel and High Speed Engines

Comparing the European and American types of automobiles the speaker pointed out that the relatively high fuel mileage obtained from the former was due probably to the higher cost of fuel and taxes which had led to the development of cars equipped with motors of lesser horsepower and higher thermal efficiency. The American type of car was sold on a basis of rapid acceleration and was equipped with an engine capable of driving the car at speeds far in excess of the legal limit. The load factor of the English car is 35 to 40 per cent, while that of the American is but 15 to 25 per cent.

Modern motor car engines are of high mechanical efficiency. The rolling friction of the car itself is small, the greater portion of the power generated being used to overcome wind resistance and to operate the accessories such as the generator and fan. At high speeds the fan may consume from 5 to 15 h.p. and this at a time when the air pressure on the radiator is such that a fan is scarcely required. However, in so far as the engines themselves were concerned, the increase in overall efficiency must be obtained by increasing the thermal efficiency.

Higher thermal efficiencies may be obtained by using higher compression ratios. This ratio, however, is limited in the case of the gasoline to 8:1, while the Diesel engine operates on ratios exceeding 10:1. By means of diagrams, it was shown that compared to the maximum possible efficiency for any one compression ratio, the average American motor car engine does not give the best efficiency for the compression ratios now in use. For highest efficiency, engines should be designed for specific fuels. In the case of the gasoline engine the thermal efficiency drops rapidly as the load decreases.

Mr. Candlish predicted that a properly stream-lined car with a well-designed engine would operate at a speed of 50 miles per hour on a full consumption of 35 to 40 miles per gallon. At a speed of 30 miles per hour, 70 miles per gallon of fuel should be obtained.

Passing to Diesel engines, Mr. Candlish noted that in order to have a yardstick with which to measure performance it was necessary to discuss the advantages and disadvantages of internal combustion engines in general. If the Diesel engine had no other advantage than that of operating on a cheaper fuel, it would soon lose this advantage were it to displace the gasoline engine. The comparative prices of fuel were largely due to supply and demand, and if Diesel engines were applied to automobiles, fuel oil would soon be at a premium and a tax on fuel oil would replace the present tax on gasoline.

The Diesel engine has however several inherent advantages. Since the air and gas are not compressed together, a higher compression ratio may be obtained without danger of pre-ignition. It will develop a high efficiency over a wide range of load and speed. Further, it is subject to less trouble from carbon and will run for longer periods without overhaul.

The time elapsing between ignition and the complete combustion of the charge, termed the "delay period," was shorter in the case of the Diesel than the gasoline engine which enables it to operate satisfactorily at any speed from 300 to 3,000 r.p.m. The maximum speed is governed by the dynamic loading due to heavy rotating parts rather than by thermal considerations. The disadvantages of the Diesel engine lay in the difficulties of design to overcome stresses at higher temperatures and in its greater weight per h.p. developed. The limit for engines of 1,500 feet per minute piston speed is about 15 h.p. per cylinder.

The speaker sketched the development of the Diesel engine and compared the various types and their application. The supremacy of the gasoline engine for eight passenger automobiles is not likely to be challenged but the Diesel will probably be more widely adopted for heavy bus and truck service.

The Diesel engine is rapidly supplanting steam power in railway locomotives for light and fast service. The overall efficiency of about 35 per cent for the Diesel as against 6 per cent for the steam locomotive is the deciding factor. The Diesel also finds application in marine service, though its use will be limited to boats of less than 8,000 tons displacement as where great power is required the number of cylinders and hence the number of units required becomes excessive. Diesel engines are used in aircraft. The lesser weight of fuel required with the more efficient Diesel engine more than offsets its heavier weight for long distance service.

Mr. Candlish also referred to the hydrogen engine now being developed and indicated that this engine was of great interest to Canadians. Off-peak electric power at low rates may be used for the electrolysis of water. The oxygen may be sold for industrial purposes while the hydrogen may be used to develop power at a cost equivalent to gasoline at 3 cents per gallon. The off-peak electric power available in eastern Canada would produce hydrogen equivalent in power to that of about one billion gallons of gasoline per year.

The speaker closed his address with a brief reference to the latest type of gasoline engine in which the fuel is injected into the cylinder in a manner similar to Diesel practice.

A lively discussion followed the presentation of the paper, and Mr. Candlish displayed his thorough knowledge of the subject in replying to many questions.

A hearty vote of thanks was proposed by J. E. Porter, A.M.E.I.C., and seconded by W. H. Baltzell, M.E.I.C.

## Calgary Branch

*J. Dow, M.E.I.C., Secretary-Treasurer.*
*H. W. Tooker, A.M.E.I.C., Branch News Editor.*

Thursday evening, January 11th, 1934, was the occasion of a most interesting address on the "Big Bend Highway" given to the members of the Calgary Branch of The Institute and their friends by J. M. Wardle, M.E.I.C., chief engineer of the Dominion National Parks Branch.

### Big Bend Highway

During the course of his introductory remarks, Mr. Wardle mentioned that he was a member of the Ottawa Branch, and took this opportunity of extending the greetings of that Branch to the members of the Calgary Branch.

Before presenting the three reels of motion pictures depicting the roughness of the country through which the highway travels, the nature of the construction, the many difficulties to be overcome, the methods employed in constructing this portion of the trans-Canada highway, and the different types of powered machinery used, Mr. Wardle explained that the Big Bend highway was that portion of the trans-Canada highway from Golden to Revelstoke, and followed the Columbia river between these two points around the Big Bend or most northerly point of that river, and was the last link of the highway to be completed, as it is already completed westerly as far as Golden and easterly from Vancouver as far as Revelstoke. He also explained how this portion of the highway, when completed, would be of great importance to tourist traffic, as it will open up an altogether new section of the country, mentioning the fact that tourists seldom care to make the return journey by exactly the same road by which they come.

The speaker went on to say that the Dominion government is constructing the eastern leg of the highway from Donald to the top of the Bend or most northerly point known as Boat Encampment, a distance of 78 miles, of which 60 miles was already constructed and 45 miles surfaced. The British Columbia government is constructing the western leg from Revelstoke to the top of the Bend, a distance of 100 miles, 40 miles of which is already completed, making that portion of the trans-Canada highway known as the Big Bend highway 178 miles long, and although efforts had been made to keep the maximum grade down to 6 per cent, the steepest grade was 8½ per cent.

Besides the motion pictures depicting the many details of this particular piece of work and the many labour-saving devices used in its construction, Mr. Wardle showed by means of lantern slides the details and type of bridge construction and the many difficulties to be overcome in this connection.

Following Mr. Wardle's address, a very interesting discussion took place, after which a hearty vote of thanks was given the speaker by R. S. Trowsdale, A.M.E.I.C.

The meeting adjourned at 10 o'clock p.m.

## Edmonton Branch

*R. M. Hardy, S.E.I.C., Secretary-Treasurer.*

The third dinner and meeting for the season 1933-34 was held in the Corona hotel on January 9th, 1934. R. M. Dingwall, A.M.E.I.C., the Branch chairman, presided.

### Television and the Sending of Pictures by Wire

Mr. A. M. Mitchell, Comptroller of the Alberta Government Telephones, presented a paper entitled: "Television and the Sending of Pictures by Wire."

Mr. Mitchell first dealt with the transmission of pictures by wire. He pointed out that there are four distinct steps in the process. First, the picture must be "scanned" and transferred into a series of light impulses. Second, the light must be converted into electrical energy. Third, these electrical impulses must be transmitted over the wires and received at the other end. Fourth, the electrical energy received must be converted into light again and allowed to act on a photographic plate to reproduce the original picture.

Mr. Mitchell with the help of a very excellent set of slides described in detail the technical features of each of these stages and illustrated the apparatus in current use.

Then turning to the subject of television, Mr. Mitchell stated that the problem here was essentially the same as that of sending pictures by wire. There are several practical difficulties, however, which complicate the problem of television over that of sending the picture by wire. The problems of static and of synchronizing the equipment at the sending and receiving ends present the most serious difficulties.

Mr. Mitchell went on to say that while there were several systems of television in the experimental stages he would confine his remarks to the system developed by the Bell Telephone Company of New York.

The speaker then explained the principles and apparatus used in this system illustrating his remarks with numerous slides. At the transmitting end the object to be photographed is seated before a scanning disc behind which is a powerful source of light. The scanning disc is covered with a spirally arranged set of small holes, so placed that when the disc revolves, in a period of a fraction of a second, a powerful ray of light has illuminated every point of the object to be "televised." As these light rays illuminate the object they are reflected and picked up by a set of photo-electric cells which generate an electric current varying in intensity with the intensity of the light picked up. The photo-electric cells constitute a "light microphone." These electrical impulses are then amplified and transmitted by an ordinary radio transmitter.

At the receiving end the problem is to pick up these electrical impulses and convert them back to light impulses and direct these so that they produce an image of the original object. This is accomplished as follows: the signals are picked up and amplified and then allowed to act on a neon gas lamp. The neon gas glows with an intensity varying with the intensity of current flowing through it. The light from the neon lamp illuminates a small screen (about 2 inches by 2½ inches), through a scanning disc exactly the same as that used at the sending end. If the two scanning discs are in synchronism the transmitted light rays from holes of the scanning disc at the sending end will pass through the corresponding holes of the disc at the receiving end, and an image of the "televised" object will be seen on the small screen.

In practice three transmitters are used; one for transmitting the picture, one for the speech or music accompanying it and one for the synchronizing signal of the sending and receiving apparatus.

A short discussion followed the presentation of the paper. During the discussion it was brought out that some experimenters have replaced the scanning discs with cathode ray tubes, and others with banks of neon gas tubes. It was also pointed out that television transmitters require a very wide wave band.

## Hamilton Branch

*Alex. Love, A.M.E.I.C., Secretary-Treasurer.*
*V. S. Thompson, A.M.E.I.C., Branch News Editor.*

The Hamilton Branch, Engineering Institute of Canada, met in the Science Hall, McMaster University, on the evening of Tuesday, January 9th, 1934. The annual business meeting of the Branch preceded an address by Mr. R. A. Cline, equipment engineer of the Bell Telephone Company, Toronto, on "the Teletypewriter."

H. B. Stuart, A.M.E.I.C., chairman of the Branch, presided over a gathering of members and friends numbering 50, and after hearing reports from the various committees, and election of Branch Nominating committee, he introduced new members to the Branch. The Executive having been re-elected, there were no formalities of handing over, so the business session was very brief.

W. J. W. Reid, A.M.E.I.C., then introduced the speaker of the evening.

### The Teletypewriter

Mr. Cline first of all showed on the screen diagrams of the mechanical and electrical intricacies of the teletypewriter. Referring to the practice of leasing private telephone wires, he said that these are used in combination with both key and sounder types of transmitters as well as with the more modern teletypewriter. It is possible to use such lines for ordinary telephone conversations at the same time by means of filters at each end. This entails extra equipment at the telephone stations to overcome the distortion consequent on dual use, but even this is far less expensive than multiplication of lines. There are two common types of teletypewriter, namely those which print on a page similar to the ordinary typewriter, and those printing on a strip or tape, the latter of course, being similar in principle to the broker's "ticker."

For long distance transmission it is frequently necessary to eliminate intermediate stations and by a selector calling system, the operator can dial any station or series of stations.

The speaker outlined the chief applications of the teletypewriter under the following headings:—

(1) Press dispatches.
(2) Commercial orders, messages, etc.
(3) Police orders and information.
(4) Weather reports for airports.
(5) Any case where verbal instructions from distant points would be dangerous if misunderstood.

In connection with the fourth item, the latest development is the transmission of complete weather maps which are typed with special symbols on previously printed forms, giving pilots far more comprehensive information than any descriptive matter.

It is obvious that any matter typed on previously printed forms must be exactly spaced, and so in these cases the form is ratchet fed in the manner of a moving picture film. A development of the press service is a teletypewriter combined with the linotype machine so that news dispatches are set up in type as they come in over the wire.

At the close of the lecture, Mr. Cline gave an interesting demonstration on a complete sending and receiving unit which had been set up in the lecture room. These machines had the covers removed so that the moving parts could be clearly seen. The speaker answered a great many questions which were asked by the interested spectators.

Mr. Stuart, on behalf of the Hamilton Branch, thanked Mr. Cline for the very interesting paper and demonstration, after which the meeting adjourned to a neighbouring room where refreshments were served.

### The Ontario Research Foundation

The February meeting of the Hamilton Branch happened to fall on a very cold night, which possibly accounted for a smaller attendance than usual (45), but those who braved the elements were amply repaid for their efforts.

H. B. Stuart, A.M.E.I.C., the chairman of the Branch, in his opening remarks gave his impressions of the Annual Meeting of The Institute in Montreal. He said it was the busiest two days' convention that he had ever attended—the business being of a very serious nature and the technical papers being most interesting, not only for the papers themselves but for the many points raised in the discussion. He also brought a message of greeting from the retiring President, Dr. O. O. Lefebvre, M.E.I.C., who had visited the Branch last November.

F. W. Paulin, M.E.I.C., in a short talk, told of the excellent work done by two of our local members, J. B. Carswell, M.E.I.C., and W. D. Black, M.E.I.C., and how their addresses at the Annual Meeting had aroused much favourable comment. He also told of the tribute paid to the engineering profession by the Premier, Rt. Hon. R. B. Bennett. Mr. Paulin claimed that The Institute would thrive and prosper if members of the engineering profession continued to take the interest in current conditions that they are showing at the present time.

In connection with the subject of the evening's address Mr. Stuart read a resolution passed in 1919 by the local Branch, urging the Federal government to establish a Research Institute.

Mr. J. G. Morrow, metallurgist of the Steel Company of Canada, in introducing the speaker of the evening, referred to his long happy association with Dr. Ellis. He mentioned the fact that the Research Bureau in Ottawa had unfortunately spent a lot of money on a beautiful building and now in these times found itself restricted in its usefulness by shortage of funds. The Ontario Research Foundation was not in the same position, fortunately, and was doing a very useful work. "No one doubts the value of research in lowering the costs of production," he said in conclusion.

The speaker of the evening was Dr. O. W. Ellis, Director of Metallurgical Research, Ontario Research Foundation: Chairman of the Ontario Section, American Society of Mechanical Engineers, and former Professor of Metallurgy at the University of Toronto.

He first explained how the Foundation was started under the direction of Hon. Howard Ferguson, the original intention being that the government donation of $1,000,000 should be duplicated by contributions from industry. Actually the latter subscribed about $2,500,000, so the government increased its share to the same amount, making an endowment of $5,000,000. The speaker stressed the fact that since its inception the Foundation has paid its way without additional cost to the public. Among the diverse subjects investigated by the Foundation for the benefit of the province at large are the lignite and iron ore deposits. It has been established that the latter will probably never be of any practical use, at least for low temperature processes of reduction.

Considerable work has been done for agriculture, important results having been obtained in the elimination of contagious abortion among cattle. The speaker gave a detailed account of an inquiry into a disease causing death among geese. Investigation showed that the cause was a small parasite which attached itself to the digestive canal. These parasites, or flukes, were living in the bodies of snails and tadpoles which had been eaten by the geese. In the geese they produced organisms which bore to the original the same proportion as an elephant to a man. The organisms were prevented from thriving, or even existing in pond water by adding a solution of copper sulphate to the water.

Dr. Ellis caused some amusement by describing a possible cure for baldness which had developed from an investigation which required the injection of diphtheria antitoxin into rabbits. It is found that the shaved portion around the injection grew hair very rapidly, but the speaker's appearance showed that the cure was still in the laboratory stage.

The speaker described the work done in the textile department in testing certain fabrics used in automobile upholstery. He also devoted some time to the work of his own particular department, metallurgy. Numerous slides were shown of micro-photographs demonstrating how the structure of steel varies with the cooling rate. He also told of an investigation into change of structure in drop forgings.

W. J. W. Reid, A.M.E.I.C., proposed a vote of thanks which was enthusiastically endorsed by those present.

H. W. Powell, chairman of the Hamilton Chemical Association, brought a message of goodwill from his association and invited the engineers to attend an interesting meeting on the 21st.

Refreshments were served in the laboratory at the close of the meeting.

## Lethbridge Branch

*E. A. Lawrence, S.E.I.C., Secretary-Treasurer.*
*A. Meldrum, A.M.E.I.C., Branch News Editor.*

The Lethbridge Branch, Engineering Institute of Canada, held a meeting in the Marquis hotel on Saturday, February 17th, 1934. The meeting took the form of a ladies' night, at which the wives and lady friends of the members, also several visitors from the Crows Nest Pass, were present. During the dinner, the "Studio Trio," consisting of Gordon Henderson, 'cellist, Allan Murray, violinist, and K. A. Maclure, pianist, rendered a fine selection of music.

Following the dinner, J. Haimes, A.M.E.I.C., chairman, on behalf of the Branch welcomed the ladies and visitors. G. S. Brown, who was in charge of the musical programme, led the community singing. Mr. Wm. Meldrum delighted the audience with two outstanding vocal selections accompanied by Alan Meldrum. Mrs. Wm. Meldrum's beautiful contralto voice was heard to advantage in two lovely numbers accompanied by Mr. Meldrum.

After a brief intermission, the gathering re-assembled in the dining-room where a six-reel film showing the process of the manufacture of cloth from cotton was projected on the screen. The picture was a presentation of the Dominion Textile Company Limited. It compared the present procedure of spinning and weaving to the old methods. Modern factories contain about 40,000 spindles in one room, in the neighbourhood of 1,000 being in the care of one spinner. Under the old system, one spindle was in the care of one spinner. Modern factories employ as many as 7,000 workers.

After going through various cleaning, spinning, and weaving processes, the cotton emerges in the form of grey cloth which is sent to a finishing plant to be used in the manufacture of oil cloth, auto tops, slickers, rubber boots, etc.

If the cloth is to be coloured for dress material, etc., it is bleached, washed and dried. The design, drawn by a staff of artists, is etched onto a zinc plate and transferred to a copper roller. The material passes over several of these rollers, each of which produces its particular colour design.

At the conclusion of the showing of the film, Mr. Haimes tendered the thanks of the Branch to Mr. Cyril Watson for operating the projector. Those present then repaired to the mezzanine floor of the hotel where bridge was enjoyed, following which refreshments were served.

## London Branch

*H. A. McKay, A.M.E.I.C., Secretary-Treasurer.*
*J. R. Rostron, A.M.E.I.C., Branch News Editor.*

The annual dinner meeting of the Branch was held on January 17th, 1934, at the Highland Golf Club.

The chairman of the Branch, V. A. McKillop, A.M.E.I.C., presided, and the speaker of the evening was Brig.-General J. M. Ross, C.M.G., D.S.O., V.D.

About 35 members and guests were present at the dinner, which was much enjoyed, community singing being indulged in at intervals.

After the dinner, the Chairman welcomed the guests and then called upon Major W. M. Veitch, A.M.E.I.C., M.I.C.E., to introduce the speaker. In the course of his remarks Major Veitch gave an outline of the military career of General Ross up to the time of his recent appointment to the command of Military District No. 1 with headquarters in London, Ontario. Following this he referred to the illness of the now late Major-General Armstrong who was the immediate predecessor of General Ross in the same command, and said how sorry all those present were to hear of his sickness. He made a motion, which was adopted, that a message of sympathy coupled with sincere wishes for his speedy recovery be sent to him. General Armstrong had been at the last annual meeting and had then announced, to the regret of the members, his projected retirement.

General Ross opened by stating that he did not claim to be a speaker nor to be able to make a speech and did not intend to try it. He did not know under what delusion Mr. McKillop was labouring when he finally persuaded him to give the boys a talk. Therefore all that he was going to do was to tell a few stories of his personal experiences under fire in the Boer War and the Great War. The General then proceeded to relate several exciting incidents in his military career, which were heard with much interest.

Subsequent to the General's talk the chairman invited all the non-members to retire to the lounge and smoking room where cards and music were provided.

The business of the evening was then proceeded with, the first items being the reading of the Secretary's and Auditor's reports, both of which were passed and adopted.

The election of officers for the ensuing year then took place.

Music, which was much enjoyed, was provided by Murray Dillon at the piano and an orchestra composed of several of his friends. After the business was transacted the members joined the guests and a very enjoyable evening was spent by all.

## Moncton Branch

*V. C. Blackett, A.M.E.I.C., Secretary-Treasurer.*

A special meeting of the Branch was held on January 29th, 1934, for the purpose of discussing proposed amendments to Institute By-laws and making recommendations to the forthcoming Annual Meeting. Professor H. W. McKiel, M.E.I.C., chairman of the Branch, presided.

Only sections dealing with membership grades and qualifications were dealt with. The general feeling of the meeting was against merging the present corporate membership grades. Several speakers argued that engineers who had attained a certain degree of eminence in the profession were entitled to the distinction which the present grade of member conferred. Furthermore the higher fees paid by members was worthy of consideration and much needed revenue would be lost if the proposed amendment was adopted.

Taking up the matter of qualifications for membership and combining the views of the meeting on grades and qualifications, the following resolution was moved by J. G. Mackinnon, A.M.E.I.C.:—

> "That this Branch do strongly oppose any change being made in the present grading of Institute Members; further, that in the opinion of this Branch the time has come when admission to corporate membership in The Institute should be limited to those applicants who are graduates in engineering of some University recognized by the Council of The Institute, or who possess an education equivalent to that required for university graduation."

In speaking to the motion, Mr. Mackinnon declared conditions in the profession had changed. Rule of thumb methods had given way to exact scientific investigation. The young engineer of today had little hope of success unless he was university trained. Engineering prestige would tremendously increase with insistence on college graduation. The speaker expressed the hope that he would live to see the day when he would be regarded by the public as a man who had a profession and not merely as one holding a job.

In answer to an objection as to the effect on relations between The Institute and the provincial associations should the resolution be adopted, the chairman explained that similar provisions had already been adopted by the Nova Scotia and Quebec Associations. The New Brunswick Association had approved the principle but had not as yet demanded university qualifications as prerequisite for membership.

Mr. Mackinnon's resolution was put and carried unanimously.

## Niagara Peninsula Branch

*P. A. Dewey, A.M.E.I.C., Secretary-Treasurer.*

A. W. F. McQueen, A.M.E.I.C., was the speaker at a dinner meeting held on January 19th, 1934, at Niagara Falls. The subject was "India," and Mr. McQueen described a trip to the native State of Bhopal, made together with H. G. Acres, M.E.I.C., for the purpose of investigating hydro-electric possibilities.

The State of Bhopal, said Mr. McQueen, lies almost in the geographical centre of India, with an area of 6,900 square miles and a population of three-quarters of a million. Some seventy per cent of this population are agriculturalists who are still using the primitive methods of their forefathers. Holdings are small, taxes are heavy, and consequently the farmers are extremely poor.

In Bhopal State the average farm-holding is about 5 acres. The main crops are wheat, millet, cotton and oil seeds. With the present low world prices, 5 acres of land sown to wheat will return to the farmer the money equivalent of about $16.00. Land taxation, which is the principal source of governmental revenue in India, will probably absorb some $5.50 of this amount, thus leaving the farmer with a net return of approximately $10.50 for his season's work.

Nawab Mahomed Hamidulla Khan, the present ruler of Bhopal, is a comparatively young man, imbued with the spirit of modern progress and believes that a fuller development of the resources of his state, both human and natural, may be materially aided by a programme of industrialization.

That there is a market for certain classes of cheaper goods cannot be denied. At present considerable quantities of cheap cotton piece goods and such articles as rubber shoes are being imported, mainly from Japan. A good pair of Japanese tennis shoes can be purchased in Bhopal for only 70 cents and this type of shoe is used extensively by the natives.

The first element in a programme of industrialization is, of course, the provision of a supply of cheap power. With this end in view five hydro-electric sites were examined by Mr. Acres and Mr. McQueen. The annual monsoon rainfall in the state varies from 29 to 60 inches and most of the streams are somewhat flashy, but storage areas are available and some of these sites are undoubtedly capable of economic development. The dams would be constructed of stone masonry which is cheaper than concrete under the local conditions of material and labour.

Labour is cheap and consequently competes strongly with any attempt at bringing in modern machinery. Masons are paid 41 cents, carpenters 36½ cents, labourers 14 cents and women 9 cents a day.

Mr. McQueen's address was illustrated with moving pictures showing native scenes in and around Bhopal; elephants fording streams accompanied by automobiles, native women carrying water from the wells for the purpose of making water-bound macadam roads and farmers ploughing their worked-out soil with oxen and wooden ploughs.

An interesting discussion followed the address and then W. R. Manock, A.M.E.I.C., chairman, conveyed the sincere thanks of the Branch to the speaker for a very pleasant evening.

## Ottawa Branch

*F. C. C. Lynch, A.M.E.I.C., Secretary-Treasurer.*

Major D. L. McKeand of the Department of the Interior, spoke at the noon luncheon of January 11th, 1934, at the Chateau Laurier on the subject of "The Eastern Arctic Patrol—1933." Major McKeand is the Assistant Director of the Northwest Territories and Yukon Branch and was commissioned under the Great Seal of Canada as representative of the government in the Northern Archipelago, having made several inspection trips during the past few years.

Group Captain E. W. Stedman, M.E.I.C., chairman of the local Branch, presided at the luncheon, and in addition head table guests included: Honourable Thomas G. Murphy, H. H. Rowatt, Ralph Parsons, Doctor Harold McGill, Doctor George S. Williamson, J. Lorne Turner, R. A. Gibson, Lieut.-Col. W. A. Steel, A.M.E.I.C., Doctor R. W. Boyle, M.E.I.C., Noulan Cauchon, A.M.E.I.C., C. McL. Pitts, A.M.E.I.C., J. L. Rannie, M.E.I.C., L. Sherwood, M.E.I.C., K. M. Cameron, M.E.I.C., and R. J. Fraser.

### Eastern Arctic Patrol—1933

Major McKeand, at the commencement of his address, stated that interest in the northern islands of Canada and in the Northwest Territories generally has increased greatly of late years. Not a small portion of this interest, he stated, has been occasioned by the prominence given to this section of Canada in the Saturday evening radio broadcasts by the Canadian Radio Commission to those resident in these outlying points.

The Department of the Interior annually sends an expedition into the eastern portion of the Arctic islands for the purpose of maintaining Royal Canadian Mounted Police posts, looking after the health and well-being of the natives, undertaking certain scientific investigations, and in general patrolling the area and maintaining the sovereignty of the Canadian government. In this work a number of the other departments of the Federal service co-operate in so far as they are concerned.

Major McKeand described in detail the course of the itinerary of the 1933 patrol. The ship was the "Nascopie" belonging to the Hudson Bay Company. It sailed from Montreal on July 8th and returned to St. Johns, Newfoundland, on September 27th, having covered over 12,000 miles, the longest trip ever undertaken on these annual patrols. The ship, in the course of this patrol, visited points in Hudson and James Bays, including Charlton Island only some 500 miles north of Toronto. The northmost point of the patrol was Robertson Bay, Greenland, situated 50 geographical miles south of Etah, and approximately 724 nautical miles from the North Pole.

In commenting upon the information secured by the Department of the Interior, Major McKeand stated that the administrative survey revealed, generally speaking, that the health of the population has been good. The fur catch, however, for the past season was rather poor and this with the low price of pelts has caused some hardship.

Fortunately, seal and walrus, on which the Eskimos largely depend for food for themselves and their dogs and also to some extent for clothing, were fairly abundant. Walrus were caught much further south in Hudson Bay than usual.

To assist in preventing undue hardship, the Department of the Interior distributed 10,500 pounds of dried buffalo meat, part of the product of the annual slaughter of surplus animals at Buffalo National Park, Wainright, Alberta. As an experiment, five hundred green buffalo hides from the same source were distributed to those looking after Eskimo relief at the various posts. They were for issue to those natives who had an inadequate supply of caribou skins or other bedding.

This year the scientific features of the expedition were more prominent than ever before. Geological examinations were made in areas of the south shore of Hudson Strait and near Cape Smith on the east side of Hudson Bay. A representative of the Department of Marine inspected the stations of the meteorological service at seven different points and new stations were installed at Coral Harbour, at Southampton Island, and at Clyde river, Baffin Island. Much valuable information was obtained regarding topography and climate and a number of special observations were made during the voyage, particularly regarding optical phenomena. A parasitological survey was inaugurated, a pioneer effort on this continent, and a new branch of scientific investigation from the world's standpoint.

Major McKeand paid a high tribute to Doctor M. O. Malte who conducted botanical research which was, unfortunately, terminated at Charlton Island by his lamented illness and subsequent death. The work which Doctor Malte had done on this and previous occasions in the north will undoubtedly prove of great value for further botanical studies in the future.

### Annual Branch Meeting

The twenty-fourth Annual Meeting of the Ottawa Branch of The Engineering Institute of Canada was held at Standish Hall, Hull, on the evening of January 11th, 1934. About eighty members were present, the retiring Chairman, Group-Captain E. W. Stedman, M.E.I.C., presiding. In the unavoidable absence of F. C. C. Lynch, A.M.E.I.C., secretary, Mr. R. K. Odell acted as secretary.

The chairman, in presenting his address, reviewed the activities of the Branch for the past year. Although Ottawa was feeling the effect of reductions in staff of the various government departments and also of reductions in pay for the remaining personnel, there has been no serious loss in membership, the attendance at Branch activities has been good, and the financial position has been satisfactory. The slight reduction in membership, a total of 405 compared with 415 a year ago, should be more than made up with the turn of conditions for the better. It was to be feared that some who had dropped out of The Institute did not realize the importance of having a Dominion-wide organization of engineers in an age when extensive organization has become the basis of all professions. One instance alone of the value of such an organization was the work done for unemployed engineers throughout the Dominion.

The chairman also expressed the feeling that the younger members of The Institute could participate more actively in the Branch proceedings and suggested that some steps should be taken to encourage them in the contribution of papers.

With regard to finances, two abnormal expenditures were incurred during the year, namely, the expenses of the Annual Meeting of The Institute which was held at Ottawa in February, and the contribution to the special Plenary Meeting of the Council at Montreal in November.

Sixteen luncheon meetings and two evening meetings were held by the Branch with an average attendance slightly greater than that of the previous year. Social functions consisted of a dinner dance at the Chateau Laurier on December 15th which some 175 members and friends attended.

The Aeronautic Section, affiliated with the Branch, had a very active year, one gratifying feature of which was the increase in the number of Branch members taking an active interest in it. This Section, with J. H. Parkin, M.E.I.C., as chairman, and Alan Ferrier, A.M.E.I.C., as secretary, held eight meetings in all during the year. At these meetings professional papers were read and technical demonstrations given, relating to the science of aeronautics.

One of the very important activities of the Branch was the work of the Special Committee on Unemployment. Under the chairmanship of G. J. Desbarats, M.E.I.C., this committee has done exceptional service in connection with the Relief Camps of the Departments of Labour and National Defence. Although opportunities for appointments in the Ottawa District were not great, Mr. Desbarats utilized them to the utmost, doing everything possible at all times to put the right man in the right place.

During the year, The Institute, and particularly the Ottawa Branch, suffered severe loss in the passing of two of its members, A. M. Grant, M.E.I.C., who died on January 19th, 1933, and Mr. O. Higman, a life member, who died on November 8th.

Mention was also made by the Chairman of the kind and gracious support and publicity received during the year from the three local newspapers, the *Ottawa Citizen*, the *Ottawa Journal* and *Le Droit*.

Following the Chairman's address, reports were presented from the Secretary-Treasurer, and from regular committees with chairmen as follows:

| | |
|---|---|
| Proceedings | E. Viens, M.E.I.C. |
| Membership | W. F. M. Bryce, A.M.E.I.C. |
| Employment | G. J. Desbarats, M.E.I.C. |
| Advertising | J. G. MacPhail, M.E.I.C. |
| Rooms and Library, Branch By-laws and Reception | W. S. Kidd, A.M.E.I.C. |
| Aeronautic Section | Dr. J. H. Parkin, M.E.I.C. |
| Dinner Dance | Group Captain E. W. Stedman, M.E.I.C. |

The financial statement, according to the Secretary-Treasurer, showed that the assets of the Branch were $1,665.06, a decrease of $285.01 from last year. The Branch also passed a motion to continue the policy of donating prizes to the Ottawa and Hull Technical Schools for competition among the students.

## Quebec Branch

*Jules Joyal, A.M.E.I.C., Secretary-Treasurer.*

On January 15th, 1934, a well-attended luncheon meeting was held by the Quebec Branch at the Chateau Frontenac. The speaker, Lieutenant-Colonel J. B. Dunbar, A.M.E.I.C., District Engineer Officer, Department of National Defence, delivered a brief but very interesting paper on "Road Making by Hand Methods Using an Asphaltic Emulsion."

Mr. Dunbar was introduced by the chairman, Hector Cimon, M.E.I.C., and J. A. Duchastel, M.E.I.C., moved a vote of thanks, to which a hearty response was made by all present.

### Road Making by Hand Methods, Using an Asphaltic Emulsion

About a year ago, the Canadian government decided to open at Valcartier, Que., a concentration camp for about 1,700 single, unemployed, homeless men. This decision was in accordance with the general policy of establishing such camps at various places in Canada and having them administered by the Department of National Defence.

One requirement at Valcartier was the construction of dust-proof roadways within the camp limits, and in accordance with the policy decided upon for all works, the use of machinery was to be kept to a minimum and hand labour employed to the greatest extent. Another governing factor was that all costs, including material used in all works, must not exceed the sum of $1.00 per head per day.

The Terolas, which is an emulsion of asphalt produced in Canada by Colas Road Ltd., was used as a binder for the aggregate available on the spot which is sand.

Each batch of mixture was made up of three wheel-barrow loads of material excavated from the shoulders mixed by hand with 43 pounds of Terolas and approximately 30 pounds of water: the result was 6¾ cubic feet to one batch or four batches per cubic yard.

After mixing was completed, the material was wheeled, shoveled on to the sub-grade and spread by hand rakes to approximately ½ inch more than the final thickness of 3 inches and to the correct camber of ¼ inch per foot; then the wooden screeds were brought into use followed as closely as possible by a small roller weighing 400 pounds which was drawn to and fro by ropes from both sides of the road. Immediately following the small roller, a larger roller weighing 4 tons which was pushed and pulled by from twenty-seven to fifty-four men, was used to give final finish to the base-course.

One cubic yard of the above mixture supplied material for 10 square yards of the base-course of roadway.

In applying the armour coat, Terolas was sprayed on the base-course surface at a rate of ¼ gallon per square yard and covered immediately with ¾-inch crushed gravel in sufficient quantity to fill any slight depression and to provide a one stone thickness. This course was well rolled and broom dragged to obtain a smooth surface; then more Terolas was applied at the rate of ¼ gallon per square yard and covered with ⅜-inch crushed gravel at approximately 20 pounds per square yard; then this was rolled.

Owing to the limiting factors already mentioned and to improvised plant, progress was slow but the average rate of construction was 555.5 square yards of finished road per day costing $0.3937 per square yard.

The above described method of road construction was used during the summer 1933 on about 1,600 lineal yards of 20-foot pavement and 1,400 lineal yards of 16-foot pavement.

## Saint John Branch

*Sidney Hogg, A.M.E.I.C., Secretary-Treasurer.*
*Charles M. Hare, S.E.I.C., Branch News Editor.*

Continuing the policy of fostering closer co-operation between The Engineering Institute of Canada and the Provincial Association, the Saint John Branch sponsored a dinner meeting held in the Admiral Beatty hotel on January 25th, 1934. At 7 p.m., sixty members of the Provincial Association and The Engineering Institute of Canada, along with several distinguished guests, sat down to dinner, presided over by G. A. Vandervoort, A.M.E.I.C., chairman of the Saint John Branch.

Following the toast to the King, G. C. Torrens, A.M.E.I.C., proposed a toast to the Association of Professional Engineers, and spoke of the value of organization both to the engineers themselves and to the public. J. D. Garey, A.M.E.I.C., responded briefly, characterizing engineers as men of action rather than words.

Mr. Vandervoort proposed the toast to The Engineering Institute of Canada and stated that in the future, engineers must play a more prominent part in the economic and financial life of the country. Engineers had taken the guesswork out of production and were, in fact, blamed to quite an extent for the present conditions, because of the developments of mechanism. This charge was unfair. It is distribution that is at fault. If the engineer was going to protect the good he had done he would have to take a hand in removing the guesswork from distribution.

"Through the ages the different civilizations have been benefited by the creative builders who to day would be called engineers," said W. J. Johnston, A.M.E.I.C., responding, and he next referred to advances in transportation and communications made by engineers.

John N. Flood, A.M.E.I.C., proposed the "toast to our guests," welcoming those present who were not engineers.

Replying to this, Brigadier J. L. R. Parsons, officer commanding District No. 7, during the course of his remarks gave some facts about the relief camps in the province. There were now 500 men in the camp in Sunbury county, the morale of the men in the camps was excellent and all seemed content with the treatment they were receiving. The life they were leading and the mild discipline imposed on them were good for them both morally and physically. Nine graduate engineers are at present employed as foremen and squad bosses in the relief camps of New Brunswick.

Responding to the same toast, D. B. Rogers spoke appreciatively of the important contribution which engineering had made to the newspaper profession, particularly in the development of mechanical equipment and lines of communication.

On completion of the toast list, moving pictures of the latest type of snow-ploughing apparatus were shown through the courtesy of J. T. Turnbull, A.M.E.I.C., district highway engineer, who explained the films. Snow removal work in New Brunswick, Mr. Turnbull observed, was as yet very limited. He briefly outlined the technique of snow removal.

### The Task of Economics

Professor B. S. Kierstead, B.A., guest speaker, spoke on "The Task of Economics." Acceptance of the inevitable, sitting back and taking things as they come, he contended, would only mean more frequent and more serious depressions in the future. The world might withstand another depression, or perhaps several more, but sooner or later collapse of the present social system would come unless something was done to forestall it, he asserted. "It is said of the British that they 'muddle through'," Professor Kierstead observed. Great Britain never muddled through. She got where she is by hard clear thinking and courageous action. Great Britain has never muddled through any major crisis and will not muddle through this crisis.

The first job of the economist was the job of convincing people that the economist knew what he was talking about. Economic or social order had run afoul, and haphazard policy, attempted in ignorance of real economic knowledge, would not prove a successful remedy.

It may be true, he said, that we are emerging from the depression. but this is not due to our efforts but to the natural swing of the business cycle.

The speaker went on to say that the problems of the world were becoming more difficult and without clear thinking and definite action, depressions would be more frequent and more severe in the future. In former times depression was famine. Engineers had learned to make things so well that to day there was no longer any problem of famine, but a problem of distribution. Depressions today are as normal as good times, and they are a normal period recurring every eight or ten years.

There was one point on which practically all economists agreed, the causes of depression, which could be placed under three heads, political causes, industrial causes and financial causes. The disagreement concerned the respective importance of the causes, and which should be tackled first. In his opinion this was to do the job which was most expedient first, then go on to the others.

Professor Kierstead then referred to the different factors in moulding public opinion, expressing the belief that the press in many instances had failed to live up to its responsibility as a moulder of public opinion on economic matters. As an example of misdirected guidance he referred to the attitude of a large section of the United States press in insisting on the exaction of the last dollar of war debts, despite the obvious effect of such a policy in promoting stagnation and disruption.

In contrast he mentioned the part which many Canadian newspapers had played in conscientiously preparing the public for acceptance of the idea of a central bank for Canada—a very essential and practical step toward the solution of a definite Canadian problem.

The press can and does exert a predominating influence, he said, but in order to be effective it must be backed up by an enlightened and intelligent public opinion.

A vote of thanks to the speaker was moved by Captain W. H. Blake, A.M.E.I.C., and seconded by G. G. Murdoch, M.E.I.C.

## Sault Ste. Marie Branch

*G. H. E. Dennison, A.M.E.I.C., Secretary-Treasurer.*

"Theory and Application of the Use of Orifices for Industrial Flow Measurements" was the subject of an address before the Sault Ste. Marie Branch by Mr. O. Brauns on January 26th, 1934, following the regular monthly dinner at the Windsor hotel.

After touching briefly on other methods of flow measurement, Mr. Brauns took up in detail the orifice method. He developed the fundamental formulae involved and proceeded with the theory of orifice design, discussing the influencing factors. Following a mathematical discussion of the various orifice discharge coefficients Mr. Brauns described their practical application in the orifice constant $c$, a function of the diameter ratio $d/D$.

The quantity of fluid passing through an orifice is directly proportional to the square root of the pressure differential caused by the orifice and Mr. Brauns indicated by drawings and exhibits how this pressure differential is obtained and recorded in typical installations.

The immense importance of accurate flow measurements was stressed by Mr. Brauns in closing his address. First from the standpoint of process requirements where quantities must be definitely known or where a continuous record of flow will indicate certain results achieved and second in distributing charges correctly for steam water or fluid to various plant equipment or processes. Steam flow measurements has been one of the most important uses of orifice type meters where a complete record of the amount of steam generated in each unit of a plant is essential to an intelligent understanding of the efficiencies being obtained and where, for accounting purposes, the distribution of this steam should be definitely known. In one local plant some thirty steam flow meters are in use to measure and record the use each day of over one thousand dollars worth of steam.

The meeting was presided over by E. M. MacQuarrie, A.M.E.I.C., chairman of the Branch, and the balance of the business carried over from the annual meeting was disposed of. The financial report for 1933 was read and adopted on motion of Messrs. H. F. Bennett, A.M.E.I.C., and L. R. Brown, A.M.E.I.C. A report by C. H. E. Rounthwaite, A.M.E.I.C., chairman of the Committee on Legislation and Remuneration, was adopted on motion of Messrs. A. H. Russell, A.M.E.I.C., and Carl Stenbol, M.E.I.C.

## Toronto Branch

*W. S. Wilson, A.M.E.I.C., Secretary-Treasurer.*
*O. Holden, A.M.E.I.C., Branch News Editor.*

On November 2nd, 1933, a very interesting paper entitled "The Relation of Certain Chemical and Physical Characteristics of Cements to the Qualities of Concrete" was presented at the regular meeting of the Toronto Branch by Mr. W. J. D. Reed-Lewis, consulting engineer on Portland cement and formerly superintending engineer of the Super Cement Company, Detroit, Michigan.

Mr. Reed-Lewis opened his remarks with a brief summary of the essential raw materials used in the manufacture of cement, and a description of various methods of manufacture and types of cement plants.

The speaker then gave a technical description of the chemical reactions which occur during the manufacture and hydration of cement, and the effect that compounds formed by these reactions have upon the ultimate character of the concrete. As some compounds impart undesirable properties to the concrete, attention must be given to the chemical composition of the cement, so that these undesirable properties may be controlled. Methods of computing from the chemical composition of the cement, the potential constitution in terms of kiln materials in the clinker, and the ultimate hydrous compounds in the cement were outlined by the speaker.

Cements high in tri-calcium silicate impart to the concrete high strengths at early ages, but excessive volume changes due to high setting temperatures may result. Concretes made from cements high in di-calcium silicate gain strength slowly, but they are more resistant to disintegration as there is less free lime present. Since 1900 there had been a general trend toward cements having high percentages of tri-calcium silicate, but in recent years more attention has been given to obtaining a balanced proportion of the two silicates, so that advantages of each may be realized.

The rate of hydration of cement is largely dependent upon the fineness of the particles. Pulverizing stimulates the reaction with water, but the limit to which cement particles may advantageously be reduced in size depends upon the chemical composition.

Existing specifications limit the residue on a No. 200 mesh sieve (nominal diameter 74 microns), but as particles larger than 40 microns are practically inert and the bulk of the active particles are smaller than 30 microns, any study of cement grinding must consider sub-sieve sizes.

Tests made by separating cements into sub-sieve sizes and recombining them into cements of synthetic fineness have disclosed many interesting features. It has been found that the rate of hydration bears a definite relation to the particle size. Particles of 75 microns diameter are only 18 per cent hydrated after twenty-eight days, while particles of 7 microns diameter are 62 per cent hydrated in twenty-four hours.

A yardstick of the fineness of cements ground in the mill may be obtained by a summation of the products obtained by multiplying the percentage of each size fraction by the reciprocal of its mean effective diameter. This has been termed the coefficient of effective fineness, or "C.E.F." Tests show that there is a straight line relation between the C.E.F. and the degree to which the cement is hydrated at various ages, and hence to the compressive strength of concrete.

The speaker concluded his remarks by referring to the methods used for controlling the grinding to give a desired grading of effective sizes in the manufacture of cements.

The meeting was adjourned after a discussion of the paper and a vote of thanks extended to the speaker on behalf of those present.

### Planning Towards Economic Recovery

On Thursday evening, January 18th, 1934, members of the Toronto Branch convened in the Debates room at Hart House, following an informal dinner in the Common room. The meeting was addressed by Professor Gilbert E. Jackson, B.A. (Cambridge), Professor of Political Economy, University of Toronto. The speaker, who was introduced by Professor T. R. Loudon, M.E.I.C., gave a most interesting and instructive address on the subject of "Planning Towards Economic Recovery." He also extended to members of The Institute a cordial invitation to co-operate with the Canadian Political Science Association in the study of economic problems. The meeting was very ably presided over by Archie B. Crealock, A.M.E.I.C.

In introducing his subject, Professor Jackson pointed out that in planning for economic recovery, Canadians had to choose one of two alternative methods. One was the method adopted by the United States, and the other that pursued by Great Britain.

It is a well-known fact that by lavish government expenditures, prosperity can be created. The world-wide prosperity of the war period was perhaps the most recent large-scale example of this principle. Such expenditures called for heavy budgetary deficits requiring the floating of large government loans, possibly at unfavourable interest rates. The fear of uncontrolled inflation made it difficult to obtain money except on short-term securities.

This method, however, had the disadvantage of greatly increasing the governmental obligations, and was bound eventually to react somewhat unpleasantly through higher tax levies. It was likened to the administration of a highly potent stimulant, which, although it may carry the patient over a serious crisis, might result in an uncomfortable aftermath. Owing to the delay in taking action in the United States (March 4th, 1933), conditions there had become so acute that of the two methods available, the one adopted was perhaps the most suitable under the existing circumstances.

In Great Britain, a more gradual, but nevertheless equally effective, method had been adopted much earlier in the depression period (September, 1931), at which time she was forced to relinquish the gold standard. Great Britain's policy was to first form a national government which, by drastic economy and increased taxation, succeeded in balancing the budget. The burden of interest on government bonds was materially lessened by refunding the war loans through the issuance of low-interest-bearing bonds.

This low interest rate on government securities, coupled with an easy credit policy, led to an abundance of money in the hands of private investors seeking investment in industry and in public works. This "easy-money" condition was well known through many precedents to gradually bring about a healthy form of prosperity. By virtue of getting an early start, Great Britain was enabled to employ this method with advantage, and the results to date, while not as spectacular as those obtained over a relatively short period in the United States, offer ample proof of its effectiveness. It had the added advantage of not leaving an aftermath of huge public debts as a burden to posterity.

After setting forth the characteristics of the two recovery processes, the speaker pointed out that either might serve equally well in the case of Canada, and that it behooved Canadians to decide which they would choose. To take no positive steps of either kind toward recovery would be to prolong unnecessarily the suffering due to the existing industrial stagnation.

In conclusion, the speaker drew attention to the fact that the durable goods industries had suffered more than others in the depression. Since this is the branch of industry in which engineers are chiefly employed, it was to their interest to co-operate as far as possible in the study of economic problems.

In reply to an inquiry as to how much Canada would have to spend to carry out a programme similar to that to be presently undertaken by the United States, Professor Jackson estimated that, in proportion to the population, Canada would have to undertake some $850,000,000 of new expenditures to parallel the $10,000,000,000 appropriation of the United States.

Following a further brief discussion, Professor T. R. Loudon strongly recommended that arrangements be made for a joint meeting of the Canadian Political Science Association and The Engineering Institute of Canada, to be attended by members resident in Toronto and in the adjacent districts. The Chairman then called for a vote on Professor Loudon's recommendation. The meeting was unanimously in favour of such a meeting, and it was understood that the Branch executive would make the necessary arrangements.

A. U. Sanderson, A.M.E.I.C., moved a vote of thanks to the speaker of the evening, to which a hearty response was made by all present.

## Winnipeg Branch

*E. W. M. James, A.M.E.I.C., Secretary-Treasurer.*
*E. V. Caton, M.E.I.C., Branch News Editor.*

On Thursday evening, January 4th, 1934,at the regular meeting of the Winnipeg Branch of The Engineering Institute of Canada, presided over by Professor G. H. Herriot, M.E.I.C., chairman, Mr. R. D. Colquette, Associate Editor of *The Country Guide*, gave an address on "Iron Debts and Rubber Dollars."

### Iron Debts and Rubber Dollars

The speaker stated that advances in the development of the machinery of production had outstripped the development of machinery for the exchange of goods after they had been produced. A time lag was natural since production precedes distribution and the lag had been accentuated by the terrific rate at which production had been increased during the last half century. The credit for the rapid improvement in productive processes, he said, must go chiefly to the engineering professions and they had a right to ask why millions of workers were deprived of the opportunity of supplying themselves not only with the improvements of modern science, but also with the sheer necessities of existence. The trouble lay, he claimed, not in the fields of production, transportation or distribution of goods, but in the realm of finance. The present depression had been precipitated by the stock market crash. It would probably not have lasted more than 18 months if it had not been accompanied by a fall of about one-third in the price level of all commodities and a much greater fall in the price received for primary products.

The speaker traced the history of price levels showing that after the Napoleonic war they fluctuated downward until 1850 when new supplies of gold from California and Australia increased the world's monetary gold stocks with the resulting rise in price levels which continued until 1873. A similar rise began in the middle 90's when, after the trend of prices had been downward for nearly 25 years, monetary gold stocks were increased by the introduction of the cyanide process in the Rand and the opening of the new gold field in the Yukon.

The fall in prices since 1929, said the speaker, was chiefly the result of the return of industrial countries to the gold standard. When France returned in 1928 the scramble for gold began. Monetary gold stocks were barely sufficient to maintain pre-war price levels. Since the price of gold was fixed in gold standard countries it could not rise and the effect of the increased demand for gold had to be reflected in the fall of commodity prices. He supported the idea of inflating back the price level of the 20's and outlined two proposals for stabilizing prices at that level. One proposal advanced by Keynes would divorce the currency from gold reserves and maintain prices by altering the price of gold. The other proposal advanced by Fisher, would maintain a fixed purchasing power for the dollar by altering the amount of gold it contained. Stable prices, he said, would not be a panacea for all our economic ills except in the sense that a panacea was one of several different remedies all of which would have to be applied.

A very active discussion took place at the end of the meeting and a hearty vote of thanks was tendered to the speaker for his interesting address.

## The Nickel Industry in 1933

Robert C. Stanley, president of The International Nickel Company of Canada Limited, in a year-end analysis of the nickel market for 1933 discloses the profound changes which the depression has wrought in the industrial attitude towards better materials, better performance and lower ultimate costs.

World consumption of nickel in all forms for the first ten months of 1933 was 77,609,280 pounds as compared with slightly more than 49,500,000 pounds in the same period of 1932 and with the 112,481,600 pounds of the corresponding part of the peak year, 1929.

Although commanding increasing importance as an alloying element in combination with ferrous and other non-ferrous metals, the variety of uses for pure nickel continues to widen. Pure nickel for coinage is growing in popularity, and in radio tube manufacture, the consumption was approximately twice that of last year. These include grid glow tubes, photo-sensitive tubes, various types of rectifiers and ubes for use in control of spot welding machinery. In the chlorinationt process of oil refining a leading company has replaced its old equipment of lead-coated steel with tanks of pure nickel. Pure nickel tubing offered to industry has also helped to maintain a market.

Nickel-clad steel plate consisting of a solid layer of pure rolled nickel permanently bonded to a heavier layer of steel provides high resistance to corrosion with great structural strength and relatively low cost. Introduced in 1931, one of its most recent applications is in steam locomotive fireboxes where both corrosion and stress are factors.

Of the non-ferrous nickel alloys, monel metal has retained its position as a leading white metal alloy. Seamless and welded monel metal tubing have been used to replace piping of older and softer materials. In the breweries it is finding a number of uses, such as for filter screens, pump rods, continuous coolers and the like. The household field continued to provide an important outlet for this alloy. A spectacular use of monel metal during the year was for both shafts and propellers of Gar Wood's "Miss America X." In the marine field, new shipbuilding programmes are requiring considerable tonnage of this alloy for valve trim, pump rods and liners, turbine blades, propellers and propeller shafting, galley sinks and dresser tops. It has been adopted for important structural parts of seaplanes, which are exposed to the action of salt water.

The successful experience with monel metal forgings in the Panama canal for such parts as gate and valve equipment has led to its adoption for similar parts for Madden dam and Boulder dam. It has been possible to furnish this material in large shafts with a minimum breaking strength of 90,000 pounds per square inch, a minimum yield point of 70,000 pounds per square inch, elongation in two inches of 20 per cent to 30 per cent, and a reduction in area of 20 per cent to 50 per cent.

Inconel (80 per cent nickel) introduced two years ago as Inco Chrome Nickel, primarily for dairy equipment, has already found important applications in a dozen other fields. It is available in sheets, rods, seamless tubes, wires and other forms required by industry.

Its most recent form of commercial production is as Inconel-clad steel which, like nickel clad steel, is the permanent bonding of a tough layer of tarnish and corrosion resisting white metal with the cheaper strength of steel.

With monel metal and pure nickel, Inconel enjoys a wide use in chemical, textile dyeing, food process plants, and in brewing, wine making and distilling.

Solid nickel silvers (5 per cent to 30 per cent nickel) are available in many castings for architectural trim, plumbing fixtures and certain classes of food handling equipment. A wide range in colour, hardness and melting point can be obtained by appropriate changes in the composition of the alloy. Also extruded sections of complicated shapes are now being produced.

Nickel brass and bronze (½ per cent to 8 per cent nickel) due to engineering requirements for higher physical properties in readily castable bronzes have led to the introduction of nickel to obtain the desired results.

A copper-nickel-tin bronze, containing approximately 8 per cent nickel, has been developed. It is responsive to heat treatment and, remaining tough, develops an elastic limit of some 55,000 pounds per square inch.

Nickel in bearing metals (½ per cent to 2 per cent nickel) as the copper-lead bearing alloys frequently contain a small amount of nickel properly to disperse the lead. A bearing metal consisting of cadmium hardened by the addition of approximately 2 per cent of nickel has been devised recently.

In cupro-nickel alloys (15 per cent to 50 per cent nickel) tests and service behaviour continue to favour tubes of 20 per cent to 30 per cent nickel content for condensers and heat exchangers handling corrosive substances.

With nickel in ferrous alloys, nickel alloy steels (¼ per cent to 12 per cent nickel) developments during the year indicate the important markets for these steels are ship-building and the attention given to revolutionary changes in the design of passenger trains.

There has been an increase in the tonnage of heat resisting alloys produced this year over that of 1932. This is due both to installation of new equipment and to replacement of inferior alloys.

It has also been established experimentally that nickel within the range of ¼ per cent to 1 per cent is a powerful agent for conferring toughness at temperatures slightly below freezing point of the metal, particularly with steels containing more than 0.25 per cent carbon.

In stainless steels (7 per cent to 35 per cent nickel) the outstanding feature was the growing recognition of its structural qualities for such uses as aircraft frames and wing construction.

Also much of the experimentation with light-weight, high-speed trains is in terms of stainless steel construction; and naval architects are now turning to this alloy for masts, funnels and superstructures of new ships.

The largest application of the year was in the brewery business, for barrels, fermentation tanks and other equipment..

In the classification of nickel cast irons (½ per cent to 5 per cent nickel) the outstanding application has been a nickel-chromium-molybdenum composition grain roll for hot rolling of metals. This possesses greater strength, more uniform structure, and greater wear resistance than compositions formerly used; it also resists the cracking tendency due to the high temperatures of service. Also, every automobile body builder in the United States is now using heat treated nickel-chromium cast iron dies.

Another development has been the extended production of a nickel-chromium type of malleable cast iron. This material has a strength approximately 75 per cent to 80 per cent greater than that of regular malleable iron, and in addition has a higher degree of hardness, which ensures considerably better resistance to wear and abrasion.

Alloy cast iron up to 3 per cent nickel is being used extensively for the brake drums of heavy duty trucks and buses. A foundry making castings for two car builders has increased the nickel content from 0.1 per cent to 0.15 per cent in its Mayari mix for cylinder block and cylinder head castings.

The greatest development in nickel cast irons however, is through the expanding applications for three special compositions—Ni-Resist for resistance to corrosion and to heat particularly in the chemical industry, marine, railroad, automotive and airplane fields for pumps, valves, sleeves, pistons, etc. Ni-Hard for resistance to wear and abrasion particularly for chilled rolls for both hot and cold rolling of sheet metals; for mining and the processing of cement, ore, coal and limestone. In the ceramic, glass and abrasive industries it is used for Muller tires, dies, grinding pans, screens and so forth. Ni-Tensyliron to meet the demand for greater strength. This, the most recent of the three special nickel alloy cast irons to be developed, is being used by foundries to provide products which can successfully compete with other materials to which simple cast iron had been losing business. A manufacturing advantage is that this alloy can be efficiently produced from a regular malleable iron base mixture.

## The Commissioning of the King George V Graving Dock, Southampton

The King George V Graving Dock at Southampton, which was formally opened by H.M. the King on July 26th, 1933, was utilized for the first time recently, when the White Star liner *Majestic* of 56,598 tons, was taken in for overhaul. The vessel was towed towards the gate by six tugs and was then drawn to its final position by winches, the operation occupying about an hour. After closing the gates pumping out was begun, the equipment for this purpose consisting of four 54-inch centrifugal pumps, which will empty the content of 250,000 tons in about four hours. A full description of the dock appeared in our issue of June 30th, 1933, but it may be recalled that it has an effective length of 1,200 feet, is 135 feet wide at the entrance and 165 feet wide at cope level. The depths over the sill and over the keel blocks are 47 feet and 45 feet, respectively, at high water ordinary neap tides. The gate is of the sliding caisson type, and weighs 4,600 tons, including the water ballast; it is operated by a system of main and auxiliary motors with push-button control gear. The pumps are also electrically driven and are housed in a chamber 40 feet below ground level. They are operated by a single attendant from a control desk in the motor room, which is provided with a diagram of the pipe layout to show which pumps are working and which valves are open or closed.—*Engineering.*

# Preliminary Notice

## of Applications for Admission and for Transfer

February 22nd, 1934

The By-laws provide that the Council of The Institute shall approve, classify and elect candidates to membership and transfer from one grade of membership to a higher.

It is also provided that there shall be issued to all corporate members a list of the new applicants for admission and for transfer, containing a concise statement of the record of each applicant and the names of his references.

In order that the Council may determine justly the eligibility of each candidate, every member is asked to read carefully the list submitted herewith and to report promptly to the Secretary any facts which may affect the classification and selection of any of the candidates. In cases where the professional career of an applicant is known to any member, such member is specially invited to make a definite recommendation as to the proper classification of the candidate.*

If to your knowledge facts exist which are derogatory to the personal reputation of any applicant, they should be promptly communicated.

**Communications relating to applicants are considered by the Council as strictly confidential.**

The Council will consider the applications herein described in April, 1934.

R. J. Durley, Secretary.

* The professional requirements are as follows—

**A Member** shall be at least thirty-five years of age, and shall have been engaged in some branch of engineering for at least twelve years, which period may include apprenticeship or pupilage in a qualified engineer's office, or a term of instruction in a school of engineering recognized by the Council. The term of twelve years may, at the discretion of the Council, be reduced to ten years in the case of a candidate for election who has graduated from a school of engineering recognized by the Council. In every case the candidate shall have held a position in which he had responsible charge for at least five years as an engineer qualified to design, direct or report on engineering projects. The occupancy of a chair as a professor in a faculty of applied science of engineering, after the candidate has attained the age of thirty years, shall be considered as responsible charge.

**An Associate Member** shall be at least twenty-seven years of age, and shall have been engaged in some branch of engineering for at least six years, which period may include apprenticeship or pupilage in a qualified engineer's office or a term of instruction in a school of engineering recognized by the Council. In every case a candidate for election shall have held a position of professional responsibility, in charge of work as principal or assistant, for at least two years. The occupancy of a chair as an assistant professor or associate professor in a faculty of applied science of engineering, after the candidate has attained the age of twenty-seven years, shall be considered as professional responsibility.

Every candidate who has not graduated from a school of engineering recognized by the Council shall be required to pass an examination before a board of examiners appointed by the Council. The candidate shall be examined on the theory and practice of engineering, with special reference to the branch of engineering in which he has been engaged, as set forth in Schedule C of the Rules and Regulations relating to Examinations for Admission. He must also pass the examinations specified in Sections 9 and 10, if not already passed, or else present evidence satisfactory to the examiners that he has attained an equivalent standard. Any or all of these examinations may be waived at the discretion of the Council if the candidate has held a position of professional responsibility for five or more years.

**A Junior** shall be at least twenty-one years of age, and shall have been engaged in some branch of engineering for at least four years. This period may be reduced to one year at the discretion of the Council if the candidate for election has graduated from a school of engineering recognized by the Council. He shall not remain in the class of Junior after he has attained the age of thirty-three years, unless in the opinion of Council special circumstances warrant the extension of this age limit.

Every candidate who has not graduated from a school of engineering recognized by the Council, or has not passed the examinations of the third year in such a course, shall be required to pass an examination in engineering science as set forth in Schedule B of the Rules and Regulations relating to Examinations for Admission. He must also pass the examinations specified in Section 10, if not already passed, or else present evidence satisfactory to the examiners that he has attained an equivalent standard.

**A Student** shall be at least seventeen years of age, and shall present a certificate of having passed an examination equivalent to the final examination of a high school, or the matriculation of an arts or science course in a school of engineering recognized by the Council.

He shall either be pursuing a course of instruction in a school of engineering recognized by the Council, in which case he shall not remain in the class of Student for more than two years after graduation; or he shall be receiving a practical training in the profession, in which case he shall pass an examination in such of the subjects set forth in Schedule A of the Rules and Regulations relating to Examinations for Admission as were not included in the high school or matriculation examination which he has already passed; he shall not remain in the class of Student after he has attained the age of twenty-seven years, unless in the opinion of Council special circumstances warrant the extension of this age limit.

**An Affiliate** shall be one who is not an engineer by profession but whose pursuits, scientific attainments or practical experience qualify him to co-operate with engineers in the advancement of professional knowledge.

**The fact that candidates give the names of certain members as reference does not necessarily mean that their applications are endorsed by such members.**

FOR ADMISSION

DuCHENE—ANDREW HUBERT, of 271 Sherbrooke Street, Peterborough, Ont., Born at Quebec, Que., Dec. 29th, 1907; Educ., B.Sc. (E.E.), Univ. of N.B., 1930; 1930 to date, asst. foreman on tests, Canadian General Electric Co. Ltd., Peterborough, Ont.

References: B. L. Barns, B. Ottewell, V. S. Foster, A. L. Dickieson, L. DeW. Magie.

EVANS—OWEN ALLEN, of 179 Denis St., Sault Ste Marie, Ont., Born at Sault Ste Marie, Jan. 6th, 1909; Educ., B.Sc. (Metallurgical), Queen's Univ., 1933; 1930, instr'man., Dept. of Northern Development; 1931, asst. in Fitzgerald Labs.; 1932, mining at Hollinger Gold Mines; 1933 (summer), assayer and mill operator, Minto Gold Mine; 1933 to date, assayer, Algoma Central Railway, Sault Ste Marie, Ont.

References: A. E. Pickering, A. H. Russell, E. M. MacQuarrie, R. S. McCormick, H. F. Bennett.

FULLER—ALLAN FREDERICK SAMUEL, of 2345 Smith St., Regina, Sask., Born at Winnipeg, Man., Aug. 11th, 1910; Educ., B.Sc. (Mech.), Univ. of Sask., 1933; 1929-30-31 (summers), inspection work, city engr's. dept., Regina, Sask.

References: D. A. R. McCannel, R. W. Allen, C. J. McGavin, C. J. Mackenzie, R. A. Spencer.

GAGNON—JOHN ALFRED, of Petewawa, Ont., Born at Ottawa, Ont., June 16th, 1875; Thirty-five years experience on various construction jobs, including highway, building, and dam constrn.; at present, sub-foreman on Project No. 40, Dept. of National Defence, Petewawa, Ont.

References: J. L. H. Bogart, N. Malloch, A. Lafleche, L. J. Gleeson, F. C. Askwith, J. E. N. Cauchon.

GERMAN—ALAN MacDONNELL, of Toronto, Ont., Born at Toronto, Nov. 25th, 1890; Educ., B.A.Sc., Univ. of Toronto, 1914; 1914-15, engr., Canadian Dredging Co. Ltd., Section No. 5, Welland Ship Canal; 1915-16, overseas, Can. Engrs.; 1919 to date, with Canadian Dredging Co. Ltd., as follows—1919-24, engr., Section No. 5, Welland Ship Canal; 1925-30, local mgr., Section No. 7, Welland Ship Canal; 1930 to date, asst. mgr. and gen. supt. of Company.

References: E. G. Cameron, A. J. Grant, E. L. Cousins, C. S. L. Hertzberg, A. R. Dufresne.

GRANT—ALEXANDER JAMES, of 187 Cochrane Ave., Rockcliffe Park, Ottawa, Born at Providence, R.I., U.S.A., Aug. 16th, 1898; Educ., B.Sc. (Elec.), McGill Univ., 1923. One year grad. student course, Westinghouse Company, Pittsburgh; 1924-31, with Westinghouse Electric Co. as follows—1924-25, meter factory; 1925-26, supply engrg.; 1926-28, res. engr., meter factory; 1928-31, design and appn. of remote metering apparatus; 1931 to date, associate physicist, National Research Council, Ottawa, Ont.

References: R. W. Boyle, J. H. Parkin, B. G. Ballard, H. A. Dupre, B. S. McKenzie.

HOLMAN, CLIVE WHELPTON, of 113 Lansdowne Ave., Sault Ste Marie, Ont., Born at Eltham, England, Aug. 12th, 1896; Educ., 1909-14, Dulwich College; Assoc. Member, Inst. Mech. Engrs. (Great Britain) (by examination), 1923; 1914 (8 mos.), ap'tice, fitting shops, South Metropolitan Gas Co., London, England; 1914-19, war service, including 2½ years as leading mechanic on rigid airships, airship engine running, mtce. and repair; 1919-20, drawing office, 1920-21, asst. to clerk of works, South Metropolitan Gas Co.; 1921, asst. engr., Chupanga Sisal Plantation, Mozambique, Portuguese East Africa; 1922-24, engr., Sisal Factories at Kedai and Kibwezi, Kenya Colony; 1927-28, dfting and contract offices, mining dept., Fraser & Chalmers Engineering Works, Erith, England; 1928-29, workshops mgr., Vasin-Gishu Rly. Constrn., Kenya Colony; 1929-30, asst. on dfting, estimating, etc., The Gorman Engrg. Co., Toronto; 1930-31, dftsman., The Dodge Mfg. Co., Toronto, Ont.; at present, teacher of mech'l. dfting., Technical and Commercial High School, Sault Ste Marie, Ont.

References: C. Stenbol, J. H. Jenkinson, K. G. Ross, A. H. Russell.

LAMOUREUX—MARCEL, of St. Guillaume, Que., Born at St. Johns, Que., Oct. 7th, 1906; Educ., B.Eng., McGill Univ., 1932; 1933 to date, junior engr., Lake St. Louis Bridge Corporation, Montreal.

References: O. O. Lefebvre, J. A. Beauchemin, E. Brown, R. DeL. French, C. M. McKergow.

MATTSON—RAGNAR JOHN, of Montreal, Que., Born at Vasteras, Sweden, March 16th, 1894; Educ., B.Sc. (Civil Engr.), Royal Coll. of Engrg., Stockholm, 1920; 1920 (July-Dec.), Republic Struct'l. Iron Works, Cleveland, Ohio, struct'l. steel designer: 1920-21, boiler maker, Carnegie Steel Company, Pittsburgh; 1921-22, research engr., Swiss Engrg. Academy, Stockholm; 1922 (Feb.-Apr.), designer, Allmanna Ingenjors Byran, Stockholm; 1922 (Apr.-Dec.), struct'l. steel designer, Krupps, Germany; 1923, engr., Industriebau A.G., Germany; 1923-24, engr., Paul Anderson, contractor, Vasteras; 1925-28, designer, engr., Foundation Co., New York; 1928 to date, engr., Foundation Co. of Canada Ltd., marine engrg., design of floating plant caisson and other engrg. constrn. design.

References: R. E. Chadwick, F. G. Rutley, W. Griesbach, C. D. Woolward, A. S. Wall.

McMILLAN—JAMES, of Calgary, Alta., Born at Glasgow, Scotland, March 26th, 1896; Educ., B.Sc. (E.E.), Univ. of Alta., 1924; Students' course, Can. Westinghouse Co., Hamilton; 1922 (summer), rodman and chainman, City of Edmonton engrg. dept., and erecting switching equipment, Can. Westinghouse Co., service dept.; Summer 1923, with Can. Westinghouse Co., service dept., as foreman in charge, installing auxiliary switching equipment at Edmonton Power House and installing complete substation at Imperial Oil Refinery, Calgary; 1924-26, office correspondent and sales engr., Can. Westinghouse Co. Calgary; 1926, sales engr. in charge Edmonton office of same company; 1926-27, students' course; 1927-31, gen. elect'l. engrg. work, including layout of distribution systems, transmission line constrn. substation and switching structure design and erection, and from 1931 to date, purchasing agent, Calgary Power Co. Ltd., Calgary, Alta.

References: H. J. McLean, G. H. Thompson, H. J. McEwen, W. Anderson, R. S. Trowsdale, H. J. MacLeod, N. B. LeBourveau, H. B. Sherman.

PEELE—PERCY FREDERICK, of Calgary, Alta., Born at New Westminster, B.C., Feb. 17th, 1902; Educ., B.A.Sc., Univ. of B.C., 1924; 1924-25, testing dept., Can. Gen. Elec. Co., Peterborough, Ont.; 1925-28, sales engr. at Vancouver, and 1928 to date, sales engr. at Calgary, for same company. Work includes wiringlayouts, selecting elect'l. equipment and supervising installn. of same in industrial plants and power houses—also advising in the revamping of equipment or layout of established industrial plants for reasons of increased economy, efficiency and output.

References: R. S. Trowsdale, H. J. McLean, F. N. Rhodes, R. MacKay, G. H. Thompson.

TUCKER—EDWARD FRANCIS, of Montreal, Que., Born at St. Albans, Vt., Oct. 11th, 1900; Educ., B.S. (Chem. Engrg.), Clarkson College of Technology, Potsdam, N.Y., 1922. Chemical Engr., 1932; 1918 (4 mos.), asst. chemist, Diamond Creamery Co.; 1919-22 (summers), St. Lawrence Transmission Co., prelim. and final topog'l. surveys, dam and power plant location, also layout of transmission lines; 1922-23, Hanna Paper Corporation, 6 mos. on paper machine operation and 6 mos. as asst. engr. of mill control and operation; With Stebbins Engrg. and Mfg. Co.—1923-24, routine engrg. office work with some gen. mill constrn. and installn of acid-proof ceramic linings; 1924-27, res. engr. and later field supt., in charge of acid-proof lining installns., tanks, towers and digesters during constrn. of a number of large plants; Canadian Stebbins Engrg. and Mfg. Co. Ltd., Montreal:—1928-29, acting chief engr., 1929, asst. mgr., and 1930 to date, vice-president and manager.

References: F. O. White, J. C. Day, K. S. LeBaron, F. E. Amlie, L. Sterns, W. S. Kidd.

VALIQUETTE—FRANCOIS, 360 Wiseman Ave., Outremont, Que., Born at Montreal, Aug. 1st, 1906; Educ., B.A.Sc., C.E., Ecole Polytechnique, Montreal, 1932; 1929-30-31 (summers), student engr., Road Dept., Prov. of Quebec; 1933 to date, junior engr., Lake St. Louis Bridge Corporation, Montreal.

References: O. O. Lefebvre, A. Frigon, J. A. Beauchemin.

FOR TRANSFER FROM THE CLASS OF JUNIOR

HAURY—JEAN ERNEST, of Montreal, Que., Born at Lausanne, Switzerland, Nov. 1st, 1902; Educ., Diploma of Electrician, Burgdorf Technical School, 1923. Passed E.I.C. Exams. for admission as Junior. 1923-24, dftsman., Co. Electric-Industrielle, France; 1924, electrician, Thomson-Houston Co., Paris, France; 1924-26, designing engr., Soc. d'Appareils de Levage, Paris, France; 1927 28, surveying, Montreal Light Heat & Power Cons.; 1928-29, asst. engr., Montreal Tramways Co.; 1929-32, sales engr., W. K. Davidson, Co., Montreal; 1932 to date, engr. in charge of technical bureau, light and power divn., City of Montreal. (*Jr. 1928.*)

References: P. A. N. Seurot, C. J. Desbaillets, C. E. Gelinas, H. W. Vaughan.

LEITCH—HUGH JAMES, of Montreal, Que., Born at Westmount, Que., May 31st, 1900; Educ., B.Sc. (Civil), McGill Univ., 1926; 1921-22, steel detailing and designing, Phoenix Bridge and Iron Works Ltd., Montreal; 1924-25, asst. erection engr., Canadian Vickers Ltd.; 1926-29, res. engr. on erection of lock gates of Welland Ship Canal for Steel Gates Co. Ltd.; 1929-33, asst. engr., designing dept., and June 1933 to date, manager of warehouse dept., Dominion Bridge Company, Montreal, Que. (*S. 1920. Jr. 1927.*)

References: E. A. Ryan, D. C. Tennant, C. S. Kane, E. S. Mattice, R. M. Robertson.

MACKINNON—WILLIAM DUNCAN, of Donnacona, Que., Born at Allenford, Ont., Nov. 17th, 1901; Educ., B.Sc., Queen's Univ., 1925; 1924-27, training course, later sales and service engr., Bailey Meter Co., Cleveland, Ohio, and Jan. to May 1927, sales and service for same company in Montreal; With Donnacona Paper Co. Ltd., as follows—1927-29, chemist and steam plant enrg., 1929-32, steam plant supt.; 1932 to date, supt., board mill and steam plant. (*S. 1924, Jr. 1929.*)

References: C. A. Buchanan, A. A. MacDiarmid, R. H. Farnsworth, L. H. Birkett, L. M. Arkley.

MOON—GEORGE DOUGLAS, of 11 Maple Ave., Quebec, Que., Born in Hope Township, Ont., Nov. 20th, 1900; Educ., B.A.Sc., Univ. of Toronto, 1923; 1923-25, Can. Westinghouse Co., ap'tice course, elect'l. engrg.; 1925-26, demonstrator, 3rd year, elect'l. engrg., Univ. of Toronto; 1926-28, asst. field engrg., and 1928 to date, design, preparation, supervision and inspection of estimates in connection with outside plant constrn., and at present district engr., Bell Telephone Company of Canada, Quebec, Que. (*S. 1921, Jr. 1928.*)

References: R. B. McDunnough, G. H. Cartwright, A.R. Decary, J. B. P. Dunbar.

FOR TRANSFER FROM THE CLASS OF STUDENT

ADAMS, GEORGE RONALD, of Cocullo, Rep. of Panama, Born at Woodstock, Ont., May 25th, 1903; Educ., B.Sc. (Civil), Queen's Univ., 1927; 1926 (summer), bldg. inspr., Can. Int. Paper Co., Gatineau, Que.; 1926-27, inspr., Price Bros., Riverbend, Que.; 1927 (June-Nov.), dftsman., Dominion Bridge Co., Lachine; 1927-30, constrn. engr., Tropical Oil Co., El Centre, Colombia, S.A.; 1930-31, asst. to mech. supt., at Courtauld's, Cornwall, for the Foundation Co. of Canada; 1931-32, constrn. engr., U.S. Fleet Air Base, Coio Solo, Panama Canal Zone; 1932-33, asst. to chief of mech'l. installn., Madden Dam, Callahan Constrn. Co., Panama Canal Zone; Mar. 1933 to date, engr. in charge of road bldg. for Veragues Mines Ltd., in province of Veragues, Panama. (*S. 1926.*)

References: G. W. Beecroft, W. L. Malcolm, E. L. Dilworth, W. P. Wilgar, F. R. Leadley.

BUNTING—WILLIAM LLOYD, of Flin Flon, Man., Born at Swan River, Man., April 12th, 1906; Educ., B.Sc. (C.E.), Univ. of Man., 1928; 1923 (summer), rodman, Dom. Govt. Reclam. survey of Carrot River; 1924-26 (summers), rodman, and 1927 (summer), instr'man., Prov. of Man., Reclam. Branch; 1928-29, res. engr., Good Roads Board, Prov. of Man.; 1929 (Sept.-Dec.), chief concrete inspr., Seven Sisters Falls; 1930, instr'man., Slave Falls; 1931-33 (8 mos.), concrete inspr.; 1931 (summer), gravel checker, Good Roads Board; 1932 (May-Nov.), night operator in charge of gold mill; 1932-34, crusher operator, Flin Flon, Man.; at present, supt. of public utilities, Municipality of Flin Flon, Man. (*S. 1927.*)

References: R. W. McKinnon, E. W. M. James, J. N. Finlayson, A. J. S. Taunton, T. T. Wilson.

CHISHOLM—DONALD ALEXANDER, of Schumacher, Ont., Born at Eureka, N.S., June 18th, 1906; Educ., B.Sc. (Civil), N.S.T.C., 1932; 1922-25 (summers), rodman and office asst., on highway constrn.; 1926 (summer), instructor at Survey Camp, St. Francois Xavier College; 1927-28, instr'man., Nova Scotia Gypsum Co., Antigonish, N.S.; 1929, leveller on rly. location, 1929-30, dftsman. on improvements to car ferry terminals, C.N.R.; 1932-33, engr. on design and constrn. of additions to high school bldgs., examination and report on proposed improvements to hydro-electric plant, Town of Mulgrave, N.S.; at present, miner, McIntyre Porcupine Mines, Schumacher, Ont. (*S. 1930.*)

References: F. R. Faulkner, S. Ball, F. B. Fripp, C. W. Edmonds, E. L. Baillie.

DECHMAN—WALTER FAIRCHILD, of 131 Catherine St., Sydney, N.S., Born at Wedgeport, N.S., Aug. 22nd, 1906; Educ., B.Sc. (C.E.), N.S.T.C., 1929; Summer 1928, road location survey, N.S. Power Commn.; 1929-30, constrn. of paper mill, Dalhousie, N.B.; 1930-31, engr., Bolivian Power Co., La Paz, Bolivia, S.A.; 1931-33, res. engr., Dept. of Highways, Nova Scotia; 1933 (Sept.-Dec.), temp. work as dftsman., Halifax Harbour Commnrs. (*S. 1929.*)

References: W. P. Copp, F. R. Faulkner, C. M. Smyth, C. S. Bennett.

MADELEY—W. ARTHUR, of 4359-West 11th Ave., Vancouver, B.C., Born at Wakamatsu, Japan, Oct. 17th, 1906; Educ., B.A.Sc. (Civil), Univ. of B.C., 1932; 1926 (summer), survey helper, B.C. Prov. Topog'l. Survey; 1927-28, rodman, dftsman., P.G.E. Rly.; 1929 (summer), rodman, dftsman., C.N.R.; 1930-31 (summers), dftsman., clerk, P.G.E. Rly.; at present, sub-foreman, Project No. 66, Dept. of National Defence, Blueberry Creek, B.C. (*S. 1928.*)

References: C. L. Bates, R. W. Brock, K. M. Chadwick, J. P. Coates, W. H. Powell, W. O. C. Scott, E. A. Wheatley.

PEFFERS—WILLIAMS OSWALD, of Kingston, Ont., Born at Gateshead-on-Tyne, England, Nov. 17th, 1905; Educ., B.Sc. (Elec.), Univ. of Alta., 1931; 1929 (summer), Dept. Public Works, Alta.; 1928-30 (summers), attached, Royal Candn. Signals; at present, District Signal Officer, Mil. Dist. No. 3, Kingston, Ont. (*S. 1930.*)

References: H. J. MacLeod, N. C. Sherman, L. F. Grant, R. S. L. Wilson, J. E. Lyon.

MELLOR—JOHN HAROLD, of 619 Belmont Ave., Westmount, Que., Born at Montreal West, Que., Aug. 18th, 1910; Educ., B.Sc. (Mech.), McGill Univ., 1930; 1927-28 (summers), dfting and field work, Canadian Salt Co., Windsor, Ont.; 1929 (summer), mech'l. repair work, General Motors of Canada Ltd., Oshawa, Ont.; 1930 to date, field engr., mill constrn. and mtce., Canadian Copper Refiners, Montreal, Que. (*S. 1930.*)

References: A. A. Mellor, C. M. McKergow, E. Brown, G. W. F. Ridout-Evans, R. Comette.

TAYLOR—WILLIAM RUSSELL COATES, of Atikokan, Ont., Born at Winnipeg, Man., Jan. 24th, 1906; Educ., B.Sc. (Elec.), Univ. of Man., 1922; 1923-24, elec'tl. constrn. and main. dept., and 1924-27, trouble dispatch, Winnipeg Electric Co.; 1929-31, designing dftsman., and 1931-32, operator, Northwestern Power Company; 1932-34, operator, Ontario and Minnesota Power Co.; at present at Moose Lake Power Plant, Atikokan, Ont. (*S. 1928.*)

References: E. V. Caton, E. P. Fethersonhaugh, V. W. Dick, J. N. Finlayson, L. M. Hovey, A. S. Williams.

## New Brunswick Coal Output

During 1933 the coal production of the province of New Brunswick increased 59 per cent, and that province experienced the largest coal output in its history, according to figures submitted by W. E. McMullen, Inspector of Mines, in his annual report to the Minister of Lands and Mines.

The amount of coal produced in the Minto-Chipman area was 269,499 tons, or 100,000 tons greater than in 1932. Two causes contributed to this encouraging result, the report states.

First, the coal can be produced at lower cost than coals of the same grade coming from without the province, and secondly because all the principal operators have adopted methods for eliminating waste, screening and grading which give the customer a good article and retain his business. About 51 per cent of the coal production goes to the Canadian National and Canadian Pacific railways, 5 per cent is used in the New Brunswick Power Commission's plant at Grand Lake, and the balance of 44 per cent is principally used by industrials and institutional buildings.

Employment at the mines has been well maintained so that the six Minto companies alone have had an average of eight hundred and ninety-seven men throughout the year, and the mines of the Minto and Chipman region collectively now employ steadily about one thousand men.

## Planning a Better Country

For the first time in our national history, planning for physical, economic and social improvement is being made a prime object of study. An active and serious effort is being made to effect some degree of discipline in our heretofore uncoordinated programmes of developing and exploiting the land and natural resources of nation, region and state.

In several instances the potentialities of great regional areas, such as the Tennessee Valley, are under intensive study by specially designated authorities. More than half of the states have appointed planning boards to take the inventory of natural wealth, trends of industry and agriculture and population. The mere intention of introducing intelligent order in our national future is of itself an achievement of such great significance that it cannot be allowed to pass unnoticed. But the results of such studies, the proper balancing and coordinating of our manifold development activities, are capable of bringing more national happiness than any other programme in a generation. The task of appraising the present for the benefit of the future is the greatest challenge the expert planner has ever had presented to him.

—*Engineering News-Record.*

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The Dominion Water Power and Hydrometric Bureau of the Department of the Interior of Canada has issued the annual review of hydro-electric and water-power development throughout the Dominion during the year 1933 which gives a brief description of those undertakings which were begun or which reached the developed stage during that period and of extensions and replacements in existing plants.

This discloses that while no new large water-power undertakings were begun in 1933, installations were completed and brought into operation amounting to 270,210 horse-power, so that the total of water-power developments installed in Canada at the end of 1933 amounts to 7,332,070 horse-power. The most notable and encouraging feature of the year has been the recovery in power demand and it is anticipated that the total production for the year will not be much short of 1930, the highest year of record.

## EMPLOYMENT SERVICE BUREAU

The Service is operated for the benefit of members of The Engineering Institute of Canada, and for industrial and other organizations employing technically trained men—without charge to either party.

*All correspondence should be addressed to*

**The Employment Service Bureau, The Engineering Institute of Canada**
**2050 Mansfield Street, Montreal**

## Situation Vacant

SALES ENGINEER. Well known firm wishes to make connection with a sales engineer familiar with air compressor and Diesel engine market. Please state former experience. Apply to Box No. 1002-V.

## Situations Wanted

MECHANICAL ENGINEER, Canadian, with technical training and executive experience in both Canadian and American industries, particularly plant layout, equipment, planning and production control methods, is open for employment with company desirous of improving manufacturing methods, lowering costs and preparing for business expansion. Apply to Box No. 35-W.

MECHANICAL ENGINEER, A.M.E.I.C. Married. Experience in machine shops, erection and maintenance of industrial plant mechanical and structural design. Reads German, French, Dutch and Spanish. Seeks any suitable position. Apply to Box No. 84-W.

YOUNG ENGINEER, B.A., B.Sc., A.M.E.I.C., R.P.E., Ont. Competent draughtsman and surveyor. Eight years experience including design, superintendence and layout of pulp and paper mills, hydro-electric projects and general construction. Limited experience in mechanical design and industrial plant maintenance. Apply to Box No. 150-W.

PURCHASING ENGINEER, graduate mechanical engineer, Canadian, married, 34 years of age, with 13 years' experience in the industrial field, including design, construction and operation, 8 years of which had to do with the development of specifications and ordering of equipment and materials for plant extensions and maintenance; one year engaged on sale of surplus construction equipment. Full details upon request. Apply to Box No. 161-W.

CIVIL ENGINEER, age 44, open for employment anywhere, experience covers about 20 years' active work, including 7 years on municipal engineering, 2 years as Town Manager, 3 years on railway construction, 3 years on the staff of a provincial highway department, 2 years as contractor's superintendent on pavement construction. Apply to Box No. 216-W.

REINFORCED CONCRETE ENGINEER, B.Sc., P.E.Q., eight years experience in construction design of industrial buildings, office buildings, apartment houses, etc. Age 30. Married. Apply to Box No. 257-W

MECHANICAL ENGINEER, B.Sc., McGill '19, A.M.E.I.C. Married. Twelve years experience including oil refinery power plant, structural and reinforced concrete design, factory maintenance, steam generation and distribution problems, heating and ventilating. Available at once. Location immaterial. Apply to Box No. 265-W.

ELECTRICAL ENGINEER, B.Sc., '28, Canadian. Age 25. Experience includes two summers with power company; thirteen months test course with C.G.E. Co.; telephone engineering, and the past thirty months with a large power company in operation and maintenance engineering. Location immaterial and available immediately. Apply to Box No. 266-W.

MECHANICAL ENGINEER, age 28, nine years all round experience, Grad. Inst. of Mech. Engs. England, E.E.I.C. Technical and practical training with first class English firm of general engineers; shop, foundry and drawing office experience in steam and Diesel engines, asphalt, concrete machinery, boilers, power plants, road rollers, etc. Experience in heating and ventilation design and equipment; 18 months designing draughtsman with Montreal consulting engineers. 2½ years sales experience, steam and hot water heating systems, power plant equipment, machinery, oil-burning apparatus. Canadian 4th class Marine Engineers Certificate; C.N.S. experience. Available at short notice. Apply to Box No. 270-W.

DESIGNING DRAUGHTSMAN, experience in layout of steam power house equipment and piping. Wide experience in mechanical drive and details of machinery, gearing, and hoists. Accustomed to layout of small mill buildings of steel and timber, structural design and details. Good references. Present location Montreal. Apply to Box No. 329-W.

PLANE-TABLE TOPOGRAPHER, B.Sc., in C.E. Thoroughly experienced in modern field mapping methods including ground control for aerial surveys. Fast and efficient in surveys for construction, hydro-electric and geological investigations. Apply to Box No. 431-W.

ELECTRICAL ENGINEER, B.Sc., A.M.E.I.C., Am.A.I.E.E., age 30, single. Eight years experience H.E. and steam power plants, substations, etc., shop layouts, steel and concrete design. Location immaterial. Available immediately. Apply to Box No. 435-W.

CIVIL ENGINEER, B.A.Sc., and C.E., A.M.E.I.C., age 30, married. Experience over the last ten years covers construction on hydro-electric and railway work as instrumentman and resident engineer. Also office work on teaching and design, investigations and hydraulic works, reinforced concrete, bridge foundations and caissons. Location immaterial. Available at once. Apply to Box No. 447-W.

## Situations Wanted

SALES ENGINEER, M.A.Sc. Univ. of Toronto, wishes to represent firm selling building products or other engineering commodities, as their representative in Western Canada. Located in Winnipeg. Apply to Box No. 467-W.

CIVIL ENGINEER, B.Sc., A.M.E.I.C., with six years experience in paper mill and hydro-electric work, desires position in western Canada. Capable of handling reinforced concrete and steel design, paper mill equipment and piping layout, estimates, field surveys, or acting as resident engineer on construction. Now on west coast and available at once. Apply to Box No. 482-W.

MECHANICAL ENGINEER, B.Sc. Age 28, married. Four and a half years on industrial plant maintenance and construction, including shop production work and pulp and paper mill control. Also two and a half years on structural steel and reinforced concrete design. Available at once. Apply to Box No. 521-W.

CIVIL ENGINEER, Canadian, married, twenty-five years' technical and executive experience, specialized knowledge of industrial housing problems and the administration of industrial towns, also town planning and municipal engineering, desires new connection. Available on reasonable notice. Personal interview sought. Apply to Box No. 544-W.

### Employment Service Bureau

This bureau is maintained by The Engineering Institute of Canada for the benefit of members and organizations employing technically trained men.

An enquiry addressed to 2050 Mansfield Street, Montreal, will bring full information concerning the services offered. Details can also be obtained from Branch secretaries who are located in the larger centres throughout Canada.

Brief announcements of men available and positions vacant will be published without charge in The Engineering Journal and the Bulletin. Replies addressed in care of the required box number will be forwarded to the advertiser without delay.

An additional service also offered those who are unemployed or wish to change their positions, is the opportunity of placing their names and records on file at 2050 Mansfield Street for consideration by employers wishing to employ engineers. This is of great assistance as many employers will not advertise or wish to locate a suitable man on short notice. If desired the information contained in these records can be kept confidential.

Forms for registration purposes may be obtained from The Institute Headquarters or Branch secretaries.

ELECTRICAL AND MECHANICAL ENGINEER, B.Sc., A.M.E.I.C. Experience includes C.G.E. Students Test Course and six years in engrg. dept. of same company on design of electrical equipment. Four summers as instrumentman on surveying and highway construction. Recently completed course in mechanical engineering. Available at once. Location preferred Ontario, Quebec, or Maritimes. Apply to Box No. 564-W.

CIVIL ENGINEER, age 25, single, graduate. Creditable record on responsible hydro and railroad work in both Eastern and Western Canada. Apply to Box No. 567-W.

MECHANICAL ENGINEER, A.M.E.I.C., with twenty years experience on mechanical and structural design, desires connection. Available at once. Apply to Box No. 571-W.

MECHANICAL ENGINEER, B.A.Sc., '30, desires position to gain experience, and which offers opportunity for advancement. Experience in pulp and paper mill and one year in mechanical department of large electrical company. Location immaterial. Available immediately. Apply to Box No. 577-W.

DOMINION LAND SURVEYOR, and graduate engineer with extensive experience on legal, topographic and plane-table surveys and field and office use of aero-photographs, desires employment either in Canada or abroad. Available at once. Apply to Box No. 589-W.

MECHANICAL ENGINEER, Canadian, technically trained; eighteen years experience as foreman, superintendent and engineer in manufacturing, repair work of all kinds, maintenance and special machinery building. Location immaterial. Available at once. Apply to Box No. 601-W.

CHEMICAL ENGINEER, S.E.I.C., B.Sc., University of Alberta, '30. Age 31. Single. Six seasons' practical laboratory experience, three as chief chemist and three as assistant chemist in cement plant; one year's p.g. work in physical chemistry; three years' experience teaching. Desires position in any industry with chemical control. Available immediately. Apply to Box No. 609-W.

## Situations Wanted

DESIGNING ENGINEER AND ESTIMATOR, grad. Univ. of Toronto in C.E., A.M.E.I.C., twenty years experience in structural steel, construction and municipal work. Available at once. Apply to Box No. 613-W.

CIVIL ENGINEER, A.M.E.I.C., R.P.E., Ontario; three years construction engineer on industrial plants; fourteen years in charge of construction of hydraulic power developments, tower lines, sub-stations, etc.; four years as executive in charge of construction and development of harbours, including railways, docks, warehouses, hydraulic dredging, land reclamation, etc. Apply to Box No 647-W

MECHANICAL ENGINEER, A.M.E.I.C., Canadian, technically trained; six years drawing office. Office experience, including general design and plant layout. Also two years general shop work, including machine, pattern and foundry experience, desires position with industrial firm in capacity of production engineer or estimator. Available on short notice. Apply to Box No. 676-W.

ELECTRICAL AND CIVIL ENGINEER, B.Sc., Elec., '29, B.Sc., Civil '33. Age 27. Jr.E.I.C. Undergraduate experience in surveying and concrete foundations; also four months with Canadian General Electric Co. Thirty-three months in engineering office of a large electrical manufacturing company since graduation. Good experience in layouts, switching diagrams, specifications and pricing. Best of references. Available immediately. Apply to Box No. 693-W.

MECHANICAL ENGINEER, B.Sc., '27, Jr.E.I.C. Four years maintenance of high speed Diesel engines units, 200 to 1,300 h.p. Also maintenance of D.C. and A.C. electrical systems and machinery. Draughting experience. Westinghouse apprenticeship course. Practical mechanical and electrical engineer with a special study of high speed Diesel engine design, application and operation. Location in western or eastern Canada immaterial. Apply to Box No. 703-W.

COMBUSTION ENGINEER, R.P.E., Manitoba, A.M.E.I.C. Wide experience with all classes of fuels. Expert designer and draughtsman on modern steam power plants. Experienced in publicity work. Well known throughout the west. Location, Winnipeg or the west. Available at once. Apply to Box No. 713-W.

ELECTRICAL ENGINEER, B.Sc., University of N.B., '31. Experience includes three months field work with Saint John Harbour Reconstruction. Apply to Box No. 722-W.

MECHANICAL ENGINEER, age 41, married. Eleven years designing experience with project of outstanding magnitude. Machinery layouts, checking, estimating and inspecting. Twelve years previous engineering, including draughting, machine shop and two years chemical laboratory. Highest references. Apply to Box No. 723-W.

CIVIL ENGINEER, B.Sc. (Alta. '31), S.E.I.C. Experience includes three seasons in charge of survey party. Transitman on railway maintenance, and concrete bridge designing Nature of work and location immaterial. Apply to Box No. 724-W.

YOUNG CIVIL ENGINEER, B.Sc. (Univ. of N.B. '31), with experience as rodman and checker on railroad construction, is open for a position. Apply to Box No. 728-W.

DESIGNING ENGINEER, M.Sc. (McGill Univ.), D.L.S., A.M.E.I.C., P.E.Q. Experience in design and construction of water power plants, transmission lines, field investigations of storage, hydraulic calculations and reports. Also paper mill construction, railways, highways, and in design and construction of bridges and buildings. Available at once. Apply to Box No. 729-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.Sc., Univ. of B.C. '30. Single, age 24. Sixteen months with the Allis-Chalmers Mfg. Co. as student engineer. Experience includes foundry production, erection and operation of steam turbines, erection of hydraulic machinery, and testing texropes and centrifugal pumps. Location immaterial. Available at once. Apply to Box No. 735-W.

CIVIL ENGINEER, M.Sc., A.M.E.I.C., R.P.E. (Ont.), ten years experience in municipal and highway engineering. Read, write and talk French. Married. Served in France. Will go anywhere at any time. Experienced journalist. Apply to Box No. 737-W.

ELECTRICAL AND RADIO ENGINEER, B.Sc. '31, E.E.I.C. Age 25. Nine months experience on installation of power and lighting equipment. Eight months on extensive survey layouts. Two summers installing telephone equipment. Specialized in radio servicing and merchandising. Available at once. Location immaterial. Apply to Box No. 740-W.

CIVIL ENGINEER, graduate '29. Married. One year building construction, one year hydro-electric construction in South America, fourteen months resident engineer on road construction. Working knowledge of Spanish. Apply to Box No. 744-W.

SALES ENGINEER, B.Sc., McGill, 1923, A.M.E.I.C. Age 33. Married. Extensive experience in building construction. Thoroughly familiar with steel building products; last five years in charge of structural and reinforcing steel sales for company in New York state. Available at once. Located in Canada. Apply to Box No. 749-W.

DESIGNING ENGINEER, graduate Univ. Toronto '26. Thoroughly experienced in the design of a broad range of structures, desires responsible position. Apply to Box No. 761-W

## Situations Wanted

CIVIL ENGINEER, S.E.I.C., B.Sc. Queen's Univ '29. Age 25. Married. Three years experience as construction supt. and estimator for contracting firm. Experience includes general building, bridges, sewer work, concrete, boiler settings, sand blasting of bridges and spray painting. Available at once. Apply to Box No 776-W.

CIVIL ENGINEER, B.Sc., '25, Jr.E.I.C., P.E.Q., married. Desires position, preferably with construction firm. Experience includes railway, monument and mill building construction. Available immediately. Apply to Box No. 780-W.

DRAUGHTSMAN, experience in civil engineering, forestry engineering, land surveying and house construction. Good references. Apply to Box No. 781-W.

ELECTRICAL AND SALES ENGINEER, S.E.I.C., grad. '28. Experience includes one year test course, one year switchboard design and two years switchboard and switching equipment sales with large electrical manufacturing company. Three summers Pilot Officer with R.C.A.F. Available at once. Apply to Box No. 788-W.

ELECTRICAL ENGINEER. Specializing in power and illumination reports, estimates, appraisals, contracts and rates, plans and specifications for buildings. Available on interesting terms. Apply to Box No. 795-W.

CIVIL ENGINEER, S.E.I.C., graduate '30, age 23, single. Experience includes mining surveys, assistant on highway location and construction, and assistant on large construction work. Steel and concrete layout and design. Apply to Box No. 809-W.

CIVIL ENGINEER, college graduate, age 27, single. Experience includes surveying, draughting concrete construction and design, street paving both asphalt and concrete. Available at once; will consider anything and go anywhere. Apply to Box No. 816-W.

CIVIL ENGINEER, B.E. (Sask. Univ. '32), S.E.I.C. Single. Experience in city street improvements; sewer and water extensions. Good draughtsman. References. Available at once. Location immaterial. Apply to Box No. 818-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. (Queen's '32), age 21. Three summers surveying in northern Quebec. Interested in hydraulics and reinforced concrete. Available at once. Location immaterial. Apply to Box No. 822-W.

CIVIL ENGINEER, B.Sc., A.M.E.I.C., with fifteen years experience mostly in pulp and paper mill work, reinforced concrete and structural steel design, field surveys, layout of mechanical equipment, piping. Available at once. Apply to Box No. 825-W.

ELECTRICAL ENGINEER, S.E.I.C., grad. '29, age 24, married; experience includes one year Students Test Course, sixteen months in distribution transformer design and eight months as assistant foreman in charge of industrial control and switchgear tests. Location immaterial. Available at once. Apply to Box No. 828-W.

CIVIL ENGINEER, B.A.Sc., D.L.S., O.L.S., A.M.E.I.C., age 46, married. Twelve years experience in charge of legal field surveys. Owns own surveying equipment. Eight years on technical, administrative, and editorial office work. Experienced in writing. Desires position on survey work, assisting in or in charge of preparation of house organ, on staff of technical or semi-technical magazine, or on publicity, editorial or administrative office work. Available at once. Will consider any salary, and any location. Apply to Box No. 831-W.

CIVIL ENGINEER, M.Sc., R.P.E. (Sask.). Age 27. Experience in location and drainage surveys, highways and paving, bridge design and construction city and municipal developments, power and telephone construction work. Available on short notice. Apply to Box No. 839-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. '32 (Univ. of N.B.). Age 25, married. Two years experience in power line construction and maintenance; one year of highway construction; one summer surveying for power plant site, location and spur railway line construction. Available at once. Location immaterial. Apply to Box No. 840-W.

CIVIL ENGINEER, B.Sc. '15, A.M.E.I.C., married, extensive experience in responsible position on railway construction, also highways, bridges and water supplies. Position desired as engineer or superintendent. Available at once. Apply to Box No. 841-W.

CIVIL ENGINEER, B.Sc. (Alta. '31), S.E.I.C., age 24. Experience, three summers on railroad maintenance, and seven months on highway location as instrumentman. Willing to do anything, anywhere, but would prefer connection with designing or construction firm on structural works. Available immediately. Apply to Box No. 846-W.

MECHANICAL ENGINEER, Jr.E.I.C., technical graduate, bilingual, age 30. Two years as designing heating draughtsman with one of the largest firms of its kind on this continent handling heating materials; three years designing draughtsman in consulting engineers' office, mechanical equipment of buildings, heating, ventilation, sanitation, power plant equipment, writing of specifications, etc. Present location Montreal. Available at once. Apply to Box No. 850-W.

BRIDGE AND STRUCTURAL ENGINEER, A.M.E.I.C., McGill. Twenty-five years' experience on bridge and structural staffs. Until recently employed. Familiar with all late designs, construction, and practices in all Canadian fabricating plants. Desirous of employment in any responsible position, sales, fabrication or construction. Apply to Box No. 851-W.

STRUCTURAL ENGINEER, B.A.Sc., A.M.E.I.C. Twenty-two years experience in design of bridges and all types of buildings in structural steel and reinforced concrete Three years experience in railway construction and land surveying. Apply to Box No. 856-W.

MECHANICAL ENGINEER, B.Sc. '32, S.E.I.C. Good draughtsman. Undergraduate experience:—One year moulding shop practice; two years pipe fitting and sheet metal work; one year draughting and tracing on paper mill layout; six months machine shop practice; and eight months fuel investigation and power heating plant testing. Desires position offering experience in steam power plants or heating and ventilating design. Will go anywhere. Apply to Box No. 858-W.

MECHANICAL ENGINEER, age 31, graduate Sheffield (England) 1921; apprenticeship with firm manufacturing steam turbine generators and auxiliaries and subsequent experience in design, erection, operation and inspection of same. Marine experience B.O.T. certificate thoroughly conversant with Canadian plants and equipment. Available on short notice. Any location. Box No. 860-W.

CHEMICAL ENGINEER, B.Sc. (McGill '21), A.M.E.I.C., age 36, married; three years since graduation with pulp and paper mills; eight years in shops, estimating and sales divisions of well-known gas engineering and construction companies in the United States. Excellent references. Available on short notice. Apply to Box No. 866-W.

CONSTRUCTION ENGINEER (Toronto Univ. of '07). Experience includes hydro-electric, municipal and railroad work. Available immediately. Location immaterial. Apply to Box No. 886-W.

ELECTRICAL ENGINEER, graduate 1929, S.E.I.C. Single. Experience includes two years with electrical manufacturing concern and one on highway construction work. Available at once. Will go anywhere. Apply to Box No. 887-W.

CIVIL ENGINEER, B.Sc., Montreal 1930, age 26, single, French and English, desires position technical or non-technical in engineering, industrial or commercial fields, sales or promotion work. Experience includes three years in municipal engineering on paving, sewage, waterworks, filter plant equipment, layout of buildings, etc. Available immediately. Apply to Box No. 891-W.

ELECTRICAL ENGINEER, grad. Univ. of N.B. '31. Experienced in surveying and draughting, requires position. Available at once. Will go anywhere. Apply to Box No. 893-W.

CIVIL ENGINEER, B.A.Sc., Jr.E.I.C., age 29, single. Experience includes two years in pulp mill as draughtsman and designer on additions, maintenance and plant layout. Three and a half years in the Toronto Buildings Department checking steel, reinforced concrete, and architectural plans. Available at once. Location immaterial. At present in Toronto. Apply to Box No. 899-W.

ENGINEER, Jr.E.I.C., specializing in reconnaissance and preliminary surveys in connection with hydro-electric and storage projects Expert on location and construction of transmission lines, railways and highways. Capable of taking charge. Location immaterial. Apply to Box No. 901-W.

DESIGNING ENGINEER, A.M.E.I.C. Permanent and executive position preferred but not essential. Fifteen years experience in designing power plants, engine and fan rooms, kitchens and laundries. Thoroughly familiar with plumbing and ventilating work, pneumatic tubes, and refrigeration, also heating, electrical work, and specifications. Apply to Box No. 913-W.

INDUSTRIAL ENGINEER, B.Sc. in M.E., age 25, married, is open for a position of a permanent nature with an industrial concern. Experience includes three years in various divisions of a paper mill and two years in an electrical company. Apply to Box No. 917-W.

ENGINEER, B.Sc., A.M.E.I.C., R.P.E. (N.B.), age 35, married. Seven years' mining experience as sampler, assayer, surveyor, field work, and foreman in charge of underground development; two years as assistant engineer on highway construction and maintenance Available on short notice. Apply to Box No. 932-W.

CIVIL ENGINEER, B.Sc., '25, McGill Univ., Jr.E.I.C., P.E.Q., age 32, married. Experience as rodman and instrumentman on track maintenance. Seven and one-half years with Canadian paper company, as assistant office engineer handling all classes of engineering problems in connection with woods operations, i.e., road buildings, piers, booms, timber bridges, depots, dams, etc. Apply to Box No. 933-W.

ELECTRICAL ENGINEER, Dipl. of Eng., B.Sc. (Dalhousie Univ.), S.B. and S.M. in E.E. (Mass. Inst. of Tech.), Canadian. Married. Seven and a half years' experience in design, construction and operation of hydro, steam and industrial plants. For past sixteen months field office electrical engineer on 510,000 h.p. hydro-electric project. Available at once. Apply to Box No. 936-W.

CIVIL ENGINEER, B.Sc., O.P.E. Experience includes several years on municipal work-design and construction of sewers, steel and concrete bridges, watermains and pavements. Available at once. Apply to Box No 950-W.

ELECTRICAL ENGINEER, twenty years experience, desires position, either temporary or permanent. Experienced in design, construction, and operation of power and industrial plants, and supt. of construction Apply to Box No. 974-W.

CIVIL ENGINEER, B.Sc. (Univ. of Sask. '33), S.E.I.C., age 28, single. Experience in testing hydro-electric equipment, draughting, surveying, city street, improvements, technical photography. Available at once. Location immaterial. Apply to Box No. 986-W.

ENGINEER SUPERINTENDENT, age 44. Engineering and business training, executive ability, tactful, energetic. Had charge of several large projects. Intimate knowledge of costs and prices, reports and estimates Available immediately. Any location. Apply to Box No. 1021-W.

CIVIL ENGINEER, B.Sc. (Queen's 14), A.M.E.I.C., Dominion Land Surveyor, 5 months' special course at the University of London, England, in municipal hygiene and reinforced concrete construction. Experience covers legal and topographic surveys, plane tabling and stadia surveying, railway and highway construction, drainage and excavation work. Available at once Apply Box No. 1035-W

ELECTRICAL ENGINEER AND GEOPHYSICIST Age 36. Married. Seven years experience in geophysical exploration using seismic, magnetic and electrical methods. Two years experience with the Western Electric Company of Chicago, working on equipment and magnetic materials research. Experienced in radio and telephone work, also specializing in precise electrical measurements, resistance determinations, ground potentials and similar problems of ground current distribution. Apply to Box No. 1063-W.

ELECTRICAL ENGINEER, B.A.Sc. Univ. Toronto '28. Experience includes Can. Gen. Elec. Co. Test Course. Also more than two years in the engineering dept. of the same company. Available on short notice. Preferred location central or eastern Canada. Apply to Box No. 1075-W.

ELECTRICAL ENGINEER, B.Sc. Married. Eight years electrical experience, including operation, maintenance and construction work, electrical design work on large power development, mechanical ability, experienced photographer, employed in electrical capacity at present. Available on reasonable notice. Apply to Box No. 1076-W.

INDUSTRIAL ENGINEER, B.A.Sc. in Chem. Eng. (Tor. '31), S.B in Indust. Eng. (Mass. Inst. of Tech. '32), S.E.I.C. Age 25 years. Northern Electric Training Course. Construction and sales experience Rockefeller Research Associate at McGill University in industrial engineering for past year and to date. Desire work in production or financial departments of a manufacturing plant. Apply to Box No. 1098-W.

CIVIL ENGINEER, age 27, graduate 1930, single. Experience includes detailing, designing and estimating structural steel, plate work and pressure vessels; also hydrographic surveying. Available at once. Apply to Box No. 1111-W.

ELECTRICAL ENGINEER, S.E.I.C., single, age 24 years. Four consecutive years at Univ. of N.B. in electrical engineering. Summer experience in bridge and road construction and auto repairing, desires position in industrial or power plant. Any locality. References on request. Apply to Box. No. 1114-W.

CIVIL ENGINEER, B.Sc. Sask. '30. S.E.I.C. Age 24 years. Experience in municipal engineering, including sewer and water construction, sidewalk construction, paving, storm sewer design, draughting, precise levelling, and reinforced concrete bridge construction. Unmarried. Available at once. Will go anywhere. Apply to Box No. 1115-W.

ELECTRICAL ENGINEER, B.Sc.E.E. (Univ. of N.B. '31) C.G.E. Test Course included industrial control, induction motors and transformers; the transformer test included desk work for two months on computing losses, efficiencies, etc. Available at once. Apply to Box. No. 1119-W.

## Wanted to Purchase

Second-hand or used Land Surveying Compass with tripod. Must be in good condition. Describe fully and state price wanted. Apply to Box P-15.

Second-hand Transit in good condition. Must be reasonable price. Apply to Box P-18.

## For Sale

TRANSIT THEODELITE—horizontal and full vertical 5" circles, reading to 20 secs. Fully equipped for stellar and solar observations. Three screw-Reading glass at each vernier—3 eye pieces—strident buble-Prism attachment for eye piece at large vertical angles. Light weight all non wearing parts aluminum. Apply to Box No. 18-S.

# Purchasers' Classified Directory

## *A Selected List of Equipment, Apparatus and Supplies*

For Alphabetical List of Advertisers see page 16.

A

**Acids:**
Canadian Industries Limited.
**Aerial Survey:**
Canadian Airways Ltd.
**Ammeters and Voltmeters:**
Bepco Canada Ltd.
Crompton Parkinson (Canada) Ltd.
**Angles, Steel:**
Bethlehem Steel Export Corp.
**Ash Handling Equipment:**
Babcock-Wilcox & Goldie McCulloch Ltd.
Combustion Engineering Corp. Ltd.
E. Long Ltd
**Asphalt:**
Barrett Co. Ltd.
**Axles, Steel, Forged:**
Dominion Foundries & Steel Ltd.

B

**Ball Mills:**
Dominion Engineering Works Limited.
Foster Wheeler Ltd.
Wm. Hamilton Div. Canadian Vickers Ltd.
**Balls, Steel and Bronze:**
Can. S.K.F. Co. Ltd.
**Barking Drums:**
Canadian Ingersoll-Rand Company, Limited.
**Bars, Steel and Iron:**
Bethlehem Steel Export Corp.
Dominion Foundries & Steel Ltd.
**Bearings, Ball and Roller:**
Can. S.K.F. Co. Ltd.
**Billets, Blooms, Slabs:**
Bethlehem Steel Export Corp.
Dominion Foundries & Steel Ltd.
**Bins:**
Canada Cement Co. Ltd.
**Blasting Materials:**
Canadian Industries Limited.
**Blowers, Centrifugal:**
Can. Ingersoll-Rand Co. Ltd.
**Blue Print Machinery:**
Montreal Blue Print Co.
**Boilers:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Canadian Vickers Ltd.
Combustion Engineering Corp. Ltd.
Foster Wheeler Limited.
E. Leonard & Sons Ltd.
Vulcan Iron Wks. Ltd.
**Boilers, Electric:**
Can. General Electric Co. Ltd.
Dominion Engineering Works Limited.
Northern Electric Co. Ltd.
**Boilers, Portable:**
Foster Wheeler Ltd.
E. Leonard & Sons Ltd.
**Boxes, Cable Junction:**
Northern Electric Co. Ltd.
**Braces, Cross Arm, Steel, Plain or Galvanized:**
Northern Electric Co. Ltd.
**Brackets, Ball Bearing:**
Can. S.K.F. Co. Ltd.
**Brakes, Air:**
Can. General Elec. Co. Ltd.
**Brakes, Magnetic Clutch:**
Northern Electric Co. Ltd.
**Bridge-Meggers:**
Northern Electric Co. Ltd.
**Bridges:**
Canada Cement Co. Ltd.
Canadian Vickers Ltd.
Dominion Bridge Co. Ltd.
**Bucket Elevators:**
Jeffrey Mfg. Co. Ltd.
Plessisville Foundry.
**Buildings, Steel:**
Dominion Bridge Co. Ltd.

C

**Cables, Copper and Galvanized:**
Northern Electric Co. Ltd.
**Cables, Electric, Bare and Insulated:**
Can. Westinghouse Co. Ltd.
Can. General Electric Co. Ltd.
Northern Electric Co. Ltd.
**Caissons, Barges:**
Dominion Bridge Co. Ltd.
**Cameras:**
Associated Screen News Ltd.
**Capacitors:**
Bepco Canada Ltd.
Can. Westinghouse Co. Ltd.
Lancashire Dynamo & Crypto Co. of Can. Ltd.
**Cars, Dump:**
E Long Ltd.
**Castings, Brass:**
The Superheater Co. Ltd.
**Castings, Iron:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Dominion Engineering Works.
Foster Wheeler Ltd.
E. Leonard & Sons Ltd.
E. Long Ltd.
The Superheater Co. Ltd.
Vulcan Iron Wks. Ltd.
**Castings, Alloy Steel:**
Dominion Foundries & Steel Ltd.
**Castings, Steel:**
Dominion Foundries & Steel Ltd
Vulcan Iron Wks. Ltd
**Catenary Materials:**
Can. Ohio Brass Co. Ltd.
**Cement Manufacturers:**
Canada Cement Co. Ltd.
**Chains, Silent and Roller:**
The Hamilton Gear & Machine Co. Ltd
Jeffrey Mfg. Co Ltd.
**Channels:**
Bethlehem Steel Export Corp.
**Chemicals:**
Canadian Industries Limited.
**Chemists:**
Milton Hersey Co. Ltd.
Roast Laboratories Reg'd.
**Chippers, Pneumatic:**
Canadian Ingersoll-Rand Company, Limited.
**Choke Coils:**
Ferranti Electric Co.
**Circuit Breakers:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.
**Clarifiers, Filter:**
Bepco Canada Ltd.
Crompton Parkinson (Canada) Ltd.
**Clutches, Ball Bearing Friction:**
Can. S.K.F. Co. Ltd.
**Clutches, Magnetic**
Northern Electric Co. Ltd.
**Coal Handling Equipment:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Combustion Engineering Corp. Ltd.
E. Long Ltd.
**Combustion Control Equipment:**
Bailey Meter Co. Ltd.
**Compressors, Air and Gas:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Canadian Ingersoll-Rand Company, Limited.
**Concrete:**
Canada Cement Co. Ltd.
**Condensers, Steam:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Canadian Ingersoll-Rand Company, Limited.
Foster Wheeler Limited.
**Condensers, Synchronous and Static:**
Bepco Canada Ltd.
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Crompton Parkinson (Canada) Ltd.
Harland Eng. Co. of Can. Ltd.
Lancashire Dynamo & Crypto Co. of Can. Ltd.
Northern Electric Co. Ltd.
Bruce Peebles (Canada) Ltd.
**Conduit:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co Ltd.
**Conduit, Underground Fibre, and Underfloor Duct:**
Northern Electric Co. Ltd.
**Conduits, Wood Pressure Creosoted:**
Canadian Wood Pipe & Tanks Ltd.
**Controllers, Electric:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.
**Couplings:**
Dart Union Co. Ltd.
Dresser Mfg. Co. Ltd.
**Couplings, Flexible:**
Dominion Engineering Works Limited.
Dresser Mfg. Co. Ltd.
**Couplings, Flexible:**
Wm. Hamilton Div. Canadian Vickers Ltd.
The Hamilton Gear & Machine Co. Ltd.
**Cranes, Hand and Power:**
Dominion Bridge Co.
**Cranes, Locomotive:**
Dominion Hoist & Shovel Co. Ltd.
**Cranes, Shovel, Gasoline Crawler, Pillar:**
Canadian Vickers Ltd.
Dominion Hoist & Shovel Co. Ltd.
**Crowbars:**
B. J. Coghlin Co. Ltd.
**Crushers, Coal and Stone:**
Canadian Ingersoll-Rand Company, Limited.
Jeffrey Mfg. Co. Ltd.

D

**Dimmers:**
Northern Electric Co. Ltd.
**Disposal Plants, Sewage:**
W. J. Westaway Co. Ltd.
**Ditchers:**
Dominion Hoist & Shovel Co. Ltd.
**Drills, Pneumatic:**
Canadian Ingersoll-Rand Company, Limited.
**Dynamite:**
Canadian Industries Limited.

E

**Economizers, Fuel:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Combustion Engineering Corp. Ltd.
Foster Wheeler Limited.
**Ejectors:**
Darling Bros. Ltd.
**Elbows:**
Dart Union Co. Ltd.
**Electric Blasting Caps:**
Canadian Industries Limited.
**Electric Railway Car Couplers:**
Can. Ohio Brass Co. Ltd.
**Electrical Supplies:**
Can. General Elec. Co. Ltd.
Can. Ohio Brass Co Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.
**Electrification Materials, Steam Road:**
Can. Ohio Brass Co. Ltd.
**Elevating Equipment:**
E. Long Ltd.
Plessisville Foundry.
**Elevators:**
Darling Bros. Ltd.
**Engines, Diesel and Semi-Diesel:**
Canadian Ingersoll-Rand Company, Limited.
Harland Eng. Co. of Can. Ltd.
**Engines, Gas and Oil:**
Canadian Ingersoll-Rand Company, Limited.
**Engines, Steam:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Canadian Vickers Ltd.
Harland Eng. Co. of Can. Ltd.
E. Leonard & Sons Ltd.
**Evaporators:**
Foster Wheeler Limited.
**Expansion Joints:**
Darling Bros. Ltd.
Foster Wheeler Limited.
**Explosives:**
Canadian Industries Limited.

F

**Feed Water Heaters, Locomotive:**
The Superheater Co. Ltd.
**Filtration Plants, Water:**
W. J. Westaway Co. Ltd.
**Finishes:**
Canadian Industries Limited.
**Fire Alarm Apparatus:**
Northern Electric Co. Ltd.
**Floodlights:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.
**Floor Stands:**
Jenkins Bros. Ltd.
**Floors:**
Canada Cement Co. Ltd.
**Forcite:**
Canadian Industries Limited
**Forgings:**
Bethlehem Steel Export Corp.
**Foundations:**
Canada Cement Co. Ltd.

G

**Gaskets, Asbestos, Fibrous, Metallic, Rubber:**
The Garlock Packing Co. of Can. Ltd.
**Gasoline Recovery Systems:**
Foster Wheeler Limited.
**Gates, Hydraulic Regulating:**
Canadian Vickers Ltd.
Dominion Bridge Co. Ltd.
**Gauges, Draft:**
Bailey Meter Co. Ltd.
**Gear Reductions:**
The Hamilton Gear & Machine Co. Ltd.
**Gears:**
Dominion Bridge Co. Ltd.
Dominion Engineering Works Limited.
The Hamilton Gear & Machine Co. Ltd.
E. Long Ltd.
Plessisville Foundry.
**Generators:**
Bepco Canada Ltd.
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Crompton Parkinson (Canada) Ltd.
Harland Eng. Co. of Can. Ltd.
Lancashire Dynamo & Crypto Co. of Can. Ltd.
Northern Electric Co. Ltd.
Bruce Peebles (Canada) Ltd.
**Governors, Pump:**
Bailey Meter Co. Ltd.
**Governors, Turbine:**
Dominion Engineering Works Limited.
**Gratings, M. & M. Safety:**
Dominion Bridge Co. Ltd.

H

**Hangers, Ball and Roller Bearing:**
Can. S.K.F. Co. Ltd.
**Headlights, Electric Railway:**
Can. General Elec. Co. Ltd.
Can. Ohio Brass Co. Ltd.
Can. Westinghouse Co. Ltd.
**Heat Exchange Equipment:**
Foster Wheeler Limited.
**Hoists, Air, Steam and Electric:**
Canadian Ingersoll-Rand Company, Limited.
Dominion Hoist & Shovel Co. Ltd.
Wm. Hamilton Div. Canadian Vickers Ltd.
**Humidifying Equipment:**
W. J. Westaway Co. Ltd.

I

**Incinerators:**
Canada Cement Co. Ltd.
**Indicator Posts:**
Jenkins Bros. Ltd.
**Industrial Electric Control:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.
**Injectors, Locomotive, Exhaust Steam:**
The Superheater Co. Ltd.
**Inspection of Materials:**
J. T. Donald & Co. Ltd.
Milton Hersey Co. Ltd.
**Instruments, Electric:**
Bepco Canada Ltd.
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Crompton Parkinson (Canada) Ltd.
Ferranti Electric Ltd.
Moloney Electric Co. of Canada, Ltd.
Northern Electric Co. Ltd.
**Insulating Materials:**
Canadian Industries Limited.
**Insulators, Porcelain:**
Can. Ohio Brass Co. Ltd.
Northern Electric Co. Ltd.
**Intercoolers:**
Foster Wheeler Limited.

J

**Journal Bearings and Boxes, Railway:**
Can. S.K.F. Co. Ltd.

L

**Lacquers:**
Canadian Industries Limited.
**Lantern Slides:**
Associated Screen News Ltd.
**Leading Wire:**
Canadian Industries Limited.

# Purchasers' Classified Directory

**Library Films:**
- Associated Screen News Ltd.

**Lighting Equipment, Industrial and Street:**
- Can. General Elec. Co. Ltd.
- Can. Westinghouse Co. Ltd.
- Northern Electric Co. Ltd.

**Lightning Arresters:**
- Can. General Elec. Co. Ltd.
- Can Westinghouse Co. Ltd.
- Ferranti Electric Ltd.
- Northern Electric Co. Ltd.

**Line Materials:**
- Can. Ohio Brass Co. Ltd.
- Northern Electric Co. Ltd.

**Locomotives, Electric:**
- Can. General Elec. Co. Ltd.
- Can. Westinghouse Co. Ltd.

## M

**Machinery, Hydraulic:**
- Dominion Engineering Works Limited.

**Machinery, Metal and Wood-Working:**
- Dominion Engineering Works Limited.

**Magnetic Separators:**
- Northern Electric Co. Ltd.

**Material Handling Equipment:**
- Jeffrey Mfg. Co. Ltd.
- E. Long Ltd.
- Plessisville Foundry.

**Metallurgists:**
- Roast Laboratories Reg'd.

**Meters, Boiler, and Coal:**
- Bailey Meter Co. Ltd.

**Meters, Electric:**
- Can. General Elec. Co. Ltd.
- Can. Westinghouse Co. Ltd.
- Ferranti Electric Ltd.
- Northern Electric Co. Ltd.

**Meters, Flow:**
- Bailey Meter Co. Ltd.
- Neptune Meter Co. Ltd.

**Meters, Liquid (Hot or Cold):**
- Bailey Meter Co. Ltd.
- Neptune Meter Co. Ltd.

**Mine Cars:**
- Canadian Vickers Ltd.
- E Long Ltd.

**Mining Machinery:**
- Canadian Ingersoll-Rand Company, Limited.
- Canadian Vickers Ltd.
- Dominion Engineering Works Limited.

**Motion Pictures:**
- Associated Screen News Ltd

**Motors, Electric:**
- Bepco Canada Ltd.
- The Can. Fairbanks-Morse Co. Ltd.
- Can. General Elec. Co. Ltd.
- Can. Westinghouse Co. Ltd.
- Crompton Parkinson (Canada) Ltd.
- Harland Eng. Co. of Can. Ltd.
- Lancashire Dynamo & Crypto Co. of Can. Ltd.
- Northern Electric Co. Ltd.
- Bruce Peebles (Canada) Ltd.

**Moulded Goods, Rubber and Asbestos:**
- The Garlock Packing Co. of Can. Ltd.

## O

**Oil Burning Equipment:**
- Bethlehem Steel Export Corp.

**Oil Refining Equipment:**
- Foster Wheeler Limited.

**Ornamental Iron:**
- Vulcan Iron Wks. Ltd.

## P

**Packings, Asbestos, Cotton and Flax, Metal, Rubber:**
- Tho Garlock Packing Co. of Can. Ltd.

**Paints, all purposes:**
- Canadian Industrice Limited.

**Paving Materials:**
- Barrott Co. Ltd.

**Penstocks:**
- Canadian Vickers Ltd.

**Penstocks, Wood-Stave:**
- Canadian Wood Pipe & Tanks Ltd.

**Phase Rotation Indicators:**
- Ferranti Electric Ltd.

**Photographs, Commercial and Portrait:**
- Associated Screen News Ltd.

**Piling, Steel Sheet:**
- Bethlehem Steel Export Corp.

**Pillow Blocks, Plain, Ball and Roller Bearing:**
- Can. S.K.F. Co. Ltd.
- Plessisville Foundry

**Pinions:**
- The Hamilton Gear & Machine Co. Ltd
- Plessisville Foundry.

**Pipe, Wood Stave:**
- Canadian Wood Pipe & Tanks Ltd.

**Pipe Coils:**
- The Superheater Co. Ltd.

**Pipe Couplings and Nipples:**
- Dart Union Co. Ltd.

**Plates, Steel:**
- Bethlehem Steel Export Corp
- Dominion Foundries & Steel Ltd.

**Pneumatic Tools:**
- Canadian Ingersoll-Rand Company Ltd.

**Pole Line Hardware:**
- Can. Ohio Brass Co. Ltd.
- Northern Electric Co. Ltd.

**Polishes:**
- Canadian Industries Limited.

**Powder, Black and Sporting:**
- Canadian Industries Limited.

**Power Switchboards:**
- Bepco Canada Ltd.
- Can. General Elec. Co. Ltd.
- Can. Westinghouse Co. Ltd.
- Crompton Parkinson (Canada) Ltd.
- Harland Eng. Co. of Can. Ltd.
- Northern Electric Co. Ltd.

**Preheaters, Air:**
- Babcock-Wilcox & Goldie-McCulloch Ltd.
- Combustion Engineering Corp
- Foster Wheeler Limited.

**Projectors:**
- Associated Screen News Ltd.

**Pulleys:**
- Plessisville Foundry.

**Pulleys, Ball Bearings, Loose:**
- Can. S.K.F. Co. Ltd.

**Pulp and Paper Mill Machinery:**
- Can. General Elec. Co. Ltd.
- Canadian Ingersoll-Rand Company, Limited
- Can. Westinghouse Co. Ltd
- Dominion Engineering Works Limited.
- Wm. Hamilton Div. Canadian Vickers Ltd.
- Harland Eng. Co. of Can. Ltd.

**Pulverized Fuel Systems:**
- Babcock-Wilcox & Goldie-McCulloch Ltd.
- Bethlehem Steel Export Corpn.
- Combustion Engineering Corp. Ltd.
- Foster Wheeler Limited.

**Pump Valves, Rubber:**
- The Garlock Packing Co. of Can. Ltd.

**Pumps:**
- Babcock-Wilcox & Goldie-McCulloch Ltd.
- Canadian Ingersoll-Rand Company, Limited.
- Darling Bros. Ltd.
- Foster Wheeler Limited.
- Wm. Hamilton Div. Canadian Vickers Ltd.
- Harland Eng. Co. of Can. Ltd.

**Purifiers, Water:**
- W. J. Westaway Co. Ltd.

## R

**Radiator Air Vents and Traps:**
- Darling Bros. Ltd.
- Jenkins Bros. Ltd.

**Radiator Valves:**
- Can. Ohio Brass Co. Ltd.
- Darling Bros. Ltd.
- Jenkins Bros. Ltd.

**Radio Receiving Sets:**
- Can. General Elec. Co. Ltd
- Can. Westinghouse Co. Ltd.
- Northern Electric Co. Ltd.

**Radio Transformers:**
- Ferranti Electric Ltd.

**Rail Bonds:**
- Can. Ohio Brass Co. Ltd.
- U.S. Steel Products Co.

**Rail Braces and Joints:**
- B. J. Coghlin Co.

**Railway Equipment:**
- Can. General Elec. Co. Ltd.
- Canadian Ingersoll-Rand Company, Limited.
- Can Ohio Brass Co. Ltd.

**Receivers, Air:**
- Canadian Ingersoll-Rand Com-Limited.
- E. Leonard & Sons Ltd.

**Recorders:**
- Bailey Meter Co. Ltd.

**Refrigerating Machinery:**
- Canadian Ingersoll-Rand Company, Limited.

**Regitherms, Syphon:**
- Darling Bros. Ltd.

**Regulators, Feed Water:**
- Bailey Meter Co. Ltd.

**Reservoirs:**
- Canada Cement Co. Ltd.

**Riveted Pipe:**
- Dominion Bridge Co. Ltd.

**Roads:**
- Canada Cement Co. Ltd.

**Road Machinery:**
- Plessisville Foundry.

**Rods:**
- Bethlehem Steel Export Corp.

**Rolls, Paper Machine:**
- Dominion Engineering Works Limited.

**Rope, Wire:**
- Dom. Wire Rope Co. Ltd.

## S

**Saw Mill Machinery:**
- E. Long Ltd.

**Screening Equipment:**
- Canadian, Ingersoll-Rand Company, Limited.
- Foster Wheeler Ltd.

**Separators, Electric:**
- Northern Electric Co. Ltd.

**Sewers:**
- Canada Cement Co. Ltd.

**Shovels — Powered Electric or Gasoline:**
- Canadian Vickers Ltd.
- Dominion Hoist & Shovel Co. Ltd.

**Skip Hoists:**
- E. Long Ltd.

**Smokestacks:**
- Canada Cement Co. Ltd.
- Canadian Vickers Ltd.
- Foster Wheeler Ltd.
- E. Leonard & Sons Ltd.

**Softeners, Water:**
- W. J. Westaway Co. Ltd.

**Sporting Powder:**
- Canadian Industries Limited.

**Springs — Automobile, Railway, Wire:**
- B. J. Coghlin Co. Ltd.

**Stains:**
- Canadian Industries Limited.

**Stair Treads:**
- Darling Bros. Ltd

**Steam Pipe Casing (Wood Stave)**
- Canadian Wood Pipe & Tank Ltd.

**Steam Plant Equipment:**
- Babcock-Wilcox & Goldie-McCulloch Ltd.
- Combustion Engineering Corp. Ltd.
- Foster Wheeler Limited.
- Harland Eng. Co. of Can. Ltd.

**Steam Traps:**
- Darling Bros. Ltd.

**Steel Plate Construction:**
- Canadian Vickers Ltd.
- Dominion Bridge Co. Ltd.
- Foster Wheeler Ltd.
- E. Leonard & Sons Ltd.

**Stokers:**
- Babcock-Wilcox & Goldie-McCulloch Ltd.
- Combustion Engineering Corp. Ltd.

**Structural Iron and Steel:**
- Canadian Vickers Ltd.
- Dominion Bridge Co. Ltd.
- Vulcan Iron Works Ltd.

**Superheaters:**
- Babcock-Wilcox & Goldie-McCulloch Ltd.
- Foster Wheeler Limited.
- The Superheater Co. Ltd.

**Surge Absorbers:**
- Ferranti Electric Ltd.

**Switchboards, Power Lighting:**
- Bepco Canada Ltd.
- Can. General Elec. Co. Ltd.
- Can. Westinghouse Co. Ltd.
- Crompton Parkinson (Canada) Ltd.
- Harland Eng. Co. of Can. Ltd.
- Northern Electric Co. Ltd.

## T

**Tanks:**
- Babcock-Wilcox & Goldie-McCulloch Ltd.
- Canada Cement Co. Ltd.
- Canadian Vickers Ldt.
- Darling Bros. Ltd.
- Dominion Bridge Co. Ltd.
- Foster Wheeler Ltd.
- E. Leonard & Sons Ltd.
- Vulcan Iron Wks. Ltd.

**Tanks, Wood:**
- Canadian Wood Pipe & Tanks Ltd.

**Tees:**
- Dart Union Co. Ltd.

**Telegraph Line Material:**
- Northern Electric Co. Ltd.

**Testing Sets:**
- Moloney Electric Co. of Can., Ltd.

**Thermometers, Recording:**
- Bailey Meter Co. Ltd.

**Tiles:**
- Canada Cement Co. Ltd.

**Tinplate:**
- Bethlehem Steel Export Corp.

**Towers, Cooling, Fractionating:**
- Foster Wheeler Limited.

**Track Tools:**
- B. J. Coghlin Co. Ltd.

**Transformers, Instrument, Testing, Distribution:**
- Bepco Canada Ltd.
- Ferranti Electric Ltd.
- Moloney Electric Co. of Can., Ltd.

**Transformers, Lighting and Power:**
- Bepco Canada Ltd.
- Can. General Elec. Co. Ltd.
- Can. Westinghouse Co. Ltd.
- Crompton Parkinson (Canada) Ltd.
- Ferranti Electric Ltd.
- Moloney Electric Co. of Can., Ltd.
- Northern Electric Co. Ltd.
- Bruce Peebles (Canada) Ltd.

**Transmission Poles and Towers:**
- Dominion Bridge Co. Ltd.

**TrolleyMaterials:**
- Can. Ohio Brass Co. Ltd.

**Tubes, Boiler, Lapwelded Steel, and Iron:**
- Babcock-Wilcox & Goldie-McCulloch Ltd.
- Canadian Vickers Ltd.
- E. Leonard & Sons Ltd.

**Turbines, Hydraulic:**
- Dominion Engineering Works Limited.
- Wm. Hamilton Div. Canadian Vickers Ltd.

**Turbines, Steam:**
- Babcock-Wilcox & Goldie-McCulloch Ltd.
- Harland Eng. Co. of Can. Ltd.

**Turbo Generators:**
- Bepco Canada Ltd.
- Can. General Elec. Co. Ltd.
- Can. Westinghouse Co. Ltd.
- Lancashire Dynamo & Crypto Co. of Can. Ltd.

**Turntables:**
- Dominion Bridge Co. Ltd.

## U

**Unions:**
- Dart Union Co. Ltd.

## V

**Valve Controls:**
- Northern Electric Co. Ltd.

**Valve Discs, Rubber:**
- The Garlock Packing Co. of Can. Ltd.
- Jenkins Bros. Ltd.

**Valves:**
- Can. Ohio Brass Co. Ltd.
- Dominion Engineering Works Limited.
- Jenkins Bros. Ltd.

**Valves, Relief:**
- Neptune Meter Co. Ltd.

**Varnishes:**
- Canadian Industries Limited.

**Ventube:**
- Canadian Industries Limited.

## W

**Washers, Air:**
- Canadian Ingersoll-Rand Company Limited.

**Water Cooled Furnaces:**
- Babcock-Wilcox & Goldie-McCulloch Ltd.
- Combustion Engineering Corp. Ltd.
- Foster Wheeler Limited.

**Welding Machines, Electric and Accessories:**
- Can. General Elec. Co. Ltd.
- Can. Ohio Brass Co. Ltd.
- Can. Westinghouse Co. Ltd.
- Northern Electric Co. Ltd.

**Wheels, Fly and Gear:**
- The Hamilton Gear & Machine Co. Ltd.

**Winches, Stop-log and Headgate**
- Canadian Vickers Ltd.

**Wire:**
- Bethlehem Steel Export Corp.

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# THE ENGINEERING JOURNAL

VOL. XVII No. 4

APRIL 1934

## *In this issue*



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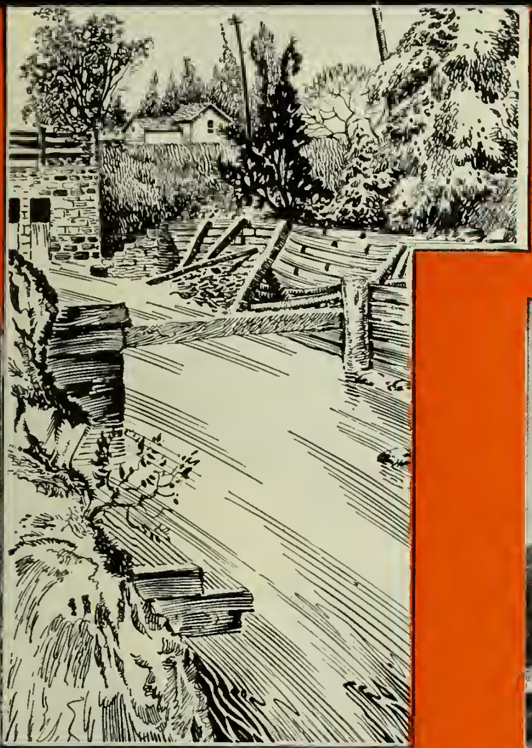
THE ENGINEERING INSTITUTE *of* CANADA

# The Romance of the Construction Industry in Canada



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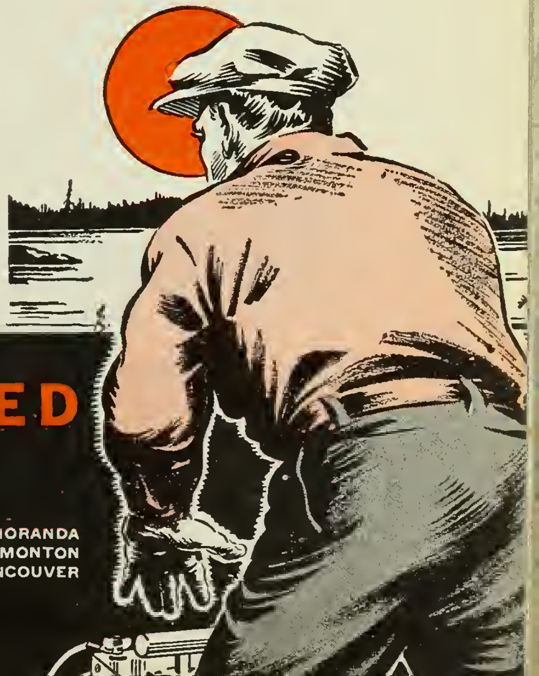

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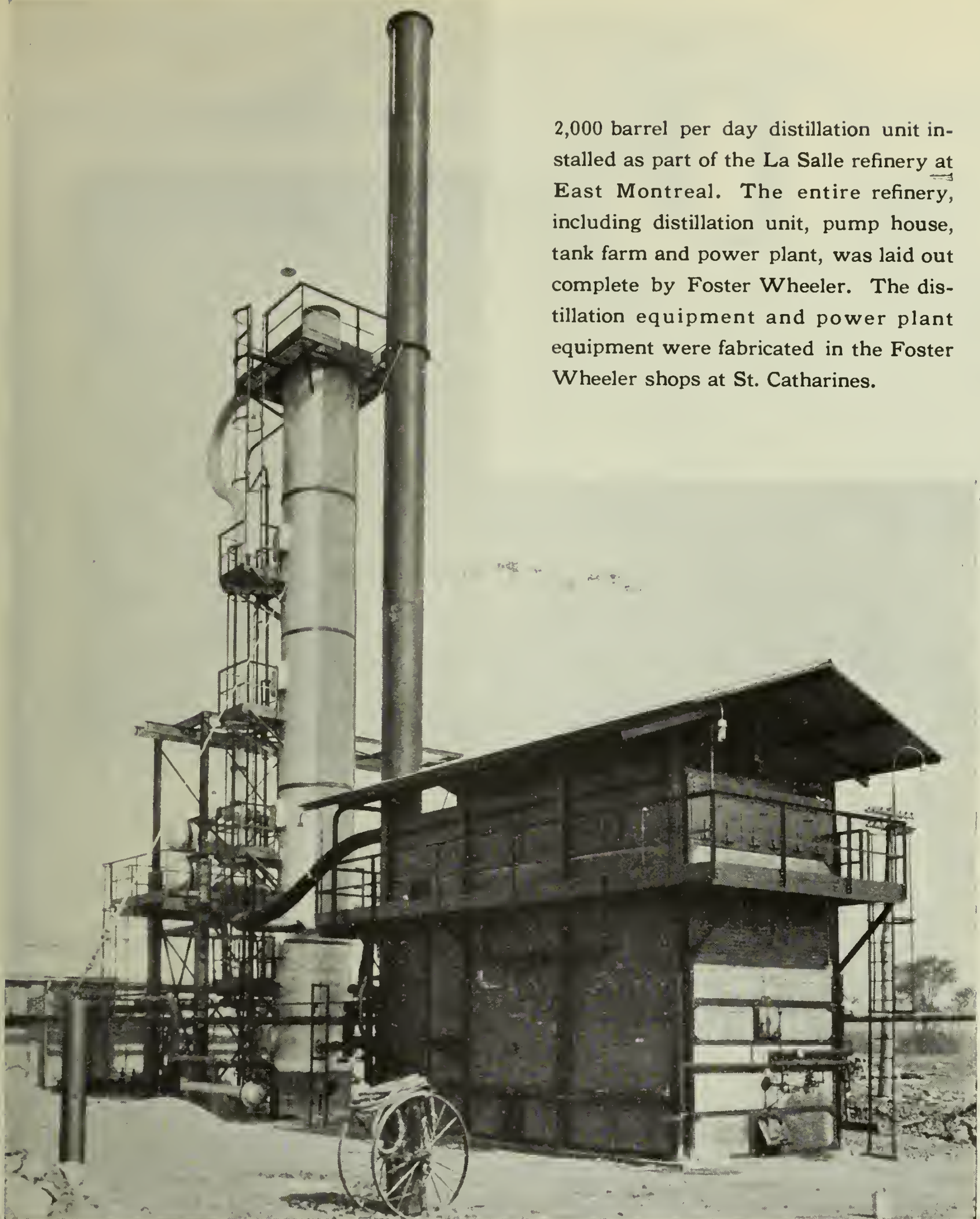

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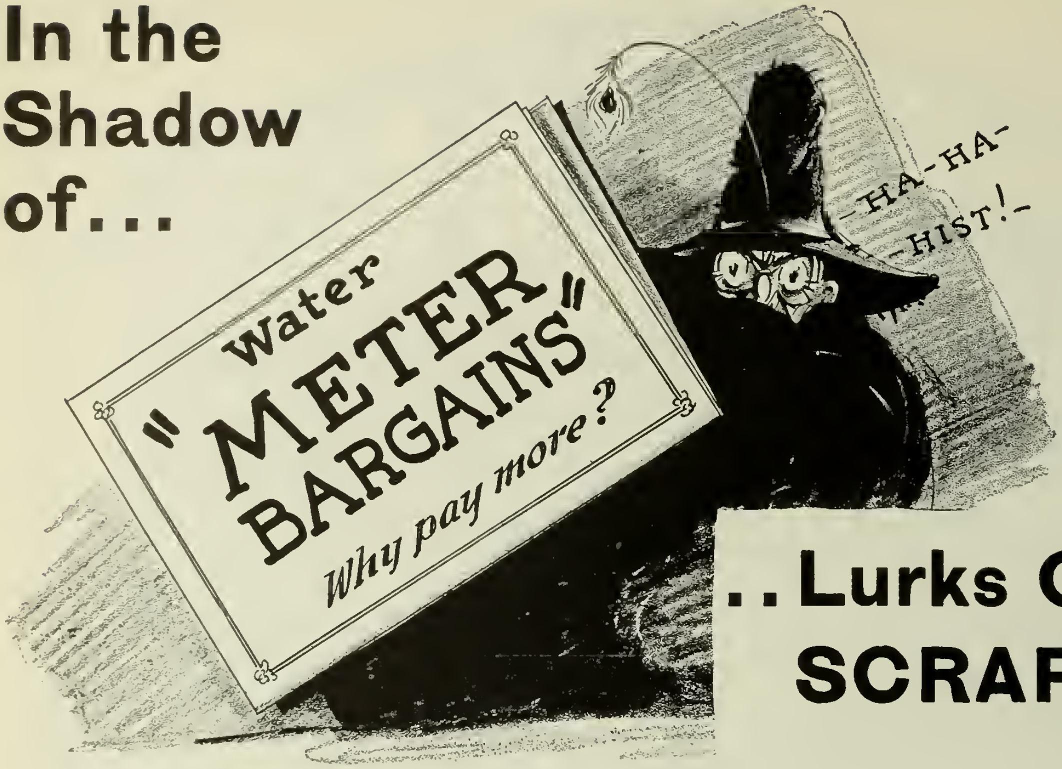


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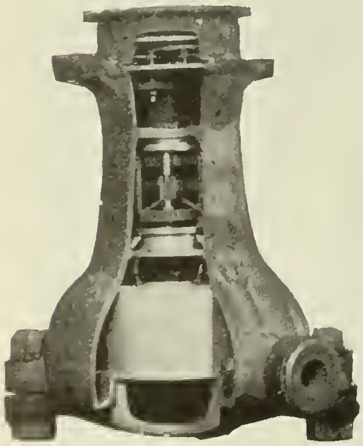

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# Mineralization in the Great Bear Lake District

*D. F. Kidd,*
*Geological Survey, Department of Mines, Ottawa, Ontario.*

**Paper presented before the Ottawa Branch of The Engineering Institute of Canada, February 22nd, 1934, and published with the permission of the Director, Geological Survey, Department of Mines.**

**SUMMARY.—The author sketches briefly the history of the district and the local conditions as regards transportation, fuel and power. He discusses the more important of the mineral occurrences of silver or pitchblende which are now known in the locality and gives statistics as to the world's production of radium as affecting the possibilities of radium supply from the Great Bear Lake district.**

Great Bear lake lies 900 miles north-northwest of Edmonton and is in the District of Mackenzie, N.W.T. The mineral deposits of silver and pitchblende (an uncommon radium-bearing uranium mineral) are on the east shore of the lake. Deposits have been found in two areas, at Echo bay 30 miles south of the Arctic circle, and at Camsell river 35 miles further south at the southeast corner of the lake.

The railhead is at Waterways, Alberta, 305 miles by rail north of Edmonton. From here there is a boat route to Echo bay by way of Resolution, Simpson and Norman, a distance of 1,380 miles, and a more direct aircraft route, by way of Rae on the north arm of Great Slave lake, with a length of 750 miles. There are two obstructions to navigation on the boat route, a 16-mile portage over a motor road between Fitzgerald and Fort Smith on the Slave river, and 4 miles of fast shallow water on the Bear river. Small scows can be tracked through this second obstruction and some progress has been made in building a road round it.

The freight rate by the boat route from Waterways to Echo bay is 10 cents per pound. By aircraft the rate on casual express varies from 63¾ cents per pound at some seasons to 75 cents per pound. On contract freight the rates are probably lower.

The seasons for the two kinds of transport are shown in Table I. The table represents average conditions, individual seasons varying considerably. The reason for the long interruption to aircraft communication during freeze-up and break-up periods is apparent.

There are low rather regular shores round most of Great Bear lake but along the east side is the western edge of a much dissected upland which forms along the shore very rugged hills up to 1,100 feet in height. The topography is reminiscent of parts of the north shore of Lake Superior.

TABLE I

SEASONS ON MACKENZIE TRANSPORT ROUTES

| Type of Transport | Good at McMurray | Good at Echo bay | Good McMurray to Echo bay |
|---|---|---|---|
| For aircraft on skis | Dec. 1-15th to April 15th | Nov. 15th to May 15th | Dec. 1-15th to April 15th |
| For aircraft on floats | May 1st to Oct. 10th | June 15th to Sept. 20th | June 15th to Sept. 20th |
| For boat transport | May 15th to Oct. 15th | July 20th to Oct. 1st | July 20th to Oct. 1st |

The country is close to the edge of the Barren Lands or northern plains. Though some of the timber is gnarled and twisted, where it occurs in groves good logs for cabin construction can be secured. Firewood is already scarce at some places. Good grade lignite coal outcrops at one place on the west shore of the lake and could be used for fuel. Fuel oil and gasoline, produced from the oil well 40 miles below Norman on the Mackenzie river, are used in the district.

There are possible water-power sites at Whiteagle Falls on Camsell river, and on the Sloan river. At Camsell river it has been reported that more than 10,000 h.p. could be developed.*

There is at present one settlement at Cameron bay in the inner part of Echo bay, another abandoned one at Hunter bay on the Arctic circle, and several mining camps.

The presence of copper deposits in far northwest Canada has been known since early in the 16th century, and they were first visited by Hearne in 1771 during one of the most remarkable single-handed journeys of exploration ever made in Canada. Copper deposits at Hunter bay on Great Bear lake were first staked in 1922. Real attention focused on the area with the advent of aircraft transportation. In 1929 the two prominent prospecting companies using aircraft, Northern Aerial Minerals Exploration (N.A.M.E.) and Dominion Explorers, having met with but little success in the region tributary to Hudson bay, worked their way west as far as the Coppermine river and Great Bear lake. In the same year Gilbert LaBine of the Eldorado Gold Mines, a small Manitoba concern, also arrived at Great Bear lake to prospect for copper. Returning the following year he made in May 1930 at Echo bay a find of pitchblende, and in the following year rich silver mineralization at the original discovery and at Dowdell point 6 miles to the south. These discoveries started a staking rush in August 1931 and this lasted intermittently till the autumn of 1932. Since 1932 discoveries have mostly been extensions of earlier finds.

Figure 1† is a view looking west across LaBine Point. The Eldorado mine buildings are seen in the centre of the photograph.

There are two kinds of deposits of present interest in the district: (1) pitchblende and silver deposits, often with secondary values in copper, lead and gold, and (2) silver deposits. The rocks consist of two sedimentary and volcanic groups intruded by large bodies of granite and

Fig. 2—View Looking South Along East Side of Great Bear Lake.

associated rocks, and later by smaller bodies, dykes and sills, of basic rocks. The mineral deposits are related in source to some of the intrusives, and as they occur round the borders of the granite masses these may be the source.

The silver and pitchblende are in zones of fracturing and crushing in the rocks; zones which in some cases are thousands of feet in length. The pitchblende is in narrow seams up to an inch wide of extremely high grade material, and as much larger lenses with quartz, this also being rich ore though of lower grade than the seams. The seams are colloform slabs which can readily be hand-cobbed from the gangue rock. The silver is present as the native metal and in several other silver minerals. It occurs irregularly distributed in the same kind of zones as the pitchblende, at some places associated with it.

The more important occurrences are: Eldorado Gold Mines, LaBine Point, silver and pitchblende; Echo bay

Fig. 3—Sledge Travel, Great Bear Lake, June 15th, 1932.

claims of Consolidated Mining and Smelting Company, 1¼ miles northeast of LaBine Point, silver and pitchblende; Bonanza claims of Eldorado Gold Mnes, Dowdell Point, silver; M Group claims of Bear Exploration and Radium, Contact lake, silver and pitchblende; and at Camsell river, Whiteagle Mines, silver.

Figure 2 is a view from an altitude of 5,000 feet looking south along the east side of Great Bear lake and across Echo bay. LaBine Point is in middle distance and Dowdell Point in the background. Crosses indicate the location of mineral deposits: on LaBine Point the Eldorado mine, on Dowdell Point the Bonanza deposits, in left foreground the Echo bay claims deposit of Consolidated Smelters.

At the Eldorado Mine at LaBine Point there are three mineralized zones which trend east-northeast and converge in that direction. Pitchblende occurs in all three zones and has been mined at the surface from two of them. Only the middle zone carries silver, and this chiefly in its northeast part where very rich silver mineralization has been found.

Mining from surface pits was started in 1931 and a shipment of pitchblende was made that year. In 1932 a further shipment of pitchblende and one of silver ore was made. Also a small mining plant with a Diesel operated compressor was shipped in and an adit started to cut the middle zone. This has been accomplished and the zone has been drifted along for several hundred feet. As there is disseminated silver mineralization as well as the high grade type the company in 1933 shipped in a concentrating mill which is reported to be now in operation.

On the Echo bay group of claims to the northeast a great deal of surface trenching and short hole diamond drilling has been done. Six shear zones with lengths of hundreds of feet have been traced in an area 600 feet wide and 2,000 feet long along their strike. Rich silver mineralization has been found at some places in nearly all the zones and in 1933 pitchblende as well was found in one of them. No underground work has as yet been done.

On the Bonanza claims at Dowdell Point spectacular silver mineralization has been found at two distinct localities ½ mile apart. The only development is a little surface stripping. This has exposed at each place some splashes of very rich silver ore.

*Information from Dominion Water-power and Hydrometric Bureau.

†Figures 1 and 2 are published by courtesy of the R.C.A.F.

On the M Group claims at Contact lake silver and low grade pitchblende were found in 1931 and 1932. They occur in a single fracture zone extending up a hillside. An adit has been driven several hundred feet along this zone, a small gasoline driven compressor being used. Silver is said to have been found at a number of places in the tunnel. The pitchblende is of less importance.

At the site of the Whiteagle property on Rainy lake, an expansion of Camsell river, a silver find was made in 1932. High grade silver mineralization occurs in one pit sunk in a fracture zone which extends down a hill to the lake. An adit started last summer from the lake shore has explored the zone for several hundred feet and much more silver is said to have been found.

The mineralization at all the properties at Great Bear lake is characterized by its high grade but irregular distribution. This is a quite usual feature in high grade ores. It however makes it very difficult to estimate even approximately tonnages and grades of unmined ore. It is probably true that similar conditions existed at Cobalt, Ontario, and that few companies there ever had large ore reserves in sight.

These high grade deposits may be likened to a plum pudding in which the high grade patches are the plums. The analogy is not exact as there may be low silver values (it is reasonable to expect them in most cases) between the bodies of high grade. These low grade portions may even be mined at a profit in themselves. It is for the purpose of concentrating this type of mineralization to a product sufficiently rich to ship that Eldorado has built a mill and B.E.A.R. and Whiteagle are planning to do so. It appears to be the policy of Consolidated Smelters to do extensive exploration by surface work and diamond drilling before making any considerable investment in mining or milling equipment.

It is apparent that it is and always will be very difficult to estimate the worth of properties in this field. The presence of one small bit of rich mineralization, or of indications of it, may encourage the spending of large sums in an honest endeavour to find more. In most cases it is

**Fig. 4—Cabin, Lindsley Bay.**

almost impossible to say the money should not be spent, though efforts may to some extent be graded in degree of hopefulness. In the Echo bay area probably all ground not in the bounding granite bodies is worth careful surface prospecting for silver, that is, surface examination by experienced silver prospectors, but not extensive trenching of shear zones, though this may be warranted on some ground. Whether underground exploration is justified if indications of silver mineralization are found on the surface depends on the factors of the individual cases. Diamond drilling to determine values in these deposits is of doubtful worth though it will of course locate mineralized zones.

Deposits of the type described are attractive to the less scrupulous promoter. It is rarely possible to say there is no hope in an enterprise. They can point to the analogy with Cobalt, the fourth greatest silver camp in the world, an analogy which has been stressed more than is warranted from the geological conditions at the two places, and there is the attraction of a distant field and of a little known substance, radium, with a very high nominal value.

The production from Great Bear lake is as yet small, but then it is a young camp being developed under new and

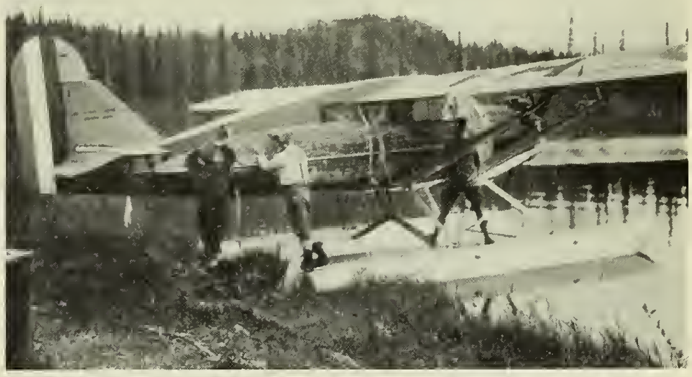

**Fig. 5—Combining Advantages of Canoe and Aircraft Transportation.**

rather difficult conditions. Also with the high grade product shipped there is a considerable production from a small tonnage. For example in 1932 Eldorado Gold Mines shipped 10.6 tons of silver ore averaging 3623.2 ozs. to the ton.

The author has been accused of lack of enthusiasm because he has confined himself to the realm of facts and avoided that of possibilities. There is without question a large amount of silver exposed in the surface workings of some of the properties and some of it is very rich material. It is not possible to estimate by eye the approximate grade of exposed material as could often be done at Cobalt, so till the companies engaged in mining in the area do systematic sampling at fixed distances, not at good places, no real idea of the size of possible ore bodies can be known.

The radium production from the Great Bear lake field may well prove less important in gross final commercial value than the silver production, though its real value from the standpoint of human welfare may be much greater. At the present time, as far as known to the writer, the Eldorado property alone has notable amounts of pitchblende though others have some.*

The radium industry of the world is at present a Belgian monopoly. The major part of the supply comes from a mine at Shinkolobwe in the southeast part of the Belgian Congo. The company operating this property is a subsidiary of the Union Minière de Haut Katanga, the large copper mining company in which the Belgian government has a substantial interest. The world's radium supply has always been nearly a monopoly as is shown in Table II. First it was Czechoslovakia producing radium from the same ore from which it was first isolated by the Curies, then the United States producing from low grade ores in the western states, and now the Belgian Congo which with its high grade ores put the United States out of the business very rapidly.

The price of radium has ranged widely since it first appeared in commercial markets (see Table III).

The present price of \$50-\$70 a milligram, depending on type of container and size of lot, was established in 1923. The Belgian company has always been secretive about grade of ore mined, extent of reserves, and particularly production costs, so it is not known whether the quoted

*Since going to press discoveries of pitchblende have been reported from Beaverlodge lake, 90 miles south of Echo bay.

price represents only a fair return on their invested capital or whether it is designed to be just low enough to throttle American competition. It is generally believed that the recent marked falling off in Belgian production has been due to accumulation of unsold stocks. The company have an elaborate sales and service organization, are renting radium, and are reported to be selling it on the instalment plan.

It is therefore extremely difficult to evaluate the factors in the marketing of radium. The world's new radium business is not large. The production figures (from Table II) and an average price of say $60,000 per gram give for 1931 $2,650,000 for the 44 grams and for 1932 only $600,000 for 10 grams.

Table II
Approximate World Production of Radium
Compiled from various published sources.
(In grams)

| Year | Czecho-slovakia | United States | Belgian* Congo |
|---|---|---|---|
| 1908 | ...... | ...... | ...... |
| 1909 | 0.7217 | ...... | ...... |
| 1910 | 1.2937 | ...... | ...... |
| 1911 | 2.0144 | ...... | ...... |
| 1912 | 1.6977 | ...... | ...... |
| 1913 | 2.1174 | 2.1 | ...... |
| 1914 | | 9.6 | ...... |
| 1915 | | 4.71 | ...... |
| 1916 | 8.2289 (1914-1918) | 8.17 | ...... |
| 1917 | | 13.83 | ...... |
| 1918 | | 22.79 | ...... |
| 1919 | 0.9689 | 28.648 | ...... |
| 1920 | 2.2310 | 32.539 | ...... |
| 1921 | 3.221 | 35.693 | ...... |
| 1922 | 2.256 | 24.189 | ...... |
| 1923 | 1.521 | 12.212 | 20 |
| 1924 | 1.433 | 3.365 | 22 |
| 1925 | 1.200 | 2.952 | 20 |
| 1926 | ...... | 1.725 | 20 |
| 1927 | 3 (?) | ...... | 26 |
| 1928 | 3 (?) | ...... | 42 |
| 1929 | 3.5 | ...... | 60 |
| 1930 | 3.6 | ...... | 60 |
| 1931 | 3.7 | ...... | 40 |
| 1932 | 4.0 | ...... | 6 |
| | 40.2 | 202.523 | 316 |

*Reported as production but may be sales.

*Other Countries*

| | |
|---|---|
| Portugal | 15 gm. |
| Madagascar | 8 gm. |
| Russia | 6 gm. |
| Cornwall | 5 gm. |
| South Australia | 1 gm. |

Note.—Carnotite ore containing possibly 20 gm. or more of radium was exported from United States to Europe 1912-14.

Table III
World Radium Prices†
(Per milligram)

| | |
|---|---|
| 1904 | $10-$25 |
| 1905 | $25-$50 |
| 1906 | $60 |
| 1909-10 | $75-$105 |
| 1911-12 | $150 |
| 1912-14 | $180 |
| 1915 | $160 |
| 1916-22 | $120, $110, $105 |
| 1923 | $70 |
| 1923-34 | $50-$70 |

†After C. Matignon, Revue Scientifique, Aug. 3, 1925, translated in Smithsonian Institute Report 1925, pp. 221-234. (With additions.)

# The Relations of Economics to Engineering

## (Parts III and IV)

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**Note: The Past-Presidents' Prize for 1933 was awarded to this essay which is published by direction of Council.**

*Parts I and II which appeared in the February 1934 issue of The Journal gave a brief historical review of the development of engineering and the development of economics, and proceeded to discuss the interrelated development of these branches of knowledge, their connected functions in furthering material welfare and their secondary effects on cultural progress.*

### Part III—What Should be the Relations?

#### A. Connection in Modified Industrial System

The proper relations can only be determined in the light of their place in the best system for improving man's life. Existing conditions indicate that the traditional organization of the industrial system is inadequate, and some revision is necessary if progress is to be continued in the future. This necessitates some important changes in the character of traditional economics, but embraces many of the teachings of the modern economists who belong to the radical school in some modified form.

*Nature of Modern Industry*

During the past century, as industry has become mechanized, always in the direction of larger quantity production, the industrial system has taken on the character of an inclusive organization of interlocking mechanical processes. These processes and sub-processes are so balanced among themselves that the due working of any part is conditioned on the due working of the rest of the system. This interdependent and interlocking mechanical system is not bounded by national barriers, but, as regards material welfare, all civilized peoples are drawn together into a single going concern. There still remain a few industries which have not been drawn into the system of mechanical processes and quantity production, but the great underlying industries which form the back-bone of the system are the ones that shape the main conditions of material life and set the pace for the rest.

Besides growing more complex and interlocking, the industrial system has developed in another way that is not yet generally realized. This is the change from the Machine Age to the Power Age, with the result that today our industrial economy is based upon the expenditure of power resources and not of man-hours. In the Machine Age, although a transfer of skill from the worker to the machine was effected, the worker was still important, other power resources were limited, and time spent by the worker was the important element in material advance. Now, chiefly due to the vast stores of power made available by the electrical industry since 1910, power for industry is virtually unlimited. Because of this and the great developments in automatic machinery, the worker is less important, man-hours no longer are the determining element in production, but their place is taken by power. Thus economic relationships in industry have been reversed by the transition.

*Need for Economic Planning*

It is upon these two factors—the interlocking nature of the industrial system, and the reversed economic relationships in the system caused by the transition from the

Machine Age to the Power Age—that the need for changes rests. It is because of them that economic planning is needed, involving an organized control over such aspects of economic life as production, the distribution of purchasing power, and the fixing of prices.

On account of the delicately balanced nature of the present industrial system, a minor fault in any part can easily throw the whole system out of balance. When that happens, as is so apparent today, material progress is effectively interrupted. Since an economic force is likely to be destructive to the extent that it is uncontrolled, it appears that a primary need of the present system is some measure of control to check diverse interests. Control in the industrial field in turn postulates economic planning on a national scale at least. (The common term 'economic planning' is used, although the planning must also be technological in nature.)

*Scope of Planning*

Economic planning is not a hard and fast, completely pre-determined scheme. Rather it is a method or technique of attacking problems which develops in practice. The large objectives of planning may be defined, however, and these must be accepted, to be translated into more detailed goals and standards for action day by day, not by a central board only, but with the aid of agencies throughout society. Many suggestions for planning have been published during the past year, and out of these the general objectives of planning may be constructed.

Based as it is on mass production, the industrial system must have mass consumption to drain off its products continually, i.e., production and consumption must be balanced. Otherwise unit costs mount due to the accumulation of overhead charges, or the distribution system breaks down.

To balance production and consumption means that output must be balanced with purchasing power plus desire to buy. Since the purchasing of the products of industry is done predominantly by the wage earning classes, this means that the flow of funds going into wages and investment must be controlled. Furthermore, desire to buy as applied to the wage earning classes is to some extent a function of the feeling of security in employment. It is significant, therefore, that in modern life, as the worker decreases in importance as a producer, he increases in importance as a consumer.

When the implications of this changed status of the workers are clearly understood, it is evident that the world is not suffering from technological unemployment, but rather from unemployed technology. If the purchasing power of consumers is maintained, and the hours of labour adjusted to spread leisure equitably, each new technical advance can result in a rise in the social standards of all. An increase in the amount of leisure available, however, throws a heavy responsibility upon education to fit man to make the best use of the newly acquired leisure, and to teach man how to enjoy the new opportunities afforded by the underlying material advance. From this standpoint, therefore, technical progress must be balanced against educational progress in the use of leisure.

It is apparent that the extent to which the industrial system as it has now developed can be useful in obtaining a better life for man depends upon the effectiveness with which the system is controlled and its working planned. Doubtless an economic plan may exist and still fall short of the full implications of organized planning; but if it falls very far short it will break down and destroy the element of control.

*Connected Functions in Planning*

The complexity of the industrial system gives ample scope for both engineering and economics, and, in order to keep the system running, a close connection between the two sciences must be maintained. The organizing habits and technique of engineering, which have proved so useful in the material field, should also prove helpful in the social field. Recognition of the disparity between the marvellous efficiency of industrial technique and the halting, destructive behaviour of economic life as a whole, lends weight to this view. There is no question but that scientific management and management engineering have worked wonders internally for individual industries. To apply the same technique to planning for all industries seems logical, provided certain necessary modifications are included. There is an important difference in the functions of planning in the two fields. In the past, management engineers have planned exclusively for separate industries internally, but the general economic plan entails planning for all industries together, externally in relation to separate industries. In this wider field the assistance of the economist is needed. The engineer can think in terms of fulfilling material human wants, but it requires the economist's point of view to gauge these wants.

Economic planning, furthermore, includes more than scientific management on a broader scale to take in all industries. It includes also the formulation and application of some fundamental economic reforms in the organization of society. While these reforms can be adequately designed by economists, the co-operation of the engineers is required to carry them out. Thus, not only does engineering need the help of economics in running its part of a planned economy, but economics also needs engineering assistance in carrying out its own functions.

Finally, both sciences need to attain wider dispersion of the particular knowledge of each in the field of the other. In other words, the engineer needs to become more economic-minded, and the economist more engineering-minded.

### B. Equal Status and Stage of Development

When engineering and economics do not go hand in hand, social progress is retarded. This can happen in several ways, some of the most important of which are discussed below.

*Separation of Responsibility and Authority Disadvantageous*

One of the primary laws underlying efficient administration in any field is that responsibility and authority must always go together. As shown in an earlier section, responsibility and authority have continually become more divorced as the modern industrial system developed. This situation has produced two notable disadvantages to society at large.

In the first place, a lack of efficiency in the advancement of material welfare has resulted. Since the engineers have not had the authority to make needed changes in the manner or tools of material advancement, this advancement has sometimes had to be halted until the requisite authority was obtained. Furthermore, lack of authority has detracted from the urge of technologists to create.

The second serious disadvantage has been to facilitate uncoordinated developments which often have ill effects, in the beginning at least. Frequently some new development has brought a distinctly harmful conflict of the new and the old in the industrial system. Examples of this were abundant during the Industrial Revolution—the hand weavers destroying newly installed power looms, sawyers congregating to break up the first water-powered mill. The change from the Machine Age to the Power Age during recent times also gives ample evidence of this conflict. As more power is applied to industry and human labour replaced, instead of all society benefiting by the additional leisure, it is faced with the miseries of unemployment, and the delicately balanced industrial system is thrown out of balance by the loss of purchasing power formerly accruing to the now unemployed workers.

Thus the lack of closer correlation between engineering and economics, which would bring together again responsibility and authority, retards the attainment of new levels of life and standards of living, and often creates unhappiness for part of society during transition stages.

*Effects of Overbalance of Engineering*

The retarding effect on material progress caused by a lag in the development of economics behind engineering has been noted previously. There are also several ill effects caused by engineering pushing ahead of economics. The waste which an uncoordinated technological advance can create is appalling. Not only does it cause waste of time, abilities and resources, since the greatest use cannot be made of the development until the world is economically ready for it, but it may bring about waste and hardship through cut-throat competition, both direct and indirect. The increasing amount by which production continued to outstrip distribution since the war had its share in bringing about the business troubles of today. The intense competition engendered by ever-expanding production caused nations to make a feverish search for new markets at the same time as they raised tariff barriers at home to safeguard their domestic markets. The results are now apparent to all—international trade has been strangled with drastic consequences to all industries. Furthermore, as competition became more intense, the consumer, instead of benefiting by lower prices, often had to pay more to live. The protection and subsidies which governments were forced to hand out to industries overburdened with overhead charges, and the ever-increasing amounts which industrialists were forced to spend in intensive advertising to overcome both direct and indirect competition, resulted in increased costs to the consumer, either in the form of taxes or in higher prices for goods.

The reason for ill effects resulting from too fast development of engineering is lack of adequate knowledge of how to make the best use of it. In other words, economic development must not be outdone by engineering, or disastrous results may occur. The engineer works in good faith to increase the usefulness and efficiency of industry, but without the requisite economic co-operation his results may be the opposite of his desires. He is prone to regard industry merely as a technical problem, whereas it is fundamentally an economic problem as well. It is not enough to work towards the creation of the maximum of goods; these must be created with a minimum of inconvenience and human suffering in such a way as to promote the best distribution of wealth. Cheap production is not an ultimate good, it is so only if it leads to right distribution and does not violate the demand of the workers for tolerable conditions of labour.

*Effects of Overbalance of Economics*

The effects of economic development outstripping technology, while not as unfortunate as those of the reverse situation, are not altogether beneficial. An overbalance of economic development may be taken as existing when ability to distribute and consume wealth exceeds the ability to produce it. A situation partaking of this nature was to be found in Russia after the revolution, before the great technical developments under the five year plan took place. In such a situation the standard of living generally is low, and the hardships which result cannot but be considered disadvantageous to society at large.

Although such a condition can exist in separate areas, it cannot take place generally for some time to come, due to the lag in the present development of economics relative to engineering. It must not be denied, however, that it is a future possibility.

C. Closer Co-operation and Co-ordination

The discussion in the preceding sections has been concerned largely with the need for keeping engineering and economic developments in balance. It remains for the present section, therefore, to consider the benefits of closer co-operation in method and closer co-ordination of results.

*Assistance of Economic Methods to Engineering*

Probably the most important contribution which economics can make to the methods of engineering is to teach facility in dealing with indefinite concepts. Economics, dealing directly as it does with human wants and desires, has fostered within itself a manner of thinking that is elastic and adaptable to the vagaries of changeable human conduct. (Of course, it has also fostered certain other less desirable qualities which will be discussed later.) Engineers, on the other hand, being accustomed to deal predominantly with material objects and the resources of nature, acquire set habits of thought which make them incapable of dealing directly with human wants. What they need to acquire is a certain amount, not too much or the value of accurate thinking will be lost, of elasticity in thinking. Then they will not be required to take a subordinate position to those who are now better able to gauge and plan for the fulfilment of human desires.

An example of how the methods of thinking differ between the two sciences, and their results, is found in the traditional attitudes of the production and sales departments of many companies. The production department, prone to think rigidly, continually strives for more standardization, firmly believing that the resulting reductions in unit costs are the ultimate good to be achieved. The sales department, sensing the desire of consumers for variety and the competitive advantage of being able to offer wider choice than competitors, habitually demands less standardization and more variety. The two views are diametrically opposed, but the solution is obvious. To go the whole way with either method of thought is unsound, a compromise must be effected. Since the consumer has to be satisfied some variety is necessary, but at the same time, in order to supply him at a reasonable price, there must be some standardization. Where to draw the line in either direction, is, of course, a difficult question. The illustration, nevertheless, serves to point to the advisability of both engineering and economics adopting some of the other's method of thinking.

*Assistance of Engineering Methods to Economics*

The same rigid, concrete habits of thought which were found to need modification in the direction of more elasticity by learning from economics, at the same time can teach improved methods of thinking to economics. The latter can learn from engineering to attain precision in thought and so eliminate errors due to slovenly and inaccurate thinking processes. If engineering needs to acquire some of the elasticity of economic thinking, the latter in turn needs to acquire some of the clarity of engineering thinking. If this is acquired, some of the guesswork may be eliminated from economics. The fact that an engineer may be severely criticized if his estimate is 5 per cent out, while it is common to see economic forecasts which are 100 per cent in error, indicates that the latter science needs to acquire some of the accurate habits of thinking of the former.

Economics also needs to learn from engineering how to make use of group effort and get the most out of co-operative thinking. Technology became powerful when it became cumulative and kept records,—when it began to pursue knowledge systematically by observation, hypothesis, experiment, and verification. To do this adequately it was necessary to employ the principle of division of labour. Scientific fragments were broken up into smaller and smaller fragments. Group effort, not individual genius, became increasingly important, and progress came more and more to depend upon the organized co-operation of ordinary men. Economics is beginning to remove the hazards of chance from progress by keeping detailed cumulative records, but it still has to learn the great importance of group effort. Specialization in different branches of economics has taken place, but such specialization is usually determined by some brilliant individual who has a special interest, and it is not the result of systematized division of labour of the ordinary men working in the science.

*Benefits of Co-ordination of Results*

Closely akin to the need for balanced development of the two sciences is that for close co-ordination of results.

That no engineering solution is complete until the economic aspects have been considered is a truism that is too frequently overlooked; and the same truism holds good if reversed.

As stated before, the principal function of both engineering and economics is to provide better living and more happiness for man. This means that both should cater to the collective wants of man, instead of to the individual. Throughout the history of social progress the conflict between collective and individual wants has been apparent. No better illustration could be provided than the experience of the past few years, which indicates how serious can be the consequences when individual wants are increasingly better supplied to the disadvantage of the satisfaction of collective wants.

Both sciences neglected to give adequate consideration to collective wants during the years of prosperity ending in 1929. This neglect was more or less wilful in the field of economics (business management), for a policy of 'every man for himself and the devil take the hindmost' seemed to dominate industry. In the field of technology the neglect was not wilful, and was not as pernicious in its effects. Being under the control of the business managers the engineers were not in a position to cater to collective wants to the disadvantage of individual interests, even if they so desired. It must be admitted, however, that most of them were too blinded by the great achievements made in technology to see what their effects on social progress might be. Nevertheless, all through history, wherever moves on their own volition were possible, engineers have usually tried to satisfy collective wants. That they have not been subject to the necessary guidance of economics to attain this end in the best manner possible poses the need for closer co-ordination.

Provided that aims in the field of economics, therefore, can be limited primarily to the satisfaction of collective wants, closer co-ordination between the two sciences will have beneficial results. The control of environment which engineering makes possible, if properly directed, results in a larger amount of leisure for mankind and greater aggregate wealth. These in turn make possible greater development of art and culture, and give the opportunity for more universal education of the people.

Thus closer co-ordination between the results of engineering and economics can increase both the means for enjoyment and the ability to enjoy. In this way only is the primary function of both sciences fulfilled—to provide better living and more happiness for man.

## Part IV—How Can These Relations Be Brought About?

### A. Mutual Assistance in Methodology

In many ways the methods of one science may be used advantageously in the conduct of the other. This is not so much the case of engineering assisting economics, or vice versa, directly, as it is of one borrowing from the methods of the other the better to carry out its own functions. Since engineering has been developed to a greater degree than economics, it is natural that it should be able to offer the most valuable assistance in the interchange. In fact, this is true to such an extent, that economics can offer little more than an example of broadness in methods of thought (which has been fully discussed in a previous section,) while engineering has several tools of thought and technique which have proved their worth and are possibly adaptable for use in developing economics.

*Use of Deductive Method*

Systematization in a theoretical science is a sign of approaching maturity, a period typified by the construction of hypotheses rather than by mere recognition of facts, and this means deductive reasoning. There is no need to review in detail the value of the deductive method to technology. Its role is still far from played out, for while some students struggle to relate phenomena to the general laws, others work unceasingly to discover divergencies in those laws.

In economics the deductive method has been known for some time, but its early use was forced before the requisite systematization of phenomena was accomplished, with the result that the deductive method fell into more or less disrepute. More recently, however, economics, having passed through the classificatory stage, and following the example of technology, has begun again to use this method, and this time the results have been more fortunate. A few isolated thinkers using the deductive method are reported to have brought the knowledge of cyclical business fluctuations to a point from which the fateful events of the last few years can be explained in general terms, and a partial solution, within the next few years, of the problem of depressions may not be impossible.

The great difficulty is that the deductive method is still misused and its results misinterpreted by many persons recognized as authorities. If the data that economic laws postulate are present, then the consequences they predict necessarily follow. In other words, if a given situation conforms to a certain pattern, then definite other features must also be present, for their presence is deducible from the original data, (pattern). It is here that many are led to err.

There is no known method of predicting what will be the given data at any particular time. Given the data in a particular situation, economics can draw inevitable conclusions as to their implications, and if the data remain unchanged these implications will certainly be realized. Of course, if other things do not remain unchanged, the consequences predicted do not necessarily follow. The trouble is that in practice the original data almost never remain unchanged, so employment of the straight deductive method without any other assistance is practically useless. In the physical sciences this 'other assistance' is found in mathematics, which enables the investigator to handle problems in which some variables are present in the basic data.

*Use of Mathematics*

Since quantitative exactitude was regarded as an object of all scientific inquiry, it was natural that economists should early attempt to apply mathematical analysis to their science. The work of Jevons and some of his followers in this field was of considerable merit, for they avoided distortion of their results by over-simplification of the data, and improved the precision of their thinking. Others who came later, however, carried their ideas of the quantitative nature of economics to extremes, and brought the use of mathematics in this science into disrepute. The modern Quantitativists (mentioned later) provide a good example of how mathematics should not be used.

The point that these extremists missed is that the social phenomena with which economics deals are related to human valuation and desire, and the closer the connection with the vagaries of human wants the less the chance of reducing them to a quantitative basis. Nevertheless, while it may be impossible to restrict human desires to a numerical basis, it is not impossible to determine the probability of any desire being within given limits. Thus a whole new field of economic inquiry is opened up, if the economists will make use of the technique for dealing with probabilities which has been developed so highly by the engineers.

At the same time there is another important use to which the tool of mathematics can be put in economics. As pointed out in the previous section, the use of the purely deductive method alone is not very effective simply because it is impossible to cope with situations in which the basic data include variables, and such situations are the most common in practice. Since mathematics is such an admirable tool for handling complexities which are otherwise beyond the reach of human minds, the obvious procedure is for economics to learn from engineering how to use mathematics to aid the deductive method in dealing with the multitude of problems where 'other things are not equal.'

With the growing realization that economics must deal with the motivation of groups, and not individuals, the use of mathematics to handle increasing complexities becomes still more important. Thus, if economics can attain the same facility in using this valuable tool as engineering has, the present lag in the development of this science may be quickly overcome.

It must be concluded, therefore, that, although economics does involve some conceptions of a quantitative nature which require to be analysed in a mathematical spirit, most of these should be treated as probabilities rather than as definite quantities, and the chief use of mathematics in the future will probably be to facilitate dealing with otherwise unmanageable complexities and variables.

One other special branch of mathematics, however, is becoming of increasing importance to economics. This is mathematical statistics which is treated in the following section.

*Use of Statistical Method*

During the past ten years there has been repeated and flagrant misuse of statistics in economics which has aroused doubts regarding the efficacy of this tool. Under the name of Institutionalism or Quantitative Economics, observations have been made of various phenomena over considerable periods of time and in various places. The correlation of trends subject to influences of the most diverse character has been scrutinized for quantitative laws, and the results expected to have significance. Important as some of these investigations may have been at the moment at which they were made, and perhaps for a short time afterward, there was no justification in claiming for their results the status of the so-called statistical laws of the natural sciences. The theory of probability on which modern mathematical statistics is based affords no justification for averaging where conditions are obviously not such as to warrant the belief that homogeneous causes of different kinds are operating.

There are two reasons for the small esteem in which statistics is generally held in economics. The first arises from the nature of the use to which statistics has been put. The ordinary use has been to supply the records of observation as the basis for inductive reasoning. Since, in this role, statistics is applicable only in the early stages of studying any phenomena, and acts merely as an aid in forming hypotheses, it is natural that the value tends to be minimized.

The second reason is evident in the manner in which statistics has been used. Reasoning from statistics inductively, in addition to the inherent danger in all empirical reasoning, is subject to difficulties and dangers inherent in itself. The criticism that statistics can be made to prove anything is all too true unless extreme care in handling it is exercised. To use statistics in the proper manner, therefore, is a difficult matter requiring considerable skill and honesty in thought.

These obstacles in the way of more effective use of statistics in economics can be removed by borrowing from the methods of engineering. Proper handling of the tool through the adoption of scientific precision and honesty of thought, which make misuse improbable, is the first lesson to be learned.

The other is to employ statistics in the second part of the scientific method, i.e., the deductive part. The steps in the so-called scientific method, whose use resulted in such notable advances in technology, are: observation, hypothesis, deduction, and experiment. We have already seen how statistics has been used in the inductive half of this method when applied to economics. Its place in the deductive half should be to substitute for experiment. Since verification by direct experiment is usually impossible in economics and the social sciences, its place should be taken by the comprehensive collection and use of statistics. In this way deductive reasoning will be supplemented and its results checked by submitting them to the test of experience—accumulated statistical data.

B. Broader Education in Both Sciences

Education is a subject which cannot be covered adequately in a limited space, but it is such an important element in bringing the relations of economics to engineering closer to what they should be that a brief outline of the high lights is imperative.

*More Economics for Engineers in University Courses*

Briefly stated, the discussion in previous sections indicates that engineers should be taught to think more freely and often about social problems, while economists should learn habits of precision in thinking. To begin with the engineers, the first training of this nature should be given in the universities where their preliminary professional education is completed.

Engineering curricula now generally include a good grounding in the subjects of mathematics, physics and chemistry, the borderland of the natural sciences. The borderland on the other side of engineering, that embracing the social sciences, however, is virtually neglected. It is in this field, and particularly the branch concerned with economics, that instruction must be provided. When the engineer's training develops a connection with economists of the same order as the connection now developed with pure sciences, then will the requisite vision be fostered which will prevent industrial developments, that are a relative good if properly timed, from becoming a relative evil.

The scope of instruction in the economic borderland of engineering should not be merely to review the history of economic thought and tenets. Rather the work should embrace studying and investigating the economic and social uses of power, machines, transportation, communication and such technical developments. The object of these investigations should be to place this economic side of engineering on the same basis of rigorous examination and reasoning as now characterizes the scientific side. Thus, instruction should be restricted to the solution of problems as practical as possible. Probably the best method would be to use a system of class discussion based on the case method, supplemented by outside reading of standard economic texts for general information only.

*Function of Professional Engineering Societies*

The other great agent of education for engineers is the professional societies. The engineering school and university departments serve to give the young engineer his preliminary training, but it is the professional societies to which he must turn in later life to carry on his education and keep his thirst for knowledge stimulated. In broadening the engineer in his appreciation for the social results of his work, therefore, it is the duty of the engineering societies to carry on the work begun in the universities.

While the economic training received in a university engineering course (as outlined above) is designed chiefly to stimulate the right kind of thinking, the work of the professional society in this field may well be directed towards solving current problems of importance. The study of the relation between production and consumption and its place in the business depression now being conducted by a committee of the American Engineering Council is a good example of this type of work. Besides committee work, however, the important function of the engineering societies should be to foster discussions including more of the economic aspects of engineering problems. Generally the papers presented at society meetings, and the discussion which follows their presentation, are purely technical in nature. If the scope of these papers and discussions could be broadened to include more of the economic aspects, therefore, a distinct service would be performed. In addition to developing a broader state of mind in the engineers, this activity may reasonably be expected to lead to significant advances in the science of economics itself.

*More Engineering for Economists in University Courses*

Similarly, in the field of economics, something of the precision of engineering methods and a direct borrowing of engineering technique can be taught to young economists while taking their university training. At the present time, mathematics and the other natural sciences are looked upon as uninteresting and unnecessary in the training of an economist. A certain amount of such training, however, is just what an economist needs to develop in him the right methods of thinking. To make some work in these subjects a compulsory adjunct to courses in economics would be to assure a sounder development for that science in the future.

*Function of Professional Economic Societies*

Just as discussion of the economic aspects of engineering problems in the professional engineering societies is relied upon to continue the broad development begun in preliminary training, so should discussion of the engineering aspects of economic problems in professional economic societies aid in furthering the development of mature economists. All too frequently the papers delivered before such societies suggest some economic development for which the requisite technical foundation is altogether lacking or impossible of accomplishment. By turning more attention to the practical side of some of the proposals, therefore, more valuable results may be expected.

One of the portentous signs of recent times is that some outstanding economists are now turning from studies which are essentially indeterminate and controversial, and are concentrating their attention instead on specific problems which offer the possibilities of definite solutions. In such problems much of the data are readily available and politics do not ordinarily upset all calculations; e.g., the optimum size of an industry or particular company, the market for a certain product, or the proper location for a specialty plant. Consideration of such problems, primarily from the economic standpoint but at the same time not neglecting the technical aspects, indicates an important step in the direction of obtaining the needed co-ordination of economics and engineering.

*Joint Professional Society Meetings*

A final way in which the individuals can obtain some of the education which each science can give to the other is for the members of each science to come together in friendly discussion more frequently. The traditional attitude of the engineer regarding the economist as an idle theorist, and the economist regarding the engineer as a high type of plumber or machinist, must be abandoned. Each must view the other with the respect which a proper knowledge of the functions each performs engenders. On this basis, joint meetings of branches of the professional societies of the two sciences to discuss both the economic and engineering aspects of current problems would be most beneficial. (The joint meeting of the American Institute of Electrical Engineers and the Econometric Society in Chicago on June 30th 1933, is evidence that this need is beginning to be realized.) The best way to see the other person's point of view is to listen to it presented intelligently, and this is exactly what would take place in joint discussions of the proposed nature. Furthermore, the practical results of such joint meetings to discuss problems of current importance might well be considerable.

*Control by Men Versed in Both Sciences*

For controlling and outlining the general plans in a planned economy (as described in a previous section) it is evident that men with exceptional abilities and special training are needed. Past experience shows that the planning must be done by others than politicians, for most of the examples of 'government in business have not been encouraging. Clearly, however, neither engineers nor economists, even when broadened as just suggested, would be competent to control this system. Moreover, to have the central planning board made up of some engineers and some economists would likely result in friction, with one or the other faction eventually coming out on top, which might not be to the best advantage of society at large.

Since the central planning body originates broad, not detailed plans, its personnel needs to have broad views. What is required is a body of men possessing a good general knowledge of both engineering and economics, but not circumscribed by the narrow views of either profession or encumbered with all the detailed knowledge necessary for endeavour in either field alone. Successful planning requires men trained to discover the facts and lead where they indicate, at the same time possessing the foresight to make their leadership conform to the requirements of the greatest good to society in the long run. While the engineers have the requisite training to equip them to perform the first function, they lack the second; and with the economists the reverse is true. But with men trained generally in both sciences, all the requirements are present. For lack of a better term, these combination engineers and economists might be called 'economic-engineers.'

In operation, a planned industrial system makes use of a continually increasing amount of detail in its plans as they are broken down for application by smaller and smaller units of society. Thus, as the parts of the plan become more definite, men with more specialized and detailed knowledge are needed to carry them out. It is obviously impossible for an engineer to fit himself for carrying on both his and the economist's functions in any of the more specialized parts of the plan, and the same applies to the economist. The broad training recommended for all engineers and economists, therefore, is designed chiefly to enable each to gain some appreciation of the other's viewpoint and problems. So at the same time as more specialization is needed in each field by reason of the increasing complexities of life, some broadening to cover related fields is needed to give the proper perspective from which to view the individual's contribution to the plan as a whole.

With the control in the hands of 'economic-engineers,' the special ability and training of engineers and economists being available to solve the problems in their respective fields, and both engineers and economists having been trained to respect and appreciate each other's functions so as not to work at cross-purposes, the chances appear bright of running successfully an industrial system organized along the proposed lines. And under such a system many of the present difficulties confronting both material and cultural progress would be effectively removed.

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**Note:* The above references are listed under the part to which they bear the closest relation. Some, of course, also apply to parts other than the one under which they are found.

# The Development of Radio

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**Paper presented before the Montreal Branch of The Engineering Institute of Canada, January 11th, 1934.**

The historical aspects of radio are so numerous and cover so much ground that it is quite impossible to do justice to its development in a single lecture. Fleming's first book on wireless was published in 1910, and contained a very full record of radio development at that time. This book contains about 1,000 pages of small print. Development since 1910 printed in detail would require many volumes of the same size as this first volume of Fleming's. It is therefore the intention to confine this paper more particularly to the early periods of the development, since this is probably the most important and the most spectacular. The developments after 1920 will be touched upon only when necessary to emphasize the importance of some of the early developments.

In 1855 Clerk Maxwell read a paper on "Faraday's Lines of Force." He established certain fundamental relations between electric and magnetic qualities, and found the equations to be of the same type as those which express wave motion through a continuous medium, and therefore, their effects must be propagated in space with the same velocity as light. As a corollary, therefore, he proved that light was merely a form of electro-magnetic waves, identical physically with electric waves. This masterly mathematical treatise resulted in the foundation of the electro-dynamic theory of light. Many scientists, however, were reluctant to accept this new theory and abandon the old one of action at a distance, but universal acceptance of the electro-dynamic theory resulted after the work of Hertz became known.

The Hertz apparatus for radiating and receiving electric waves was remarkably simple. His transmitter or, as he called it, "exciter," consisted of two metal plates connected by rods to two metal spheres separated by about half an inch. The rods were connected to the terminals of the secondary winding of an induction coil. When the coil was energized a spark or train of sparks jumped across the gap between the two spheres. The receiver or, as Hertz called it, the "resonator," consisted of a piece of wire bent into a circle, the ends of the wire terminating in two small metal balls, thus forming a circular loop with a small gap in it; the length of this gap could be adjusted by a micrometer screw. The resonator was set up at a short distance from the exciter, and when a spark jumped across the space between the balls of the exciter, a spark was also seen to pass across the small gap in the resonator. With this apparatus Hertz carried out a large number of investigations. He reproduced electro-magnetically, and in rapid succession, all the phenomena of light, and thus completely demonstrated that light was a form of electric wave. He perceived that his experiments confirmed Clerk-Maxwell's theory. He pointed out that when sparks passed rapidly at the exciter, rectilinear oscillations were radiated into the surrounding space. The resonator was brought into all kinds of different positions in relation to the exciter, and the results accurately measured and tabulated. Hertz found that the law of radiation was the same as the corresponding law in optics. In further experiments he proved that the velocity of electric waves is the same as that of light, differing only in length of wave and penetrative power. He found that they could be reflected and even polarized, that they are propagated in straight lines, but that they cannot pass through metal screens, the presence of which causes electrical shadow effects. Hertz was the first to produce a generator of electric waves, as well as to demonstrate their physical properties. As Sir Oliver Lodge has stated, "he effected an achievement that will hand his name down to posterity as the founder of a new epoch in experimental physics." Hertz's discoveries were studied in the laboratories of many different parts of the world, and improved methods of generating and detecting electric waves were soon effected.

The resonator as used by Hertz, while serving admirably the purpose of his experiments, was an extremely inefficient detector. Many forms of detectors have been devised; amongst others Lodge invented one consisting of a metallic needle resting on a plate. The most sensitive detector, however, was of the microphonic type, in the special form invented by Professor Branly and afterwards greatly modified by Marconi.

Branly made a series of investigations into the variations of conductivity of a large number of materials under different electrical influences. He found that substances which responded best to the phenomenon of sudden increase of conductivity were iron, copper, brass, aluminum, zinc and similar metals. He discovered that the conductive effect on copper filings, caused by a near-by electrical discharge, persists for a comparatively long period, but disappears rapidly if subjected to a mechanical shock. He obtained this result therefore by tapping the tube in which the filings are contained. This principle was adopted in the original Marconi system.

Sir Oliver Lodge closely followed and verified Hertz's experiments and conclusions. At the British Association meeting in 1894, he demonstrated the efficiency of a coherer* of the Branly type as a detector of electrical waves up to a distance of 150 yards. He stated that signalling was easily carried on from a distance through walls and other obstacles. Curiously enough, no attempt was then made to carry out such experiments in the open spaces of the country or to apply anything but the feeblest power to test how far disturbances could really be detected. Lodge here stopped upon the threshold of a very important discovery. His explanation of his failure to proceed, he states in an article in 1923, was due to the fact that he was too busy with teaching work to take up telegraphic or other developments, nor, he says, did he have the foresight to perceive what turned out to be of extraordinary importance.

It is about this period that Marconi comes into prominence. In 1894 he was experimenting with an induction coil as a Hertzian emitter. He found that the space indoors was not sufficient to enable him to carry out his experiments

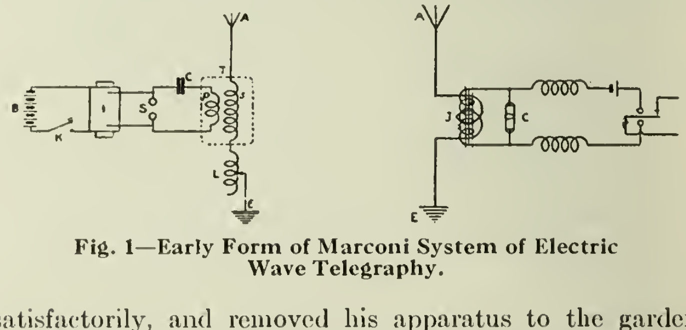

**Fig. 1—Early Form of Marconi System of Electric Wave Telegraphy.**

satisfactorily, and removed his apparatus to the garden where tests could be carried out at greater distances. He now made a most important discovery. Instead of using the two rods of a Hertzian oscillator, he connected one

*Cohesion is based on the following: S. A. Varley in England made the first practical application of the principle of cohesion in utilizing fine charcoal powder as a leak for lightning discharge, the powder being a non-conductor of electricity until caused to cohere by the action of a lightning flash. Following this, Onesti, an Italian professor, discovered that copper filings piled up between two metal plates were normally non-conductors of electricity, but became conductive when subjected to a high voltage spark discharge.

terminal of the secondary of the induction coil to a metal cylinder, or capacity, elevated to the top of a pole, and the other to a metal plate laid on the ground. An elevated aerial was thus produced which discharged across the spark gap to the earth. At the receiving end a similar capacity was erected on the top of a pole and connected to earth through a Branly coherer. He found that the Branly coherer was neither sufficiently sensitive nor reliable in its action, so some time was spent in endeavouring to improve this instrument. After a series of investigations as to the best metals for the filings a mixture of nickel and silver, in the proportion of 95 per cent nickel and 5 per cent silver, was chosen, and these filings were carefully sifted to a certain degree of fineness. The space in the tube between the two silver plugs was about one-third to one-half filled with filings and the glass tube was then exhausted of air and sealed. As a means of restoring the coherer to a non-inductive state immediately after coherence he used a tapper designed on the principle of an electric bell, the coherer tube taking the place of the bell gong.

At the same time Marconi carried out systematic experiments to ascertain in what way the height to which he elevated his capacity affected the distance at which his detector would respond. In 1895 he employed metal cubes about one foot square, which were erected on poles two metres high, and found that with similar arrangements at both ends, he could receive signals at 30 metres distance. On doubling the height to four metres, the distance of reception was increased to one hundred metres; again doubling the height to eight metres the range was increased to four hundred metres. He then increased the size of the cubes to about three feet three inches square, and with this new aerial was able to record Morse signals at a distance of about one and a half miles. He then tried placing the discharge balls of the transmitter in the focal line of a cylindrical parabolic reflector, and at the same time placed the receiving detector in the focus of a similar reflector. Thus the idea of directive radio was very early conceived. Nothing further was done at that time for practical reasons, principally because short waves were not then found to be of practical value, and the longer waves introduced high costs and physical difficulties in erection of such antennae.

In 1896 Marconi brought his invention to the notice of Sir William Preece, of the General Post Office, who had himself developed a system of wireless telegraphy by the conductive-inductive method. Sir William arranged that every facility should be granted to Marconi to demonstrate his invention, and it was successfully operated between the General Post Office and the Thames Embankment. Later experiments were carried out on Salisbury plain, when reception over a distance of eight miles was demonstrated.

Figure 1 shows an early form of Marconi system of electric wave telegraphy. *B* is a battery supplying current to an induction coil *I* with a key *K* in the primary circuit of the coil. When the coil is in action the condenser *C* is charged and then discharged with oscillations across the spark gap *S*. This creates oscillations in the aerial *A* and radiates trains of electric waves. The receiving aerial picks these up, which then act on the coherer *C* (right hand) and this permits the local battery to send a current through the coherer and the relay and operates a Morse inker. This method of reception is now antiquated and no longer used.

Sir William Preece in a lecture at the Royal Institution in 1897 made the following remarks about the Marconi experiments: "He has not discovered any new rays, his recorder is based on Branly's coherer. Columbus did not invent the egg but he showed how to make it stand on its end, and Marconi has produced from known means a new electric eye, more delicate than any known instrument, and a new system of telegraphy that will reach places hitherto inaccessible . . . Enough has been said to show that for shipping and lighthouse purposes it will be a great and valuable acquisition."

There was at once world wide interest in scientific centres. In 1897 apparatus was installed on two Italian warships and communication established up to a distance of 12 miles. Marconi's next step was the erection of a station at Alum Bay in the Isle of Wight, and another at Bournemouth. For this communication elevated aerials at a height of about 120 feet, and a 10-inch spark induction coil were used. The first paid wireless messages were sent over this circuit. In 1898 at the request of Lloyds, apparatus was installed at Ballycastle and Rathlin island, in the north of Ireland, which was successfully operated by Lloyds lighthouse keepers. In July 1898 the results of the Kingston regatta were reported from sea from the steamer *Flying Huntress*, and over seven hundred messages were sent and received. This was the first instance where a ship had been equipped for commercial purposes. In August 1898 communication was established between the royal yacht *Osborne* and Osborne House, Isle of Wight. During the next few months certain improvements were made, particularly the introduction of high frequency transformers between the aerial and the transmitting equipment. In March 1899 messages were transmitted across the English channel between South Foreland lighthouse, near Dover, and Wimereux, near Boulogne. Correspondence arrived from all parts of the world, some asking for information, some giving advice, and many from cranks and madmen who attributed the illnesses from which they suffered to the passing of the wireless waves through their bodies.

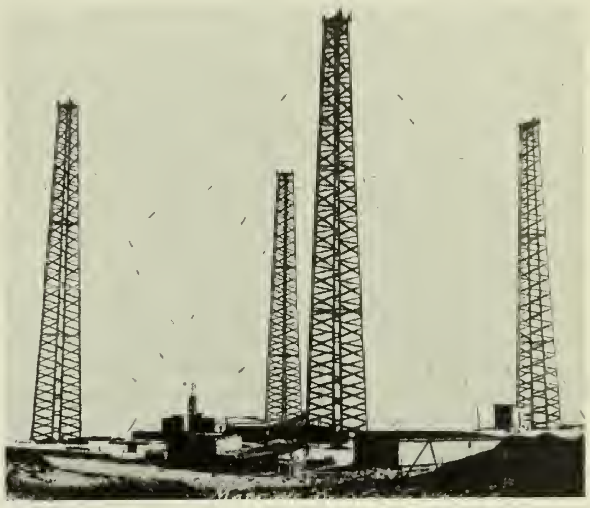

**Fig. 2—Wooden Towers used at early Trans-Atlantic Station, Glace Bay, N.S.**

Communication was next established between Chelmsford and Wimereux, a distance of 85 miles. During the same year the International Yacht Races in the United States were reported by wireless ship to shore. In the autumn of the same year two British cruisers used wireless up to a range of 85 miles during manoeuvres. From this arose the first sale of commercial equipment to the British Admiralty, who made their first purchase of thirty-two installations.

Tuned circuits were now developed both for transmitter and receiver. This was developed as far as working two or three transmitters on one aerial, and two or three receivers on one receiving aerial, provided they were tuned to wave lengths substantially different. A demonstration of wireless multiplex telegraphy was given in 1900 and 1901 when messages were sent from St. Catherine's, in the Isle of Wight, to the Lizard, a distance of 156 miles.

Attempts were now made to reach longer distances, and to do this experimental work it would be necessary to have higher masts and more power. It was thought inadvisable to use metallic masts, and limitations in height of wooden masts were somewhat severe in those days. For increase of power it was also necessary to depart from a physical laboratory type of apparatus, and instead there were developed suitable transmitters more nearly associated with the power development of that time. Also special alternators and transformers would be required.

This design work was undertaken by Dr. J. A. Fleming and apparatus of about 25 kw. input designed and the aerial erected upon a 200-foot circular wooden mast at Poldhu. It was decided to attempt to span the Atlantic with this equipment and when this installation was finished early in 1901, a similar one was started on the American side at South Wellfleet, Cape Cod. Some delay was caused by the complete collapse of the masts both in Cornwall and Massachusetts, but repairs were made and tests conducted between Poldhu and the west coast of Ireland, a distance of 225 miles. These results were such that signals were anticipated at ten times this distance.

Marconi now decided that the first test would be between Poldhu and Newfoundland, that is, transmitting at Poldhu and receiving in Newfoundland. He kept this proposed test secret for the obvious reason that there would be adverse publicity if he failed. On December 11th, 1901, the test was started by sending the letter "S" from 3.00 p.m. to 6.00 p.m. In Newfoundland, where he received every assistance from the Newfoundland government, he had arranged to use a balloon attached to his aerial in order to obtain height, but this broke away on the first ascent and was lost. On the next day, the 12th, a kite was successfully used and hoisted the aerial to a height of 400 feet. As this kite was rising and falling in the wind throughout the experiments, thus varying the electrical capacity of the aerial, it was impossible to use tuned apparatus. Marconi therefore resorted to more simple and less efficient receiving apparatus which was simply a highly sensitive self-restoring coherer connected in series with a telephone and the aerial. With this apparatus, on December 12th, 1901, he and his two assistants heard faint "S" signals. Wireless signals were thus transmitted across the Atlantic for the first time.

This achievement caused a great sensation, and subsequent results dispelled any doubts. In Newfoundland further tests were brought to an abrupt conclusion by the action of certain cable companies who claimed a monopoly of all telegraph communications in Newfoundland. However the Canadian government at once invited Marconi to Canada where he received the utmost encouragement and was offered a substantial subsidy of approximately $80,000.00 to build a station on the Canadian coast. In February 1902 his contract was ratified by the Canadian House of Commons and the Canadian government by this far-sighted and public spirited action were very largely responsible for bringing about the remarkable development in wireless communication which took place within the next two years. It was at the Canadian station erected at Glace Bay that most of the experimental work originated that led to a regular transatlantic service, and it was from this station that the first transatlantic messages were successfully transmitted. This was the beginning of long distance transoceanic communication.

In 1902 tests were carried out to see how far the Poldhu station could be detected on a ship. Receiving equipment was installed on the S.S. *Philadelphia* of the American Line and very important results were obtained. Readable messages were recorded on tape up to a distance of 1,551 miles, and beyond this the letter "S" was recorded up to 2,099 miles. The most important scientific discovery was made on this voyage, namely, that on the wavelengths then used, wireless signals travelled much farther at night than during the day. Signals failed at 700 miles during daylight, while at night they were quite strong at 1,550 miles.

Following this there was, of course, activity in all the large countries of the world. Communication was still in a more or less experimental stage. Improvements were necessary in both transmitting and receiving equipment and, also, in the aerial systems. The latter were both extensive and costly; they were also subject to the vagaries of nature, particularly during the winter time when ice would form on the aerial causing it to break. At this period, development in transmitters proceeded very slowly, but a great deal of attention was paid to the development of receiving systems, and particularly detectors. This work upon the receiving side and upon detectors was probably given more wide-spread attention than the transmitters because the need for improvement was obvious, and the cost of carrying out development was relatively inexpensive. Roughly speaking, detecting devices can be classed into: (1) spark detectors, (2) contact detectors, (3) thermal detectors, (4) magnetic detectors, (5) electrolytic detectors, (6) electrodynamic detectors, and (7) rectifying detectors. Of these groups, perhaps the most important in the development of radio were the contact detectors, of which the coherer is typical, magnetic detectors and rectifying detectors.

### Rectifying Detectors

It has been found that a small surface contact between certain conductors as, for instance, between silicon and copper, and carbon and steel, possesses the power of rectifying high frequency currents. G. W. Pickard found that a copper or steel point pressed against a piece of silicon acted as an oscillation detector when shunted by a telephone. He also found that a brass point in contact with fused zinc oxide or red oxide of zinc acted as a detector of high frequency currents. This was called the "Perikon" detector. In 1906 General H. H. C. Dunwoody used a steel point in contact with carborundum and the carborundum detector was in general use until the development of the radio valve. It is still used today to some extent as a cheap form of detector. A piece of wire in series with a crystal and a pair of headphones will give very good reproduction on present day broadcasting stations, so long as they are not too far from the broadcasting station.

The next important step in detection was the development of the Fleming valve. The Fleming development here was the harnessing of the phenomenon long known as the "Edison effect." Fleming in 1904 found that the electron stream which flows from a hot cathode to a metal anode was unilateral, and therefore it could be used as a detector of high frequency oscillations. This was the beginning of the radio valve or tube as it is known today and

Fig. 3—Ship's wireless cabin in the Experimental Days.

the principle is still in use in the so-called diode detectors and, of course, in all present day rectifier tubes for receiving sets and transmitting sets. Between 1904 and 1907 much study was given to this valve, and its behaviour observed under varied conditions of filament temperature and voltage, and degree of vacuum, etc. In 1907, due to DeForest, an epoch-making development took place and a third element known as the grid was introduced into the Fleming valve between the filament and the anode. The function of the grid was to control the electron stream between the cathode and the anode, and it was so sensitive in this regard that the electron stream would vary in magnitude with every change of potential of the grid relative to the filament even if the changes were at the rate of several million cycles a second. This discovery was the real beginning of radio as it is today. Between 1907 and the present day, much time and money has been spent upon improving the radio valve, and many hundreds of workers have been engaged upon it,

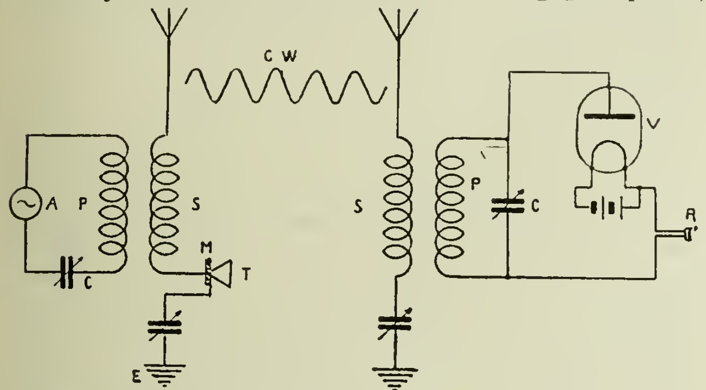


**Fig. 4—Apparatus for conducting Wireless Telephony.**

with the result that the present day valves are very complex in their structure and in their multi-purpose operation. Additional grids have been inserted and various anti-capacity structures embodied in valve design. Valves are now used for the detection of the most feeble impulses and, in the larger sizes, for the generation of very powerful high frequency impulses. This development is still going on.

### Transmitter Development

The first transmitters as used on transatlantic and ship-to-shore communication were the so-called spark transmitters. These comprised condenser and inductance which formed an oscillating circuit, a source of high tension and a spark gap for the purpose of agitating and interrupting the electric energy stored in the high frequency circuit. This energy in the oscillating circuit was transferred to the antenna where part of it was radiated into space. A train of oscillations during the periods of interruption by the spark were highly damped which caused a considerable spread on each side of the fundamental wavelength. This is what is now known as broad tuning, as distinct from sharp tuning subsequently obtained when high frequency oscillations were generated and radiated without decrement in amplitude, in what is now called continuous wave. Spark transmitters were used for a number of years, the radiated power being increased and the aerial systems made more efficient as the technical requirements became more understood. It was, however, realized that radiation on continuous waves would be infinitely better, but the means for obtaining alternating currents of the order of half a million cycles per second were not then known, nor was it known by what method radiated waves of that character could be detected.

The next outstanding step was the development of the continuous wave transmitter which was known as the Poulsen arc. This was a successful development by Poulsen of the singing arc described by Duddell. The arc was very highly developed, and some installations were put in about the end of the war which were capable of transmitting about 1,000 kw. into the aerial. These installations were operated on frequencies of the order of 20 kc. The first telephony of any commercial importance was made by Poulsen and his arc transmitter, when speech communication was established in 1909 in Denmark over a distance of 170 miles. About the same time as the introduction of the arc, much attention was being given to the development of high frequency alternators, and several types were successfully built and operated, some still being in operation today. The most notable of these were those of Goldschmidt in Germany and Alexanderson in the United States which generated a capacity of several hundred kilowatts, and operated on frequencies of the order of 15 or 20 kc.

The most outstanding development in transmitters has been the application of the valve which was developed during the War period intensively, and far beyond the initial stage of the construction of the DeForest valve, but nevertheless, on the same principle. It is probable that development would have been much slower under ordinary peace circumstances than under the research inspired by the War and its needs. The first outstanding demonstration of the value of the valve in public service was made by the American Telegraph and Telephone Co. when they telephoned across the Atlantic using a transmitter which employed a very large number of small valves operating in parallel. This demonstration was followed by some years of research on this problem which culminated in the opening of the New York-London circuit for commercial telephony in 1927, and, in the meantime, valves of very much greater power had been developed. These were of quite different design to the small receiving valves with glass envelopes. In these large valves a copper anode forming part of the envelope and water cooled, was used to carry away the heat from the valve. This was the so-called water cooled tube. They are now made with power ranging from 5 kw. up to several hundred kilowatts. Shortly after the Armistice, many of the wireless organizations again turned their efforts to peaceful occupations and development now centered largely around the valve, perfecting its use in transmitters and receivers. One of the first long distance circuits to be used on commercial radio telegraph with a valve transmitter was a circuit between Great Britain and Canada. The transmitting set in Glace Bay used about forty-eight 500-watt valves in parallel, with the opening of the valve circuit on continuous wave. The spark transmitter was abandoned on this circuit.

Figure 4 illustrates the nature of the apparatus for conducting wireless telephony. On the left-hand side is the transmitter by which continuous electric waves are thrown off from the aerial. These are altered in amplitude or height by speaking to the microphone *T*. At the receiving station (on the right) the aerial picks up these waves, and

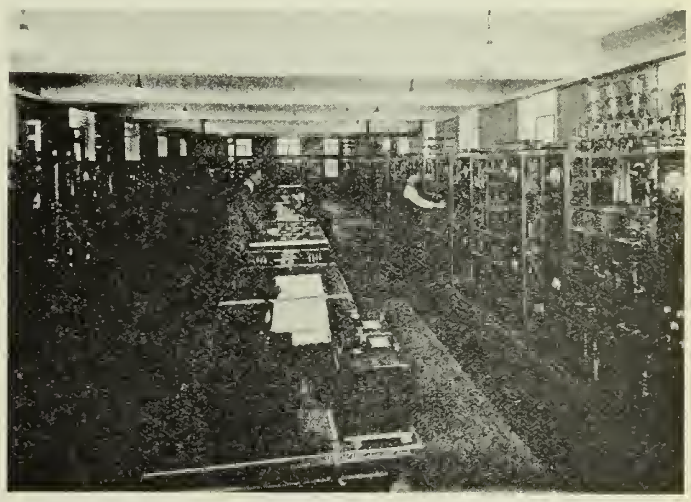

**Fig. 5—Transmitting Room in Modern Trans-Altantic Station.**

they are rectified by a thermionic valve *V* and heard as speech sounds in the telephone receiver *R*.

The next occurrence of importance was the discovery in about 1924 that short waves, that is, waves between 20 and 100 metres, were not as useless for long distance communication as had been supposed. There seemed to be a sudden burst of activity in transmission and reception on these shorter waves. Investigation on a large scale and over long distance did not seem to have been carried out until tests were made by Marconi from Poldhu with a transmitter of the call sign 2YT. During these tests signals were received very clearly in Montreal on a single valve receiver with little or no aerial. This demonstrated at that time that short waves of the order of between 20 and 30 metres could be received quite well during daylight hours but were inaudible during darkness. It was also noted that wavelengths of between 60 and 100 metres could be received quite loudly during darkness but not during the day.

From these tests arose the development of the beam circuit between England and Canada. Theoretically, the transmission was supposed to be directive, that is, more or less concentrated in a small sector. The receiving aerial system was also made so that it would theoretically only be responsive to a small sector in a given direction. This, at that time, was regarded by many as something in the nature of a huge and costly experiment. It was admitted that there might be concentration of radiation in the neighbourhood of the transmitter. It was also thought that it was possible that such concentration would be lost by dissipation and diffusion as the distance from the transmitter increased. Fortunately, however, the installation behaved more or less according to theory, and there was at once concentrated development in many countries in the matter of improving and installing means for short wave directive transmission and reception. At this time the essential difference between long wave and short wave was the relatively small cost of short wave equipment and its relative high speed operation and freedom from static as compared with long wave operation.

Shortly after the conclusion of the test periods on these circuits, another important occurrence in nature became painfully apparent, namely, fading. During certain conditions of the upper atmosphere subsequently associated with sun spots and magnetic storms, there are times when short wave signals will disappear for hours. Theories have been developed for the general behaviour of short waves which involve certain hypothesis concerning the so-called Heaviside layer. This trouble is still experienced but its vagaries are now better understood.

As transmitters are today, it may be generally said that on short wave, transmissions are carried out with valve transmitters, while on long wave long distance transmitters, some of the older means such as alternators and arcs are still being used chiefly as a matter of economy in capital costs. On the receiving side, the introduction of valves brought about a very radical change in design of receivers. One of the most important was the development of the reaction receiver, and another the heterodyne receiver. In the former the output of the valve was fed back upon itself, resulting in a marked amplification due to the cumulative effect. The latter consisted of the use of the output of a local oscillator to beat with the incoming high frequency continuous wave, the difference between the frequency of the incoming wave and the local oscillator being a frequency within audible range. This combination gives a musical note. This was an outstanding development in the detection of continuous wave. In selectivity and sensitivity, another outstanding development was the superheterodyne receiver which in simple terms is the use of a beat oscillator which produces supersonic beats between the incoming signal and the oscillator, this supersonic beat being amplified to a very high degree through what is called an intermediate amplifier and then rectified by a valve rectifier followed by a low frequency amplifier working into a loud speaker. It is the most widely used type of receiver today and owes its popularity to extremely sharp selectivity.

# An Explanation of Modern Sinking Funds

*J. B. Macphail, A.M.E.I.C.,*
*Power Engineering Company Limited, Montreal*

Modern issues of public utility and industrial bonds generally contain clauses providing for the periodic retirement of portions of the issue, but no convenient method has hitherto been available to enable a person with little mathematical training to determine the cumulative effect of these provisions; that is, to determine what proportion of the issue will be retired by maturity or at some earlier date, for this is the really important part of the matter.

The purpose of this paper is to show the quantitative result of a large class of these retirement clauses, covering nearly all modern Canadian issues, where some percentage of issued or outstanding bonds is to be retired annually, together, sometimes, with whatever can be purchased with interest from coupons of bonds previously retired. No tables are known to be available for this purpose, and neither the words of these clauses nor their expressions in mathematical form appear in some text books where one would expect to find them. Perhaps, also, the subject has been thought too difficult to be apprehended by any but the initiate but, as will be seen later, it can be set forth in very simple terms.

There are other methods of retirement now in operation, but they affect only a few issues and are all special cases. A complete treatment of these methods would be out of place here, because they are all different and require individual treatment by one expert in the necessary calculations. They are often interesting, and to take only two examples, there are the Southern Canada Power Company bonds where instead of retirement there is a provision that 15 per cent of gross revenue must be set aside annually for maintenance, renewals, and permanent additions; and for bond retirement only to the extent of any unexpended balance on these accounts: and bonds of Dominion Telegraph Securities where a fraction, just over five per cent of the issue, was held back and deposited with the trustee so that it would accumulate at compound interest to retire the whole issue.

A sinking fund was once considered to be a sum accumulated by periodic payments from current income, which, with the assistance of compound interest, was to retire a debt due at a future date, but the meaning has been extended to cover various methods of periodic retirement of portions of a debt. A complete discussion of what should be done in this respect is also out of place here: it is proposed only to show the future effect of what has been done, and not to consider the adequacy of those results when attained.

Three simple formulae will cover nearly all cases which occur in practice. Their derivation need not be given, because it is necessary only to proceed along the usual algebraic lines of working out the operation of the fund in symbolic form for the first three years, observing that the results in each case can after some transformation be made to form a geometrical series and taking the sum of the series. The results only are given, with examples of their use. They could perhaps have been put in the form of a set of tables, but the necessary multiplication is so simple that anyone can use them in their present form.

Three symbols or abbreviations, common to all cases, are introduced for simplicity and require a little preliminary explanation.

Let $M$ be the amount of the bond issue at time zero. It may often be taken as $100 because the formulae will then give retirements in percentages.

Let $n$ be the number of years, taken to the year end, for which the sinking fund is supposed to have been in operation. If an issue is dated January 1st, 1930, the various transactions which occur on January 1st, 1935, are considered to belong to the end of the fifth year, and the formulae for five years give conditions just after completing these operations. Bond texts and financial reference books are sometimes not quite precise in their sinking fund descriptions, and in that event an extract from the trust deed must be obtained from the trustee. If a sinking fund is described as beginning in 1932, for example, it might commence with a payment at the first of the year, or at the end of the year with amounts drawn from 1932 earnings. But if it is to begin on some given date there is no ambiguity, for zero time is then the same date in the preceding year.

Let $R$ be the amount of bonds redeemed at the end of $n$ years, including redemptions made on the last day of the year.

Coupon rates or retirement rates given in percentages are here expressed as decimals. A 5 per cent coupon is called 0.05 and a 1 per cent retirement rate is written 0.01.

Case 1.—Sinking fund as a percentage ($= t$) of bonds outstanding at the end of each year with no interest on bonds redeemed.

If $Z = (1 - (1 - t)^n)$ then $R = M \times Z$......(1)

and $Z$ is found in Table I for various years and rates.

*Example:*—What percentage of an issue will be retired at the end of the fortieth year if 1 per cent of bonds outstanding at the end of each year are annually retired? From Table I on the line of $n = 40$ in the column $t = 0.01$ find $Z = 0.331$.

So $R = \$100 \times 0.331 = 33.1$ per cent.

Case 2.—Sinking fund as a percentage ($= s$) of bonds originally issued plus interest (at coupon rate $= c$) on bonds previously redeemed.

If $Y = ((1+ c)^n - 1)/c$ then $R = M \times s \times Y$....(2)

and $Y$ is found in Table II for various years and coupon rates.

*Example:*—What percentage of a 5 per cent issue will be retired at the end of the thirtieth year with a sinking fund of one half of one per cent of bonds originally issued plus interest on bonds previously redeemed? From Table II on the line of $n = 30$ in the column $c = 0.05$ is found $Y = 66.44$.

So $R = \$100 \times 0.005 \times 66.44 = 33.22$ per cent.

Case 3.—Sinking fund as a percentage ($= t$) of bonds outstanding at the end of each year plus interest (at coupon rate $= c$) on bonds previously redeemed.

If $Y = ((1 + u)^n - 1)/u$ then $R = M \times t \times Y$....(3)

and $Y$ is found in Table II for various years and for the composite rate $u = c - t$.

Table I

Values of $Z$

| Years | Values of $t$ | | |
|---|---|---|---|
| $n$ | 0.01 | 0.015 | 0.02 |
| 5 | 0.049 | 0.073 | 0.096 |
| 10 | .096 | .140 | .183 |
| 15 | .140 | .203 | .261 |
| 20 | .182 | .261 | .332 |
| 25 | .222 | .315 | .397 |
| 30 | .260 | .365 | .455 |
| 35 | .297 | .411 | .507 |
| 40 | .331 | .454 | .555 |
| 45 | .364 | .493 | .597 |
| 50 | .395 | .530 | .636 |

*Example.*—Assume an issue of \$1,000,000 of 5 per cent bonds. How much of it will be retired at the end of the thirtieth year if there is an annual sinking fund of one half of one per cent of bonds outstanding at the end of each year plus interest on bonds previously redeemed? Since $u = c - t = 0.05 - 0.005 = 0.045$, there is found in Table II on the line $n = 30$ in the column $u = 0.045$ a value of $Y = 61.01$.

So $R = \$1,000,000 \times 0.005 \times 61.01 = \$305,050$

A few further remarks will complete this elementary presentation. Table I has been newly computed, because it is believed, after enquiry, not to have been published before. Table II will be recognized as an ordinary annuity table given in many text and reference books which, however, are not often found in the hands of the public; and even if they were, many people would have to engage an actuary to find the proper page. Hence it is repeated here, and especially so because its application to the present use is not entirely self-evident.

Great exactness is not possible in these calculations, because fractional bonds are not available and the prices at which purchases can be made are not known in advance: nor is it necessary, because for practical purposes a small variation in the amount ultimately retired is of little importance. The compounding of interest semi-annually may be neglected on these grounds.

Table II can also be used when there is an increase in retirement rate a few years after the sinking fund begins, on the assumption that the investment will not until then have attained its full earning power. For example in Canada Cement Company 5½ per cent bonds due in 1947, application of formula (2) on a basis of \$100 issued shows that the 2 per cent rate in the first five year period will retire \$11.16, and that the 3 per cent rate in the second period of thirteen years will retire \$54.87, to which must be added compound interest of (not the compound amount of) \$11.27 or a total of 77.3 per cent retirement by maturity.

Table II may also be replaced by an ordinary compound interest table at the expense of a little additional calculation. A full discussion of all possible uses would not be in keeping with the ideal of simplification which has, it is hoped, been attained in these explanations.

Table II

Values of $Y$

| Years | Values of $c$ or $u$ | | | | | | |
|---|---|---|---|---|---|---|---|
| $n$ | 0.030 | 0.035 | 0.040 | 0.045 | 0.050 | 0.055 | 0.060 |
| 2 | 2.03 | 2.04 | 2.04 | 2.04 | 2.05 | 2.06 | 2.06 |
| 4 | 4.18 | 4.21 | 4.25 | 4.28 | 4.31 | 4.34 | 4.37 |
| 6 | 6.47 | 6.55 | 6.63 | 6.72 | 6.80 | 6.89 | 6.98 |
| 8 | 8.89 | 9.05 | 9.21 | 9.38 | 9.55 | 9.72 | 9.90 |
| 10 | 11.46 | 11.73 | 12.01 | 12.29 | 12.58 | 12.88 | 13.18 |
| 12 | 14.19 | 14.60 | 15.03 | 15.46 | 15.92 | 16.39 | 16.87 |
| 14 | 17.09 | 17.68 | 18.29 | 18.93 | 19.60 | 20.29 | 21.02 |
| 15 | 18.60 | 19.30 | 20.02 | 20.78 | 21.58 | 22.41 | 23.28 |
| 16 | 20.16 | 20.97 | 21.82 | 22.72 | 23.66 | 24.64 | 25.67 |
| 18 | 23.41 | 24.50 | 25.65 | 26.86 | 28.13 | 29.48 | 30.91 |
| 20 | 26.87 | 28.28 | 29.78 | 31.37 | 33.07 | 34.87 | 36.79 |
| 22 | 30.54 | 32.33 | 34.25 | 36.30 | 38 51 | 40.86 | 43.39 |
| 24 | 34.43 | 36.67 | 39.08 | 41.69 | 44.50 | 47.54 | 50.82 |
| 25 | 36.46 | 38.95 | 41.65 | 44.57 | 47.73 | 51.15 | 54.86 |
| 26 | 38.55 | 41.31 | 44.31 | 47.57 | 51.11 | 54.97 | 59.16 |
| 28 | 42.93 | 46.29 | 49.97 | 53.99 | 58.40 | 63.23 | 68.53 |
| 30 | 47.58 | 51.62 | 56.08 | 61.01 | 66.44 | 72.44 | 79.06 |
| 32 | 52.50 | 57.33 | 62.70 | 68.67 | 75.30 | 82.68 | 90.89 |
| 34 | 57.73 | 63.45 | 69.86 | 77.03 | 85.07 | 94.08 | |
| 36 | 63.28 | 70.01 | 77.60 | 86.16 | 95.84 | | |
| 38 | 69.16 | 77.03 | 85.97 | 96.14 | | | |
| 40 | 75.40 | 84.55 | 95.03 | | | | |

# DEPARTMENT OF NATIONAL DEFENCE RELIEF CAMPS AND PROJECTS

*Major G. R. Turner, M.C., D.C.M., A.M.E.I.C.* [1]

## DISCUSSION

Mr. Tom Moore[2]

Mr. Moore observed that he appreciated having received an advance copy of the author's paper as there was much contained therein of value in enabling one to understand the extent of the work being carried on and the purpose of the same

He was particularly interested in the chapter on page 4 respecting criticisms of the plan. In this it was stated that it seemed illogical to contend that such personnel should receive prevailing rates of wages in preference to the large number of married men with families who were now unemployed. This statement corroborated the protest that work should not be done by these single men which could and should legitimately be done under proper wage conditions in such manner that either unemployed married or single men would have equal opportunity of employment.

To have taken hordes of single men into Kingston and Barriefield to construct permanent buildings while married men, skilled at their respective trades were compelled to walk the streets seeking employment was, in the eyes of organized labour at least, an injustice.

Further on, referring to preference of men to work at their trade for the 20 cents per day the article said "Many young men who have had no opportunity to learn a trade welcome a job as carpenter's helper, etc., in order that they may qualify as handymen when industry revives." This was one evil which labour had struggled to eradicate over many years and in co-operation with employers had, in Ontario and some other sections of Canada, checked the growth of handymen by the inauguration of qualified apprenticeship plans. It was only aggravating an already acute situation for mechanics to know that with any slight revival of trade they would be met by competition from "handymen" willing to work at less than proper wages and who had been encouraged to become such by those administering these camps.

In direct contrast to this was the statement on page 2 that appointments as engineers and other administrative posts were filled by (the engineers' trade union) The Engineering Institute of Canada, and in the case of the medical by (their trade union) the Canadian Medical Association.

Further, a different scale of payment was established for these which, when board was included, was in many instances not much below that paid by industry generally.

What justification was there for trained mechanics being accorded less consideration both in respect to their manner of hiring and also the rates of pay given to them?

One thing further: Mr. Moore was not sure that the statement on page 5 regarding the conservation corps of the United States being paid only $5.00 per month for personal use was exactly correct. He did know the regulations provided that men willing to allow part of their wages to be paid direct to some dependents were to be given preference for employment.

Mr. Moore in closing observed that he trusted that his criticisms would be accepted in the same friendly spirit in which they had been made, as his only purpose was to endeavour to make Labour's protests better understood.

Major G. R. Turner, m.c., d.c.m., a.m.e.i.c.[3]

The author remarked that Mr. Tom Moore had made several observations which were of interest as indicating his reaction to the scheme.

These observations, which had been made in a friendly spirit, could not be interpreted as indicating any hostility to the scheme generally, but as emphasizing certain features which organized labour considered undesirable. In view of this and of the cordial relations which existed between Mr. Moore and the officers of the Department of National Defence charged with the responsibility of this scheme, it was desired to make it quite clear that his observations were accepted in the spirit in which they were given, and further, that comments on his observations were given in a similar spirit, the object being merely to invite attention to the factors which appeared to justify those features to which Mr. Moore took exception.

Mr. Moore considered that the statement that "it seems illogical to contend that single homeless unemployed should receive prevailing rates of wages in preference to married unemployed with families" corroborated Labour's protest that work, such as the building construction at Kingston and Barriefield, should *not* be done by these single men which could and should legitimately be done under proper wage conditions and in such a manner as to give either unemployed married or single men opportunities of employment. The answer to this criticism was that these buildings anticipated the ordinary programme of the Department by a number of years and, in consequence, no skilled mechanic was being deprived, either now or in the near future, of any work through the construction of these buildings as a relief project for single homeless men. In fact, the lack of skilled relief personnel on the projects at Kingston, Barriefield, Trenton, etc., had afforded opportunities of employment to certain married men in those vicinities which they would not have had if these relief projects had not been instituted.

Mr. Moore condemned the principle of affording opportunities to young men to work as carpenters', etc., helpers, and so be handymen when industry revives. He stated that organized labour had struggled for years to inaugurate qualified apprenticeship plans and to eradicate the evil of the "handyman" who was willing to work for less than proper wages, and so offered serious competition to skilled mechanics. Perhaps the intention of the clause "in order that they may qualify as handymen when industry revives" might be more satisfactorily expressed in the words "in order that they may qualify for more remunerative jobs than that of unskilled labourers when industry revives." Fair wage schedules of the Dominion and various provincial Departments of Labour made provision for higher rates of wages for "helpers" for various trades and for "skilled labourers" than were prescribed for "unskilled labourers." There was no intention whatsoever of producing a number of "handymen" to replace or compete with skilled tradesmen when industry revived; the object was merely to give these young men who, through no fault of their own had been unable to learn a trade, opportunities of learning the rudiments of a trade or trades, becoming "handymen" with tools, and so be able to be classified as "tradesmen's helpers" or "skilled labourers" when they left the projects for normal employment. No man could learn a trade unless he obtained practical experience in that trade and surely it was not unreasonable to give these young

(1) Paper presented before the Annual General Professional Meeting of The Engineering Institute of Canada, and published in the February 1934 issue of The Journal.

(2) President, The Trades and Labour Congress of Canada, Ottawa, Ont.

(3) General Staff, Department of National Defence, Ottawa, Ont.

men every opportunity to acquire knowledge and experience and fit themselves for something more remunerative than jobs as unskilled labourers. The primary purpose of this relief scheme was to increase the morale of the personnel afforded relief, and this could not be done by denying ambitious personnel any opportunities that might be presented of acquiring knowledge and experience of a trade.

Mr. Moore had remarked that, in direct contrast to the treatment accorded the skilled mechanics, was the filling of the technical appointments by The Engineering Institute of Canada, which he designated as the "engineers' trade union." However, the paper specifically indicated that these appointments were filled for the most part by "*nominees*" of The Engineering Institute, and it could not be too strongly emphasized that The Engineering Institute had *not* restricted its nominations to its own members. It had given consideration to qualified unemployed engineers in need of relief whether they were members of The Institute, members of the Provincial Professional Engineers Associations or non-members of either. This appeared to be a feature of The Institute's activities that should be generally commended and that should considerably enhance its value and prestige among the members of the engineering profession as a whole.

Mr. Moore asked what justification existed for trained mechanics being accorded less consideration than engineers, doctors and others on the supervisory staffs both in respect of method of hiring and rates of pay, stating that the rates given the supervisory staff were, when board, etc., were included, not much below that paid by industry generally. Mr. Moore had apparently overlooked the fact that positions on the supervisory staff were normally filled by married men with dependents, whereas the relief labourers were single and homeless. Further, even $100.00 per month (the maximum rate of allowance) did not seem excessive for a graduate of any of our universities who had expended a considerable amount on his education and no one of either the engineering or medical professions would agree that the rates of $40.00 to $100.00 per month (and only a few received the $100.00 rate) were too high compared with those paid by industry generally, even under present conditions.

Finally, Mr. Moore questioned the accuracy of the statement that personnel of the Civilian Conservation Corps in the United States received only $5.00 per month for personal use. To quote from a paper presented by Professor Nelson C. Brown of the New York State College of Forestry at the recent convention of the Canadian Pulp and Paper Association in Montreal, Professor Brown then stated that each enrollee assigned $25.00 from his $30.00 monthly pay direct to his dependents, and also remarked that distress had been definitely relieved in homes by the contribution of $25.00 per month out of the monthly wage of $30.00. Also an article by Mr. Robert Fechner, Director of Emergency Conservation Work, published in the New York Times of February 4th, 1934, stated that the men received $30.00 per month, of which about five-sixths was sent directly home by the War Department to the families of the enrolled men.

G. McL. Pitts, A.M.E.I.C.[4]

Mr. Pitts suggested that the scheme should act as a "relief valve" during normal business periods, as well as in times of great stress such as the present. If The Engineering Institute of Canada were to associate more closely with this scheme it would do a great deal for the community and would at the same time greatly increase its prestige. He wished to know if it would not be possible to use this type of project for the maintenance of highways and airports particularly in the winter.

Major G. R. Turner

The author replied that these projects were merely to care for the men until they were assimilated into industry by normal employment demands. Out of one hundred and twenty-three projects, thirty-five were landingfield projects, as part of the trans-Canada airways. At present in Alberta and British Columbia projects were instituted for highway construction and Ontario had relief projects for highway construction under provincial arrangements. "Snow removal" projects had not been considered.

W. McG. Gardner, A.M.E.I.C.[5]

Mr. Gardner wished to know if there were any more projects in view in the near future.

Major G. R. Turner

Major Turner answered that the main difficulty was in selecting suitable projects that could be executed economically during the winter due to our climatic conditions.

Dr. A. Stansfield, M.E.I.C.[6]

Dr. Stansfield wished to know why there were so many more camps in British Columbia than elsewhere.

Major G. R. Turner

Major Turner replied that it was due primarily to climatic conditions, and secondly to the fact that a large number of transient unemployed normally migrate to British Columbia from the Prairie Provinces after the harvest season.

Major LeRoy F. Grant, M.E.I.C.[7]

Major Grant stated that from personal observation he had noted that both the morale and the spirits of the men in these camps were raised, that the men were satisfied and indeed pleased, with the community life. He also remarked that those in charge declared that they received full value in work from the men, this considering all the expenses such as food, clothing, wages, etc.

G. J. Desbarats, M.E.I.C.[8]

Mr. Desbarats drew attention to the benefits which should accrue to The Institute, due to the assistance which had been given in forwarding this relief scheme. He stated that The Engineering Institute of Canada had been the means of placing many married men on the supervisory staff, at low pay, but enough to keep them going and to carry them along until they could get back into their rightful places in the world. The action of the government in giving preference to engineers for these positions had been of great value.

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(4) Maxwell and Pitts, Montreal.

(5) Superintendent of Construction and Maintenance, Montreal Tramways Company, Montreal.

(6) Professor of Metallurgy, McGill University, Montreal.

(7) Royal Military College, Kingston, Ont.

(8) Ottawa, Ont.

# THE UTILIZATION OF MAGNESIAN CARBONATES

*F. E. Lathe*[1]

## DISCUSSION

W. G. Worcester, M.E.I.C.[2]

Professor Worcester observed that the author's paper had proved so interesting that he wished to express his appreciation of the value of such work, the first of its kind in Canada, to the refractory and metallurgical industries of the Dominion.

He had studied the paper from the view point of a ceramic engineer, and felt that the author and his co-workers were to be congratulated on their attack on the problem and the successful outcome, in that they were pioneering with an unsatisfactory and unproved raw material. Further, they had carried the work to a point where laboratory results had been reproducible under commercial conditions, so that today industrial plants were operating successfully and economically on the new Canadian refractories. Thus the position of the Dominion had been altered from that of an unsafe dependency upon importations of magnesian refractories to one of independence.

Professor Geo. A. Guess[3]

Professor Guess stated that the first impression one was apt to obtain in reading the paper was perhaps the benefit which this industry in Quebec had derived from research. The author was naturally excused for stressing this, but from the metallurgists' point of view the interesting thing was that he had developed two new and valuable refractories.

The first was a prepared material ready for patching a basic furnace or for producing a monolithic basic bottom in a new furnace. The second was a refractory brick with great resistance to sudden temperature changes. The author had stated that the addition of chromite reduced the shrinkage in burning. Since it also reduced the spalling one would expect the coefficient of expansion to be lower. Magnesite brick had a high coefficient of expansion and a high heat conductivity. Therefore, it would be interesting to know what these values were for the new basic brick.

Mr. F. E. Lathe[4]

The author in reply to Professor Guess observed that the coefficient of expansion and thermal conductivity of this compound had not been determined, but presumably they were between those of magnesite and chromite. The increase in spalling resistance had been brought about by properly proportioning the grain sizes of the two constituents; it was quite independent of shrinkage.

The shrinkage in burning was quite a different question. Chromite and magnesian clinker, when burned alone, each had a large shrinkage, yet when properly combined the shrinkage could be practically eliminated.

A. Stansfield, D.Sc., M.E.I.C.[5]

Dr. Stansfield remarked that some of the early attempts to utilize the Canadian magnesian carbonates for furnace linings, by sintering in admixture with iron ore, had been made in his laboratory about 1917 by Mr. J. R. Donald, M.E.I.C., and others, and also several pounds of electrically fused magnesia from the Grenville deposit had been produced. It was extremely satisfactory to recognize the work that had been done since 1925 by the staff of the National Research Council and their co-workers, and to realize what an advance had been made, not only in the utilization of the Canadian carbonates, but also in the wider field of basic refractories.

The deposits in the township of Grenville might be described as "magnesitic dolomites." They were supposed to be unsuitable for use in open-hearth furnaces in place of Austrian magnesites because they contained too much lime and were deficient in iron. During the war this material had been sintered with the addition of iron ore, making a refractory that could be used in furnaces, but it had not been as good as the Austrian clinker and so could not retain the market when the latter was once more available. The industrial researches described by the author had not merely overcome the original handicap of the Canadian material, but had produced a basic lining that was superior to the best natural magnesian clinker.

When lining an open-hearth with Austrian clinker, the refractory, in rather coarse grains, was mixed with about one third of its weight of basic slag and shovelled into the furnace. The slag melted and cemented together the almost infusible grains of magnesite and in time, as the slag dissolved magnesia from the adjacent grains of refractory, the slag itself became less fusible, so that the whole lining remained solid at the high temperature of the open-hearth furnace. As, however, the spaces between the grains were of considerable size and as the mixing of the refractory with the slag must be far from perfect, a long time must elapse before the added slag became sufficiently refractory, and there might be places in the lining where some of the slag remained molten and could be washed out by the molten steel or slag of the furnace charge, leaving cavities that would lead to a serious breaking up of the lining. The new basic refractory had been so constituted that there was no need to add any slag when making the hearth. The necessary fluxing material had been intimately and evenly mixed by machinery and each minute grain of periclase was surrounded by the necessary minimum amount of bond, so that the operation of bonding or setting was more rapid and there could be no pockets of fusible slag to cause the destruction of the lining. As no slag was used to fill the cavities between the larger grains of clinker, the product was carefully graded so that there was enough of the smaller sizes to fill these spaces completely, forming, after setting, a truly monolithic lining.

Magnesite bricks were extremely valuable for use in the construction of furnaces that had to stand very high temperatures, and would be more generally used if it were not that they spalled very seriously when exposed to sudden changes of temperature. The new bricks described by the author, which were composed of finely crushed Canadian magnesitic dolomite clinker mixed with coarsely crushed chromite, scarcely spalled at all under the most severe conditions; they should last much longer than the older type of brick and could be used in many places for which the older brick were unsuitable.

This industrial research illustrated the value to industry and to the Canadian people of scientific training and of original thought that was not bound down too closely by the existing methods of reaching a desired end. It also illustrated the necessity for team work. It was seldom that any one man, no matter how capable, could completely solve any of the industrial problems that con-

(1) Paper presented before the Annual General Professional Meeting of The Engineering Institute of Canada, and published in the December, 1933, issue of The Journal.

(2) Professor of Ceramics Engineering, University of Saskatchewan, Saskatoon, Sask.

(3) Department of Metallurgy, University of Toronto, Toronto, Ont.

(4) Director, Division of Research Information, National Research Council, Ottawa, Ont.

(5) Professor of Metallurgy, McGill University, Montreal.

tinually presented themselves, but a combination of men who had been trained in scientific research and industrial workers who were familiar with the technical requirements and the limitations of large-scale operation could usually achieve success. Lastly, in this time of industrial depression, when the National Research Council had been considered by many as a luxury that should be dispensed with, it was satisfactory to realize that its action in this particular had been fully justified.

F. D. Adams, Ph.D., D.Sc., Hon.M.E.I.C.[6]

Dr. Adams stated that he had been a member of the National Research Council when they decided to undertake this work. In his opinion, the Canadian railways had benefited by a large sum annually due to the utilization of these deposits; there had been an increase in coal consumption; exports of magnesian products had increased and imports had decreased. He believed that the results of the research would practically establish some new industries.

L. F. Goodwin, Ph.D., M.E.I.C.[7]

Dr. Goodwin suggested that figures relating to tonnage and value be included in the author's paragraph pertaining to the commercial development of this industry, also that they include some figures on imports and exports of magnesian products. He would be interested to know what the effect was on Austrian magnesite imports, where the various chromite products could be obtained, and how it happened that the excellent flooring had been developed so recently when the results of investigations had been known for so long.

Mr. F. E. Lathe

The author observed that he was not at liberty to give tonnage figures and they would have to be obtained from Canadian Refractories Limited. He could only state that sales had been greatly increased in spite of the severe depression in the steel industry; an active sales campaign had been partly responsible for this. Austrian magnesite brick were still being imported, as the new brick were not yet being manufactured in Canada. The brick used in this country were being brought in from England, where they had been manufactured under the instructions of one of the Canadian research men. At the present stage they were producing variety rather than large tonnage, but it was hoped that American manufacture would soon be arranged, making possible large-scale applications of the new brick in Canada.

Replying to Dr. Goodwin's question in regard to plastic magnesia, he stated that a difficulty in the application of the Canadian material lay in the fact that there was much dolomite in the rock, and ordinary calcination decomposed this, forming free lime, which was very detrimental to the quality of the product. This difficulty had been overcome by carefully controlled calcination, followed by the addition of magnesium sulphate to neutralize any small amount of free lime formed, with the result that there was no free lime in the product. Foreign plastics contained little lime, but this was usually all in the free condition, so that they were inferior in this respect. A second difficulty in the use of any plastic magnesia was that it was very hygroscopic, and imported plastics often contained much magnesium hydrate. The Canadian plastic was being marketed in containers practically moisture proof. In general it might be said that any condition resulting in the formation of magnesium hydroxide was detrimental, whether this was due to the absorption of moisture from the air, the use of too weak magnesium chloride solution, or to any other cause.

H. J. Roast, M.E.I.C.[8]

Mr. Roast mentioned Dr. Donald's work on plastic magnesia and stated that a cathedral in Montreal had a Canadian flooring which, although not perfect, was still giving service after many years. He inquired whether the magnesium sulphate used in the neutralization of lime was added in the solid or liquid condition.

Mr. F. E. Lathe

The author stated that in practice the calcined plastic was analyzed and the calculated amount of magnesium sulphate was added to it in solid form, before grinding. It could, if necessary, be added to the magnesium chloride solution at the time of making up the flooring mixture, in which case it would be in liquid form, but this method was not recommended, as it was more difficult to determine the proper amount of magnesium sulphate to be added.

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[7] Professor of Chemical Engineering, Queen's University, Kingston, Ont.
[8] Roast Laboratories Reg'd., Montreal, Que.

# Recent Progress in Light Sources

*Samuel G. Hibben,*
*Director of Applied Lighting, Westinghouse Lamp Company, Bloomfield, N.J.*

**Paper presented before the Hamilton Branch of The Engineering Institute of Canada, December 12th, 1933.**

*(Abridged)*

Useful kinds of artificial lamps and portable lighting devices have existed for three thousand years. Farther back than that it was a matter of the fagot or the bonfire if anything at all. The incandescent metal filament lamp has been in existence for only about thirty years. The first incandescent lamp for exterior decorations at the World's Fair in Chicago appeared about forty years ago. (See Fig. 1.) The filamentless or gaseous conductor lamps are some three years old, so modern illuminants have not been freely used for any considerable time.

The following table of efficiencies in lumens* per watt of consumption illustrates the progress made in lighting.

| Date available | Type of source | Amount of light per unit of energy used |
|---|---|---|
| 1879 | Early filament lamp | 1.4 |
| 1893 | Carbonized filament lamp | 3.3 |
| 1905 | Metalized filament (carbon) | 4.0 |
| 1906 | Tantalum metal filament | 4.8 |
| 1907 | Squirted tungsten filament | 7.9 |
| 1911 | Drawn tungsten wire | 10.0 |
| 1913 | Inert gas-filled lamp | 12.6 |
| 1926 | Mazda (inside frosted) lamp | 13.2 |
| | Best Mazda (projector type) | 25.0 |
| | High pressure mercury | 40.0 |
| | Sodium vapour lamps | 50.0 |
| | Solar disc (at 6,000 degrees C.) | 80.0 |

This brings to the fore the question of lamp life and efficiency in so far as it affects the pocket book, because it is the desire of everyone to obtain the most light for the least money. Many times one has heard expressed that

*A lumen is the measure of the quantity of light which will produce the illumination of one foot-candle on an area of one square foot at a distance of one foot from a light source. A uniform source of one candlepower emits $4\pi$ lumens.

"lamps do not last as long as they used to do." In many instances they do not, and in many services they should not! If one wants an inefficient, long-life lamp, he can have it, but if a modern, efficient medium-lived is required it also is available. If one wants a very high efficiency short-life lamp, he may have that too.

Consider for example a series of 60-watt lamps, all consuming the same amount of power, but differing only in the matter of life and efficiency.

Fig. 1—Replica of "Stopper" Lamp.

The first lamp will, barring mechanical breakage, have a life of one thousand years. That is its "rated" life, but it does not emit light. The next will live eighteen thousand hours, producing a little light, but with a shorter life. Next there is one that will burn five thousand hours, still somewhat brighter, but not bright enough. Then the one thousand-hour lamp which is the lamp of commerce today. This gives a good bright light of reasonably white colour, with a fair average life. Still, it may not be the best design because if one were willing to sacrifice a little life and use the seven hundred and fifty-hour lamp it would be possible to obtain still more light. A fifty-hour lamp may sometimes be satisfactory if it is going to be used for a short time a week, as a cellar light, or for occasional fine work like sewing or engraving. To take photographs or if a great deal of light was wanted with little need for life, a five-hour lamp should be burned. It emits 1,870 lumens, compared to 740 lumens from the one thousand-hour lamps.

Thus there are the two extremes,—five hours, to many years. The range of filament lamps is interesting, since an increase in efficiency results in a shorter lived lamp but with a tremendous gain in usable light. The cheapest lamp is that which produces its light the cheapest; not the one which merely lasts a long time.

These various lives have gone in extreme directions. For instance the long life lamp we would use for an infra-red or heater lamp, with possibly a life of many years if continually burned, but designed to produce heat and not visible radiation. Its uses seem destined to multiply rapidly.

At the other extreme is the lamp whose light is emitted for less than 1/100 of a second. It is the common photo-flash lamp in which there is a certain amount of oxygen and aluminum foil so that it burns almost instantly emitting more than four millions of lumens in a fraction of a second. Pictures can be taken without such a discomforting flash if a specially coloured bulb is added. Such a lamp is used to take pictures of animals, sports events or courtroom scenes, or wherever glare is to be minimized, without sacrificing the actinic value so necessary to good photographic results.

The photoflood lamp of approximately one hour's life, for taking motion pictures, is a very efficient photography and emergency service lamp. Another recent addition is the long tubular lamp of filament type used in the Century of Progress street lamps in Chicago. A considerable sale is now being found for lamps with two filaments of different candle-powers within the same bulb named the "three-light" lamps. These have a double contact base so that one may have a 200-watt lamp or a 300-watt lamp, or by burning both filaments a 500-watt lamp, thus giving greater flexibility in illuminating stores and shops. (Fig. 2.)

Sealing of the lead-in wires or connections to a lamp bulb in the form of a sphere so as to resist crushing, and developing a self-sealing tight connection so the lamps can be used under water provides a submarine or diving lamp useful beneath the surface of the ocean. It took about three years to discover how not to make such lamps. Attempts were made to seal wires inside a pipe with suitable materials to resist high pressure, but that proved exactly the wrong way to do it. The only way to effect tight joints, is to wrap the wires loosely with rubber tape and let the pressure of the water seal it. About 100 or 300 feet down, the pressure of the water is so great that the rubber tape is moulded into a solid block and sealed. Dr. Beebe, who has gone down 1,000 feet in the ocean for the observation of fish and marine phenomena, uses divers' lamps of this kind as lures.

It is quite possible to obtain light without going through the medium of heat, and without heating up a metal as is done in a tungsten filament lamp. Whether light is considered as a series of waves of projection, or as quanta, like shots, the ordinary atom of the molecule in the element has been thought of as consisting of a nucleus of a positive charge of electrical energy or "proton" and a series of rotating "planets" of negative charges around the centre as in the solar system. The orbits have various radii, these negative

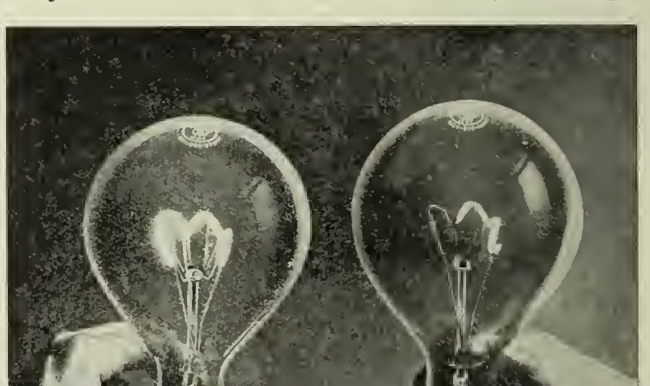

Fig. 2—Three-Light Lamps.

charges balancing the positive charges. What is being attempted is to dislodge these negative charges out of their orbits, for the purpose of man's lighting need—out of their respective paths around the nucleus. If the radius of a negative charge moving around its nucleus is changed, and then allowed to fall back to its old orbit, there will be a giving up or freeing of the energy put into it, and that freed energy may appear as luminous energy or visible radiation. When it is stated that a certain atom is "ionized" it simply means that a charge or electron is dislocated out of a certain path of revolution.

Most scientific research starts with observing Nature's wonders. In the higher latitudes, on nights in winter, of sudden temperature changes, ionization of the gases of the atmosphere may be found and those gases become luminous under the influence of the earth's polar electrical field. This is called the aurora borealis. Crypton, xenon, argon, nitrogen are possible illuminants. Everyone is familiar

Fig. 3—"Black Bulb" Ultra-Violet lamp.

with the glass tubing used with neon gas. Neon is ionized by bombarding the gas atoms with a stream of electrons in the tube, and there results the orange yellow glow. Each gas has its especial spectrum or composite colour.

Most of the tubing in outdoor signs contains neon (orange) or mercury (blue) or helium (cream). They consume on the order of 10 watts per foot of tube, and require high voltage to start. Very little light is obtained from these tubes, say 3 or 4 lumens per watt, compared to 20 from filament lamps, so the ordinary sign tubing is not so good as an illuminant *per se*. One can increase the pressure of the gas as is being done now in metallic vapour lamps, and get 30 or 40 lumens per watt. Heat the electrode or cathode and thus increase the storm or flow of electrons from such, and thus increase the output of light.

Included in the hot cathode type of vapour lamps are neon, mercury, zinc, sodium and several others. Some of these are in the form of a bulb rather than in the form of a tube. The mercury lamp of a hot cathode type of vapour unit in a bulb gives a blue spectrum. There is a limited current flow, and by putting the electrodes within a bulb instead of a tube more convenient shapes for reflectors may be achieved.

Mercury vapour may show ultra-violet or short wave radiation, too short to be seen by the human eye. Ultra-violet radiation has many uses among which is that of increasing the lime and phosphorus content of the blood and so improving the condition of the bones, teeth, finger-nails. As a body treatment it will tan the skin and aid in curing certain diseases chiefly of the outer surfaces. It will also develop ozone in the air, to purify or sterilize.

Extremely short waves, from special lamp types, will produce tan or sunburn in two or three minutes. Short wave ultraviolet can speed up the tanning of leather, aid in the detection of oils in sewage, the testing of pigments as against sun-fading and the fastness of dyes—useful in a hundred different ways.

In the production of this "black light" the hot cathode type of lamps can be used in producing mercury spectra. Practically the only "light" escaping will be of the short wave length invisible to the human eye but visible if photographed. (See Fig. 3.)

In 1933 an interesting sodium vapour lamp installation was made at Port Jervis, N.Y., where some 3,000 feet of concrete highway is illuminated using ornamental steel standards spaced 125 feet apart along the outer edge of the roadway, 6 feet from the paving line. (See Fig. 4.) This is a two-lane 30-foot width highway extending from the edge of the business district into the suburbs and constituting part of a main artery for east and west traffic. Mounted on the top of each standard at a height of approximately 14 feet is a Westinghouse sodium vapour lamp bulb nominally rated at 4,000 lumens, enclosed in a heat-insulating vacuum cylinder or flask, and in turn surrounded by a glass bowl refractor. The ornamental steel pole and lighting fixture includes a special light density opalescent outer globe, some 18 inches in diameter.

Within the base of each post is mounted a transformer operating on the 6.6 ampere series primary circuit and delivering to each sodium lamp, through the four-wire secondaries up the posts, the two voltages required for lamp operation. The series circuit for this group of sodium lamps is part of a straight a.c. system now feeding other series filament lamps in the city, and from a standard automatic tub transformer. A clock switch throws in the lamps at dusk and they burn until dawn, approximately fourteen hours.

As lighting science progresses it is opening out into so many enlarging fields that there is no end in sight in the development of illuminants and lighting research.

Fig. 4—Highway Lighting with Sodium Vapour Lamps.

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## Municipalities and Engineering Services

Some time ago the Council drew the attention of The Institute's members to the course taken by certain municipalities in advertising for tenders for the professional engineering services required for the design of their waterworks, sewage treatment plants or other public works. It was pointed out that this practice is not only open to serious objection from the engineers' point of view, but also is not in the best interests of the city, as leading to a form of competitive underbidding which makes it unlikely that the city will obtain services of the highest character. A city father with a troublesome appendix would hardly ask for competitive bids from surgeons for the necessary operation, nor would he receive them if he did so, but apparently he has no hesitation in regarding an engineer's professional skill and experience as an ordinary article of commerce to be purchased at the lowest price obtainable. The efforts of engineering societies to discourage this kind of thing, and the publicity given to such cases have not yet resulted in entirely preventing their repetition.

Quite recently there have been instances where the practice has taken a somewhat different form. Early this year, for example, a city in Ontario needed a city engineer, and advertised the vacancy, requiring applicants to state the salary they require. This action is not only expressly forbidden by Section 253 of the Ontario Municipal Act, R.S.O. 1927, and its amendments, but is evidently unethical, for it is, in fact, another form of competitive underbidding.

Cases of this kind have been considered by the Council of The Institute, and in Council's opinion members of The Institute should refrain from replying to advertisements of this character, or, indeed, to any enquiry made under conditions which render it doubtful whether the best man available will receive the appointment.

## Institute Members and The Journal

Among the engineering societies of the world there are few whose main body of membership is distributed over so wide an area and engaged in such widely diversified branches of engineering as is the case with The Engineering Institute of Canada. In an organization of this kind there is special need for some means of regular communication with all the members, in the form of a periodical which will keep them informed of each other's professional and social activities, will further their mutual interests and will serve as a medium for the interchange of professional knowledge.

In fact, such a magazine must be more than a mere record of the proceedings of Council, or a collection of the technical papers presented at meetings. It should in addition be available as a kind of forum for the membership, affording space for notes and correspondence giving members' views on technical problems or questions of the day. It should reflect the ideas of the thoughtful engineer, and encourage their presentation to the membership for discussion.

Since it was established in 1918, The Engineering Journal has won for itself a definite place in the growing array of technical periodicals. It differs from most of these in being owned by those who contribute the bulk of its contents. It has amply justified the enthusiasm of its founders and has knit together the twenty-five Branches of The Institute in a way which would have otherwise been impossible. Its technical articles have recorded the varied engineering activities of The Institute's members. In the Branch News will be found the story of the proceedings of our Branches. Its Personal items are consulted by members all over the country for tidings of old friends and acquaintances from whom they have long been separated.

But there is always room for improvement in a magazine of this kind, and the Editor would like to point out two features, which, with the active help of the membership, it would be possible to include, which in his opinion would add materially to the interest of The Journal, and which, most important of all, could be made effective without any additional drain upon the funds of The Institute.

For some reason or other, many of our members seem reluctant to see themselves in print. Apart from the larger works which furnish subjects for important professional papers, there are many engineering projects of lesser scope which present features of technical interest, particularly to the younger members. Why are these not described in brief, pithy articles by those who are familiar with them? Why do members hesitate to tell others of the dodges they have had to evolve or the gadgets they have had to devise to get over some difficulty or to make good some mechanical or electrical defect? No doubt many engineers feel that the problems arising in their daily work are of so ordinary a kind that they cannot be of interest to others. This may be true in a few cases, but in many instances such information would prove most helpful to those engaged in similar lines of work. Will our members, particularly the younger ones, take note of this and render a service to The Institute and to themselves by contributing material of this kind?

The correspondence columns form one of the most interesting features in the monthly magazines of several of our sister societies. Some of the letters they contain comment upon the subject matter of papers previously published, others give the writers' views on some topic of the day. All form part of a body of discussion which is readable and informative, and affords to those who take part in it admirable practice in the art of expressing oneself clearly and tersely. Why do we not have more material of this kind in The Journal? Surely it is not because the average member does not think, or cannot put his thoughts into words. Taking a few topics at random, has he no ideas on such subjects as slum clearance, fishways, the depreciation of electrical machinery, the post-graduate education of engineers, or traffic regulation in cities? No apology is needed for bringing these matters to the notice of our readers.* The Journal depends for its contents upon our members, who have it in their power to supply or withhold the material we need to make our chief publication worthy of The Institute and fully representative of its membership.

The Journal's Board of Management and the Editor invite all members who can do so to co-operate by sending in contributions likely to be of interest to their fellow members, whether in the form of professional papers, notes, letters or memoranda. They are asked to contribute to our correspondence columns, and to submit discussion and comment on papers previously published or on topics of engineering interest. If they will do this, The Journal will continue to gain in interest and popularity and will become increasingly effective as the organ of The Engineering Institute of Canada.

*See also The Engineering Journal:—
March 1932, p. 162, "The Interchange of Professional Knowledge."
April 1933, p. 186, "Engineers' English."
May 1933, p. 226, "Fifteen Years of The Journal."

## Address of Sir William Clark, K.C.S.I., K.C.M.G., High Commissioner for the United Kingdom

**At the luncheon held on Thursday, February 8th, 1934, during the Annual General and General Professional Meeting of The Engineering Institute of Canada, held on February 8th and 9th, 1934, in Montreal.**

It is a great pleasure to be the guest of this Institute which represents so comprehensively the distinguished and honourable profession of the engineer. I use those adjectives advisedly, gentlemen, for yours is the outstanding profession of this age. You and your predecessors, the inventors, the scientists, the engineers of previous generations have been the architects of this modern civilization of ours, and have brought about wonderful changes within the last century. It is hard to realize that if a man of the Augustan age had been transported across eighteen centuries to the Napoleonic era, he would have felt much more at home than a man of the Napoleonic era if transported across one century to our own times.

Through those eighteen centuries, for example, the world had to be content with the horse for locomotion. When Napoleon drove across Europe in the travelling carriage, he probably passed over worse roads than those along which the Romans marched and which made their great Empire possible.

You and your predecessors have brought the world into one close unit. You are the magicians. As a layman, I have no idea how you do it, or why it is that the bridges you are going to talk about this afternoon, stand up. I don't know how your complex machines work. When I am taken through some vast plant, and am half deafened with the noise, I realize that the only thing to do is to cease to ask for information and merely to realize what very great men you are.

But, gentlemen, recently, I am sorry to say, some doubts have been expressed. It has been suggested that your influence in the world has not been wholly beneficent, but instead of being a benefit your work may actually have become a detriment to the prosperity of the world. It has been said that the extent of your activities, the extent of the mechanization for which you are responsible, has caused at one and the same time, over-production and unemployment, and, indeed, as some people argue, has precipitated the crisis through which we have all been passing. If that were true, it would be a very serious business for the world because it would mean that humanity would have to forswear further progress in the lightening of its burdens.

But, as a matter of fact, it is not, I believe, a tenable theory. I think you will agree with me that it is one of those *a priori* theories, which look plausible at first sight, similar to that of the people who tell you that unemployment is merely the result of over-population. What is true is this: that the rapidity with which new processes have been developed, new inventions and new industries have been created, has created disturbances which have contributed to the derangement of our economic equilibrium, but that is a different thing from arguing that progress itself can be an evil.

A very obvious example is the course of events in the nitrate industry. A beneficent providence decreed that near the Pacific coast of South America should be found vast deposits of nitrate of soda which were subsequently carried both to our own country and all over the world, creating wealth and aiding transportation, commerce and production. The same Providence also decreed that there should be nitrogen in the air, free to all, and now as the result of the work of busy engineers, the same nitrate is made much more cheaply from the air. The result has been the bankruptcy of a great industry, great losses to shipping and the impoverishment of one of the most prosperous of the South American nations. Nevertheless, a balance of advantage to the world undoubtedly remains.

The reason why the theory started that over-mechanization produced the slump is, I think, that in certain industries undoubtedly there has been—and certainly on this continent—over-expansion of plants, due partly, no doubt, to uneconomic, anarchic competitiveness on the part of the people in charge of those industries, and partly to what may be called an over-development of the machine mentality.

Such over-development no doubt contributed to the general disturbance, but was not one of the primary causes. I was reading the other day a book written by a friend of mine, a distinguished economist, whose books I sometimes buy, not merely because he is a friend, and still less because he is a distinguished economist, but because his books, unlike those of most other distinguished economists, are intelligible and therefore flattering to my limited understanding. He demonstrated very clearly, by the use of statistics, that even in 1929 there was not actually in the United States a larger expansion of industry in general than the income of the time justified, but there was over-expansion in certain industries which certainly contributed to the general derangement of financial equilibrium.

So far as Great Britain is concerned, it has been an advantage to us that since the War there has been little over-expansion of that kind. I don't say that we have been wiser than the people on this side of the Atlantic, but circumstances have been different. Between 1925 and 1929, we did not have a boom. We went back to the gold standard in 1925 and that meant a period of deflation. We did not participate in the advantages of other countries during that time and were not tempted to launch into heavy fixed capital commitments. That has proved an advantage during the slump, because our plants have had a smaller proportion of idle capacity. It has meant that our industrial concerns have been able to conserve their resources, and to use them for expansion and improvement, now that better times are in view.

The turn of the tide in Great Britain came with our departure from the gold standard in September 1931.

That relieved the monetary tension. It took some time to have its effect. The bank rate was at first maintained at a high point to protect our gold reserves, but from about February or March, 1932, the Bank of England reduced the bank rate and started buying securities in the open market; and thus paved the way for the great conversion operation of the summer. The success of that operation was of immense importance; not only to us, in the saving of interest on our large national loans, but also for the rest of the world. We have established low rates for long-time borrowing by good borrowers in London, and for that matter, elsewhere.

We have to confess that the national extravagance in our expenditure helped to precipitate the crisis but, none the less, the intrinsic financial situation in England was, in effect, sound. Our great banks had tucked away hidden reserves and profits made in better times and they entered the depression in so strong a position that there has never been any whisper during the depression of any trouble in that direction. You in Canada know what an immense difference it makes when banks are in that happy state—what an immense difference it makes to have the support of a sound and strong banking system!

This fundamentally sound situation shows itself in another way in the recovery recently of the capital market. It shows that there are still savings laid away and that investors have recovered confidence. In the last year, just finished, we have been able to lend a hundred and thirty million sterling. It has been mostly utilized at home and much of it in industry, which shows that industry is on the upgrade. Not much went overseas—but some thirty million of it went to the British Empire.

As to the improvement in national finances in Great Britain, the revenue returns for the first nine months are very encouraging. Our system is rather a peculiar one. The income tax comes in in the last three months of the financial year so we always run a deficit for the first nine months, covered by borrowing on treasury bills. Last year the deficit was over two hundred million sterling at the end of the year and this year it is only one hundred million. That is partly due to an increase of twelve millions in revenue, but the larger improvement was on the expenditure side with a saving of fifty-five million. It was a tremendous saving, due mostly to the saving on interest in the various conversions which have taken place, and also in the low rate of treasury borrowing.

We are full of hope about getting our taxes a little lower. Hope is the only thing that isn't taxed in England at the present time and we are looking forward with a reasonable modicum of it to the budget speech. Even the Chancellor of the Exchequer has permitted himself some optimism in a recent speech.

The other great advantage we have had, apart from the advantage of going off the gold standard, was the adoption of a tariff. Whatever view any of you may take on the fiscal issue, I think you will agree that a tariff when first put on is bound to be a very useful stimulant. Let me give an illustration from dynamics. Suppose somebody has taken in succession—a rash thing to do—five cocktails. I think you will agree that he gets a better, more effective kick, between zero and the first cocktail, than between the fourth and fifth.

That is a fair parallel as between our fiscal policy and that of other nations. During the slump, everybody has had to go on raising tariffs, whereas we have started, mostly, from no tariff at all. The great advantage to us has been that whereas every country which like England depends on foreign trade has naturally lost a lot of trade abroad, we have been able to compensate by getting a lot of additional trade at home—additional because tariffs have gone on for the first time. Also, it has helped us greatly in negotiations. We have been able to enter into the Ottawa agreements—there is no time to talk of them today. We have also been able to make arrangements with foreign countries which have helped our trade in certain lines, especially as regards coal, and also, a little retaliation has been practicable when it has seemed necessary. We were rather helpless under our free trade system; when other countries did things we didn't like, or treated us unfairly, or showed discrimination, we couldn't do anything about it, but the position is different now.

Now for a few indications of the actual improvement which has taken place. The best index of course, is the trend of unemployment. Unemployment figures in the course of this year, since last June, have fallen by some 679,000 and the numbers of men taken into employment have increased by 742,000. The latter figure includes new entrants into industry, as well as men in employment before. Our figures are actual figures and not estimates; they are based on the registration of men in industry for insurance purposes.

In some of our industries, employment has been steadily maintained right through the winter season, and in the heavier industries, particularly, the improvement continues. Indeed, the basic industries are showing a very remarkable recovery. The average monthly production of steel in 1933 has gone up by 33 per cent compared with 1932 and that has been due very largely to the increased demand for capital equipment which is in itself a good sign, for that demand is what falls off most in times of depression. Railways have been re-equipping themselves, building has been increasing, also ship-building. Our motor industry has made remarkable progress; in the first nine months of the year its production increased by 23 per cent as compared with the same nine months of the year before.

And the engineers—I don't want to make your mouths water—the engineering industry have got their order books full enough to be happy for about the next six months.

Our export trade, of course, has not been so good. That is a different picture, but even there some improvement is shown; it has increased by some two million pounds over 1932, which in fact represents a considerably larger increase in the volume of trade because there has been a further fall in prices.

Especially there has been a satisfactory increase in exports under such headings as the non-ferrous metals, woollens, iron, steel, motors, and in the increased import of raw materials—wool, cotton, timber, hides, and iron ore—is a good omen for the future.

All this gives an encouraging picture. But there is still unhappily a nigger in the woodpile, and that is in the foreign trade. We have increased our share of the world trade, but, unfortunately, the volume of the world trade is lower again in 1933 as compared with what it was for 1932.

That may not worry those people who think any nation can pull itself up by its own shoe strings—an experiment in engineering which I fancy none of you would think very feasible. But despite all those indications of improvement to which I have referred the fact remains that in Great Britain we have still two million two hundred thousand men unemployed and you will find a similar phenomenon in other countries. Clearly the cause of the trouble is the failure to attain the recovery of international trade, and I am afraid one must add, with the present situation of the world and the unhappy state of political insecurity in Europe and the Far East, the prospects of its restoration are not, at the moment, as good as one would wish. We must admit that, but I don't want to dwell on that dark side. I would rather ask you to note the progress that has been made. We see how great it has been as we look back on the whirlpools and the rapids through which we have passed in the last two years. I would ask you rather to cling to the thought that the lowest point of the depression was reached and passed about a year ago.

There are a lot of people who disbelieve in the influence of the trade cycle, partly because they think we oughtn't to go on allowing trade cycles to influence human affairs and there is a great deal to be said for that no doubt, but it is a comforting thought for the moment that while the cycle has brought us down, it unquestionably took an upward turn about February or March of last year and is now carrying us up. I have given you indications of this in my own country. You business men know of similar indications in Canada, and there is evidence from other countries, from Australia, especially, and from South Africa, and of course one is glad to see it in many foreign countries as well.

Especially, I would ask you to recall—I am speaking now, I need hardly say, not for Great Britain alone, but for all our peoples—that whatever mistakes any of us may have committed—and there have been plenty of them—none of our people have at any time made bad worse by giving away to panic. They have borne their afflictions with a patient stoicism which has been above all praise and they have earned the right to emerge from their troubles by maintaining their courage unimpaired through all these difficult and dangerous times. (Applause.)

## Meeting of Council

A meeting of Council was held at Headquarters on Tuesday, March 20th, 1934, at eight o'clock p.m., with President F. P. Shearwood in the chair, and eight other members of Council present.

A committee under the chairmanship of Mr. R. E. C. Chadwick, M.E.I.C., was appointed to co-operate with the National Committee on Sound Public Finance which has been established under the auspices of the Canadian Chamber of Commerce.

The committee under the chairmanship of Mr. Fraser S. Keith, M.E.I.C., which was appointed to study the proposed Civil Service classification scheme of the Government of Saskatchewan, reported that a memorandum had been prepared on behalf of the Council of The Institute, and together with supporting representations from the Saskatchewan Branch of The Institute, had been submitted to the Saskatchewan Public Service Commission.

The following committees were appointed for the year 1934:

*Gzowski Medal Committee*

R. W. Angus, M.E.I.C., *Chairman*
F. C. Dyer, M.E.I.C.
F. R. Ewart, M.E.I.C.
W. P. Near, M.E.I.C.
R. B. Young, M.E.I.C.

*Board of Examiners and Education*

A. F. Dyer, A.M.E.I.C., *Chairman*
W. P. Copp, M.E.I.C.
F. R. Faulkner, M.E.I.C.
H. S. Johnston, M.E.I.C.
J. Stephens, M.E.I.C.
E. O. Turner, A.M.E.I.C.

*Membership Committee*

D. C. Tennant, M.E.I.C., *Chairman*
A. Frigon, M.E.I.C.
F. S. B. Heward, A.M.E.I.C.
C. K. McLeod, A.M.E.I.C.

*Unemployment Committee*

D. C. Tennant, M.E.I.C., *Chairman*
A. Duperron, M.E.I.C.
R. J. Durley, M.E.I.C.

*Students' and Juniors' Prizes*

| | | |
|---|---|---|
| H. N. Ruttan Prize | R. S. L. Wilson, *Chairman* | Edmonton |
| | F. M. Steel | Calgary |
| | H. L. Swan | Victoria |
| John Galbraith Prize | E. G. Cameron, *Chairman* | St. Catharines |
| | R. L. Dobbin | Peterborough |
| | J. J. Traill | Toronto |
| Phelps Johnson Prize | Ernest Brown, *Chairman* | Montreal |
| | C. B. Brown | Montreal |
| | F. Newell | Montreal |
| Ernest Marceau Prize | A. B. Normandin, *Chairman* | Quebec |
| | H. Cimon | Quebec |
| | B. Grandmont | Three Rivers |
| Martin Murphy Prize | A. Gray, *Chairman* | Saint John |
| | H. J. Crudge | Moncton |
| | A. F. Dyer | Halifax |

On the recommendation of Mr. Challies, and after consultation with Mr. Keith, it was decided to establish a Committee on Relations with National Societies, its chief function being to promote friendly relations with sister Engineering Societies. It was decided to request Mr. John Murphy, M.E.I.C., of Ottawa, to act as chairman of this committee, and nominate its membership for the approval of Council.

A draft programme for the Western Professional Meeting of The Institute, to be held conjointly with the Summer Convention of the American Society of Civil Engineers in Vancouver in July, was submitted by the local joint committee making the arrangements for the meeting, and was tentatively approved by the Council, subject to the adjustment of minor details.

A letter from the Hon. W. A. Gordon, Minister of Labour, to Dr. Lefebvre as President of The Institute, thanking The Institute for its effective co-operation with General McNaughton and the Department of National Defence in their efforts to handle the problem of relief camps set up under the Department, was noted with appreciation.

Seven resignations were accepted, a number of members were reinstated, seven members were placed on the Non-Active List, and three Life Memberships were granted.

A number of applications for admission and for transfer were considered, and the following elections and transfers were effected:

| *Elections* | | *Transfers* | |
|---|---|---|---|
| Members | 3 | Junior to Assoc. Member | 8 |
| Assoc. Members | 5 | Junior to Affiliate | 1 |
| Juniors | 1 | Student to Assoc. Member | 2 |
| Students admitted | 8 | Student to Junior | 1 |

The Council rose at ten forty-five p.m.

## OBITUARIES

### The Right Hon. the Earl of Aberdeen, P.C., LL.D., Hon.M.E.I.C.

Deep regret is expressed in recording the death at his home, the House of Cromar, Tarland, Aberdeenshire, on March 7th, 1934, of The Right Hon. the Earl of Aberdeen, P.C., LL.D., Hon.M.E.I.C.

The Marquis of Aberdeen, who was born in 1847, succeeded to the earldom in 1870, being the seventh holder of the title, which was created in 1682. In 1880 the Earl was appointed Lord Lieutenant of Aberdeenshire, and in 1881 became High Commissioner of the General Assembly of the Church of Scotland. During the Gladstonian administration of 1886 he held the office of Lord Lieutenant of Ireland. The next position of high prominence to which his lordship was called was that of Governor General of Canada, which office he held from 1893 to 1898, his regime opening two years after the death of Sir John A. Macdonald, first Prime Minister of the Dominion. In 1905 Lord Aberdeen entered upon a second term as Lord Lieutenant of Ireland, a term which extended to the unusually long period of ten years. On leaving Ireland, Lord Aberdeen was created a Marquis. In a few months the Marquis again assumed the position of High Commissioner of the Church of Scotland, and his second period as such marked the close of his long years of public service.

On January 4th, 1894, when he was Governor General of Canada, the Marquis of Aberdeen, having graciously consented, was elected an Honorary Member of The Institute (then the Canadian Society of Civil Engineers).

### William Henry Wardwell, M.E.I.C.

The membership of The Institute will learn with regret of the death at Montreal on March 15th, 1934, of Major William Henry Wardwell, M.E.I.C.

Major Wardwell was born at Buffalo, N.Y. on June 8th, 1875, and graduated from Cornell University in 1897. In 1898 and 1899 he was engaged on design and as head of the testing department of the J. J. Case Company, at Racine, Wis., and in the following year he was superintendent of the Wisconsin Wheel Works at Racine. In 1901 Major Wardwell came to Canada as chief engineer and superintendent of construction for the Shawinigan Carbide Company, in complete charge of the construction and equipment of the plant. From 1904 to 1907 he was general manager of the Continental Heat and Light Company, and subsequently until 1911 occupied the same position with the Shawinigan Carbide Company. In 1912-1913 Major Wardwell was a partner in the firm of Reynolds Wardwell Company, Montreal, and in the latter year entered private practice in Montreal as a consulting engineer specializing in fireproof design and construction. On the entry of the United States into the war Major Wardwell offered his services to the American authorities, and he was given a special commission, being in charge of airplane assembly. For the service which he rendered to the United States his country offered him the rank of colonel, which he refused.

Returning to private life at the end of the war, Major Wardwell established himself in Montreal's commercial life, particularly in the field of architectural engineering. One of his best known feats of engineering was undertaken some years ago, when he planned the moving of the Morgan Trust building from its original site to some distance up the street.

Major Wardwell was a member of the United Services Club, the Canadian Club and the Thistle Curling Club. An influential member of the American Legion, he was a past commander of the Montreal Post.

He become a Member of The Institute on March 25th, 1919.

### W. J. V. Bennett

Regret is expressed in recording the death by drowning on March 1st, 1934, of W. J. V. Bennett, vice-president of the Bennett and White Construction Company, Calgary, an Affiliate of the Calgary Branch of The Institute.

Mr. Bennett, who was held in high esteem by those who knew him, settled in Calgary in 1910, when he started in the construction business with his brother. In 1920 he joined the firm as it is known now, and had been active in it since that time.

The accident which caused Mr. Bennett's death was the breaking of a gang plank above a flume. Mr. Bennett fell into the flume and was carried down beneath the ice.

## PERSONALS

H. Ross MacKenzie, A.M.E.I.C., chief engineer of the Department of Highways, Province of Saskatchewan, Regina, Sask., was elected president of the Association of Professional Engineers of Saskatchewan, at the annual meeting of that Association held in Regina on February 22nd, 1934.

Karel R. Rybka, A.M.E.I.C., has entered private practice in Montreal as a consulting engineer for the mechanical and electrical equipment of buildings. After graduation from the University of Prague in 1923, Mr. Rybka was engaged for several years on various engineering work in Prague. Coming to Canada in 1928, he joined the staff of Ross and Macdonald, architects, in Montreal. Mr. Rybka is the author of the book "Amerikanische Heizungs und Lueftungspraxis" and of other papers on engineering subjects.

Colonel W. G. Tyrrell, D.S.O., M.E.I.C., has accepted the appointment of Assistant Director of Transportation at the War Office, England. Colonel Tyrrell's duties involve technical and engineering matters regarding transportation services (railways, inland water transport and docks), agreements with home railway companies, questions involving transportation policy and intelligence, technical instruction and training of railway troops and the administration of the Transportation Branch of the Supplementary Reserve. Colonel Tyrrell was promoted to his present rank on January 1st, 1933, with seniority June 3rd, 1923.

R. M. Calvin, A.M.E.I.C., has been appointed sales manager of Canadian Vickers Limited, according to a recent announcement. Mr. Calvin has been acting sales manager since June 1933. His connection with this company dates back to 1927, when he joined the sales staff of the industrial engineering department. He is a graduate of Queen's University, from which he received the degree of B.A. in 1911 and B.Sc. in 1914. Following graduation, Mr. Calvin was on the engineering staff of the Canadian Stewart Company on the Toronto harbour improvements, resigning in November 1914 to enlist for overseas. He served with the Canadian Engineers from that date until he was discharged with the rank of Major in March 1919. In 1919 Mr. Calvin joined the staff of the Dominion Water Power Branch of the Department of the Interior at Ottawa, and was engaged on power investigation. During the years 1921 to 1927 he was connected with the H. S. Taylor Company, in Montreal, and the Dominion Rubber Company.

H. G. Thompson, A.M.E.I.C., has recently joined the sales force of Canadian Vickers Limited, and will specialize in the boiler field.

Following his return from overseas, where he served with the R.N.A.S., Mr. Thompson completed his course at the University of Toronto, from which he graduated in 1922 with the degree of B.A.Sc., and from November of

H. G. Thompson, A.M.E.I.C.

the same year until May 1923 was engaged on engineering design, estimating and sale of heating and ventilating equipment with the Canadian Sirocco Company, Limited, Montreal. From June to November 1923, he was supply engineer for pulp mill equipment with the Riordon Company Limited at Temiskaming, Que., and from that time until 1925 was connected with the Combustion Engineering Corporation Limited, as engineer on erection, service and sale of boilers, mechanical stokers, etc., and later as assistant to the Montreal manager. In October 1925 Mr.

Thompson joined the staff of Affiliated Engineering Companies Limited, and in 1930 became associated with F. S. B. Heward and Company Limited, Montreal. During the past two years Mr. Thompson has been on the staff of The Institute as Editor of Indices of the E.I.C. Engineering Catalogue.

### J. E. Armstrong, A.M.E.I.C., President of the American Railway Engineering Association

J. E. Armstrong, A.M.E.I.C., assistant chief engineer of the Canadian Pacific Railway Company, Montreal, has been elected President of the American Railway Engineering Association. With election to this office, Mr. Armstrong in addition automatically becomes chairman of the engineering division of the American Railway Association.

Born in Peoria, Ill., Mr. Armstrong graduated from Cornell University in 1908, and was subsequently until 1912 assistant on the engineer corps of the Cleveland and Pittsburgh Division of the Pennsylvania Company at Cleveland, Ohio. In 1912 he became assistant engineer with the Canadian Pacific Railway, and in 1928 received the appointment which he now holds.

Mr. Armstrong has been engaged on many important works including the Quebec joint terminals, the waterfront development at Saint John, railway revision during the war, and the construction of the Toronto viaduct from 1924 to 1930.

In 1927 Mr. Armstrong was a director in the American Railway Engineering Association, and in the following year became second vice-president.

## ELECTIONS AND TRANSFERS

At the meeting of Council held on February 23rd, 1934, the following elections and transfers were effected:

*Members*

CARRIE, G. Milroy, B.A.Sc., (Univ. of Toronto), general manager, Canadian Refractories Limited, Montreal, Que.

DUNCAN, George Marr, designing engr., Department of Public Works of British Columbia, Victoria, B.C.

*Associate Members*

BRAUNS, Otto L. J., C.E., (Royal Inst. Tech., Stockholm), asst. chief chemist, Abitibi Power and Paper Co., Sault Ste Marie, Ont.

HARKNETT, Stewart George, (A.M.Inst.E.E.), manager, elect'l. dept., Mumford and Medland, Winnipeg, Man.

WILSON, William Fairbairn, (Univ. of St. Andrews), in charge of appraisal and valuation, Winnipeg Electric Company, Winnipeg, Man.

*Transferred from the class of Junior to that of Associate Member*

CURREY, Allan Robert, B.Sc. (Queen's Univ.), president and chief engineer, Industrial Utilities Ltd., Montreal, Que.

EAGER, Norman H. A., B.Sc. (McGill Univ.), M.C.E. (Cornell Univ.), industrial engr., Shawinigan Water and Power Company, Montreal, Que.

KURTZ, Harold John, B.Sc., (Queen's Univ.), 402 Bartram Ave., Sudbury, Ont.

PHILLIPS, John Bernard, B.Sc., M.Sc., Ph.D., (McGill Univ.), lecturer, chemical engrg., McGill University, Montreal, Que.

TOYE, Arthur MacFarlane, B.A.Sc., (Univ. of Toronto), designing engr., Dept. Highways Ontario, Toronto, Ont.

WIGHTMAN, John, B.Sc., (McGill Univ.), field engr., Cons. Mining and Smelting Co., Amos, Que.

WINSLOW, Kenelm Molson, B.Sc. (McGill Univ.), sales engr., Dominion Engineering Works, Montreal, Que.

*Transferred from the class of Student to that of Associate Member*

MOORE, William Herbert, B.Sc., M.Eng., (McGill Univ.), engr., Canadian Marconi Co. Ltd., Montreal, Que.

*Transferred from the class of Student to that of Junior*

BOUCHER, Raymond, B.A.Sc., C.E., (Ecole Polytech., Montreal), 19 Clinton St., Cambridge, Mass.

HUNT, Edward Victor, B.Sc., (Univ. of Man.), Davenport Works, Canadian General Electric Co. Ltd., Toronto, Ont.

*Students Admitted*

ROBINSON, William Morecroft, (McMaster Univ.), 23 Market St., Dundas, Ont.

ROYER, Jacques, (McGill Univ.), 1990 Rachel St. East, Montreal, Que.

SCOBIE, A. Gordon, (McMaster Univ.), 472 King William St., Hamilton, Ont.

TAYLOR, James Lawrence, (Queen's Univ.), Barriefield, Ont.

TUCKER, Robert Norman, (McMaster Univ.), 123 Chestnut Ave., Hamilton, Ont.

At the meeting of Council held on March 20th, 1934, the following elections and transfers were effected:

*Members*

GOHIER, Joseph Arthur Ernest, B.Sc., (McGill Univ.), consltg. engr., 10 St. James St. East, Montreal, Que.

LEE, Leonard Alldwyn Cole, B.A.Sc., (Univ. of Toronto), chief concrete engr., bldg. dept., City Hall, Toronto, Ont.

SANCTON, George Edward, (Finsbury Tech. Coll.), pres. and gen. mgr., Fraser & Chalmers of Canada Ltd., Montreal, Que.

*Associate Members*

AUSTIN, Frank Douglas, B.A.Sc., (Univ. of Toronto), 1510 Bathurst St., Toronto, Ont.

BENETT, Charles Morgan, B.Sc., (McGill Univ.), inspection engr., Charles Warnock and Co., Montreal, Que.

DYER, Walter Gerald, B.Sc., (Univ. of Sask.), transitman, C.P.R., Regina, Sask.

McLEOD, Simon Fraser, inspector of boilers and machinery, Govt. of Alberta, Lethbridge, Alta.

MOXON, George Burnham, (Assoc. Member, Inst. C.E. (Great Britain)), 359 Victoria Ave., Westmount, Que.

*Junior*

MIALL, Edward Jr., (Grad., R.M.C.), (Univ. of Toronto), sub-foreman, Unemployment Relief Project No. 40, Petewawa, Ont.

*Transferred from the class of Junior to that of Associate Member*

COULTER, Hugh John, B.A.Sc., (Univ. of Toronto), foreman, meter shop, Detroit City Gas Co., Detroit, Mich.

GOBY, Thomas, B.Sc., (Tri-State Engrg. Coll.), sales engr., Armco Culvert Mfg. Assn., W. Q. O'Neall Co., Crawfordsville, Indiana.

GRAY-DONALD, Erceldoune Donald, B.Sc., (McGill Univ.), supt., power divn., Quebec Power Company, Quebec, Que.

KERRY, Armine John, Capt., R.C.E., (Grad., R.M.C.), B.Sc., (McGill Univ.), works officer, Mil. Dist. No. 5, Quebec, Que.

NAISH, Sidney Gordon, B.Sc., (Durham Univ.), eastern district mgr., Peacock Bros. Ltd., Sydney, N.S.

RAPLEY, Blake Parker, B.Sc., (Queen's Univ.), asst. mech'l. supt., Imperial Oil Refineries Ltd., Sarnia, Ont.

SAMPSON, Cyrus Dexter, (Acadia Univ.), engr., Intercolonial Coal Co. Ltd., Westville, N.S.

SPOTTON, John Greer, B.A.Sc., (Univ. of Toronto), sales engr., Delaney and Pettit Ltd., Toronto, Ont.

*Transferred from the class of Junior to that of Affiliate*

BROSSEAU, Joseph Charles, (Montreal Tech. School), engr., City Hall, Verdun, Que.

*Transferred from the class of Student to that of Associate Member*

LAING, Addison Kerr, B.Sc., (McGill Univ.), hydrographic engr., Hydrographic Service, Dept. of Marine, Ottawa, Ont.

WEIR, Ronald Albert Stanley, (McGill Univ.), asst. industrial lubricating engr., Imperial Oil Limited, Montreal, Que.

*Transferred from the class of Student to that of Junior*

PATRIQUEN, Frank Andrew, B.Sc. (E.E. and C.E.), (Univ. of N.B.), junior engr., Saint John Harbour Commission, Saint John, N.B.

*Students Admitted*

DESCOTEAUX, Paul R., (Ecole Polytechnique), 1660 St. Andre St., Montreal, Que.

FLETCHER, Thomas Henry, (Univ. of N.B.), 278 Westmoreland St., Fredericton, N.B.

FLEURY, Maurice, (Ecole Polytechnique), 40 Spring Grove, Outremont, Que.

HYDE, Arthur Edwin, (McMaster Univ.), 101 Newlands Ave., Hamilton, Ont.

LEFEBVRE, Jean, (Ecole Polytechnique), 11 Laviolette Ave., Outremont, Que.

MASON, George Anthony Ritchie, (Univ. of Alta.), 3023-3rd St. West, Calgary, Alta.

VINCENT, Paul, (Ecole Polytechnique), 837 Hartland Ave., Outremont, Que.

YOUNG, Gilbert Maxwell, (McGill Univ.). 6347-24th Ave., Rosemount, Montreal, Que.

## BOOK REVIEW

### Materials of Aircraft Construction

*By F. T. Hill, F.R.Ae.S., M.I.Ae.E., Sir Isaac Pitman and Sons Ltd., London, 1933. Cloth, 5½ by 8¾ inches, 363 pp., figs., tables, 20/.*

Reviewed by E.W.S.

This book is described by the author in his preface as being primarily for students of aircraft engineering. It has, however, a much wider application, because of its definite value to the aircraft designer.

The first chapter deals with mechanical testing, and whilst purposely omitting an unnecessary repetition of the description of testing machines and methods which are usually to be found in similar text books, it deals at some length with the vagueness of the meaning and value of several mechanical properties which are generally called for in material specifications and indicates the reasons for employing the proof stress in British specifications for aircraft materials.

When dealing with steel and iron in the second chapter, the author enters at once into a very incomplete discussion of the iron-carbon equilibrium diagram without any previous explanation of this type of diagram. It is doubtful whether this part of the book would be grasped by a man who had not had previous training in metallurgical subjects, and to one so trained it would provide no new or useful information.

The greater part of the book is devoted to a description and discussion of the various materials called for by the British Standards Institute specifications for aircraft materials, and the British Air Ministry D.T.D. specifications, the former specifications being those in common use, and the latter specifications being those for materials which have a more limited application at the present time. It gives very little information not already included and published in these specifications, but as a classification and a guide to the use of these specifications the book can serve a very useful purpose without, however, satisfactorily providing the more detailed information upon the reasons for the existence of many special materials, which a deep study of the subject requires, but which would necessarily make the book much larger and more expensive.

The last chapter, which has been borrowed with permission from another publication, provides an interesting discussion upon the designer's selection of materials.

## Recent Additions to the Library

### Proceedings, Transactions, etc.

American Society of Mechanical Engineers: Transactions, Vol. 55, 1933.

Australasian Institute of Mining and Metallurgy Inc.: Proceedings, March 1933, "Sintering and Smelting Mixed Lead Carbonate-Lead Sulphide Concentrates at Mount Isa, Queensland," by F. A. Forward, M.E.I.C.

### Reports, etc.

*Canada, National Research Council:*
16th Annual Report, 1932-33.

*Canada, Dom. Water Power and Hydrometric Bureau:*
Supplement to Water Resources Paper No. 55, Directory of Central Electric Stations in Canada—Nov. 1, 1932.

*Carnegie Institute of Technology:*
Colleges of Engineering and Industries, Catalogue 1933-1934.

*Canada, Civil Service Commission:*
Annual Report for the year 1933.

*Canada,* Report of the Minister of Public Works on the Works Under His Control, for the year ended March 31st, 1933.

*Air Ministry, Aeronautical Research Committee, Great Britain*
Reports and Memoranda:
- No. 1561—Flow Near a Wing which starts suddenly from Rest and then stalls.
- No. 1559—Use of Networks to Introduce Turbulence into a Wind Tunnel.
- No. 1560—Heat Transmission through Circular, Square and Rectangular Pipes.
- No. 1563—A Survey of the Air Currents in the Bay of Gibraltar in 1929-1930.
- No. 1558—Tests of a Roots Type Aircraft Engine Supercharger.
- No. 1304—Torsional Resonance Characteristics of a Twelve-Cylinder Vee Aero Engine.

### Technical Books, etc., Received

Materials of Aircraft Construction, by F. T. Hill. (*Sir Isaac Pitman and Sons.*)

Carnegie Steel Company, supplement to Pocket Companion, abridged edition CB Sections.

Joint Sewerage Works for Twelve Municipalities in New Jersey, by Alexander Potter. (*Sewage Works Journal, January, 1934.*)

American Sewerage Practice, Vol. II, by Metcalf and Eddy. (*McGraw-Hill Book Company.*)

Society of Automotive Engineers, Handbook, 1933.

## BULLETINS

*Air Compressors*—A 4-page folder received from the Worthington Pump and Machinery Corporation, Harrison, N.J., describes the Worthington air compressor units type VA-2, for garages, repair shops and service stations. This equipment is made in 8 sizes, requiring motors of ¾ to 7½ h.p., and having a displacement of 4¼ to 34 cubic feet per minute at 150 pounds.

*Pumps*—Worthington Pump and Machinery Corporation, Harrison, N.J., have issued a 4-page leaflet describing the vertical triplex single-acting type Worthington power pumps, equipped with Worthington Multi-V-Drive. Particulars of specifications of pump, motors and drive, together with a list of capacities and sizes manufactured are included.

*Water Tube Boilers*—Canadian Vickers Limited, Montreal, have published Bulletin LH 10, describing their low head water tube boilers, together with particulars of three classes.

*Electric Steam Generator*—An 8-page booklet received from E. Leonard and Sons, Ltd., London, Ont., describes the Penzold electric steam generator mentioning the unusual features and special advantages of this system, among which is claimed high efficiency and dry steam, no generation of gas through arcing and long life of electrodes. Operation may be manual or automatic, and from 10 to 125 per cent of rating.

*Sodium Silicate*—A 16-page booklet received from the Sodium Silicate Manufacturers' Institute, Philadelphia, Pa., contains details regarding sodium silicate cured concrete pavements in the United States, together with particulars of specifications.

*Metal Doors*—Richards-Wilcox Canadian Company Limited, London, Ont., have issued an 8-page illustrated booklet with types of and use of metal doors manufactured by that company.

*Instruments*—A circular received from The Brown Instrument Company Philadelphia, Pa., gives brief particulars of various types of instruments manufactured by the company. This includes pyrometers, flow meters, gauges, tachometers, etc.

### Engineering Centenaries in 1934

Among those who have contributed notably to the progress of engineering, few occupy a more honoured place than Thomas Telford, the shepherd's son, who rose to the head of the engineering profession. Telford's roads, canals, bridges and docks contributed largely to the improvement of the transport facilities of the country, and his standing among his fellows led to his being made the first president of the Institution of Civil Engineers. He died in Abingdon-street, Westminster, September 2nd, 1834, and was buried in the nave of Westminster Abbey. Only six years ago a monument was erected to him at Westerkirk, Dumfriesshire, where he was born. The year of Telford's death also saw the passing away of three notable Frenchmen, Marie Joseph Jacquard (1752-1834), famous for his loom; General Henri Joseph Paixhans (1783-1834), distinguished for his work on artillery, and Jean Nicolas Peter Hachette (1769-1834) the mathematician, whose work on the descriptive geometry of Monge was of great utility to engineers. Of the many men who, born in 1834, achieved distinction as inventors or engineers, only a few can be mentioned. Samuel Pierpont Langley, one of the great pioneers of aviation, was born on August 22nd. 1834; Gottlieb Daimler, the first to make a light high-speed spirit engine fit for land transport, was born on March 17th, 1834, while Johann Bauschinger whose work on the testing of materials led Dr. Unwin to speak of him as a "prince of observers," was born on June 11th, 1834. The same year saw the birth also of Loftus Perkins, a pioneer of the use of high-pressure steam at sea; Joseph Vavasseur, the inventor of the copper band on projectiles and the hydraulic recoil for gun mountings; of Gustav Hermann Wedding, whose writings on metallurgy led to his being awarded the Bessemer Medal of the Iron and Steel Institute; and also of Sir William Preece and James Mansergh, both of whom had the honour of being elected to the chair once occupied by Telford.

—*Engineering.*

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The Dominion Water Power and Hydrometric Bureau of the Department of the Interior of Canada has issued its annual review of the water power resources of Canada, developed and undeveloped as at February 1st, 1934. This bulletin comprises nine pages in mimeographed form and deals also with current progress in development, the utilization of water power in the principal industries, and the past and future growth of water power development.

Copies of the bulletin may be obtained, free of charge, on application to the Director of the Dominion Water Power and Hydrometric Bureau, Ottawa, Ont.

### Erratum

#### Practical Designing in Reinforced Concrete

In the book review by Vernon R. Davies, A.M.E.I.C., on "Practical Designing in Reinforced Concrete" which appeared on page 153 of the March, 1934, issue of The Journal the following sentence "He might also have stated that the kern radius is equal to one third the outer radius only when the ratio of outer and inner radii is equal to 3" should read as follows: "He might also have stated that the kern radius is equal to one third the outer radius only when the ratio of outer and inner radii is equal to $\sqrt{3}$."

# The United States Public Works Administration

### An address delivered before the Winnipeg Branch of The Engineering Institute of Canada, February 1st, 1934

*by William Nelson Carey,*
*Federal Engineer, Public Works Administration for Minnesota*

On March 4th, 1933, when Franklin Delano Roosevelt was inaugurated President, the United States of America was struggling along under the industrial and social handicap of twelve million unemployed workers. Thirty million other citizens used up their savings and mortgaged their homes and farms to keep their unemployed relatives and friends from starvation or from becoming public charges.

In the face of vehement and oft repeated assurances by press and politician to the effect that prosperity was "just around the corner," 1933 produced a more dismal outlook than ever. Public confidence was gone. In spite of our brass lunged calamity howlers and our quieter, communist, borers from within, the seaworthiness of our ship of state worried the majority but little. What was needed was a new pilot with new ideas. The world now knows how fully President Roosevelt has met those specifications. Our National Industrial Recovery Act, passed last June by a specially convened session of Congress, was the development of many old thoughts into a new idea of colossal proportions. I shall speak on but one phase of that Act, Public Works, and hope to show you, that for the United States at least, the public works path affords us solid footing in our climb toward national industrial recovery.

The National Industrial Recovery Act of June, 1933, is in two principal sections, Title One and Title Two. Title One is the part of the Act whose function it is to co-ordinate and stabilize business, to overcome cutthroat competition and unfair business practices and to stabilize labour in business and industry. It provides for the adoption of codes of fair business practice in the several branches of business and industry. Through shortened hours the number of employees has been increased greatly.

The provisions of Title One of the Act, the NRA, were designed to march abreast of those of Title Two, the Public Works Section, or PWA. While the effect of the NRA is to increase purchasing power through shortened hours, and spread work and other methods, the real impetus toward increased purchasing power is set up through the financing of public works in large volume. In the Federal government itself rested the only useable source of extended credit. The President and Congress created a fund of $3,300,000,000 to be used to finance public works. Never before has there been so vast a sum appropriated in peace time by any government in the history of the world.

The PWA, Public Works Administration, early set the tests which projects must pass before they might be accepted for financing. Acceptable projects must be for public works which are actually needed. Projects must be sound from an engineering or architectural viewpoint, they must be legally permissible and socially desirable, and the financing scheme proposed must be sound. For such projects PWA has made loans and grants to states, cities, counties and other governmental subdivisions. For certain limited types of acceptable projects such as public markets, toll bridges or vehicular tunnels, hospitals and dry docks, private, non-profitmaking corporations may secure loans but not grants. All Federal agencies such as the Corps of Army Engineers, the U.S.B.P.R., the Navy Department and others have received outright appropriations for the full cost of their projects.

Non-federal PWA projects; those of governmental subdivisions, as states, counties, cities, towns, school boards and villages, receive either a loan including grant, or a grant only, depending upon the financial situation of the respective municipalities. A grant or gift by the Federal government, amounting to thirty per cent of the aggregate construction cost of the project, plus field supervision cost, is made to municipalities for all approved projects. If the municipality has funds available which, together with the grant, will pay for the project, it may apply for and receive a grant only. If the municipality needs to borrow the money to cover the full cost of the project, it may apply for and receive both loan and grant. The grant is in the same amount in either case. Any government subdivision, through its proper officers, may make application for a PWA loan and grant or grant only to cover any public works project. An application must be made along prescribed lines set out by regulations. It must be submitted to the State Engineer, PWA, in quadruplicate. The general items which must be covered by the applicant in his application follow:

(1) Names: of applicant, his attorney, his engineer or architect. Population figures.

(2) Amount of loan requested, the security offered, with particulars. The amount of grant requested, if grant only is needed.

(3) A description of the project with, at least, skeleton specifications and drawings sufficient to give a thorough understanding of the project. An engineering or architectural report. A rather detailed cost estimate together with a showing as to need of the project and its social desirability.

(4) A detailed estimated revenue and expense statement covering the project.

(5) A complete financial statement covering the municipality making the application; showing property valuation, debt, defaults, tax rate, tax returns, current expenses and general industrial conditions.

(6) A legal memorandum covering the powers of the applicant as they relate to the project. This is an extremely detailed statement covering some thirty-seven items.

A PWA office has been set up in each state. It consists of a State Advisory Board, a State Engineer and a force of engineers, architects, lawyers, clerks and stenographers. The advisory boards each consist of three public spirited citizens who devote part time to PWA duties. The function of the State Advisory Board is largely to weigh the social aspects of each project and to conduct public hearings on controversial projects. The State Engineer, PWA, is the executive and administrative head of the State PWA office. The engineers, architects, financial clerks and attorneys are provided for the purpose of examining the applications, plans, specifications, contracts, etc., received and to draft a full report along prescribed lines for each project. After an application has been examined in the State Office, the State Engineer approves or disapproves it. An outline of each report is then submitted to the State Advisory Board for its approval or disapproval. Our Minnesota Board meets once a week for this purpose. After action by the State Engineer and State Board is taken, the application and State Engineer's report, in triplicate, is forwarded to the Central PWA Office at Washington.

The Examining Section of the Central Office is divided into three divisions: engineering, finance and legal. When applications and reports from State Engineers are received at Washington, a copy of the application and report goes to each division for examination. The engineering, financial and legal features of a particular project can then be reviewed simultaneously. The head of each of these divisions approves or disapproves the project. If all approve, the application then goes to the Special Board of Public Works, PWA, for final action. Secretary of Interior Harold Ickes, the Administrator of PWA, is chairman of the Board. The Special Board of Public Works is composed of four Cabinet Members and three other officials, one of whom is the Deputy Administrator. The Deputy Administrator, Colonel H. M. Waite, is in active charge of the Central PWA Office which has a force of about two thousand persons at present. If the examination of a project in the Central Office reveals special conditions, it is routed through a Special Board of Review on its way to the final Board of Public Works. If an application is rejected by the Central Office, the applicant is advised of the reasons and is given an opportunity for a hearing before the Special Board of Review. Every possible effort is made both in the State Offices and in the Central Office to determine all of the facts on every project and to weed out all which appear unsound.

When final favourable action has been taken by the Administrator on any particular application, the State Engineer of the state of origin of the application, is notified by wire that an allotment of funds in a certain amount has been made for the project. The State Engineer in turn notifies the applicant who usually takes prompt steps to get the project into construction as soon as possible. The telegraphic allotment advice is followed from Washington in a few weeks with a formal contract between the Federal government and the borrower municipality or other agency, which contract sets up the conditions under which Federal funds will be advanced to the borrower. A copy of the contract goes to the State Engineer. When the borrower executes the contract and conforms to the regulations set up, he then may proceed with his work with assurance that Federal funds will be forthcoming when needed. If the approved application is for a grant only, the applicant may start work upon signature of his contract with the PWA, and the federal grant of thirty per cent of the construction cost will be forthcoming as soon as the work is well along.

If the approved application is for a loan and grant, the bonds or other securities of the borrower are purchased by the Federal Government and the cash needed to carry out the work is placed in an escrow account in a Federal Reserve bank to the credit of the borrower. It can be used by the borrower as the project progresses, only as his need is certified by the PWA auditors, field inspectors and the State engineer. All bonds accepted by the PWA are taken at par, and carry an interest rate of four per cent. The National Industrial Recovery Act provides that all bonds or other securities accepted by PWA shall be "reasonably secured." An impression existed in some quarters at the outset of PWA operations that the words "reasonably secured" would be interpreted to mean that any excuse for a bond would be snapped up by PWA in an effort to start public work quickly. This error of thought was promptly corrected by the Administrator, who has demanded securities of unquestionable soundness in all cases, and who has disabused all of any thought that the loans obtained would not have to be paid back in full.

When the important matter of funds has been attended to for a given project, the State Engineer, PWA, has more work to do. He must see that all proceedings of the governing body of the borrower community are taken properly; proceedings to authorize the construction, to obtain rights of way if needed, to appoint a consulting engineer or architect if one is not regularly employed by the borrower, to order contract plans and specifications, or to do any other official act in connection with the project. The State Engineer also must examine and approve the detailed plans and specifications to the end that the construction to follow will be both structurally and economically sound, that true competition can be had in the bidding, and that the engineer or architect responsible is authorized legally to render professional service on public work. He must see that the project is advertised widely, that bids are tabulated properly, and that the lowest responsible bidder gets the contract if he is qualified. The State Engineer must obtain and examine the qualifications of the successful contractor as to his regular place of business, his plant, his experience and his financial stability. The contract with the builder must contain all required provisions for compliance with PWA regulations as well as being in proper legal form to cover public work, and the State Engineer must see that this is done. He must also know that workmens' compensation insurance is carried and that a performance bond in proper form and for the full amount of the contract is put into effect before work starts. When the State Engineer has satisfied himself that all these things and others not named have been attended to correctly, he gives the borrower a final O.K. to start construction. It is possible for the borrower to have most of these details out of the way between the time he submits his application and the date the contract for funds has been executed. If this is done, construction may start immediately upon completion of contract for funds. Most of these duties and requirements apply only to non-federal projects as these projects are the only ones for which the State Engineer, PWA, has responsibility.

Once a PWA contract gets under way it is inspected by PWA engineering or architectural inspectors at sufficiently frequent intervals or continuously as may be required to enforce adherence to the construction contract. Auditors of the PWA keep constant check on labour and material expense. Trained PWA special agents, many of them engineers, have roving commissions to check all reported violations of contracts or other improper or unfair practices. These special agents report directly to a separate Division of Investigation, the Chief of which reports directly to the Administrator. Every precaution has been taken to exclude rigorously all graft or corruption from PWA projects.

All PWA contracts contain definite provisions to provide for compliance with PWA regulations. The outstanding regulations are those which limit the hours of work by an individual to thirty hours per week, those which set up a minimum wage scale and provide for payment of labour in full in cash, and those which require the procurement of labour through the U.S. Department of Labour Re-employment Service. A thirty-hour week was set up to put more men on the same job. A minimum wage scale was provided to insure wages for the short week which would permit men to live in decency and comfort. The Central Office, in co-operation with the U.S. Department of Labour and representatives of organized labour, set fifty cents an hour for unskilled labour and one dollar twenty cents an hour for skilled labour as minimum wages for all the states in the northern one-third of the United States. Some State Engineers, in co-operation with officials of organized labour, contractors, engineers, architects and municipal officials, set up intermediate scales based on the basic minima given. We took such action in Minnesota beginning with our first construction job which started last September. The Minnesota PWA labour classification and wage scale has been made part of every Minnesota non-federal PWA contract to date and will continue to be so included. PWA recognizes the right of labour to collective bargaining agreements with contractors. It protects both union labour and non-union labour. There is no PWA prohibition to higher wages than those set in the minimum scales. The Minnesota scale sets up eight groups of labour classification. Unskilled labour at fifty cents per hour minimum falls in group one. Group two covers the slightly higher classifications and provides a minimum of sixty cents per hour. The several following groups provide successively higher minima, in ten cent increments, until group eight is reached with a minimum of one dollar and twenty cents per hour for skilled labour. Our scale has proved entirely satisfactory to date.

Labour on PWA projects, as provided for in the contract provisions, must be secured either through union locals or from the local agency of the U.S. Department of Labour Re-employment Service. In Minnesota practically all the PWA labour is secured through the Re-employment Service. If a contractor is a "closed shop" contractor, that is, has agreements in force with organized labour, he is expected to place requisition for his labour on a given PWA project at the local union headquarters. If the union labour agencies do not furnish the labour requisitioned within forty-eight hours of the demand made for it, then the "closed shop" contractor may secure his labour from the Federal Re-employment Service.

"Open shop" contractors place their requisitions for labour on the Re-employment Service in the first instance. No contractor may hire directly the labour required on his contract. He may discharge men as he chooses but he must procure them in the manner outlined. He may carry his own supervisory and administrative employees from job to job but no others. Agencies of the Federal Re-employment Service are set up in each county. The men appointed on County Re-employment Boards serve without pay, with the possible exception of a paid secretary. Unemployed workers of each county are required to register at their Re-employment Agency Office. Labour on PWA jobs in each county must be obtained, if it is available, from the Re-employment Office labour lists of that county. In this manner labour is put to work on jobs close to home and labour migration to any material extent is prevented. Because of the large numbers of unemployed, there has been no difficulty experienced to date in Minnesota, and so far as I know, in any other state, in obtaining high class labour of any kind through the Re-employment Service. Hand in hand with the local labour use requirement is a requirement that local materials be used, other things being equal. The theory back of the local labour and local material requirements is that it is only fair to employ the men and use the material, so far as possible, of the community which is paying directly about seventy per cent of the cost of a given non-federal PWA project.

When the three-billion dollar appropriation was made available last fall, non-federal projects in large numbers were not available to place in construction quickly. Many large and small all-federal projects were ready. Non-federal projects did not begin to receive allotments in volume until November and December. The latest official figure, received on January 27th, shows the total of non-federal allotments to that date to be $870,028,704. This sum has been provided for the construction of 2,118 non-federal projects by States, municipalities and other political subdivisions and public agencies. As the entire PWA appropriation, to all practical purposes, now has been allotted, it follows that, approximately $2,230,000,000 was allotted to all-federal projects. It should be remembered that an all-federal allotment of $400,000,000 was made for Federal roads and another $400,000,000 was paid out to the Civil Works Administration to finance its activities. Individual non-federal allotments have been comparatively small, running from a few hundred dollars in extreme cases to several million. Minnesota's smallest PWA non-federal allotment was $900 to finance a village well, and our largest allotment was $18,000,000 to finance a joint trunk sewer and sewage disposal plant for Minneapolis and St. Paul.

The entire PWA organization had to be brought into being almost over night. All the necessary regulations and safeguards had to be built up in their entirety. The requisite machinery for handling non-federal applications for loans and grants was found to be not only of extraordinary size but complicated as well. It is only natural that the time expected to be consumed from the organization of PWA to the construction of public work projects in volume was underestimated. The result was that, when winter came upon us, widespread non-federal PWA construction had not been attained. There was still a large unemployment list and the buying power expected to result from PWA jobs had scarcely begun to register. It appeared evident that the full force of PWA construction would not be felt before next spring. Something had to be done before spring to take men in large numbers from relief rolls and place them on pay rolls. On November 7th, 1933, the Civil Works Administration, or CWA, was created for that purpose and an allotment of $400,000,000 from PWA funds was made to the CWA.

A basic principle governing PWA projects is that detailed plans and specifications shall be made to cover each project, that it be advertised for competitive bidding and that a contract be let to the lowest responsible bidder. To obtain speed and to put a large volume of hand labour at work with a minimum of delay, the CWA abandoned this basic PWA requirement and proceeded to put thousands of CWA projects under way by day labour. CWA was decentralized and final approval of its projects was left to a CWA Administrator appointed in each state. The objective of CWA, as announced on November 15th, was to put four million persons to work before December 15th. Approximately half of this number was to be taken from men then on public relief rolls. CWA accomplished its objective. All public works projects of the character usually constructed or carried on either by the public authority or with public aid to serve the interests of the general public were made eligible as CWA projects. The limitations were that the projects should be socially and economically desirable, that they could be undertaken quickly and that not more than fifteen per cent of the total cost of a project could be expended for materials. The hours of labour were limited to the thirty hour week and the PWA minimum wage scale also was adopted. Neither PWA nor CWA permits persons under sixteen years of age to be employed. CWA is still in operation but is expected to be discontinued or at least postponed by May 1st, next. It was provided as a stop-gap to fill the inevitable lag which occurred in getting PWA construction under way in volume.

There can be no question that the PWA drive to transfer men from the relief rolls to pay rolls is obtaining results. A report of a survey by the Dodge Corporation, industrial statisticians, made public January 14th, 1934, revealed a strikingly larger volume of construction during December, 1933, than in any month since October, 1931. Private construction as well as public construction shared in the increase, in confirmation of the theory of stimulation of industries through PWA upon which theory the whole programme was undertaken. There is a spirit of optimism and of confidence abroad in the land which has not been felt in years. A definite step has been taken in the war on the depression and the public feels the advantage which lies with a vigorous offensive attack. We have a new, national pilot, a new deal and our course is set on new landmarks. Again our industrial ship is moving under a full head of steam, our crew is well organized and has complete faith in its leader. With the existing unprecedented spirit of co-operation in industry, with new jobs for millions and with optimism and confidence prevailing, we firmly believe that our ship of state is well on its way out of the Sargasso sea of depression toward the home port of Prosperity.

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*The Canadian General Electric Company* announces a new line of capacitors for power factor correction. A substantial reduction in size, rating for rating, is one of the advantages of these devices, which are treated and filled with Pyranol, whose insulating and dielectric properties permit an unusually small capacitor for a given rating, and which is non-inflammable and non-explosive. The line also includes new box-type units and small rack-type capacitors, both for indoor service.

# BRANCH NEWS

## Border Cities Branch

*C. F. Davison, A.M.E.I.C., Secretary-Treasurer.*
*F. J. Ryder, S.E.I.C., Branch News Editor.*

At the regular monthly meeting of the Border Cities Branch held on Friday, March 9th, 1934, Mr. Ernest Wilby, A.A.I.A., Professor of Architecture at the University of Michigan, was guest-speaker. Mr. Wilby gave an intensely interesting discourse on "A Trip Through the Past."

A Trip Through the Past

Stating that architecture is the oldest profession, while engineering is the youngest profession, and that architecture has passed down to this generation with no schisms since earliest times, Mr. Wilby briefly outlined the problems that have beset architects throughout their history.

Architects of the past he stated knew of and used only compression and the law of gravity. Since the introduction of tension into structures architects have encountered considerable difficulty. They have found it impossible to "make tension beautiful." Creating beautiful structures utilizing tension members remains a challenge to the coming generations of architects.

Egyptian architecture, Mr. Wilby pointed out, was remarkable for its massiveness and the degree of accuracy achieved in construction.

The Greeks, in the speaker's opinion, reached the highest point in intellectual development. This was because they were interested in the solution of problems rather than in their commercial utility. Knowledge has increased in quantity very considerably since their time but the intelligence of the Greeks has never been equalled.

Their architecture indicated a mastery of accuracy and design. The Ionic temple in Athens is considered as a landmark in architecture and the Parthenon as it existed is considered to be the most perfect building ever built.

The speaker likened the Romans to present day Canadians and Americans. The Romans were exceptionally practical. Evidence of this was the Coliseum, the aqueducts, and the Pantheon. They also appreciated the need for the beautiful. Being unable to build beautiful structures themselves they employed the Greeks to build them for them. They discovered natural cement and its use permitted the building of large arches, aqueducts, and durable roads.

Mr. Wilby then dwelt on structures of more recent times. In England are many examples of Gothic architecture which in almost every case runs on the narrow side of safety structurally.

In the discussion following the address it was brought out that the most enduring and beautiful structures are those composed of materials natural to the site and that such structures gain beauty from the surrounding landscape. It was also pointed out that one of the main reasons for the deterioration of most ancient large structures is the fact that following generations have made use of them as quarries.

Mr. Wilby illustrated his talk with postcard views, projected through a stereopticon of his own manufacture, which were of interest to all.

Following the address a hearty vote of thanks was extended to Mr. Wilby by the chairman.

## Calgary Branch

*J. Dow, M.E.I.C., Secretary-Treasurer.*
*H. W. Tooker, A.M.E.I.C., Branch News Editor.*

Engine No. 8,000

At a general meeting held at the Board of Trade rooms on Thursday evening, January 25th, 1934, a large attendance of the members of the Calgary Branch and their friends were privileged to hear an address by Mr. T. F. Donald, mechanical engineer of the Canadian Pacific Railway, on Locomotive No. 8,000.

Mr. Donald's address was illustrated by motion pictures showing in animated form the principle of steam generation which is a radical departure from the ordinary locomotive, marine or stationary boiler. The films also depicted interesting scenes taken during the construction of the locomotive and also of its assembly.

The principal feature of engine No. 8,000 is a system known on this continent as the Elesco multi-pressure system, which consists of three distinct separate units:

(*a*) The closed circuit, with maximum pressure of 1,700 pounds per square inch.
(*b*) The high pressure boiler, with 850 pounds pressure.
(*c*) The low pressure boiler, with 250 pounds pressure.

The closed circuit is really a water tube boiler forming fire box and combustion chamber and is composed of a number of small diameter forged nickel steel drums. This is filled with distilled water and the unit is then sealed. Steam generated in the circuit is not used in the cylinders, it does not leave the circuit, consequently there is no loss of water. The steam separates from the water in the top drums, flows into the top of the sixteen multi-tube coils, called heat transfer elements, and almost entirely submerged in the high pressure boiler water. During its flow the steam loses its heat to the lower temperature water in the high pressure boiler, turning it into steam at 850 pounds. As it loses its heat it condenses, and as condensate flows back to the bottom drums of the fire box ring where it is again turned into steam. There is no fixed pressure for the closed circuit, it varies depending upon the demands of the locomotive. Under normal conditions it ranges from 1,300 to 1,500 pounds and for peak loads to 1,600 pounds. Safety valves are set at 1,700 pounds.

The high pressure boiler is a seamless forged nickel steel drum, protected from contact with the flames by lagging and fire resisting steel plates. The high pressure feedwater is taken to the low pressure boiler at 250 pounds and delivered to the high pressure boiler by a high pressure pump.

The low pressure boiler is similar to the barrel part of an ordinary locomotive and located ahead of the combustion chamber. Steam is generated in the low pressure boiler at 250 pounds by the heat in the fire box gases after they leave the fire box. The steam from the high and low pressure boilers passes through superheaters located in the fire tubes of the low pressure boiler before entering the cylinders.

Two stages of expansion are necessary to derive all benefits of the 850 pounds pressure, first in a high-pressure cylinder and then in low pressure cylinders.

After the 850 pounds steam pressure performs its work in the high pressure cylinder, it is exhausted at a pressure of 250 pounds into mixing chambers located in the low pressure cylinder steam pipes, where it intermingles with the 250 pounds pressure superheated steam from the low pressure boiler, this intimate mixture reheats the high pressure exhaust steam so that there is a superheated mixture fed into the low pressure cylinders, where it is expanded to nearly atmospheric pressure in the performance of its work and then exhausted through the stack.

This engine has a tractive effort of 83,300 pounds and has developed 97,400 pounds on one occasion. It can haul a train of 10,000 tons, about one hundred and fifty loaded grain cars, on level track.

Following Mr. Donald's address a most interesting discussion took place, after which a hearty vote of thanks was given the speaker by F. N. Rhodes, A.M.E.I.C.

The meeting adjourned at 10.00 o'clock p.m.

A very pleasant evening was enjoyed by all those present at a joint annual dinner of the Calgary Branch of The Engineering Institute of Canada, the Association of Professional Engineers of Alberta, and the Institute of Mining and Metallurgy, held at the Renfrew Club on Saturday evening, February 10th, 1934. Eighty-four members and their friends attended.

P. T. Bone, M.E.I.C., presided at the dinner. Recitations and songs were given by Messrs. D. Carswell and G. H. Patrick, A.M.E.I.C., assisted at the piano by Mr. Lloyd Roberts.

The speakers were Mr. J. D. Baker of Edmonton, President of the Association of Professional Engineers, who recounted the work that had been accomplished by that body during the past year, also stressing the point that engineers as a whole should take more interest in international affairs. Mr. Baker said that he was very pleased indeed to be able to announce the appointment to Life Membership in the Association of P. T. Bone, M.E.I.C., and J. S. Tempest, M.E.I.C. H. J. McLean, A.M.E.I.C., chairman of the Calgary Branch of The Institute, next spoke in a lighter vein, and was followed by the Venerable Archdeacon Swanson, the speaker of the evening, who addressed the gathering, choosing as his subject "People I have Met" and in a reminiscent style enlarged greatly on his subject to the amusement of all present.

## Halifax Branch

*R. R. Murray, A.M.E.I.C., Secretary-Treasurer.*
*C. Scrymgeour, A.M.E.I.C., Branch News Editor.*

The regular monthly meeting of the Halifax Branch was held on Thursday, March 15th, 1934, at the Halifax hotel, with forty of the members present, and the chairman of the Branch, R. L. Dunsmore, A.M.E.I.C., presiding.

The first part of the meeting, following the regular dinner, was taken up for general discussion by the members of the proposed alterations to the By-laws affecting The Engineering Institute of Canada, and among those who took part in the discussion were past-chairmen A. F. Dyer, M.E.I.C., H. S. Johnson, M.E.I.C., Professor W. P. Copp, M.E.I.C., and others.

At the conclusion of the discussion, Mr. W. B. Burchall, advertising publicity manager of the Canadian Airways, Limited, was introduced to the members of The Institute by the chairman, following which Mr. Burchall gave a highly instructive and interesting address on the contribution of the aeroplane to Canadian industrial development, the address being accompanied by a particularly fine series of slides illustrating the class of work which the Canadian Airways had done since its inauguration in Canada.

## Hamilton Branch

*A. Love, A.M.E.I.C., Secretary-Treasurer.*
*V. S. Thompson, A.M.E.I.C., Branch News Editor.*

The March activities of the Hamilton Branch got off to an early start with a joint meeting with the Toronto Branch on the first day of the month. The meeting was held in Hart House, Toronto University, and Hamilton Branch was well represented by a delegation of twenty-two including three from the Babcock-Wilcox and Goldie McCulloch Engineering Society, Galt.

Archie B. Crealock, A.M.E.I.C., the genial chairman of the Toronto Branch, presided at the dinner which was served in the graduates' dining hall, and at which there were about sixty present. Among the guests were a few outstanding in Institute affairs—Brig.-Gen. C. H. Mitchell, M.E.I.C., Dean of the Faculty of Applied Science, Toronto University and Past President of The Institute, A. H. Harkness, M.E.I.C., Past Vice-President, and F. W. Paulin, M.E.I.C., Councillor.

Dean Mitchell very kindly conducted a party over Hart House and pointed out the many notable features of this attractive building.

It was not intended that this should be a reunion of Glasgow University graduates, but there were four present, including the speaker of the evening.

The professional meeting was held in the Debates room and was very well attended. Mr. Crealock opened the proceedings and then turned over the meeting to Mr. Stuart, who explained that the paper to be presented by Mr. Carswell had been prepared by a committee composed of J. B. Carswell, M.E.I.C. (Chairman), E. P. Muntz, M.E.I.C. and H. B. Stuart, A.M.E.I.C.

### The Status of the Engineer in Industry

Mr. Carswell then spoke on "the Status of the Engineer in Industry." It was early noticed that the speaker preferred to stick to the truth, even if it did hurt, and told the engineers in no uncertain terms that the status of the engineer in industry was by no means what it might be; that while industry was going merrily along the engineer was there doing his part, but when industry declined to the vanishing point, it did not necessarily follow that the engineer should disappear also, as it would seem at present. With his long valuable training, the engineer should be able to do some constructive work and take his place with those who are striving to open up lines of activity, where there is at present nothing but stagnation. The speaker's criticism extended to engineering meetings; his advice while of a general nature was directed mainly towards the younger engineers.

As was to be expected the talk started an interesting discussion which was free and frank, and brought out many suggestions both good and otherwise. It is to be hoped that some good will follow the presentation of this paper and the ensuing discussion, but it is certain that the general feeling of the meeting was that joint meetings and interchange of visits are most desirable, and no doubt the future will see more of them.

### Visit to Plant of Sovereign Potteries, Limited

At the invitation of Mr. Paulin and the management of Sovereign Potteries, Ltd., the members of the Branch and their ladies were enabled to visit this interesting new industry on Saturday, March 17th, 1934. About one hundred and fifty guests took advantage of the opportunity of inspecting the processes in the manufacture of dinnerware for the first time in Canada.

The visitors were shown first the new clay which is brought from several different sources, but mainly from Saskatchewan and Georgia.

The clays are mixed and washed, any iron present being removed with magnets. It is then squeezed into flat slabs to remove excess water, and stored for approximately one week.

All moulds used in the plant are of plaster of paris and are made on the premises.

The visitors were particularly interested in the cups, which are spun for a few seconds only. The handles are made in separate moulds and stuck on by hand. The handles of jugs and pitchers however are cast integral with the body of the piece.

Up to this stage the clay is still moist and is allowed to stand for a day or two before piling into saggars or earthenware containers for bisque firing. The first firing takes six days, during which the ware is subjected to its maximum heat for about two days. About 60,000 pieces can be heated at one firing in one bisque furnace.

The ware, now classified as bisque, is dipped in a glazing fluid and dried by means of fans. As soon as it is dry it is piled again in saggars, but this time it is necessary to separate each piece from its neighbour as the glazing coat is easily broken or fused. The saggars are then returned to another furnace for the second firing which produces the glazed surface.

The temperature of the furnaces is regulated by means of pyrometric samples known as seger cones which give warning through mica inspection windows when the desired heat has been attained. After removal from the second furnace the ware is finished except in the case of decorated ware which is varnished and to which transfers are applied. This necessitates one more heat treatment to evaporate the varnish and bake the coloured design on to the surface. Many attractive samples of decorated ware were on display and the visitors were much impressed by the variety of designs.

Before departing, coffee was served and each lady was presented with a cup and saucer with The Institute crest as a souvenir of a very interesting and instructive afternoon.

## London Branch

*H. A. McKay, A.M.E.I.C., Secretary-Treasurer.*
*Jno. R. Rostron, A.M.E.I.C., Branch News Editor.*

The regular February meeting of the Branch was held on the 21st, at the Physics building, University of Western Ontario.

Mr. Garnet A. Woonton of the University staff was the speaker, and his subject "The Oscillograph and Its Uses."

The chairman of the Branch, Frank C. Ball, A.M.E.I.C., presided and in introducing the speaker said that the branch was greatly indebted to Mr. Woonton and to members of the University staff who were not only giving their time, but had gone to great trouble in arranging the apparatus for a practical demonstration.

### The Oscillograph and Its Uses

Mr. Woonton opened by giving some of the formulae and graphs which were usually employed to express the frequency and magnitude of sound waves.

The oscillograph situated at one side of the room was actuated from a microphone at the other side and connected by electric wires. A small screen was installed in front of the oscillograph on which moving delineations of the sound waves were thrown. Demonstration was first given by actuating tuning forks of different sizes, the various sounds being depicted on the screen by an illuminated line travelling from one side to the other and showing by different shapes and waves and intervals the character, magnitude and frequency of the sounds transmitted. Later, other sounds were demonstrated such as those of the human voice and various musical instruments, each giving a characteristic graph.

The use of the instrument was not confined to sound waves however, for demonstrations were given showing graphs produced by different kinds of electric currents, alternating and direct, and with various cycles.

Many questions were answered by Mr. Woonton and his assistants. Replying to one question Mr. Woonton said that the oscillations of moving bodies could be registered by the oscillograph provided the oscillations of the bodies were converted into electric currents.

E. V. Buchanan, M.E.I.C., manager of the London Public Utilities Commission, in moving a vote of thanks to the speaker, referred to the uses to which the oscillograph had been put in his own experience.

About fifty members and guests were present.

## Ottawa Branch

*F. C. C. Lynch, A.M.E.I.C., Secretary-Treasurer.*

### Public Health in Quebec

At the noon luncheon on January 25th, 1934, the guest speaker was Theo. J. Lafreniere, D.Sc., M.E.I.C., chief engineer of the Bureau of Health, Province of Quebec. He spoke on "Public Health in Quebec." Dr. Lafreniere occupies the chair of Sanitary Engineering, Ecole Polytechnique de Montréal, and served for several years on the Finance Committee and Board of Examiners of The Engineering Institute of Canada.

Alan K. Hay, A.M.E.I.C., newly elected chairman of the local Branch, presided and in addition the head table guests included: Hon. Alfred Duranleau, Hon. Murray MacLaren, Dr. O. O. Lefebvre, M.E.I.C., Amedee Buteau, Dr. E. R. Faribault, Col. A. E. Dubuc, M.E.I.C., Dr. Eug. Poitevin, G. J. Desbarats, M.E.I.C., J. V. Beauchemin, Jean D. Chene, A.M.E.I.C., C. A. Menard, J. E. St. Laurent, M.E.I.C., A. Lafleche, A.M.E.I.C., R. Blais. With the exception of the chairman and two of the guests, those at the head table were all graduates of the Ecole Polytechnique de Montréal.

Professor Lafreniere, in commencing his address, traced the history of public health engineering in Quebec from the middle of the seventeenth century down to the present day. In 1706, for instance, the inspection of meat and bread was established and in the same year the chief of police of the colony, visiting Montreal, found the streets in such a deplorable state that he ordered their reconstruction and required sewers on St. Pierre Street.

From the time of the cession of Canada to England in 1763 up to about sixty years ago, public health matters remained stationary, the measures of the French regime being maintained. In 1870, the Municipal Code was passed, giving to every municipality the powers to make regulations concerning health matters. When the smallpox epidemic occurred in 1885, the legislative authorities passed a special act creating a commission which later became the permanent board of health of the province. The present activities of this organization concern themselves with water supply, sewerage, milk supply, housing, and nuisances.

With regard to water supply, a survey in 1931 revealed the fact that water for domestic use is obtained from rivers for 84 per cent of the population, from lakes for 6 per cent of the population and from springs and wells for 10 per cent of the population. Numerous typhoid fever epidemics have been caused in the past through the general use of rivers as a source of supply and accordingly the main concern of the sanitary engineering division has been to obtain the improvement of these supplies. Filtration plants were established in the larger cities and towns and chlorination plants in those municipalities that could not for the present afford the cost of the more expensive works. It is interesting to note that the typhoid death rate decreased from 25.5 in 1910-1914 to 6.8 in 1932.

The speaker also dealt with questions of sewerage, milk pasteurization, housing, and nuisances. The pasteurization of milk is compulsory in the city of Montreal and vicinity only, although there are forty-three plants in areas beyond this in the province. Approximately 45 per cent of the population of the province is served with pasteurized milk. The consumption based on the pasteurized milk is one-third of a quart per head per day.

The main activities of the Engineering Division of the Bureau of Health concern themselves with the above mentioned features, but other features are touched upon. The examination and control of swimming pools; bathing beaches are becoming a special problem; tourist camps are under the jurisdiction of a special department; ventilation of schools and public buildings is controlled by general by-laws; permits are required to harvest natural ice, etc.

In conclusion, stated the speaker, the Quebec Public Health Act contains the necessary powers to control the environment for the benefit of the public.

The Great Bear Lake District

"The Great Bear Lake District" was described by D. F. Kidd, Ph.D., of the Geological Survey of Canada, at a noon luncheon address on February 22nd, 1934, before the local Branch at the Chateau Laurier. Dr. Kidd spoke largely from personal experience, having conducted geological surveys and explorations in this and other localities of the Northwest Territories in recent years. His address was illustrated by lantern slides and by motion pictures taken by himself.

A. K. Hay, A.M.E.I.C., chairman of the Ottawa Branch, presided and in addition head table guests included: Hon. T. G. Murphy, Grote Stirling, M.E.I.C., H. H. Rowatt, Dr. Charles Camsell, M.E.I.C., G. J. Desbarats, M.E.I.C., F. H. Peters, M.E.I.C., Group Captain E. W. Stedman, M.E.I.C., John McLeish, M.E.I.C., W. B. Timm, A. L. Cumming, R. J. Traill and A. M. Narraway.

Along the east shore of Great Bear lake, where the mineralization occurs, "a much dissected upland comes to the edge of the lake and forms very rugged hills up to 1,100 feet high. The topography is reminiscent of parts of the north shore of Lake Superior," stated Dr. Kidd.

Possible waterpower sites are at Whiteagle falls on Camsell river, where it has been reported 10,000 h.p. can be developed, and on the Sloan river. At present there is one settlement at Cameron bay, another abandoned settlement at Hunter bay, and several mining camps.

At Hunter bay copper deposits were first staked in 1922 but real attention was focussed on the Great Bear lake area with the advent of aircraft transportation and the historic find of pitchblende at Echo bay in May, 1930.

Dr. Kidd briefly outlined the geological features of the district, explaining that the deposits were of two kinds: first, pitchblende and silver, often with secondary values in copper, lead and gold; and secondly, silver.

He also detailed the various kinds of mineralization at the different properties and gave an account of production methods to date.

In commenting upon the radium possibilities, Dr. Kidd expressed the opinion that "radium production from the Great Bear lake field may well prove less important in gross final commercial value than the silver production, though its real importance from the standpoint of human welfare may be much greater."

The radium industry of the world is at present practically a Belgian monopoly, the major portion coming from a mine in southeastern Belgian Congo. The Belgian company has always been secretive about the grade of ore mined, the extent of their reserves, and particularly about production costs. It is therefore extremely difficult to evaluate the factors in the marketing of radium.

This paper appears in full on page 167 of the April issue of The Journal.

## Peterborough Branch

*H. R. Sills, Jr.E.I.C., Secretary.*
*W. T. Fanjoy, Jr.E.I.C., Branch News Editor.*

The Electric Eye

The fascinating story of the electric eye, the device which has also made possible the "photography" of sound, for the talking movies, the opening of the World Fair gates by light from a distant star and countless other miracles, was unfolded to the Peterborough Branch, Thursday night, February 8th, 1934. The speaker was A. G. Turnbull of Toronto, a representative of the Canadian General Electric Company.

In 1873, an operator stationed in a trans-Atlantic cable station on the coast of Ireland noticed that the operation of his equipment was affected by the amount of light which happened to fall on certain selenium or selenium-coated electrical conductors which formed a part of his apparatus; with that observation the birth of the electric eye many years later was heralded.

The electric eye, using the term broadly, is simple in principle. It is a device which causes variations in the flow of an electric current in concurrence with variations of the intensity of light allowed to fall on the device; in other words it is a mechanism which translates light into electrical energy.

Mr. Turnbull had a number of practical demonstrations to offer using a varied assortment of equipment.

Stating that the electric eye has recently proved extremely useful as a device to count automobiles passing a given point on a highway, people passing in and out of a theatre or packages passing out of a machine, the speaker offered another practical demonstration. He placed an electrical counting machine in the lap of one of his auditors and through the operation of photoelectric equipment caused the device to register.

One company is manufacturing electric eye equipment which will cause garage doors to open when car headlights are turned on them. Another company is specializing on electric eye equipment to be used for burglar alarm purposes.

Mr. Turnbull divided light sensitive devices into three classes. "Phototubes" are the devices operating by the photoelectrical emission of electrons from the cathode. The pioneer of the devices, the "selenium" or "copper anode tube" operates by the resistance of a conductor due to the action of the light. "Photovoltage cells" are those which generate an electromotive force when exposed to light.

Practically all photoelectric relays of the industrial type utilize photo tubes as light sensitive devices. These tubes produce currents of the order of a few microamperes which current is amplified by ordinary conventional radio type vacuum tubes to operate relays, the contacts of which can be used to accomplish whatever work is required. While the speed of response of the tube is very fast the relays being mechanical devices, limit the application of the device to applications where the light is "on" and "off" for a period of at least 1/15 second each. For high speed counting, etc., the mechanical relays are replaced by "thyratrons" which are three element mercury vapour tubes. These outfits have a speed of response up to 1/100,000th of a second.

Mr. Turnbull was very careful to point out that while the photoelectric eye has a particular field of its own, the fact that it is a relatively new and novel device carries with it the danger that it may be applied indiscriminately. Each application must be carefully checked to see if some other device is not more suitable particularly from cost and suitability angles. An example of a legitimate application is the use of the eye as a limit switch where the articles to actuate the limit are too small or too light to actuate a conventional mechanical limit switch, for instance, sheets of paper on a conveyor.

## Quebec Branch

*Jules Joyal, A.M.E.I.C., Secretary-Treasurer.*

At a meeting of the Quebec Branch held at Montcalm Palace on February 12th, 1934, Marc Boyer, S.E.I.C., delivered a very interesting paper on the "Valuation of Non-metallic Mineral Deposits," of which an abstract will appear in an early issue of The Journal.

At the same meeting two other short papers were delivered by Messrs. Maurice Royer and E. Gray-Donald, Jr.E.I.C., a summary of which will appear in the Branch News section of the next issue.

Hector Cimon, M.E.I.C., chairman of the Branch, introduced the speakers; a vote of thanks was moved by J. Joyal, A.M.E.I.C., seconded by J. Ruddick, M.E.I.C.

## Saskatchewan Branch

*S. Young, A.M.E.I.C., Secretary-Treasurer.*

The monthly meeting of Saskatchewan Branch, was held in the dining room of the Champlain hotel, at 6.15 p.m., on Friday, January 19th, 1934, some forty members and visitors being in attendance.

An interesting letter was received from W. T. Thompson, M.E.I.C., now residing at Cranberry Portage, Manitoba. Mr. Thompson expressed interest in Mr. Webster's paper delivered at the last meeting on "Mineral Resources in Northern Saskatchewan," and expressed the desire that a synopsis be published in The Journal. He also referred to an address, given previously by L. A. Thornton, M.E.I.C., dealing with Water Power Development at La Colle Falls, stating that he remembered this location especially well and referring to an exciting voyage made in a flat boat down the Saskatchewan from Prince Albert to the Pas in 1911.

Disarmament

The chairman, P. C. Perry, A.M.E.I.C., then introduced the speaker of the evening, Mr. F. C. Curtis, B.C.L., who addressed the meeting on "Disarmament." The history of disarmament, Mr. Curtis placed into three periods: from the close of the war to the opening of the disarmament conference in 1932; the conference itself and up to the crisis when Germany threatened to withdraw; and the crisis itself: the withdrawal of Germany from the League of Nations. He declared that the building of armaments was one of the chief causes of war, despite preparedness propaganda. An active military preparation means the growth in the state of a military spirit, which sooner or later grows to assume national importance in the nation's life. Outlining the various moves towards international peace, Mr. Curtis declared that disarmament outdistanced anything else in the international field, in that it was on it that Germany withdrew from the League of Nations. With four great nations, Russia, Japan, Germany and United States outside the League of Nations, and Italy only lukewarm, it holds little promise of security for France. Despite this the position is now better than it was twelve months ago. In concluding, he touched on the various steps which marked the disarmament conference and on the growth of Hitlerism. During the discussion period, the speaker stated that war propaganda of armament firms was a great factor in promoting international discontent and that it was necessary for public opinion to combat this.

H. S. Carpenter, M.E.I.C., moved a vote of thanks and congratulated the Papers and Library Committee on their selection of papers, and expressed the view that subjects of great interest outside of actual technical matters were, he thought, to be desired, and hoped that more papers of this nature would be provided. Those taking part in the discussion: Mr. Carpenter, Colonel A. C. Garner, M.E.I.C., Colonel A. P. Linton, A.M.E.I.C., Mr. P. C. Perry and J. N. deStein, M.E.I.C.

## Sault Ste. Marie Branch

*G. H. E. Dennison, A.M.E.I.C., Secretary-Treasurer.*

The regular monthly meeting of the Sault Ste. Marie Branch was held on Friday evening, February 23rd, 1934, following the regular dinner at the Windsor hotel. E. M. MacQuarrie, A.M.E.I.C., chairman of the Branch, was in the chair.

On opening the meeting reference was made to the sudden death since our last meeting of Mr. C. H. E. Rounthwaite, A.M.E.I.C. R. S. McCormick, M.E.I.C., spoke of the many fine attributes of Mr. Rounthwaite and moved an expression of regret at his passing, seconded by A. H. Russell, A.M.E.I.C.

J. LeB. Ross, M.E.I.C., then introduced the speaker of the evening, Captain James McCannel of the C.P.R. steamer *Assinaboia*, flagship of the C.P.R. lake fleet, who addressed the meeting on "A Short History of Great Lakes Shipping since 1812."

### A Short History of Great Lakes Shipping Since 1812

One of the ships of which Captain McCannel spoke was the *Chicora* built to run blockades during the American Civil War. A steamer which also carried sail, she was one of the fastest ships of the day and made several spectacular runs. After the war, she was brought to the Great Lakes by Milroy Bros. of Toronto, in 1864. She carried troops to the head of the lakes in 1870 and after sixty years active service on the Great Lakes became a tow barge where she is still employed under the name *Warrenko.*

Touching on the opening of Lake Superior to through lakes shipping and the construction of canals at Sault Ste. Marie, the views of some of the marine authorities of the day were quoted. Derision greeted the suggestion that the first locks built be constructed for ships up to 300 feet in length, and it was the considered opinion that a 200-foot lock would provide ample capacity for all time.

One of the early ships which contributed to Great Lakes mercantile history was the *Kaloolah*, a paddle steamer built at Buffalo in 1853. In 1857 she was renamed the *Collingwood* and chartered to carry the Hynd and Gladman expedition to Fort William for a survey of that area. She locked through the Sault canal, the first upbound Canadian vessel to do so, and paid a toll of $7.50.

The propeller ship *Rescue* built at Buffalo in 1855 was fitted out by a group of Toronto business men to carry mails to Grand Portage, the first step in the delivery of mail to the Red river. For this service $1,200 was paid and the first mail consisted of three letters and a newspaper, but laid the foundation of trade with the northwest. In 1866 during the Fenian Raids, the *Rescue* was converted into a gun boat.

In 1895 the Canadian canal at Sault Ste. Marie was opened by the steamer *Majestic*, a freight and passenger steamer built at Collingwood the same year. For many years the Canadian canal some 600 feet in length was the largest at the Sault though now eclipsed by the new American canals. In conclusion Captain McCannel spoke of the *Lyman C. Davis*, last of the Great Lakes fleet of sailing vessels now laying at its moorings in Toronto harbour where it is planned to burn her for the amusement of holiday crowds. He deplored such an event and urged that the ship be preserved and turned to some useful purpose such as a cadet training ship.

Captain McCannel received a sincere vote of thanks from the meeting for his excellent paper on motion of Messrs. J. H. Jenkins and A. H. Russell.

## Vancouver Branch

*A. I. E. Gordon, Jr.E.I.C., Secretary-Treasurer.*

### Utilization of Electrical Energy at the Plant of the Consolidated Mining and Smelting Company

On Monday, January 8th, 1934, a joint meeting of the Vancouver Section of the American Institute of Electrical Engineers and the Vancouver Branch of The Engineering Institute of Canada was held in the auditorium of the Medical-Dental building, when Mr. A. G. Dickenson, electrical engineer of the Consolidated Mining and Smelting Company at Trail, B.C., spoke on the above subject to an audience of ninety-two.

Mr. Dickenson confined his discussion to the Trail smelter and did not take account of the extensive use of electrical power at the Sullivan mine. At Trail, there is the main smelter and refinery at Tadanac, which covers 160 acres and employs 2,800 men, and the fertilizer plant at Warfield, a mile away, which covers 60 acres and employs 400 men. Both plants operate eight hours every day in the year and consume over 87,400 kw. With the plants in full operation this becomes 110,000 kw. Seventy-five per cent. of this power is converted to d.c. for use in refining and other metallurgical operations. There are 2,100 motors of various types totaling 51,000 h.p. Power is generated by the West Kootenay Power Company, a subsidiary of the Consolidated Company, at Bennington Falls and elsewhere.

The lecture was illustrated by numerous slides and after describing the arrangement of the plants on the ground, the speaker went into detailed description of the distribution system, the main sub-stations, and the principal types of electrical machines and equipment used in the various processes.

### Nistri Photo-grammetric Method of Air Survey

A general meeting of the Vancouver Branch, held in the auditorium of the Medical-Dental building on February 12th, 1934, was addressed by Brigadier-General Sir Charles Delmé-Radcliffe on "The Nistri Photo-grammetric Method of Air Survey."

The distinguished guest, while in charge of British forces on the Italian front during the War, became acquainted with the Italian inventor of the process and assisted in carrying it to its present degree of perfection. The system depends on the optical enlargement of aeroplane photographs by projection on a moving screen in such a manner that rays of light intersecting along one contour line show that line in sharp relief, the rest of the picture remaining a blurred background. This may be repeated and the contours drawn for any interval. The enlargement may be to any desired scale. The speaker showed slides illustrating the complicated machine, the "cartograph," which accomplishes this purpose.

Field work takes a minimum of time and an half hour's flying will provide two hundred hours of office work. A minimum of ground control is required. The time required to survey and construct a contour map of a given area is ⅓ to 1/10 that required by ordinary topographical methods and can be done at ⅓ to 1/10 the cost.

An accuracy of less than 0.5 foot error is claimed for the contours and the topographical detail is much superior to that obtained by other methods.

After considerable discussion a vote of thanks was moved by H. B. Muckleston, M.E.I.C., and the meeting adjourned.

Discussion lasting over an hour was a tribute to the very high standard of this paper.

A vote of thanks was moved by P. H. Buchan, A.M.E.I.C., chairman of the Vancouver Branch, and the meeting adjourned at 11.00 p.m.

## Winnipeg Branch

*E. W. M. James, A.M.E.I.C., Secretary-Treasurer.*
*E. V. Caton, M.E.I.C., Branch News Editor.*

The regular meeting of the Winnipeg Branch of The Engineering Institute of Canada held on February 1st, 1934, was a joint meeting of the Winnipeg Branch of The Engineering Institute of Canada, the Association of Professional Engineers of the Province of Manitoba, and the Association of Manitoba Land Surveyors.

The speaker at this meeting was Mr. William Nelson Carey, Federal Engineer, Public Works Administration for Minnesota. Mr. Carey is also a member of the American Society of Civil Engineers, and President of the Minnesota Federation of Architectural and Engineering Societies.

Owing to the great interest of Winnipeg citizens, both engineers and laymen, in the gigantic economic experiment being made by our neighbours south of the International boundary, and it being realized that Canada will be affected whether President Roosevelt's efforts end in success or failure, and the probability that Canada will shortly follow her big neighbour's example to the extent of a moderate programme of public works to relieve unemployment and stimulate business, the Technical Associations decided to invite Mr. Carey to describe what is being attempted and what has already been accomplished, in the hope that we in Canada would be able to profit by America's experience and avoid their mistakes.

Some four hundred members and visitors were present.

The chairman, Professor G. H. Herriot, M.E.I.C., briefly addressed the meeting, and for the benefit of the visitors explained the aims and objects of The Engineering Institute of Canada, emphasizing the objects of the Association as outlined in Section 1 of the By-laws. He then called on Major A. J. Taunton, A.M.E.I.C., to introduce the speaker.

The speaker took as the title of his subject "The U.S. Public Works Administration," and his address reproduced elsewhere in this issue.

After the address an active discussion took place in which many of the visitors took part.

The meeting closed with a hearty vote of thanks being tendered to Mr. Carey by Mr. D. A. Ross.

### Supper Dance

The joint supper dance of the Winnipeg Branch of The Engineering Institute of Canada and of the Association of Professional Engineers of the Province of Manitoba was held in the main dining room of the Royal Alexandra hotel on the evening of Friday, February 9th, 1934.

The room was converted for the occasion into a stage representing the evolution of surveying and engineering.

The window recesses concealed by large silhouettes depicted the progress of engineering from the initial mechanical stage to the finished product, which proved a most effective background and accentuated the occasion for which the dance was planned.

At one corner of the room a curtained wall showed off to advantage a giant thermometer on which letters of varied hues marked the dances on the programme in their rightful succession.

Tables of varying size were adorned with gold, pink and white tulips with their attendant green spike-like foliage.

The dance was featured by many pretty gowns which radiated in and out of the spot lights that were thrown from time to time on the dance floor. Noise makers and favours added merriment to the event.

# Preliminary Notice

## of Applications for Admission and for Transfer

March 26th, 1934

The By-laws provide that the Council of The Institute shall approve, classify and elect candidates to membership and transfer from one grade of membership to a higher.

It is also provided that there shall be issued to all corporate members a list of the new applicants for admission and for transfer, containing a concise statement of the record of each applicant and the names of his references.

In order that the Council may determine justly the eligibility of each candidate, every member is asked to read carefully the list submitted herewith and to report promptly to the Secretary any facts which may affect the classification and selection of any of the candidates. In cases where the professional career of an applicant is known to any member, such member is specially invited to make a definite recommendation as to the proper classification of the candidate.*

If to your knowledge facts exist which are derogatory to the personal reputation of any applicant, they should be promptly communicated.

**Communications relating to applicants are considered by the Council as strictly confidential.**

The Council will consider the applications herein described in May, 1934.

R. J. Durley, Secretary.

* The professional requirements are as follows:—

A **Member** shall be at least thirty-five years of age, and shall have been engaged in some branch of engineering for at least twelve years, which period may include apprenticeship or pupilage in a qualified engineer's office, or a term of instruction in a school of engineering recognized by the Council. The term of twelve years may, at the discretion of the Council, be reduced to ten years in the case of a candidate for election who has graduated from a school of engineering recognized by the Council. In every case the candidate shall have held a position in which he had responsible charge for at least five years as an engineer qualified to design, direct or report on engineering projects. The occupancy of a chair as a professor in a faculty of applied science of engineering, after the candidate has attained the age of thirty years, shall be considered as responsible charge.

An **Associate Member** shall be at least twenty-seven years of age, and shall have been engaged in some branch of engineering for at least six years, which period may include apprenticeship or pupilage in a qualified engineer's office or a term of instruction in a school of engineering recognized by the Council. In every case a candidate for election shall have held a position of professional responsibility, in charge of work as principal or assistant, for at least two years. The occupancy of a chair as an assistant professor or associate professor in a faculty of applied science of engineering, after the candidate has attained the age of twenty-seven years, shall be considered as professional responsibility.

Every candidate who has not graduated from a school of engineering recognized by the Council shall be required to pass an examination before a board of examiners appointed by the Council. The candidate shall be examined on the theory and practice of engineering, with special reference to the branch of engineering in which he has been engaged, as set forth in Schedule C of the Rules and Regulations relating to Examinations for Admission. He must also pass the examinations specified in Sections 9 and 10, if not already passed, or else present evidence satisfactory to the examiners that he has attained an equivalent standard. Any or all of these examinations may be waived at the discretion of the Council if the candidate has held a position of professional responsibility for five or more years.

A **Junior** shall be at least twenty-one years of age, and shall have been engaged in some branch of engineering for at least four years. This period may be reduced to one year at the discretion of the Council if the candidate for election has graduated from a school of engineering recognized by the Council. He shall not remain in the class of Junior after he has attained the age of thirty-three years, unless in the opinion of Council special circumstances warrant the extension of this age limit.

Every candidate who has not graduated from a school of engineering recognized by the Council, or has not passed the examinations of the third year in such a course, shall be required to pass an examination in engineering science as set forth in Schedule B of the Rules and Regulations relating to Examinations for Admission. He must also pass the examinations specified in Section 10, if not already passed, or else present evidence satisfactory to the examiners that he has attained an equivalent standard.

A **Student** shall be at least seventeen years of age, and shall present a certificate of having passed an examination equivalent to the final examination of a high school, or the matriculation of an arts or science course in a school of engineering recognized by the Council.

He shall either be pursuing a course of instruction in a school of engineering recognized by the Council, in which case he shall not remain in the class of Student for more than two years after graduation; or he shall be receiving a practical training in the profession, in which case he shall pass an examination in such of the subjects set forth in Schedule A of the Rules and Regulations relating to Examinations for Admission as were not included in the high school or matriculation examination which he has already passed; he shall not remain in the class of Student after he has attained the age of twenty-seven years, unless in the opinion of Council special circumstances warrant the extension of this age limit.

An **Affiliate** shall be one who is not an engineer by profession but whose pursuits, scientific attainments or practical experience qualify him to co-operate with engineers in the advancement of professional knowledge.

The fact that candidates give the names of certain members as reference does not necessarily mean that their applications are endorsed by such members.

### FOR ADMISSION

ALEXANDER—STANLEY GEORGE, of 460 Sherbrooke St., Peterborough, Ont., Born at Paisley, Scotland, March 27th, 1893; Educ., 1922, Ont. Stationary Engr's. Cert. 1st Class; Maths. Course, Chicago Tech. Coll.; I.C.S. steam engrg., 1918, chemistry, 1925; 1909-13, ap'tice machinist, International Marine Signal Co., Ottawa, Ont. (later General Engrg. Works, Ottawa); 1913-15, operating engr., Ottawa Constrn. Co.; 1915-18, Overseas, C.E.F.; 1918-20, steam plant foreman, Dept. of Engineer Services, Ottawa; 1920-23, chief operating engr. (summers), Govt. Peat Fuel Committee, Ottawa and Alfred, Ont., (winters) in charge of shift at central heating plant, Dept. of Public Works, Ottawa; 1923-26, steam plant foreman, Douglas Packing Co. Ltd., Cobourg, Ont.; 1926-31, asst. mech. supt., General Foods Corpn., Cobourg, Ont.; 1931 to date, chief operating engr. of steam power plants, Canadian General Electric Co., Peterborough, Ont.

References: B. L. Barns, V. S. Foster, B. Ottewell, H. B. Hanna, F. Bowness.

BREBNER—HECTOR STEPHEN, of 1431 St. Mark St., Montreal, Que., Born at Haddenham, Bucks, England, Feb. 4th, 1904; Educ., 1922-24, 2 year day course in engrg. science at Glasgow Univ.; Montreal Technical School—certificates in struct'l. design, 1930, electrotechnics II, 1932, and reinforced concrete design, 1933; 1924-27, 3 yr. pupilage with Nott Brodie & Co. Ltd., Bristol, England (gen. experience on railroad and reinforced concrete bridge constrn. Also trench excavation and piling work); 1927-28, with same firm as asst. engr., responsible for lines and levels on reinforced concrete sluiceway in Bristol Docks; 1929 (Feb.-Aug.), junior dftsman and tracer, Lake St. John Power & Paper Co., Montreal; Sept. 1929 to Aug. 1931 and from May 1932 to date, dftsman., Canadian Industries Limited, Montreal.

References: L. de B. McCrady, H. C. Karn, W. B. Fraser, V. R. Davies, I. R. Tait, A. B. McEwen, G. R. Stephen.

FRANCOEUR—GEORGES ULRIC, of 2447 Maplewood St., Montreal, Que., Born at Sorel, Que., April 29th, 1893; Educ., 1908-10, private technical course, dfting, surveying, etc.; 1920, returned soldier refresher course on civil engrg., McGill Univ.; 1910-14, dftsman, Sorel shipyard, and land surveying in field; 1914-19, overseas. Experience in map reading, sextants, range finders, compass, protractors and map reading for aviation purposes; 1921-23, dftsman., Dominion Engrg. Works, Lachine, Que.; 1923-25, dredging, surveying and concrete works, Atlas Constrn. Co., Montreal Waterworks; 1925-26, supt., Simplex Radio Co., Montreal; 1927, ship designer, Sorel Shipyard; 1928-31, junior engr., and 1931 to date, asst. engr., River St. Lawrence Ship Channel, Dept. of Marine, Montreal, Que.

References: N. B. McLean, A. E. Dubuc, H. A. Terreault, C. J. Desbaillets, A. Lafleche, O. C. E. Fournier.

GAUDEFROY—HENRI, of 4590 Hutchison St., Montreal, Que., Born at Montreal, June 18th, 1909; Educ., B.A.Sc., C.E., Ecole Polytechnique, Montreal, 1933; at present pursuing studies at Mass. Inst. Tech. leading to the degree of B.S. in Elec'l. Engrg.

References: A. Frigon, A. Boyer, T. J. Lafreniere, J. A. Lalonde, A. Duperron.

GRANT—ERIC, of 3645 Jeanne Mance St., Montreal, Que., Born at London, England, Feb. 14th, 1902; Educ., Prelim. Oxford and Cambridge Local Exams.; Montreal Technical School—certs. struct'l. design, 1932, reinforced concrete design, 1933; 1917-18 (18 mos.), ap'ticeship, with C. J. Maggs, M.I.M.E. supt. engr., Sprostons Ltd., British Guiana; 1919-20, machinist helper, Imperial Oil Refineries, Imperoyal, N.S.; 1920, boiler makers helper, Halifax Shipyards, Ltd.; 1921-22, field asst. to Govt. Surveyors, Lands and Mines Dept., British Guiana; 1922-23, ap'tice engr., Colonial Transport Dept., British Guiana; 1924-27, pupil and engr's. asst. to M. A. Ravenor, M.Inst.C.E., British Guiana. Georgetown city improvement schemes, sewer and water main schemes, etc.; also lab. work in connection with report on silt discharge of the Demarara River; 1928 to date, engr., on field work for Montreal Light Heat & Power Cons., Montreal. Laying out lines and grades for gas mains; preparation of profiles, design of gas main connection, reinforced concrete beams, reinforced concrete manholes, etc. Drafting, surveying and levelling.

References: J. J. Humphreys, W. J. Yorgan, D. O. Wing, H. Milliken, E. J. Turley, V. R. Davies.

HANSEN—DARREL ADRIAN, of Edmonton, Alta., Born at Hartley, Iowa, U.S.A., July 17th, 1900; Educ., B.Sc. (E.E.), Univ. of Alta., 1928; 1923-28, rodman and instr'man. on rly. location and constrn.; 1928 to date, with Calgary Power Company, and at present asst. to divn. engr., Northern Division. Work includes: supervision of transmission line constrn., location topographic surveys, material and cost estimates, switching structures and distribution systems, collecting, computing and plotting hydrometric and hydrographic data, etc.

References: R. S. L. Wilson, H. J. MacLeod, G. H. Thompson, H. B. LeBourveau, B. Russell.

LAND—HERBERT LOUIS, of Ottawa, Ont., Born at Bralanda, Sweden, June 5th, 1902; Educ., D.L.S. 1930; 1920-25, misc. surveys, British Columbia; 1925-28, asst. on land and misc. surveys in B.C., Alta., Sask. and Man.; 1929 (season), asst. topog. and aerial control survey, N.B. and P.E.I.; 1930 (season), asst. D.L.S. Peace River (subdivision); 1928-31 (winters) in office of Topog'l. Surveys Br., Dept. of Interior, dfting., map compilation, laying out projections, computing triangulation surveys, plotting aerial photographs; From June 1931 to date, on staff of River St. Lawrence Ship Channel, Dept. of Marine. Asst. to engr. in charge of contract dredging, part time in full charge. In full charge of survey parties on Lake St. Peter, winters of 1933 and 1934.

References: N. B. McLean, A. Lafleche, L. P. Kuhring, F. S. Jones, F. H. Peters, G. A. Bennett.

MAUDE—JOHN HENRY, of 613 St. Joseph St., Lachine, Que., Born at Manchester, England, Feb. 18th, 1896; Educ., 1912-21, Coll. of Technology, Manchester. 1915, senior course diploma, mech'l. engrg., Manchester Coll. of Tech., and 1921, Assoc. Manchester Coll. of Technology; 1911-17, engr. ap'tice, Sir W. G. Armstrong Whitworth, Manchester, 3 yrs., works, 3 yrs., dfting office; 1917-20, dftsman., gen. engrg. office of same company; and from 1921-24, designer, gen. engrg. dept.; 1922-29, part time evening lecturer, mech'l. engrg., Newton Heath Technical School, and Openshaw Technical School, Manchester; 1924-29, leading designer, gen. engrg. dept., Messrs. Vickers Armstrong, Manchester. Hydraulic and electric cranes, hydraulic presses and machinery, testing plants, steelworks, boiler shop and shipyard machy.; 1929-32, lecturer, evening classes, mech'l. design, Dominion Bridge Company; 1929 to date, mech'l. engr., Dominion Bridge Company, Lachine. Cranes, swing bridge machy., bascule bridge machy., plant work, etc. Hydraulic regulating gates and operating machy.

References: F. P. Shearwood, F. Newell, L. R. Wilson, R. S. Eadie, A. Peden.

ROBERTS—EVERETT H., of Regina, Sask., Born at Detroit, Mich., April 11th, 1890; Educ., 1913-14, Forestry Faculty, Univ. of Toronto. Logging Engineer Diploma, Wyman's School of the Woods, Mich.; 1910, student asst., Dominion Forestry Branch, B.C.; 1910-13, chief of forest survey party, Laurentide Paper Co., Grand Mere, Que.; 1913-14, forest asst., Dominion Forestry Branch, Prince Albert, Sask.; spring 1914, timber cruising and mapping for Royal Trust Company, Toronto, in Northern Onyario; 1914-17, asst. district forest inspr., Dominion Forest Service, Prince Albert,

1915-16, acting dist. forest inspr.; 1917-19, 2nd Lieut., U.S. Army Air Service—spruce production divn., Portland, Ore. Lumber inspr., in charge forest fire protection, U.S. Army; 1919-27, asst. district inspr., Forest Service, Dept. of the Interior, Prince Albert; 1927-29, district chief, fire protection for Sask., Dominion Forest Service, Prince Albert; 1930, acting district forest inspr. for Sask., Forest Service, Dept. of the Interior; at present, Director of Forests, Dept. Natural Resources, Prov. of Sask., Regina.
References: D. A. R. McCannel, E. B. Webster, C. J. McGavin, E. H. Finlayson, J. L. Gordon.

WHITE—ROBERT JOHN, of Fredericton, N.B., Born at Shediac, N.B., April 3rd, 1908; Educ., 1926-27, 1 year science, St. Francois Xavier Univ.; R.C.A.F. Flying Course. Commercial Air Pilot's License; 1930-31, test flight, Ottawa Air Station; 1932 (summer), asst. to D.L.S.; Dec. 1932 to Nov. 1933, foreman in charge Relief Project 29, Saint John Airport constrn.; at present, foreman, Project 123, Fredericton, N.B.
References: W. H. Blake, A. R. Babbitt, G. M. MacPhail, G. G. Hare, E. W. Stedman.

### FOR TRANSFER FROM THE CLASS OF JUNIOR

SAUVAGE—ROBERT, of Quebec, Que., Born at Montreal, Nov. 27th, 1902; Educ., B.A.Sc., C.E., Ecole Polytechnique, Montreal, 1924; 1920-23, summer work with Quebec Streams Commission; 1924 to date, bridge designing, Dept. of Public Works, Quebec, Que. *(Jr. 1925.)*
References: I. A. Vallee, A. B. Normandin, O. Desjardins, H. Cimon, J. Joyal, J. G. O'Donnell, C. Milot, T. M. Dechene.

WILLIAMS—EDWARD CLIFFORD, 233 Indian Road, Toronto, Ont., Born at Hawera, New Zealand, July 3rd, 1900; Educ., 1924-25, Canterbury College, Christchurch, N.Z.; Cert., Gordon Inst. of Technology, Geelong, N.Z.; Final Pass Cert. (1930), in elect'l. engrg. practice, City and Guilds of London (England) Institute, Dept. of Technology; 1922-23, worked as lineman and lines foreman; 1926 (Feb.-July), mtce. electn., Ford Motor Co., Geelong, N.Z.; 1926-27, foreman in charge of installn. of plant for Co-op. Phosphate Co., Geelong, N.Z.; 1927 (Aug.-Dec.), mtce. of direct current plant for B. J. Neilson, Melbourne, Australia; 1927-29, electrn. in charge of mtce. and conversion from single to three phase of plant for Bosella Preserving and Mfg. Co., Melbourne, Australia; 1929 to date, with Can. Gen. Electric Co. Ltd., as follows: 1929-30, test course, Peterborough; 1930-31, jr. asst. switchboard engr., Peterborough; 1931 to date, industrial heating specialist, Head Office, Toronto, full charge of industrial heating dept., involving supervn. of all appn. work and all commercial policies for complete line of industrial heating equipment, including resistor heated furnaces of all types, immersion type, steam generators, bldg. heating equipments and appns. of industrial heating units of all kinds. *(Jr. 1930.)*
References: D. L. McLaren, W. E. Ross, L. C. Prittie, L. D. W. Magie, W. M. Cruthers.

### FOR TRANSFER FROM THE CLASS OF STUDENT

AITKINS—JOHN CURREY, of Boissevain, Man., Born at Boissevain, Man., Oct. 11th, 1905; Educ., B.Sc. (C.E.), Univ. of Man., 1929; Passed Prelim. D.L.S. Exams., 1927; 1924-25-26 (summers), rodman and field dftsman., Topog'l. Surveys of Canada; 1927 (summers), articled pupil to D.L.S.; 1928 (summer), instr'man. in charge of party, prelim. survey, Slave Falls power development; 1929-31, office on constrn. of same project for City of Winnipeg Hydro-Electric System; 1931, instr'man., on constrn. of concrete pavement, Manitoba Good Roads Board; Oct. 1933 to date, inspecting engr., (Dom. Water Power and Hydrometric Bureau) Lac Seul Unemployment Relief Project. *(S. 1928.)*
References: J. N. Finlayson, J. W. Sanger, G. H. Herriot, J. A. MacGillivray, G. G. McEwen, B. B. Hogarth.

FRANKLIN—ROBERT LAWRENCE, of Woolwich, England., Born at Riceville, Ont., Aug. 2nd, 1908; Educ., B.Sc., Queen's Univ., 1930. At present attending the 9th Ordnance Mechanical Engineer's Course, Military College of Science, Woolwich, England; Summer 1928 and 1929 and 2 mos. in 1900, student training course, Massey Harris Co. Ltd., Toronto; 1930 (4 mos.), at Sturgeon Falls, and 1931 (4 mos.), at Iroquois Falls, mech'l. engr. in research organization, Abitibi Power and Paper Co. Ltd.; 1932 (June-Dec.), handled two bldg. contracts at Hearst, Ont.; 1900 (Feb.-June), sub-foreman, Govt. Relief Camp, Rockcliffe, Ont.; June 1933 to date, Ordnance Mechanical Engineer (4th Class), Royal Canadian Ordnance Corps. *(S. 1928.)*
References: N. C. Sherman, L. T. Rutledge, E. W. Stedman, G. R. Turner, L. M. Arkley, A. E. MacRae.

FULTON—FRASER F., of Montreal, Que., Born at Saint John, N.B., June 28th, 1905; Educ., B.Sc. (E.E.), McGill Univ., 1928; 1922-23 and summers 1924-25-26, outside plant unit cost work, N.B. Tel. Co.; 1927 (summer), rly. sales engr., 1928-31, asst. to rly sales mgr.,—equipment engr. on carrier current and telegraph apparatus, and 1931 to date, installn. estimating engr.—constrn. engrg. on fire, police and traffic signal systems, street lighting systems and power cable, for the Northern Electric Co. Ltd., Montreal, Que. *(S. 1923.)*
References: H. J. Vennes, N. L. Morgan, W. C. M. Cropper, T. Eardley-Wilmot, W. H. Jarand, B. C. Nowlan, H. R. Cleveland.

HARDY—ROBERT McDONALD, of Edmonton, Alta., Born at Winnipeg, Man., Sept. 25th, 1906; Educ., B.Sc. (Civil), Univ. of Man., 1929. M.Sc., McGill Univ., 1930; 1927 (5 mos.), dftsman., Dominion Bridge Co., Winnipeg; 1928-29-30 (summers), reinforced concrete designer, Truscon Steel Co., Winnipeg; 1931 (4 mos.), struct'l. designer, City of Edmonton; 1932, misc. surveying; 1930 to date, lecturer, dept of civil engrg., University of Alberta, Edmonton, Alta. *(S. 1928.)*
References: R. S. L. Wilson, J. N. Finlayson, E. Brown, A. Campbell, H. L. Seymour, A. Ritchie.

McCORMICK—ARCHIBALD THOMAS, of Winnipeg, Man., Born at Maryfield, Sask., Jan. 13th, 1904; Educ., B.Sc. (E.E.), Univ. of Man., 1930; 1927 (summer), timekpr. and cost clerk, City of Winnipeg Engrg. Dept.; 1928-29 (summers), subforeman and inspr., with same dept.; 1930-34, installn. and service engr., research products dept., Northern Electric Co., Winnipeg, at present special products engr., in charge of service territory for theatre sound systems. *(S. 1928.)*
References: E. P. Fetherstonhaugh, A. L. Cavanagh, J. D. Peart, G. H. Herriot, J. N. Finlayson.

McCRONE—DONALD GORDON, of 78 Iona Ave., Ottawa, Ont., Born at Toronto, May 5th, 1904; Educ., B.A.Sc., Univ. of Toronto, 1917; 1924-25 (summers), constrn. office, T. Eaton Co.; 1926 (summer), Standard Constrn. and Paving Co.; 1927-28, asst. engr., Prov. of Ontario, Dept. of Health, sanitary engrg. divn.; 1928, asst. engr., Chapman & Oxley; 1928-29, asst. engr., Dom. of Canada, Dept. of Health, sanitary engrg. divn.; 1929-31, asst. engr., Chapman & Oxley; 1931, municipality of Forest Hill; 1931 to date, with E. B. Eddy Co., as filtration plant supt., and from 1932 to date, also in charge of sulphite control and chemical laboratories. *(Jr. 1929.)*
References: J. M. Oxley, R. A. Crysler, E. A. Cross, W. S. Kidd, G. H. Ferguson.

STEWART—JOHN R., of Montreal, Que., Born at Beebe, Que., Sept. 3rd, 1905; Educ., B.Sc. (Mech.), McGill Univ., 1927; 1926 (summer), pump dept., Ingersoll Rand Co., Sherbrooke, Que.; 1927-29, constrn. work, mixing room foreman, in charge of sulphite pits, screening, mixing, coloring and delivery of stock to paper machines, Anglo Canadian Pulp and Paper Co., Limoilou, Que.; 1929 to date, service engr., in charge of service dept., and development of processes in gas welding and cutting, electric welding, etc., Canadian Liquid Air Co. Ltd., Montreal, Que. *(S. 1925.)*
References: C. M. McKergow, E. Brown, A. Stansfield, A. R. Roberts, G. Sproule.

WOOD—ROBERT, of Quebec, Que., Born at Kilmarnock, Scotland, May 12th, 1902; Educ., B.Sc. (E.E.), McGill Univ., 1924; 1920-23, dftsman., with Northern Electric Co., Ross & MacDonald and McDougall, Pease & Friedman; 1924-25, student engr., Shawinigan Water and Power Co.; 1925-27, asst. chief engr., Quebec Power Co. and Quebec Rly. Light & Power Co.; 1927-29, supt., power divn., Quebec Power Co.; 1929 to date, executive asst., Quebec Power Co., and Quebec Rly. Light and Power Co., acting as gen. mgr's. asst., particularly in analysing engrg. and economic problems affecting all divisions of the company, and in general supervising and coordinating the work of the various divnl. supts., power, gas, tramways, suburban rly., etc. *(S. 1921.)*
References: P. S. Gregory, A. Lariviere, C. V. Christie, F. S. Keith, R. B. McDunnough, G. K. McDougall, J. Morse.

## July Journals Required

Copies of the July, 1933, issue of The Engineering Journal are required for binding, and it would be appreciated if members having no further use for this issue would forward copies available to Headquarters at 2050 Mansfield Street, Montreal. An allowance of 25 cents to cover the cost of postage etc., will be made on each copy received.

The Annual Report of the Department of Public Works of New Brunswick states that road expenditures were curtailed during 1933 and expenditures for maintenance work were 18 per cent lower than in 1932 and 62 per cent under the peak year of 1930. Expenditures on permanent work were 69 per cent lower than the previous year and 90 per cent lower than during 1930.

Expenditures for 1933 were classified as follows:—

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|---|---|
| Ordinary roads | $ 233,753 |
| Municipal roads | 55,143 |
| Patrol | 254,732 |
| Permanent—main trunk | 248,799 |
| Permanent—secondary and branch | 343,883 |
| Total | $1,136,310 |

A comparatively small amount of permanent highway construction was carried on during the past year; only work found to be absolutely necessary being done. Greater attention has been given to the secondary trunk highway system, and some of these roads are being gradually brought up to almost as high a standard as the main trunk highways. All main trunk highways and a large mileage of secondary trunk highways are being regularly maintained by heavy power maintainers. Horse patrol graders are used on roads where the traffic is not heavy enough to warrant the use of power machines. Very little winter maintenance work is done on highways other than the snowing of covered bridges and bushing ice roads. It is further stated that New Brunswick has a total road mileage of 11,822 and some 1,761 road signs have been placed along the roads.

## Canada and Exchange Fluctuations

The recent spectacular changes in the exchange relationships of the pound sterling, the United States of America dollar and the Canadian dollar have effects of far-reaching importance to Canadian interests. Canadian borrowers, including the Dominion and provincial governments, municipalities and corporations, benefit by the elimination of the premium on obligations payable in United States funds. Many of the outstanding bond issues provide for payment in sterling at the option of the holder, at the rate of $4.86 to the pound, so that the premium on English exchange, if maintained, will represent a considerable charge. With sterling quoted at over $5.11 to the Canadian dollar, Canadian holders of Canadian bonds payable in sterling will find their payments subject to the Dominion government tax of 5 per cent on interest payable in a currency at a premium exceeding 5 per cent.

The premium on sterling will assist sales of Canadian products in the United Kingdom and other Empire markets, but constitutes a handicap on sales of British products in the Dominion. On the other hand the discount on the United States dollar will facilitate imports into Canada from the United States and handicap Canadian producers in respect of exports to that country. The present exchange premium provides an opportunity for British interests to transfer funds to Canada for investment in Canadian securities, or for development of Canadian branch plants or for other purposes.

While retail trade throughout Canada has continued in the doldrums, there are many indications of gradual improvement in the general economic situation in the Dominion. The value of construction contracts awarded in October was nearly double the amount for September, and was the largest for any month in the last two years. The Canadian Bank of Commerce, in its monthly commercial letter, has referred to this "surprising improvement in one of the major branches of our economy," and points out that it was due to a better demand for housing accommodation and an extension of commercial facilities, rather than to an expansion of public works.

It is reported that the *New Brunswick Electric Power Commission* now operates 235 miles of high voltage transmission line and 695 miles of distributing lines in villages and rural districts. The commission is distributing electricity directly to 5,213 customers in villages and rural sections and in addition power generated by the commission is distributed through other agencies to 17,395 customers. These figures are contained in the fourteenth annual report of the New Brunswick Electrical Power Commission.

## Situation Vacant

ENGINEER, required by a progressive Canadian company for sales and service work. Should be a graduate in chemical or mechanical engineering and have experience in combustion work or the operation of metallurgical or reheating furnaces. Apply to Box No. 984-V.

## Situations Wanted

MECHANICAL ENGINEER, Canadian, with technical training and executive experience in both Canadian and American industries, particularly plant layout, equipment, planning and production control methods, is open for employment with company desirous of improving manufacturing methods, lowering costs and preparing for business expansion. Apply to Box No. 35-W.

MECHANICAL ENGINEER, A.M.E.I.C. Married. Experience in machine shops, erection and maintenance of industrial plant mechanical and structural design. Reads German, French, Dutch and Spanish. Seeks any suitable position. Apply to Box No. 84-W.

PURCHASING ENGINEER, graduate mechanical engineer, Canadian, married, 34 years of age, with 13 years' experience in the industrial field, including design, construction and operation, 8 years of which had to do with the development of specifications and ordering of equipment and materials for plant extensions and maintenance; one year engaged on sale of surplus construction equipment. Full details upon request. Apply to Box No. 161-W.

CIVIL ENGINEER, age 44, open for employment anywhere, experience covers about 20 years' active work, including 7 years on municipal engineering, 2 years as Town Manager, 3 years on railway construction, 3 years on the staff of a provincial highway department, 2 years as contractor's superintendent on pavement construction. Apply to Box No. 216 W.

REINFORCED CONCRETE ENGINEER, B.SC., P.E.Q., eight years experience in construction design of industrial buildings, office buildings, apartment houses, etc. Age 30. Married. Apply to Box No. 257 W.

ELECTRICAL ENGINEER, B.SC., '28, Canadian. Age 25. Experience includes two summers with power company; thirteen months test course with C.G.E. Co.; telephone engineering, and the past thirty months with a large power company in operation and maintenance engineering. Location immaterial and available immediately. Apply to Box No. 266-W.

MECHANICAL ENGINEER, age 28, nine years all round experience, Grad. Inst. of Mech. Engs. England, S.E.I.C. Technical and practical training with first class English firm of general engineers; shop, foundry and drawing office experience in steam and Diesel engines, asphalt, concrete machinery, boilers, power plants, road rollers, etc. Experience in heating and ventilation design and equipment; 18 months designing draughtsman with Montreal consulting engineers. 2½ years sales experience, steam and hot water heating systems, power plant equipment, machinery, oil-burning apparatus. Canadian 4th class Marine Engineers Certificate; C.N.S. experience. Available at short notice. Apply to Box No. 270-W.

DESIGNING DRAUGHTSMAN, experience in layout of steam power house equipment and piping. Wide experience in mechanical drive and details of machinery, gearing, and hoists. Accustomed to layout of small mill buildings of steel and timber, structural design and details. Good references. Present location Montreal. Apply to Box No. 329-W.

PLANE-TABLE TOPOGRAPHER, B.SC., in C.E. Thoroughly experienced in modern field mapping methods including ground control for aerial surveys. Fast and efficient in surveys for construction, hydro-electric and geological investigations. Apply to Box No. 431-W.

ELECTRICAL ENGINEER, B.SC., A.M.E.I.C., AM.A.I.E.E., age 30, single. Eight years experience H.E. and steam power plants, substations, etc., shop layouts, steel and concrete design. Location immaterial. Available immediately. Apply to Box No. 435-W.

CIVIL ENGINEER, B.A.SC., and C.E., A.M.E.I.C., age 30, married. Experience over the last ten years covers construction on hydro-electric and railway work as instrumentman and resident engineer. Also office work on teaching and design, investigations and hydraulic works, reinforced concrete, bridge foundations and caissons. Location immaterial. Available at once. Apply to Box No. 447-W.

SALES ENGINEER, M.A.SC. Univ. of Toronto, wishes to represent firm selling building products or other engineering commodities, as their representative in Western Canada. Located in Winnipeg. Apply to Box No. 467-W.

CIVIL ENGINEER, B.SC., A.M.E.I.C., with six years experience in paper mill and hydro-electric work, desires position in western Canada. Capable of handling reinforced concrete and steel design, paper mill equipment and piping layout, estimates, field surveys, or acting as resident engineer on construction. Now on west coast and available at once. Apply to Box No. 482-W.

MECHANICAL ENGINEER, B.SC. Age 28, married. Four and a half years on industrial plant maintenance and construction, including shop production work and pulp and paper mill control. Also two and a half years on structural steel and reinforced concrete design. Available at once. Apply to Box No. 521-W.

CIVIL ENGINEER, Canadian, married, twenty-five years' technical and executive experience, specialized knowledge of industrial housing problems and the administration of industrial towns, also town planning and municipal engineering, desires new connection. Available on reasonable notice. Personal interview sought. Apply to Box No. 544-W.

ELECTRICAL AND MECHANICAL ENGINEER, B.SC., A.M.E.I.C. Experience includes C.G.E. Students Test Course and six years in engrg. dept. of same company on design of electrical equipment. Four summers as instrumentman on surveying and highway construction. Recently completed course in mechanical engineering. Available at once. Location preferred Ontario, Quebec, or Maritimes. Apply to Box No. 564-W.

### Have You Registered?

Readers of these columns will notice with interest the appearance of two situations vacant advertisements during the last two months. It is true these positions demand rather unusual requirements but it is pleasing that our registration files at last show a shortage in some lines of engineering. Members are again reminded however that the qualifications of those registered are first submitted for any vacancies before positions are advertised, and if suitable men are available the positions are filled immediately.

Some employers still think there is an unlimited number of engineers idle, but recently two firms who had chosen men, waited too long—their men had found positions elsewhere.

CIVIL ENGINEER, age 25, single, graduate. Creditable record on responsible hydro and railroad work in both Eastern and Western Canada. Apply to Box No. 567-W.

MECHANICAL ENGINEER, A.M.E.I.C., with twenty years experience on mechanical and structural design, desires connection. Available at once. Apply to Box No. 571-W.

MECHANICAL ENGINEER, B.A.SC., '30, desires position to gain experience, and which offers opportunity for advancement. Experience in pulp and paper mill and one year in mechanical department of large electrical company. Location immaterial. Available immediately. Apply to Box No. 577-W.

DOMINION LAND SURVEYOR, and graduate engineer with extensive experience on legal, topographic and plane-table surveys and field and office use of aerophotographs, desires employment either in Canada or abroad. Available at once. Apply to Box No. 589-W.

MECHANICAL ENGINEER, Canadian, technically trained; eighteen years experience as foreman, superintendent and engineer in manufacturing, repair work of all kinds, maintenance and special machinery building. Location immaterial. Available at once. Apply to Box No. 601-W.

CHEMICAL ENGINEER, S.E.I.C., B.SC., University of Alberta, '30. Age 31. Single. Six seasons' practical laboratory experience, three as chief chemist and three as assistant chemist in cement plant; one year's p.g. work in physical chemistry; three years' experience teaching. Desires position in any industry with chemical control. Available immediately. Apply to Box No. 609-W.

## Situations Wanted

DESIGNING ENGINEER AND ESTIMATOR, grad. Univ. of Toronto in C.E., A.M.E.I.C., twenty years experience in structural steel, construction and municipal work. Available at once. Apply to Box No. 613-W.

CIVIL ENGINEER, A.M.E.I.C., R.P.E., Ontario; three years construction engineer on industrial plants; fourteen years in charge of construction of hydraulic power developments, tower lines, sub-stations, etc.; four years as executive in charge of construction and development of harbours, including railways, docks, warehouses, hydraulic dredging, land reclamation, etc. Apply to Box No. 647-W.

MECHANICAL ENGINEER, A.M.E.I.C., Canadian, technically trained; six years drawing office. Office experience, including general design and plant layout. Also two years general shop work, including machine, pattern and foundry experience, desires position with industrial firm in capacity of production engineer or estimator. Available on short notice. Apply to Box No. 676-W.

DIESEL ENGINEER. Erection and industrial engineer, A.M.E.I.C., technically trained mechanical engineer with English and Canadian experience in erection and operation of steam and Diesel equipment in power house and mines, pumping, rock drilling, air compressors. Experienced in industrial and steel works operations including rolling mills, quarries, sales. Open for position on maintenance, operation or sales engineer. Location immaterial. Apply to Box No. 682-W.

ELECTRICAL AND CIVIL ENGINEER, B.SC., Elec., '29, B.SC., Civil '33. Age 27. JR.E.I.C. Undergraduate experience in surveying and concrete foundations; also four months with Canadian General Electric Co. Thirty-three months in engineering office of a large electrical manufacturing company since graduation. Good experience in layouts, switching diagrams, specifications and pricing. Best of references. Available immediately. Apply to Box No. 693-W.

MECHANICAL ENGINEER, B.SC., '27, JR.E.I.C. Four years maintenance of high speed Diesel engines units, 200 to 1,300 h.p. Also maintenance of D.C. and A.C. electrical systems and machinery. Draughting experience. Westinghouse apprenticeship course. Practical mechanical and electrical engineer with a special study of high speed Diesel engine design, application and operation. Location in western or eastern Canada immaterial. Apply to Box No. 703-W.

COMBUSTION ENGINEER, R.P.E., Manitoba, A.M.E.I.C. Wide experience with all classes of fuels. Expert designer and draughtsman on modern steam power plants. Experienced in publicity work. Well known throughout the west. Location, Winnipeg or the west. Available at once. Apply to Box No. 713-W.

ELECTRICAL ENGINEER, B.SC., University of N.B., '31. Experience includes three months field work with Saint John Harbour Reconstruction. Apply to Box No. 722-W.

MECHANICAL ENGINEER, age 41, married. Eleven years designing experience with project of outstanding magnitude. Machinery layouts, checking, estimating and inspecting. Twelve years previous engineering, including draughting, machine shop and two years chemical laboratory. Highest references. Apply to Box No. 723-W.

CIVIL ENGINEER, B.SC. (Alta. '31), S.E.I.C. Experience includes three seasons in charge of survey party. Transitman on railway maintenance, and concrete bridge designing. Nature of work and location immaterial. Apply to Box No. 724-W.

YOUNG CIVIL ENGINEER, B.SC. (Univ. of N.B. '31), with experience as rodman and checker on railroad construction, is open for a position. Apply to Box No. 728-W.

DESIGNING ENGINEER, M.SC. (McGill Univ.), D.L.S., A.M.E.I.C., P.E.Q. Experience in design and construction of water power plants, transmission lines, field investigations of storage, hydraulic calculations and reports. Also paper mill construction, railways, highways, and in design and construction of bridges and buildings. Available at once. Apply to Box No. 729-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.SC., Univ. of B.C. '30. Single, age 24. Sixteen months with the Allis-Chalmers Mfg. Co. as student engineer. Experience includes foundry production, erection and operation of steam turbines, erection of hydraulic machinery, and testing texropes and centrifugal pumps. Location immaterial. Available at once. Apply to Box No. 735-W.

CIVIL ENGINEER, M.SC., A.M.E.I.C., R.P.E. (Ont.), ten years experience in municipal and highway engineering. Read, write and talk French. Married. Served in France. Will go anywhere at any time. Experienced journalist. Apply to Box No. 737-W.

ELECTRICAL AND RADIO ENGINEER, B.SC. '31, S.E.I.C. Age 25. Nine months experience on installation of power and lighting equipment. Eight months on extensive survey layouts. Two summers installing telephone equipment. Specialized in radio servicing and merchandising. Available at once. Location immaterial. Apply to Box No. 740-W.

CIVIL ENGINEER, graduate '29. Married. One year building construction, one year hydro-electric construction in South America, fourteen months resident engineer on road construction. Working knowledge of Spanish. Apply to Box No. 744-W.

## Situations Wanted

SALES ENGINEER, B.Sc., McGill, 1923, A.M.E.I.C. Age 33. Married. Extensive experience in building construction. Thoroughly familiar with steel building products; last five years in charge of structural and reinforcing steel sales for company in New York state. Available at once. Located in Canada. Apply to Box No. 749-W.

DESIGNING ENGINEER, graduate Univ. Toronto '26. Thoroughly experienced in the design of a broad range of structures, desires responsible position. Apply to Box No. 761-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. Queen's Univ. '29. Age 25. Married. Three years experience as construction supt. and estimator for contracting firm. Experience includes general building, bridges, sewer work, concrete, boiler settings, sand blasting of bridges and spray painting. Available at once. Apply to Box No. 776-W.

CIVIL ENGINEER, B.Sc., '25, Jr.E.I.C., P.E.Q., married. Desires position, preferably with construction firm. Experience includes railway, monument and mill building construction. Available immediately. Apply to Box No. 780-W.

DRAUGHTSMAN, experience in civil engineering, forestry engineering, land surveying and house construction. Good references. Apply to Box No. 781-W.

ELECTRICAL AND SALES ENGINEER, S.E.I.C., grad. '28. Experience includes one year test course, one year switchboard design and two years switchboard and switching equipment sales with large electrical manufacturing company. Three summers Pilot Officer with R.C.A.F. Available at once. Apply to Box No. 788-W.

ELECTRICAL ENGINEER. Specializing in power and illumination reports, estimates, appraisals, contracts and rates, plans and specifications for buildings. Available on interesting terms. Apply to Box No. 795-W.

CIVIL ENGINEER, S.E.I.C., graduate '30, age 23, single. Experience includes mining surveys, assistant on highway location and construction, and assistant on large construction work. Steel and concrete layout and design. Apply to Box No. 809-W.

CIVIL ENGINEER, college graduate, age 27, single. Experience includes surveying, draughting concrete construction and design, street paving both asphalt and concrete. Available at once; will consider anything and go anywhere. Apply to Box No. 816-W.

CIVIL ENGINEER, B.E. (Sask. Univ. '32), S.E.I.C. Single. Experience in city street improvement; sewer and water extensions. Good draughtsman. References. Available at once. Location immaterial. Apply to Box No. 818-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. (Queen's '32), age 21. Three summers surveying in northern Quebec. Interested in hydraulics and reinforced concrete. Available at once. Location immaterial. Apply to Box No. 822-W.

CIVIL ENGINEER, B.Sc., A.M.E.I.C., with fifteen years experience mostly in pulp and paper mill work, reinforced concrete and structural steel design, field surveys, layout of mechanical equipment, piping. Available at once. Apply to Box No. 825-W.

ELECTRICAL ENGINEER, S.E.I.C., grad. '29, age 24, married; experience includes one year Students Test Course, sixteen months in distribution transformer design and eight months as assistant foreman in charge of industrial control and switchgear tests. Location immaterial. Available at once. Apply to Box No. 828-W.

CIVIL ENGINEER, B.A.Sc., D.L.S., O.L.S., A.M.E.I.C., age 46, married. Twelve years experience in charge of legal field surveys. Owns own surveying equipment. Eight years on technical, administrative, and editorial office work. Experienced in writing. Desires position on survey work, assisting in or in charge of preparation of house organ, on staff of technical or semi-technical magazine, or on publicity, editorial or administrative office work. Available at once. Will consider any salary, and any location. Apply to Box No. 831-W.

CIVIL ENGINEER, M.Sc., R.P.E. (Sask.). Age 27. Experience in location and drainage surveys, highways and paving, bridge design and construction city and municipal developments, power and telephone construction work. Available on short notice. Apply to Box No. 839-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. '32 (Univ. of N.B.). Age 25, married. Two years experience in power line construction and maintenance; one year of highway construction, one summer surveying for power plant site, location and spur railway line construction. Available at once. Location immaterial. Apply to Box No. 840-W.

CIVIL ENGINEER, B.Sc. '15, A.M.E.I.C., married, extensive experience in responsible position on railway construction, also highways, bridges and water supplies. Position desired as engineer or superintendent. Available at once. Apply to Box No. 841-W.

CIVIL ENGINEER, B.Sc. (Alta '31), S.E.I.C., age 24. Experience, three summers on railroad maintenance, and seven months on highway location as instrumentman. Willing to do anything, anywhere, but would prefer connection with designing or construction firm on structural works. Available immediately. Apply to Box No. 845-W.

## Situations Wanted

MECHANICAL ENGINEER, Jr.E.I.C., technical graduate, bilingual, age 30. Two years as designing heating draughtsman with one of the largest firms of its kind on this continent handling heating materials; three years designing draughtsman in consulting engineers' office, mechanical equipment of buildings, heating, ventilation, sanitation, power plant equipment, writing of specifications, etc. Present location Montreal. Available at once. Apply to Box No. 850-W.

BRIDGE AND STRUCTURAL ENGINEER, A.M.E.I.C., McGill. Twenty-five years' experience on bridge and structural staffs. Until recently employed. Familiar with all late designs, construction, and practices in all Canadian fabricating plants. Desirous of employment in any responsible position, sales, fabrication or construction. Apply to Box No. 851-W.

STRUCTURAL ENGINEER, B.A.Sc., A.M.E.I.C. Twenty-two years experience in design of bridges and all types of buildings in structural steel and reinforced concrete. Three years experience in railway construction and land surveying. Apply to Box No. 856-W.

MECHANICAL ENGINEER, B.Sc. '32, S.E.I.C. Good draughtsman. Undergraduate experience:—One year moulding shop practice; two years pipe fitting and sheet metal work; one year draughting and tracing on paper mill layout; six months machine shop practice; and eight months fuel investigation and power heating plant testing. Desires position offering experience in steam power plants or heating and ventilating design. Will go anywhere. Apply to Box No. 858-W.

MECHANICAL ENGINEER, age 31, graduate Sheffield (England) 1921; apprenticeship with firm manufacturing steam turbine generators and auxiliaries and subsequent experience in design, erection, operation and inspection of same. Marine experience B.O.T. certificate thoroughly conversant with Canadian plants and equipment. Available on short notice. Any location. Box No. 860-W.

CHEMICAL ENGINEER, B.Sc. (McGill '21), A.M.E.I.C., age 36, married; three years since graduation with pulp and paper mills; eight years in shops, estimating and sales divisions of well-known gas engineering and construction companies in the United States. Excellent references. Available on short notice. Apply to Box No. 866-W.

CONSTRUCTION ENGINEER (Toronto Univ. of '07). Experience includes hydro-electric, municipal and railroad work. Available immediately. Location immaterial. Apply to Box No. 886-W.

ELECTRICAL ENGINEER, graduate 1929, S.E.I.C. Single. Experience includes two years with electrical manufacturing concern and one on highway construction work. Available at once. Will go anywhere. Apply to Box No. 887-W.

CIVIL ENGINEER, B.Sc., Montreal 1930, age 26, single, French and English, desires position technical or non-technical in engineering, industrial or commercial fields, sales or promotion work. Experience includes three years in municipal engineering on paving, sewage, waterworks, filter plant equipment, layout of buildings, etc. Available immediately. Apply to Box No. 891-W.

ELECTRICAL ENGINEER, grad. Univ. of N.B. '31. Experienced in surveying and draughting, requires position. Available at once. Will go anywhere. Apply to Box No. 893-W.

CIVIL ENGINEER, B.A.Sc., Jr.E.I.C., age 29, single. Experience includes two years in pulp mill as draughtsman and designer on additions, maintenance and plant layout. Three and a half years in the Toronto Buildings Department checking steel, reinforced concrete, and architectural plans. Available at once. Location immaterial. At present in Toronto. Apply to Box No. 899-W.

DESIGNING ENGINEER, A.M.E.I.C. Permanent and executive position preferred but not essential. Fifteen years experience in designing power plants, engine and fan rooms, kitchens and laundries. Thoroughly familiar with plumbing and ventilating work, pneumatic tubes, and refrigeration, also heating, electrical work, and specifications. Apply to Box No. 913-W.

ENGINEER, B.Sc., A.M.E.I.C., R.P.E. (N.B.), age 35, married. Seven years' mining experience as sampler, assayer, surveyor, field work, and foreman in charge of underground development: two years as assistant engineer on highway construction and maintenance. Available on short notice. Apply to Box No. 932-W.

CIVIL ENGINEER, B.Sc., '25, McGill Univ., Jr.E.I.C., P.E.Q., age 32, married. Experience as rodman and instrumentman on track maintenance. Seven and one-half years with Canadian paper company, as assistant office engineer handling all classes of engineering problems in connection with woods operations, i.e., road buildings, piers, booms, timber bridges, depots, dams, etc. Apply to Box No. 933-W.

ELECTRICAL ENGINEER, Dipl. of Eng., B.Sc. (Dalhousie Univ.), S.B. and S.M. in E.E. (Mass. Inst. of Tech.), Canadian. Married. Seven and a half years' experience in design, construction and operation of hydro, steam and industrial plants. For past sixteen months field office electrical engineer on 510,000 h.p. hydro-electric project. Available at once. Apply to Box No. 936-W.

CIVIL ENGINEER, B.Sc., O.P.E. Experience includes several years on municipal work-design and construction of sewers, steel and concrete bridges, watermains and pavements. Available at once. Apply to Box No. 953-W.

## Situations Wanted

ELECTRICAL ENGINEER, twenty years experience, desires position, either temporary or permanent. Experienced in design, construction, and operation of power and industrial plants, and supt. of construction. Apply to Box No. 974-W.

CIVIL ENGINEER, B.Sc. (Univ. of Sask. '33), S.E.I.C., age 28, single. Experience in testing hydro-electric equipment, draughting, surveying, city street, improvements, technical photography. Available at once. Location immaterial. Apply to Box No. 986-W.

ENGINEER SUPERINTENDENT, age 44. Engineering and business training, executive ability, tactful, energetic. Had charge of several large projects. Intimate knowledge of costs and prices, reports and estimates. Available immediately. Any location. Apply to Box No. 1021-W.

CIVIL ENGINEER, B.Sc. (Queen's 14), A.M.E.I.C., Dominion Land Surveyor, 5 months' special course at the University of London, England, in municipal hygiene and reinforced concrete construction. Experience covers legal and topographic surveys, plane tabling and stadia surveying, railway and highway construction, drainage and excavation work. Available at once. Apply Box No. 1035-W.

ELECTRICAL ENGINEER AND GEOPHYSICIST. Age 36. Married. Seven years experience in geophysical exploration using seismic, magnetic and electrical methods. Two years experience with the Western Electric Company of Chicago, working on equipment and magnetic materials research. Experienced in radio and telephone work, also specializing in precise electrical measurements, resistance determinations, ground potentials and similar problems of ground current distribution. Apply to Box No. 1063-W.

ELECTRICAL ENGINEER, B.A.Sc. Univ. Toronto '28. Experience includes Can. Gen. Elec. Co. Test Course. Also more than two years in the engineering dept. of the same company. Available on short notice. Preferred location central or eastern Canada. Apply to Box No. 1075-W.

ELECTRICAL ENGINEER, B.Sc. Married. Eight years electrical experience, including operation, maintenance and construction work, electrical design work on large power development, mechanical ability, experienced photographer, employed in electrical capacity at present. Available on reasonable notice. Apply to Box No. 1076-W.

INDUSTRIAL ENGINEER, B.A.Sc. in Chem. Eng. (Tor. '31), S.B. in Indust. Eng. (Mass. Inst. of Tech. '32), S.E.I.C. Age 25 years. Northern Electric Training Course. Construction and sales experience. Rockefeller Research Associate at McGill University in industrial engineering for past year and to date. Desire work in production or financial departments of a manufacturing plant. Apply to Box No. 1098-W.

CIVIL ENGINEER, age 27, graduate 1930, single. Experience includes detailing, designing and estimating structural steel, plate work and pressure vessels; also hydrographic surveying. Available at once. Apply to Box No. 1111-W.

ELECTRICAL ENGINEER, S.E.I.C., single, age 24 years. Four consecutive years at Univ. of N.B. in electrical engineering. Summer experience in bridge and road construction and auto repairing, desires position in industrial or power plant. Any locality. References on request. Apply to Box No. 1114-W.

CIVIL ENGINEER, B.Sc. Sask. '30, S.E.I.C. Age 24 years. Experience in municipal engineering, including sewer and water construction, sidewalk construction, paving, storm sewer design, draughting, precise levelling, and reinforced concrete bridge construction. Unmarried. Available at once. Will go anywhere. Apply to Box No. 1115-W.

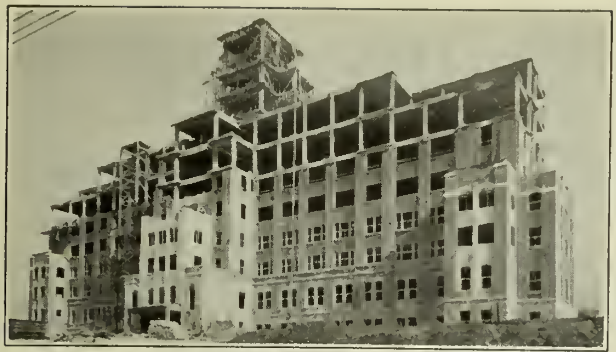
ELECTRICAL ENGINEER, B.Sc.E.E. (Univ. of N.B. '31). C.G.E. Test Course included industrial control, induction motors and transformers; the transformer test included desk work for two months on computing losses, efficiencies, etc. Available at once. Apply to Box No. 1119-W.

MECHANICAL ENGINEER, B.A.Sc. (Univ. of B.C.), M.S. (Univ. of Pittsburgh). Canadian. Age 26. Single. One year graduate student course, W.E. and M. Co., East Pittsburgh. Three and a half years engineering research in mechanics with the same company. Location immaterial. Available at once. Apply to Box No. 1123-W.

GEODETIC AND TOPOGRAPHICAL ENGINEER, D.L.S., M.E.I.C. Experience in all kinds of geodetic and topographical surveys, especially photo-topography, well versed in all kinds of air photo surveys; Canadian and U.S. patent method of determining position and elevations of points from air photographs. Available at once anywhere in Canada or the United States. Apply to Box No. 1127-B.

PETROLEUM CHEMIST, B.Sc. in Chem. Eng. Age 25, Single. One and a half years experience as assistant chemist. Capable of taking charge in small refinery. Wishes position anywhere in Canada. Apply to Box No. 1130-W.

ELECTRICAL ENGINEER, B.Sc., Queen's '33. Single, age 23. Anxious to gain experience. Present experience installing small private hydro-electric plant. Location immaterial. Available at once. Apply to Box No. 1137-W.



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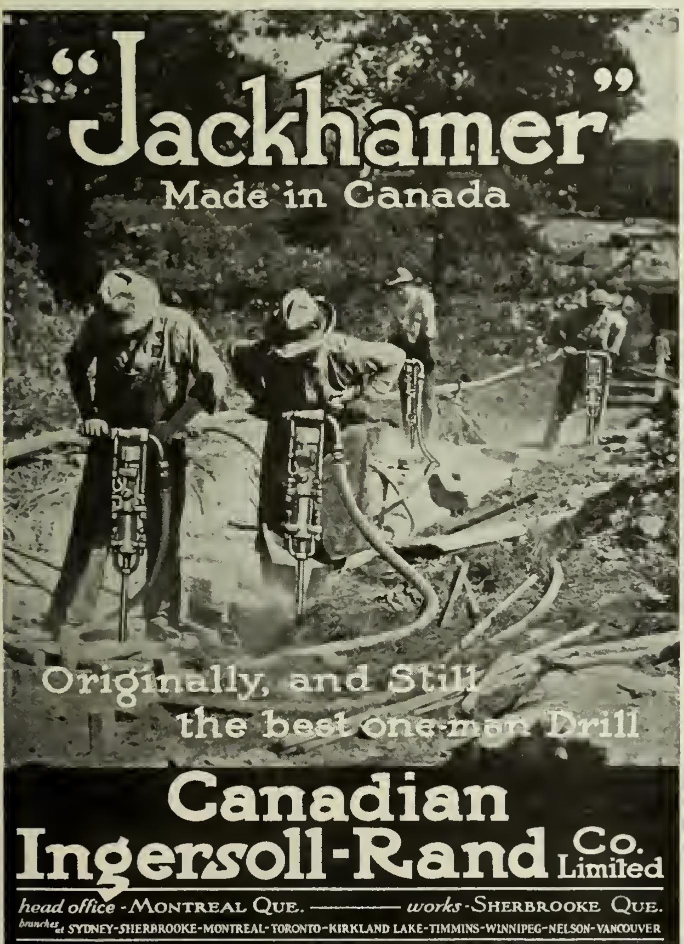


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# Purchasers' Classified Directory

*A Selected List of Equipment, Apparatus and Supplies*

**For Alphabetical List of Advertisers see page 22.**

### A

**Acids:**
Canadian Industries Limited.

**Aerial Survey:**
Canadian Airways Ltd.

**Ammeters and Voltmeters:**
Bepco Canada Ltd.
Crompton Parkinson (Canada) Ltd.

**Angles, Steel:**
Bethlehem Steel Export Corp.

**Ash Handling Equipment:**
Babcock-Wilcox & Goldie McCulloch Ltd.
Combustion Engineering Corp. Ltd.

**Asphalt:**
Barrett Co. Ltd.

**Axles, Steel, Forged:**
Dominion Foundries & Steel Ltd.
Dominion Steel & Coal Corpn. Ltd.

### B

**Ball Mills:**
Dominion Engineering Works Limited.
Wm. Kennedy & Sons Ltd.
Foster Wheeler Ltd.
Wm. Hamilton Div. Canadian Vickers Ltd.

**Balls, Steel and Bronze:**
Can. S.K.F. Co. Ltd.
Wm. Kennedy & Sons Ltd.

**Barking Drums:**
Canadian Ingersoll-Rand Company, Limited.

**Bars, Steel and Iron:**
Bethlehem Steel Export Corp.
Dominion Foundries & Steel Ltd.
Dominion Steel & Coal Corpn. Ltd.

**Bearings, Ball and Roller:**
Can. S.K.F. Co. Ltd.

**Billets, Blooms, Slabs:**
Bethlehem Steel Export Corp.
Dominion Foundries & Steel Ltd.

**Bins:**
Canada Cement Co. Ltd.

**Blasting Materials:**
Canadian Industries Limited.

**Blowers, Centrifugal:**
Can. Ingersoll-Rand Co. Ltd.

**Blue Print Machinery:**
Montreal Blue Print Co.

**Boilers:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Canadian Vickers Ltd.
Combustion Engineering Corp. Ltd.
Foster Wheeler Limited.
E. Leonard & Sons Ltd.
Vulcan Iron Wks. Ltd.

**Boilers, Electric:**
Can. General Electric Co. Ltd.
Dominion Engineering Works Limited.
Northern Electric Co. Ltd.

**Boilers, Portable:**
Foster Wheeler Ltd.
E. Leonard & Sons Ltd.

**Boxes, Cable Junction:**
Northern Electric Co. Ltd.

**Braces, Cross Arm, Steel, Plain or Galvanized:**
Northern Electric Co. Ltd.

**Brackets, Ball Bearing:**
Can. S.K.F. Co. Ltd.

**Brakes, Air:**
Can. General Elec. Co. Ltd.

**Brakes, Magnetic Clutch:**
Northern Electric Co. Ltd.

**Bridge-Meggers:**
Northern Electric Co. Ltd.

**Bridges:**
Canada Cement Co. Ltd.
Canadian Vickers Ltd.
Dominion Bridge Co. Ltd.

**Bucket Elevators:**
Jeffrey Mfg. Co. Ltd.
Plessisville Foundry.

**Buildings, Steel:**
Dominion Bridge Co. Ltd.

### C

**Cables, Copper and Galvanized:**
Northern Electric Co. Ltd.

**Cables, Electric, Bare and Insulated:**
Can. Westinghouse Co. Ltd.
Can. General Electric Co. Ltd.
Northern Electric Co. Ltd.

**Caissons, Barges:**
Dominion Bridge Co. Ltd.

**Cameras:**
Associated Screen News Ltd.

**Capacitors:**
Bepco Canada Ltd.
Can. Westinghouse Co. Ltd.
Lancashire Dynamo & Crypto Co. of Can. Ltd.

**Castings, Brass:**
The Superheater Co. Ltd.

**Castings, Iron:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Dominion Engineering Works.
Foster Wheeler Ltd.
Wm. Kennedy & Sons Ltd.
E. Leonard & Sons Ltd.
The Superheater Co. Ltd.
Vulcan Iron Wks. Ltd.

**Castings, Alloy Steel:**
Dominion Foundries & Steel Ltd.

**Castings, Steel:**
Dominion Foundries & Steel Ltd.
Wm. Kennedy & Sons Ltd.
Vulcan Iron Wks. Ltd.

**Catenary Materials:**
Can. Ohio Brass Co. Ltd.

**Cement Manufacturers:**
Canada Cement Co. Ltd.

**Chains, Silent and Roller:**
Hamilton Gear & Machine Co.
Jeffrey Mfg. Co. Ltd

**Channels:**
Bethlehem Steel Export Corp.

**Chemicals:**
Canadian Industries Limited.

**Chemists:**
Milton Hersey Co. Ltd.
Roast Laboratories Reg'd.

**Chippers, Pneumatic:**
Canadian Ingersoll-Rand Company, Limited.

**Choke Coils:**
Ferranti Electric Co.

**Circuit Breakers:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.

**Clarifiers, Filter:**
Bepco Canada Ltd.
Crompton Parkinson (Canada) Ltd.

**Clutches, Ball Bearing Friction:**
Can. S.K.F. Co. Ltd.

**Clutches, Magnetic**
Northern Electric Co. Ltd.

**Coal Handling Equipment:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Combustion Engineering Corp. Ltd.

**Combustion Control Equipment:**
Bailey Meter Co. Ltd.

**Compressors, Air and Gas:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Canadian Ingersoll-Rand Company, Limited.

**Concrete:**
Canada Cement Co. Ltd.

**Condensers, Steam:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Canadian Ingersoll-Rand Company, Limited.
Foster Wheeler Limited.

**Condensers, Synchronous and Static:**
Bepco Canada Ltd.
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Crompton Parkinson (Canada) Ltd.
Harland Eng. Co. of Can. Ltd.
Lancashire Dynamo & Crypto Co. of Can. Ltd.
Northern Electric Co. Ltd.
Bruce Peebles (Canada) Ltd.

**Conduit:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co Ltd.

**Conduit, Underground Fibre, and Underfloor Duct:**
Northern Electric Co. Ltd.

**Controllers, Electric:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.

**Couplings:**
Dart Union Co. Ltd.
Dresser Mfg. Co. Ltd.

**Couplings, Flexible:**
Dominion Engineering Works Limited.
Dresser Mfg. Co. Ltd.

**Couplings, Flexible:**
Wm. Hamilton Div. Canadian Vickers Ltd.
Hamilton Gear & Machine Co.
Wm. Kennedy & Sons Ltd.

**Cranes, Hand and Power:**
Dominion Bridge Co.

**Cranes, Locomotive:**
Dominion Hoist & Shovel Co. Ltd.

**Cranes, Shovel, Gasoline Crawler, Pillar:**
Canadian Vickers Ltd.
Dominion Hoist & Shovel Co. Ltd.

**Crowbars:**
B. J. Coghlin Co. Ltd.

**Crushers, Coal and Stone:**
Canadian Ingersoll-Rand Company, Limited.
Jeffrey Mfg. Co. Ltd.
Wm. Kennedy & Sons Ltd.

### D

**Dimmers:**
Northern Electric Co. Ltd.

**Disposal Plants, Sewage:**
W. J. Westaway Co. Ltd.

**Ditchers:**
Dominion Hoist & Shovel Co. Ltd.

**Drills, Pneumatic:**
Canadian Ingersoll-Rand Company, Limited.

**Dynamite:**
Canadian Industries Limited.

### E

**Economizers, Fuel:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Combustion Engineering Corp. Ltd.
Foster Wheeler Limited.

**Elbows:**
Dart Union Co. Ltd.

**Electric Blasting Caps:**
Canadian Industries Limited.

**Electric Railway Car Couplers:**
Can. Ohio Brass Co. Ltd.

**Electrical Supplies:**
Can. General Elec. Co. Ltd.
Can. Ohio Brass Co Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.

**Electrification Materials, Steam Road:**
Can. Ohio Brass Co. Ltd.

**Elevating Equipment:**
Plessisville Foundry.

**Engines, Diesel and Semi-Diesel:**
Canadian Ingersoll-Rand Company, Limited.
Harland Eng. Co. of Can. Ltd.

**Engines, Gas and Oil:**
Canadian Ingersoll-Rand Company, Limited.

**Engines, Steam:**
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VOL. XVII
No. 5

MAY
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THE ENGINEERING INSTITUTE *of* CANADA

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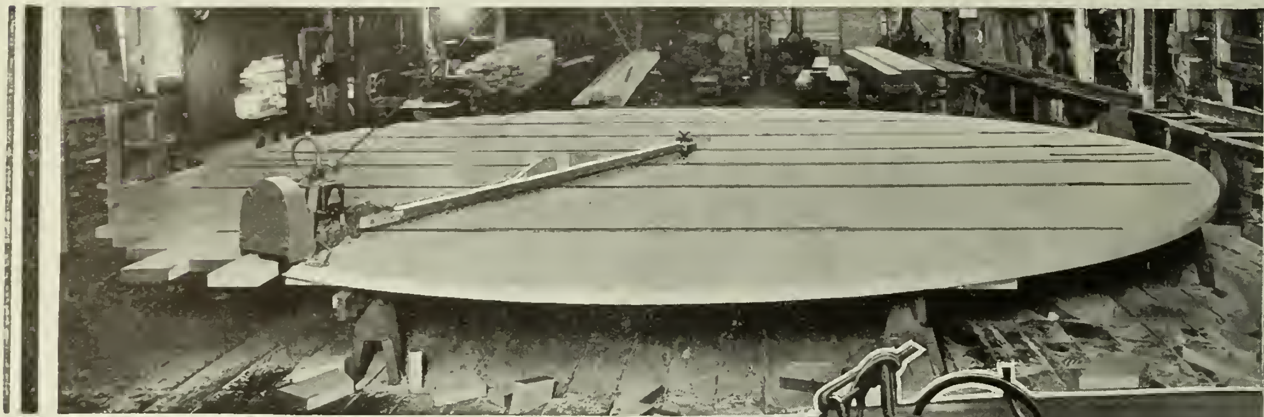

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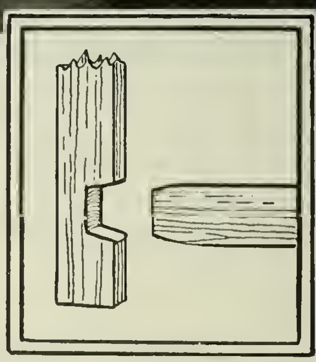

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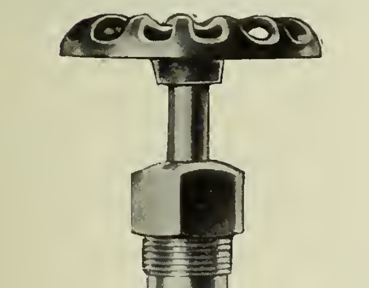

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**May 1934** **Volume XVII, No. 5**

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# The Law of Contracts and Bonds of Particular Application to Engineers and Architects

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**Paper presented before the Toronto Branch of The Engineering Institute of Canada, December 7th, 1933.**

*Editor's Note:*

*The following address was given by Mr. H. D. Anger at a joint meeting of the Toronto Branch of The Engineering Institute of Canada and the Ontario Association of Architects.*

*While Mr. Anger's remarks had particular reference to the laws of Ontario, it is felt that his address contains advice and information of great value to all engineers and architects wherever situated in Canada, and we are greatly indebted to Mr. Anger for his permission to publish it.*

*We are informed that the basic principles outlined in the address have general application throughout Canada, but that members should bear in mind that the laws of the other provinces differ in some respects from those of Ontario, the most marked divergencies existing in the Province of Quebec where the Civil Code prevails. For this reason, and on account of the complexity of the legal problems which may arise in an apparently simple case, members will appreciate the advisability of consulting one's solicitor and following his advice in all matters of importance involving contractual relations.*

The paper covers the following topics:



## Introduction

Several centuries ago one of the greatest jurists of our race, Blackstone, enunciated the great truth that no man can properly discharge the duties he owes to the public, to his family and to himself, without in some degree possessing a knowledge of the laws by which all are bound and the obligations resting on each as an individual; and, the late Pierpont Morgan gave Blackstone an emphatic endorsement by telling a meeting of bankers that the greatest risk in business is legal risk. I believe it was he also who said that keen business men were increasingly determined to give their sons a course in law as necessary equipment for business life.

When one realizes that almost every daily act in business has a legal consequence, it is obvious that Pierpont Morgan was right, and that it is essential that the doer of the act should know its consequence.

During my various activities I have to a considerable degree been brought in contact with the layman's attitude towards the study of law—and the general keynote is preconceived discouragement. There is really little reason for such discouragement. As in golf the hazards are more mental than real. While the study of law in all its branches is necessarily complex, yet, those branches which relate most closely to business transactions are not inherently complex. They are in fact mere rules of business conduct formulated by business men.

I become very impatient with the man who says "a little knowledge is a dangerous thing." A little knowledge at the right time would have saved many a litigant from a bad loss. It is to be borne in mind that it is not necessary to have such a knowledge of business law as to be your own lawyer. That is an impossible and illogical goal—as illogical as to expect a managing-director to be able to design and supervise the construction of the building and equipment. You do not need to shoot par golf to play a consistently good game, nor do you need to have a deep knowledge of law to play a consistently good business game. It is sufficient if your grasp of the fundamentals of business law warns you when to consult your legal adviser before loss has occurred instead of after.

I am constantly being asked by laymen what is meant by "common law" or "case law" and how it is applied. Possibly a brief note will be of interest to you also. Centuries ago in England the rules and customs of merchants which were found to be common to most localities were consolidated as the "common law" of the realm. In order to avoid unsettling variation it was the duty of a judge to conform to or follow the decision in an earlier case involving similar circumstances. In the course of centuries decisions on almost every conceivable set of circumstances were made and recorded in the law reports. Common law is therefore the law of precedent. The decided cases fall into classes, each class establishing a general rule or principle of law. If you and I were to have a legal dispute tomorrow it would certainly fall into one of these classes and the governing principle is usually readily discernible.

At the creation of Upper Canada the common law of England was established as our civil law, except as it should thereafter be altered by Dominion or provincial legislation. Common law comprises doubtless some seventy-five per cent of our civil law.

It is true, of course, that in applying the law of precedent, injustice seems sometimes to be meted out to some individual, and you hear judges remark that they reluctantly decide as they do. Those judges are not to be cursed —they are to be commended. In following precedent they are on firm and logical ground, for if they did not follow precedent law would be a very indefinite thing, so elastic that it could not be said to be known; lawyers could not adequately advise their clients and clients would be in a quandary, for the question would not be "what is the law" but "what is the judge likely to think?"—in short each judge would be a law unto himself.

Now unquestionably there is often great difficulty in deciding what law clearly governs a certain set of facts. One principle of law seems to govern and the pendulum swings one way. Another principle is seen to be also applicable and the pendulum swings back. Lawyers disagree, judges disagree, courts disagree, one judgment overruling another and so on. But this cannot be avoided in modern complex life, with new inventions and what-not more or less revolutionizing customs from time to time. We rely upon our legislatures to revise law from time to time to meet these new conditions. Furthermore, rarely is there a case where all the right is on one side—the problem is to ascertain the overriding right.

Yet with all these difficulties I repeat that the study of business law is not so complex as it seems to the layman. The broad general principles are an open book and the *reasoning* behind each decision is usually quite clear. If you study the reasoning the memory usually receives a reasonably indelible impression. I seriously suggest therefore that you do not stop at listening to talks on law, but that you purchase and study trite texts on various branches of business law. It will be well worth your while.

## A. Contracts in General

The law of contract is the root and foundation of almost all branches of business law. Acquisition of a decent knowledge of the law of contract therefore is of inestimable value and incidentally renders the study of other branches of business law much easier. For instance, topics that are really subdivisions or off-shoots of the law of contract are agency, employment, suretyship, insurance, negotiable paper, real estate, sale of goods, mortgages, and leases.

### I Formation of Contracts

A contract may be conveniently defined as any agreement intended to be enforceable at law. Some agreements have no such intention—such as to subscribe to a charity, intended as and being a moral obligation only.

To make a contract there must be at least two persons, but there may be any additional number.

To make a contract binding and enforceable, five things, and, in certain cases a sixth, are required:

(1) An offer by one person and its acceptance by another.
(2) Consideration (that is, money or money's worth), or a document under seal.
(3) The parties must be legally capable of contracting.
(4) There must be mutuality of mind.
(5) The purpose must be lawful, and
(6) Certain contracts must be in writing.

I will discuss these requisites in that order.

(1) *Offer and Acceptance*

The making of a contract takes many forms, but no matter what the course, it must be reducible to an offer by one party and its acceptance by the other. Having regard to business dealings as a whole, I suppose comparatively few contracts take the form of a formal document. The greatest number are made verbally, or by correspondence or telegraph, and, with certain qualifications which I shall mention, they are just as binding and enforceable as when the terms are set forth in a formal document signed by both parties.

Still another form of contract is where either the offer or the acceptance is not actually expressed but takes place by conduct. For instance, if I place an order for machinery I am in effect offering to pay the price if you fill my order, and you accept my offer by merely forwarding the machinery to me without saying anything. In such a case there is a contract the moment you send the goods. Again, I may offer to sell you something, sending the article to you for your approval—if you use it you have accepted my offer and must pay the price.

Now any offer must be accepted definitely and without qualification of any sort. The slightest change in terms destroys acceptance. To illustrate, if I offer to sell you something for $50 and you reply that you will pay $40 or that you will pay $50 by instalments or if I guarantee the thing, you have obviously not accepted my offer, but have made a counter offer to me which I may accept or refuse at my option. If I accept, there is then a contract.

As to time for acceptance, a verbal offer which does not give time for acceptance ceases when the parties separate. A written offer, with no time limit for acceptance, must be accepted within a reasonable time and before the offer is revoked. What is a reasonable time depends upon the special circumstances of each transaction.

Once an offer has been refused it cannot afterwards be accepted unless the offer is repeated. A counter-offer is in effect a rejection of the offer. A mere enquiry whether the offeror will change his terms is not necessarily a refusal.

Once an offer has been accepted, it cannot be revoked, but it may be revoked at any time before its acceptance unless the offer is under seal in which case a reasonable time must be given for its acceptance. Similarly, an acceptance once given cannot be revoked.

The use of an agent to transmit offer and acceptance, however, introduces some important factors. The great principle of acceptance is that it must be given to the offeror or to his agent authorized to receive acceptance. If there be such an acceptance there is a contract the moment it is given, regardless of the circumstances. Let us follow this thought.

If I post a letter to you containing an offer, I have thereby appointed the post-office my agent. There is a contract the moment you *post* your letter of acceptance. The post-office is my long arm reaching out for your acceptance, and there is a contract the moment you post your acceptance in the outstretched hand. Similarly, any other agent I utilize is my outstretched hand, such as the telegraph office, or a messenger.

When we realize that principle of agency it is understandable that there is a contract even though a long delay takes place in the post-office or telegraph-office before I personally receive your acceptance, or even if I do not receive it at all. If I appoint an agent I take the risk of him serving me well. (The telegraph office is however authorized only to transmit the actual message delivered to it. Neither party is bound by a mistake in transmission.)

Now what happens if you do not use my agent? While it is true, generally speaking, that, if I do not specifically require you to use my agent, there is a contract if your acceptance sent in another manner *actually reaches* me in time, yet the risk is reversed. By using your own means of communication you take the risk of your acceptance not reaching me, or reaching me too late, either because of unreasonable delay or because I have meanwhile cancelled my offer.

Because of the principle of authorized agency, we see that if I mail you an offer I can revoke it if my revocation reaches you before you have mailed your acceptance; but, if you did not use the post-office to forward your acceptance to me, I can revoke my offer before your acceptance actually *reaches* me—this I could do by telegram, telephone, messenger, etc.

Similarly, if you hand your acceptance to my agent, there is that instant a contract, and you cannot revoke it, even if you by some quicker agency can get your so-called revocation to me before your acceptance actually reaches me. This would not sound like common sense were it not for the obvious principle that a dealing with my authorized agent is a dealing with me.

Of course, if you do not use my agent to transmit your acceptance but use your own agent you can revoke your acceptance if by some quicker means you can get your revocation to me before I receive your acceptance.

The only remaining thing concerning offer and acceptance that it is practical to say is that the death, insanity, or bankruptcy of the offeror before the offer is accepted causes the offer to lapse.

(2) *Consideration*

Every contract that is not under seal requires "consideration" to make it binding. Consideration is some value given or received as an inducement to enter into the contract. Mere motive is not sufficient. Consideration need not be money, and it may have very little actual value. It could be briefly defined as some benefit received by one party, or some detriment, responsibility, or forbearance undertaken or suffered by the other.

If you undertake to do something for nothing it is not a contract and you cannot be compelled to perform it. (I must say however that if you actually perform it and do so negligently, you will be liable for damages for loss caused by your negligence.)

Consideration need not be adequate however. The courts will not make bargains for people. If you agree to do something in return for a trifle, you are nevertheless bound by your agreement. For example a man promised to do something in return for delivery to him of a certain promissory note which was outlawed by the Statute of Limitations—nevertheless, it was a piece of paper, something he wanted, and he was held bound by his contract.

There are two technical rules respecting consideration I must draw to your attention. The first rule is that a promise to do something that you are already legally bound to do, such as to perform an existing contract, is not consideration for a return promise and the latter need not be bound. For example, if you hire men to do something, and they go on strike and you agree to increase their pay if they perform their original contract, you need not pay the increase. The second rule is that consideration to be good must be something done at the time of contracting, or to be done in future. Past consideration is no consideration, such as agreeing to do something because of past benefits received. There are only two exceptions to the rule against past consideration—one is that a promise to pay a statute-barred debt is binding, and the other is that a minor's written promise, made after attaining majority, to pay debts contracted during minority, is binding.

Contracts under seal are binding without consideration. The seal imports consideration. The law presumes that when parties enter into a contract in such solemn form they do so with a full knowledge of its contents and that consideration actually existed. If fraud or undue influence is practised to obtain a contract under seal, the Court will set it aside, and in such case absence of consideration is corroborative evidence of the fraud or influence.

(3) *Capacity to Contract*

Certain persons are protected by law and are made incapable, either wholly or partly, of binding themselves by contract. Such persons are infants or minors, persons of unsound mind, intoxicated persons and Indians. (To which list at one time there were added married women, much to their disgust.) Other persons have but limited capacity to contract—such as corporations and alien enemies.

*Infants:* In Canada every male or female person under the age of 21 years is an infant or minor. The contract of an infant for the supply of *necessaries* is always binding. What are necessaries depends upon the infant's station in life. Board, lodging, clothing, medical attention and education are ordinary necessaries to all. Furthermore, things that would be luxuries to the children of a labourer would be reasonable necessaries for the children of rich men of high social position (such as engineers and architects are known to be). All contracts of an infant that are not necessaries are voidable, that is may be repudiated, by him after he attains majority. Certain contracts must be repudiated within a reasonable time after majority, else they become binding upon the infant. Where the infant acquires an interest in permanent property involving obligations, or where he makes a contract involving continuous benefits and liabilities, and actually takes some profit, he must repudiate within a reasonable time or be bound. For instance, if he leaves property he must pay rent until he repudiates and must vacate when he repudiates; an infant who holds himself out as a partner is liable for the firm's debts as any other partner until he repudiates the partnership; and an infant who buys shares in a company is liable for the unpaid portion unless he repudiates the purchase at his majority.

If, after attaining majority, an infant ratifies in writing a contract made during minority, the contract is binding.

An infant can have a contract set aside and recover back money paid. Where a contract is not enforceable against an infant, he cannot compel its performance by the other party; but, if the infant is willing to carry out the contract, he can sue the other party for damages for breach of contract.

*Persons of unsound mind:* A person of unsound mind is always liable for necessaries delivered. Any other contract is binding upon him unless it be proved that at the time the contract was made he was so insane he did not know what he was doing and that the other party knew it. If these two facts be proved, the contract is voidable by the lunatic or his legal representative at his option.

*Intoxicated persons:* The contract of an intoxicated person for necessaries delivered is binding. Any other contract is binding unless it be proved that at the time the contract was made he was so intoxicated he did not know what he was doing and that the other party knew it. If these facts be proved it is voidable at his option.

*Indians:* Indians living on reservations and not enfranchised are wards of the Crown, and are protected from fraud by being placed in a position similar to that of infants. They cannot bind themselves even for necessaries. An Indian can sue the other party for damages for breach of contract however. An enfranchised Indian has the same rights and liabilities as any other British subject.

*Corporations:* An incorporated company is an artificial person created by law. Its powers to contract are limited by its charter and by-laws; and, any contract not falling within their powers is said to be "ultra vires" or beyond their powers and therefore void.

The consent of its members to a contract is evidenced by the corporate seal impressed on the contract. Some of its contracts do not need the corporate seal; e.g., in matters of minor importance such as the hiring of employees, effecting repairs, obtaining office supplies; and, a trading company can contract without seal in matters relating to the objects for which it was created, such as the supply of the things it sells.

Apart from the above classes of exceptions no contract is enforceable against a company if it does not bear the corporate seal. This fact is of vital importance to an engineer or architect, for a contract with you for your professional services is not enforceable by you if it does not bear the corporate seal. As I shall show later however, if you actually wholly execute your part of the contract, you can recover your remuneration, for the company is not permitted to retain the benefit without paying for it.

*Municipal corporations:* The Ontario Municipal Act provides that the powers of a municipal council must be exercised by by-law. This provision has been interpreted conclusively by our courts, confirmed by the Privy Council, as absolutely requiring a contract to be authorized by by-law of the council, else there is no corporate act. Absence of a by-law therefore is fatal to the contract. It makes no difference that the other party to the contract has wholly performed his part of it, he cannot recover a cent if there was no by-law. It makes no difference that the municipality passes a by-law authorizing the construction of the undertaking. You cannot creep in under that tent—*your* employment must be by by-law.

Of course the ordinary law respecting the corporate seal applies to a municipal corporation, and we need not repeat it.

Having regard to the vicissitudes of municipal politics and to the fact that frequently most of your work other than supervision is completed before the construction by-law is passed, you can plainly see the danger you are in if, when your professional services are retained by a municipality, you do not take the precaution of having your contract under corporate seal and that contract authorized by by-law of council.

The Ontario Unemployment Relief Act, 1933, chap. 65, provides as follows:—

Section 9. Every municipality in addition to all power and authority now vested in it shall have and shall be deemed to have had for the purpose of taking advantage of and the benefit of any Act of the Dominion of Canada or province of Ontario or any order or regulation made thereunder or any agreement made in pursuance thereof or of carrying out and performing any agreement entered into for that purpose between the government of the province of Ontario and the municipality, full power and authority to undertake, carry out and complete any work and to provide direct relief, and to vote, appropriate, receive and pay all sums of money required to defray the cost or the municipality's proportion of the cost thereof or any part of the cost of the same, and, with the approval of the Ontario Municipal Board, to issue debentures of the corporation to pay the said sums or any part thereof, and to levy and collect the said cost or the municipality's proportion of the cost or any part thereof by means of taxation against the rateable property in the municipality or in the case of a work undertaken under The Local Improvement Act in the manner provided by that Act.

Does this imply that a municipal council may act under this statute without passing a by-law that would be required under the Municipal Act? I would think not. I think this statute only adds to the things a municipality may do without affecting the manner of doing it.

*Public Utilities:* While under the Ontario Public Utilities Act a Public Utility Commission is a body corporate and therefore the ordinary law respecting the corporate seal comes into operation, yet such a commission is not a municipality and hence the provision of the Municipal Act respecting the necessity of a by-law of employment does not apply.

Perhaps I had better qualify that statement by saying the by-law provision does not seem to apply. It has been held both in the trial court and the Appellate Division in Ontario that that provision of the Municipal Act does not apply to a Public Utility Commission, but the point will arise for final determination in the Supreme Court of Canada in its sittings of next February. I shall be considerably surprised if the Supreme Court of Canada holds the contrary view.

A unique but well settled point of law deals with responsibility of payment under a contract made by a Public Utility Commission. Under the Public Utilities Act, upon the election of the commissioners, all the powers, rights, authorities and privileges of the municipality respecting the particular utility are vested in and are to be exercised by the commission and not by the council of the municipality. Ownership however remains in the municipality, the commission having merely the control and management. Therefore while the commission is the proper body to make a contract relating to its objects, the commissioners have no personal liability under it. The commission has been held to be but the statutory agent of the municipality in the exercise of its powers, and therefore in case of suit under the contract the municipality is the proper defendant and not the commission. Similarly the commission is not liable for damages for tort, such as negligence, the municipality being the proper defendant.

*Alien Enemies:* An ordinary alien has all the contractual capacity of a British subject. An alien enemy is on a different footing. After hostilities have commenced, all contracts thereafter made with him, even negotiable paper, are illegal and void unless the Crown grants a special enabling license. A contract existing before hostilities commenced is suspended during hostilities—it cannot be enforced meanwhile by the alien enemy, but may be enforced after declaration of peace.

(4) *Mutuality of Mind*

The consent of both parties to the contract must be voluntary and intentional. The consent of one of the parties may have been procured by mistake, misrepresentation, fraud, duress or undue influence. Under such circumstances it would be unjust to recognize the contract.

*Mistake:* By mistake is not meant mistake in expression—that involves mere interpretation and the courts will hear an explanation. Nor is there meant a bad bargain or incorrect estimate—the party suffering has only himself to blame and cannot escape from his contract. Mistake that will invalidate a contract can only occur in three ways: (*a*) by the fraud or carelessness of a third party, (*b*) by the dishonesty of one of the parties, or (*c*) by mutual mistake as to the identity of the thing contracted for or the identity of each other. Let us illustrate briefly.

(*a*) Where a blind man or one of feeble sight, or one who cannot read, is told fraudulently by a third party that a document is other than what it is, and consequently he signs it, the contract is void for mistake. Again, where a third party is careless, as where a telegraph office incorrectly transmits an offer and it is accepted in its incorrect state, the contract is void for mistake.

(*b*) Where one party knows that the other considers him somebody else and dishonestly allows the contract to proceed, the contract is void for mistake.

(*c*) Where the thing contracted for has ceased to exist at the time the contract is made, it is void for mistake; e.g., where a cargo of grain was bought while the ship was at sea and the grain had become overheated so that the captain had had to dump it; again, where a cargo of a ship was bought, and there were two ships of the same name, one party meaning one ship and the other party the other ship, there was genuine mutual mistake which voided the contract.

*Misrepresentation:* Misrepresentation is the innocent assertion by one party of facts which are not true but which he does not know are untrue. If such misrepresentation actually induces the other party to enter into the contract he can refuse to perform it or he can sue to have it set aside. If he wishes to sue for cancellation he must act quickly after he discovers the untruth else he may lose his rights, for, if property further changes hands so that the parties cannot be restored to their original position the contract will not be set aside.

*Fraud:* Fraud is the wilful assertion of facts that are untrue, and which the asserter either knows are untrue or does not care whether they are true or not, made to a person to induce him to enter into a contract and actually so inducing him. In such a case the victim of the fraud has several options: (*a*) he can affirm the contract and demand its performance strictly according to its terms or damages for non-fulfilment; or (*b*) he can repudiate the contract and sue to have it set aside, but here again he must act quickly else he may lose his rights, such as where property further changes hands so that the parties cannot be put back into their original positions; or (*c*) he can sue for punitive damages for deceit.

*Duress:* Duress is the infliction or threat of violence or imprisonment. It renders a contract obtained by its means voidable at the option of the victim if it was practised upon the victim or his wife, parent, or child, by the other contracting party or by someone acting with his knowledge.

*Undue Influence:* Undue influence is the improper and unconscientious use of a power or influence possessed by one party over another by reason of their relationship. Undue influence is *presumed* (*a*) where one party is uneducated, inexperienced or ignorant and the other party is educated and experienced, (*b*) where one party is in immediate want and sacrifices a future advantage, and (*c*) where a gift is made by child to parent, ward to guardian, beneficiary to trustee, client to solicitor, patient to doctor, or by any person to his spiritual adviser—in all such cases the other party must prove the transaction was fair and reasonable.

Where there is no such inequality of relationship, undue influence is not presumed but must be proved to have been exercised. If it is proved the courts give relief. The principle applies wherever confidence is reposed and betrayed.

With respect to a wife, it is held that things done or contracted to be done by her for her husband's benefit are done under his undue influence if she had affection for or fear of her husband and if she had no independent legal advice. By independent legal advice is meant advice by some solicitor other than her husband's solicitor or the solicitor of the other party.

The effect of undue influence is that the transaction is voidable. If the undue influence ceases the transaction may be confirmed or ratified by some act.

(5) *Legality of Purpose*

The object of the contract must be legal else the court will not enforce it. For instance, if you rent a building to a man for the purpose of carrying on an illegal trade neither you nor he can enforce the lease.

In a discussion such as this little purpose can be served by dwelling on the various classes of illegal contracts. Something may usefully be said however respecting contracts that attempt to restrain trade. You often encounter contracts in which one party covenants not to compete against another, such covenants usually arising when a person is employed and the employer wishes to be safeguarded after termination of the employment, or where the good will of a business is sold. Such covenants are valid and enforceable if they are reasonable, that is if the forbidden territory is restricted, or if there is a time limit, or if a certain line of business only is affected. What is reasonable depends upon the special circumstances of the case. For instance, a covenant not to engage in a certain business anywhere would need strong evidence of reasonableness to support it.

(6) *Necessity of Writing*

Every contract may be verbal unless it is required by some statute to be in writing. The Ontario Statute of Frauds requires seven classes of contracts to be in writing, signed by the party to be sued or by his authorized agent, else no action may be brought upon such contracts. These classes are:

(*a*) no executor or administrator may be sued upon a verbal promise to pay out of his own pocket a debt owing by the estate;

(*b*) no guarantor may be sued upon a verbal promise to discharge the debt or liability of another;

(*c*) no person may be sued upon a verbal promise to pay or do something if a certain marriage takes place;

(*d*) no person may be sued upon a verbal agreement to sell real estate;

(*e*) no person may be sued upon a verbal agreement that is not to be or cannot be performed within the space of a year from its date;

(*f*) no vendor may be sued upon a verbal agreement to pay a real estate commission. The written signed agreement to pay commission must be separate from the sale agreement also;

(*g*) no person may be sued upon a verbal agreement to buy or sell goods having a value of $40 or over, unless the buyer pays something down or receives and accepts the goods.

The statute simply forbids action until the written evidence is obtained. It may be obtained later and action then be commenced.

The writing required need not be formal but may consist of a series of papers or correspondence. It must be sufficient to identify the parties and the terms. It need not be signed by both parties but merely by the one to be sued.

Once a contract has been reduced to writing, whether in a formal document or in an exchange of correspondence, etc., the written terms govern. Neither party can set up verbal terms not disclosed therein. If the contract does not fall into one of the foregoing classes dealt with by the Statute of Frauds, it is open to either party however to give evidence of verbal terms which complete an obviously incomplete writing, or of additional verbal terms *that do not contradict* the written terms; but no verbal terms may be proved in the case of a contract covered by the Statute of Frauds.

So much for formation of a contract. A few remarks on performance and breach may be useful.

### II. Performance of Contracts

The parties to a contract may at any stage mutually agree to cancel it, so that neither will have any further rights or liabilities under it. They may also at any stage mutually agree to alter its terms—by so doing they are making a new contract into which the former merges.

Performance of a contract may become impossible. In such a case the general rule is that performance is not excused. If a party enters into a contract unconditionally he takes the risk of being unable to perform it, even though circumstances beyond his control make performance by him impossible. For instance, if a contractor undertakes to complete by a certain date, in the absence of special clauses he must pay damages if he fails to complete then, though the failure was caused by weather conditions, strikes or phenomena.

There are several exceptions to the general rule, however. If the impossibility of performance is due to a change in the law or if the subject matter of the contract is destroyed, performance is excused. Again, a man who contracts to render personal services is excused from performance if he is unable to act because of incapacitating illness. Furthermore, the bankruptcy of either party releases him from debts and liabilities that can rank against his bankrupt estate.

III. Breach of Contract

A breach of contract may occur in various ways—by refusal to perform, by making it impossible to perform, or by simple failure to perform.

Where one party before performance by him is due refuses to perform the contract or a vital part of it, the other party may at once treat the contract as at an end, and, without awaiting the time fixed for performance, sue for damages for breach and is also absolved from further performance on his own part. If he elects so to do, the other party is not entitled to an opportunity to change his mind. If he elects to wait for the time fixed for performance before making any claim for breach of contract, he remains liable to perform his own part and the party in default is meanwhile entitled to change his mind and perform his contract.

Where one party to a contract by some act makes performance of the contract impossible, the other party is similarly at once exonerated from performance of his own part and may at once sue for damages.

Where one party during performance refuses to continue, or makes further performance impossible, the other party need perform no further and may at once sue for damages, only needing to show he was always able and willing to perform.

Where the refusal or creation of impossibility is not of a vital part of the contract, does not go to the root and essence of it, the other party cannot treat the whole contract as broken but can only claim damages caused by breach of the particular term.

Where there is neither refusal nor impossibility but simply failure to perform, whether the entire contract may be treated as repudiated depends on the nature of the contract and its terms. If the broken terms are not vital, the other party must perform his part of the contract and claim afterwards for damages caused by the other's partial breach.

Cases involving instalment contracts show to some extent the working of the rule. Where goods were to be supplied at the rate of 150 tons per month, and the seller merely supplied 21 tons the first month, it was held to be sufficient default to relieve the buyer from further performance.

Where a buyer failed to pay for one instalment because he erroneously thought he could withhold payment because of a defective prior instalment, it was held insufficient default to discharge the seller from further performance.

It is difficult to lay down a comprehensive rule because the question whether a breach is vital depends on the particular circumstances of each case. It may be said however that if the breach by one party is of such a nature as to reasonably lead to the inference that similar breaches will be committed with respect to subsequent deliveries, the whole contract is discharged at the option of the party not in default.

A further point respecting breach of contract should here be noted. Where one party has repudiated the contract or disabled himself from performing it, the other party can not only sue for damage, but if he has performed his part wholly or in part, he can sue for the value of what he has done, called a "quantum meruit."

Lastly, if damages are not an adequate remedy and performance is possible, the court will compel the defaulting party to perform the contract according to its terms—this remedy being known as specific performance.

Where, however, the court cannot supervise the carrying out of its order, such as in construction contracts, specific performance will not be granted. Nor will a contract for personal services be specifically enforced.

An injunction order restraining a party from committing a contemplated breach of contract is equivalent to an order for specific performance of the contract, and will not be granted where specific performance would not be granted. An injunction is sometimes granted as the first step in an action for specific performance; e.g., to prevent imminent disposition of property.

B. Building Contracts

Owing to the natural difficulties of an owner in entering into a building or engineering contract, a building contract has certain special features as to which brief comment may be useful.

(1) *Tender:* An invitation to tender is a mere attempt to ascertain whether a satisfactory offer can be obtained—it is an offer to negotiate, an offer to receive offers. While it is usual to advertise that the employer does not bind himself to accept the lowest tender, such is not necessary. The employer can at any moment revoke the invitation to tender and cannot be made responsible for any expenses incurred by tenderers.

A person making a tender can withdraw it at any time before acceptance, but if he does not do so it remains in force until it is accepted or until a reasonable time has elapsed. A tender being an offer, its unconditional acceptance creates a contract. If however the acceptance provides that the particular stipulations are to be settled in a formal document, there is as yet no contract binding either party. Bear in mind that in the case of a municipality the acceptance must be under seal and authorized by by-law. A tender is an offer notwithstanding that it is labelled an "estimate."

If a tenderer pays a secret commission to the engineer, architect or other agent of the employer to induce the agent to influence the employer to accept the tender, the acceptance of the tender is not binding, and the employer has the option of repudiating the contract or of confirming it and recovering the commission from the agent and recovering damages from the tenderer. Such bribery is also an indictable offence on the part of both briber and bribed.

(2) *Alterations:* Building contracts usually carry provisions empowering the employer or his architect or engineer to vary the work in some specified manner. In the absence of such a provision the contractor is entitled to refuse to submit to alterations. If there is a provision however and it is exercised, wherever the original contract can be clearly traced in the substituted work, the terms of the contract as to price, approval, etc., will be binding. If the alterations are so sweeping that the original contract is practically lost, it is deemed to have been abrogated and a new contract created to do the substituted work for a reasonable price, that is on a "quantum meruit" basis.

(3) *Entire Contracts:* An entire contract means one where one party must entirely complete his contract in order to have the right to fulfilment by the other party.

There are three ordinary varieties of entire contracts: (*a*) a contract to construct the whole building or works for a lump sum price; (*b*) a contract to construct the whole building or works for a specified price made up of separate payments for separate parts of the work; and (*c*) a contract to construct the whole building or works for a price to be ascertained upon a fixed basis, such as by a schedule of prices or on a cost plus percentage basis.

If the contract is entire and the contractor throws up the work, without any fault on the part of the employer, he has no right of action against the employer either under the contract or on a "quantum meruit" for the value of the work actually done, and he is also liable in damages for breach of contract. If he did work outside the contract he can recover for the value of it.

In a lump sum contract nothing can be recovered whatever unless and until the work is fully completed. Where the contract is for a whole price to be ascertained in a specified manner it is a lump sum contract.

If a contractor undertakes to construct the whole building or works in accordance with a specification which is divided into separate parts to each of which a price is fixed or to be ascertained in a specified manner, the contract is nevertheless entire, and no right to payment for any part arises unless and until the whole is completed. But, if the contract provides for a certain payment for a certain part as and when completed, the contract is not entire but severable and a right to payment arises on completion of a part. Each part is for all practical purposes a separate contract entire in itself.

In all cases where a piece of work is contracted to be done, and, by inadvertence or otherwise, no price is fixed for such piece, the contractor is entitled to a reasonable price. The same rule operates if the whole contract does not mention price.

If the contract is to *complete a whole work* the contractor must do everything that is indispensably necessary, and it makes no difference that such indispensable necessary works are not described in the specifications, or not shown in the drawings, or are calculated wrongly, or their cost or extent underestimated in specifications or omitted or underestimated in quantities, and this whether the specifications or quantities have been made part of the contract or not. The fact that quantities, etc., are made part of the contract does not cut down the obligation of the contractor to furnish a complete work.

But, if the contract is merely to do so much work as is described in the specifications or quantities, he cannot be compelled to do more.

In the case of an entire contract, the preparatory work such as clearing away existing works, excavating, transporting materials, etc., is part of the contract work. If unforeseen difficulties arise, such as rock being encountered instead of clay, the preparatory work is still part of the contract work.

A well-prepared fair contract would provide for the engineer or architect in his status as arbitrator allowing extra remuneration in all such cases.

(4) *Time for Completion:* Where the contract does not set a particular time for completion, a reasonable time is implied and will be allowed. What is reasonable time depends on the nature of the work, the orders which the contractor has on hand, the proper use of customary appliances and the time a reasonably diligent contractor would take.

If a particular time for completion is specified, failure to complete within such time ordinarily will not be such a breach as to release the employer, but he is entitled to damages. If, however, time has effectually been made of the essence of the contract (and this is not usual in building contracts), and completion to time expressly made a condition precedent to payment, failure to complete within such time releases the employer.

The mere insertion of words that time is of the essence is ineffective if they are inconsistent with other terms. Time cannot be of the essence if there is a clause providing for a penalty or liquidated damages for delay, nor where there is a bonus for speed.

Where time is effectually of the essence, the contractor can recover nothing if he does not complete in time.

Where time was not of the essence, or where it was but was waived by the employer, the employer still has the right to fix a reasonable time for completion and to dismiss the contractor if he does not complete within such time.

The contractor has till midnight of the last day to complete.

(5) *Excuses for Non-Completion:* It sometimes happens that performance of a building contract is or becomes impossible. In such cases the ordinary rules of contract law apply—the contractor is not excused from performance and must pay damages. It is the duty of the contractor to fully inform himself of the particulars and practicability of the work before tendering. For instance, it is no excuse for non-performance to say that the soil has a latent defect making construction impossible. If, however, the impossibility to do the work is due to failure of the employer to fulfil a condition precedent, express or implied, the contractor has no liability.

The contractor may be absolutely prevented or delayed by the employer from commencing or continuing his work. The degree of prevention determines whether he is entitled to treat the contract as repudiated by the employer or is bound to continue and recover damages sustained. For instance, such delay by the employer as to turn a summer contract into a winter one may be such as to abrogate the terms of the contract and entitle him to recover on a "quantum meruit." Again, if the employer does not provide the site by the time fixed in the contract, or at once if no time is fixed, the contractor is entitled to throw up the work and sue for damages; or, he may wait for the site and continue with his work, recovering damages caused by the delay.

Where a time limit is fixed for completion, and does not provide for relief on account of strikes, the contractor will be liable for the delay so caused.

Where no time limit is fixed, the occurrence of a strike may excuse an unreasonable time and make it a reasonable time under the circumstances. If the contract provides for strikes, but a strike lasts so long that the object of the contract is frustrated, it puts an end to the contract.

The occurrence of bad weather or storms is no excuse, as weather changes must have been contemplated by both parties when the contract was made.

Where the employer, by the terms of the contract, employs sub-contractors, or independent contractors, or specialists, he becomes liable to the contractor for delay caused by them—but not so if the contractor employs them.

If an engineer or architect in the exercise of his quasi-judicial duties delays or prevents the contractor from proceeding, such as in deciding whether work or materials are as specified and in determining questions between employer and contractor, the contractor has no remedy. But, if the delay or prevention is caused by architect or engineer in his capacity as the *agent* of the employer, the latter is liable for their defaults.

(6) *Alterations:* As it is a rule of law that wherever a statute requires a contract to be under seal it can only be varied by a document under seal, and bearing in mind

the Ontario Municipal Act requiring contracts to be also authorized by by-law, the danger of dealing loosely with municipal councils is obvious. You should do everything possible to have your retainer fully protected as to formalities. The proper way is to have a contract under corporate seal and to have a by-law passed referring to that contract and authorizing it. This contract should provide for the manner of ordering alterations in or extensions to work, so that you do not have to go back to council for another contract and another by-law.

I realize that in dealing with municipal councils it is often not expedient to press for the formalities of contract to which you are entitled for your protection. This state of affairs should not exist. It is for instance taken for granted that you must give a real estate agent a written commission agreement else he will not work for you—that is because real estate agents have well trained the public to do the proper thing. Why should not municipalities be trained so that they cannot employ an engineer or architect except in the way they know to be proper and required by the Municipal Act under which they have their being? I seriously suggest that your Institute or Association adopt measures of practice that would take this embarrassment from the individual members.

When you find yourself in a position such that extensions to the work are ordered, and you have not the protective formalities covering the same, there is one way you can protect yourself. You no doubt are acquainted with the rule of law that if a debtor in making a payment does not apply the same to any particular debt the creditor may apply it as he sees fit. If a payment is voted to you and merely applied "on account" or some such language, you are entitled to apply it to extras or extensions that you have completed, leaving the sum due to you under your formal original contract safely collectible at law. Such an application cannot be made to unfinished work, however, as there is no "debt" for it till it is finished, except in so far as the agreement provides for payment by stages of progress.

The contractor is in the same position with the employer respecting extras, alterations, or extensions as you are. Hence the contract should contain provisions for alterations or extras by the engineer or architect, and it usually does in practice. Apart from statutory requirements as to formalities, a contractor for a lump sum cannot obtain payment for extras or variations unless he can show the employer expressly or impliedly ordered them, or that the architect or engineer did so acting within his authority, or that the employer ratified unauthorized orders of the architect or engineer, or that the employer accepted the work personally or by his authorized agent.

(7) *Breach of Contract:* If the employer does not fulfil a condition precedent to the contractor's liability to commence, the contractor can throw up the contract and sue for damages or, if he proceeds with the work he may according to the circumstances be relieved from stipulations as to time and still recover damages.

If breach by the employer occurs during the work, it depends on the particular circumstances whether the breach goes to the root of the contract. If it does the contractor can abandon the work and sue for damages at once. If it does not he must complete the work and then sue. As a general rule the longer the work is in progress and the nearer to completion, the less likely is a breach to be considered as going to the root of the contract.

Notice by the employer to the contractor not to do any more work is total breach and entitles the contractor to treat the contract as rescinded so that he need do nothing further and may at once sue.

Total abandonment by the contractor entitles the employer to treat the contract as rescinded. Breach by the contractor of particular stipulations has the same effect as a similar breach by the employer. But, where the contract provides for progress or time limits under penalty of forfeiture of the contract, breach of such a stipulation may entitle the employer to exercise his powers of forfeiture.

(8) *Penalty Clauses:* In order to secure punctual performance of contracts, it is usual to insert a clause that if the work is not completed by a certain time the contractor shall pay a certain sum or sums to the employer. The amount may be a penalty or it may be liquidated damages.

If it is in effect the payment of a penalty, the sum does not bind either party and all that the employer can recover is actual damage sustained. If the intention of the parties is clear that the sum or sums represents the estimated damage, then the sum is collectible as liquidated damages. These rules operate no matter what language is used.

To make effective a provision that the stipulated sum or sums shall be liquidated damages, it is essential that a day be fixed from which they are to run, for, if there is no such date, or it has ceased to be operative by the acts of the parties without a fresh date being stipulated, all right to recover the sum as liquidated damages is at an end. It is for this reason that you insert in contracts a clause that the architect or engineer may extend the time for completion, to fix a substituted date from which liquidated damages are to run.

The employer, by causing a delay in completion, through failing to supply site, drawings or required materials, or through ordering extras, etc., may make the date fixed for completion inapplicable and forfeit the right to recover liquidated damages. The burden lies on the contractor to prove such effect.

Where there was power to deduct the liquidated damages and they are not deducted, or where the engineer or architect in issuing his final certificate does not take them into account, the right to recover is gone.

Where the right to liquidated damages is gone and the contractor completes within a reasonable time, the employer has no right to even unliquidated damages.

(9) *Forfeiture:* It is usual to provide that on the happening of certain events the employer may take possession of the work so far as it has been performed and to complete it himself or by some other contractor. The employer may also be empowered to take possession of the property of the contractor, such as materials, plant and money due (for which he must usually account).

If there is no such power provided in the contract or the power is wrongfully exercised, the act of forfeiture by the employer is a breach going to the root of the contract, giving the contractor a right to sue either for damages for breach or for the value of work actually done and materials supplied.

If the forfeiture depends on the certificate of the engineer or architect, which certificate is by the contract final and conclusive, and the certificate is given under a mistaken view of the circumstances, but honestly and in good faith, the forfeiture is not wrongful on that account.

As a general rule the court will not restrain the employer from even wrongfully exercising forfeiture, as the contractor can be compensated in damages. The employer on proper grounds may however obtain an injunction restraining the contractor from proceeding with the work.

The usual provisions for forfeiture are for not commencing the work, not regularly proceeding with the work for some fixed number of days, not proceeding to the satisfaction of the employer or his engineer or architect, not proceeding with such despatch as will in the opinion of the engineer or architect enable completion by the time stipulated, not proceeding in the manner required by or not obeying directions of the architect or engineer, not performing the work as specified, not observing stipulations, not completing as stipulated, leaving the works in an unfinished state, failing after proper notice to rectify defects, removing materials, and not maintaining the works.

The forfeiture must be put into effect within a reasonable time, after the act complained of, else delay will constitute a waiver, except where there is a continuing or fresh breach.

(10) *Sub-Contracts:* As a sub-contractor is not a party to the contract between employer and contractor, he cannot sue the employer under it. If a particular article he has undertaken to prepare or supply has not been affixed to the freehold, he remains its owner until he has delivered it, and, on the contractor's bankruptcy, he can refuse to deliver it until he is paid for it. Where the sub-contractor is liable to compensate the contractor for inferior work or defects, and the contractor is under similar liability to the employer, the latter can take an assignment of the contractor's right to compensation.

Acceptance by the employer of work done by a sub-contractor in no way makes him liable to the sub-contractor. If the latter claims an "extra" ordered by the employer he must show the original contract does not include it and must prove a distinct contract for the extra between the employer and himself.

It is because of the rule that there is no contractual status between employer and sub-contractor that unless the contract between employer and contractor provides to the contrary, the bankruptcy of the contractor entitles his trustee-in-bankruptcy to whatever is due by the employer, and the latter must pay the same, and the engineer or architect must certify accordingly, without deduction of what the contractor may owe to the sub-contractor.

Unless the contract provides otherwise, the contractor has the right to sublet portions of the work to sub-contractors and be paid for their work. He is also liable to the employer for defects in their work as if he had performed it himself, the sub-contractors being of course liable to him for the same.

If by the breach of the contractor the principal contract is forfeited, the sub-contractors can sue the contractor for damages. Conversely, if the sub-contractor causes the forfeiture or payment of liquidated damages, he may be liable to the contractor for damages accordingly, provided he was aware of such terms of the principal contract.

(11) *Independent Contractors:* An independent contractor is one who contracts to do something, employing his own means to do it, and is in the performance of his contract entirely independent of any control or interference by the other party. The test to distinguish whether he is a contractor or a servant is whether the employer retains the power not only of directing what work is to be done but also of controlling the manner of doing it—if a man can be overlooked and directed he is a servant, not a contractor.

The chief importance of the distinction lies in the question of liability for negligence. The rule is that if the work contemplated by the contract is of such a nature that it can be lawfully done without causing injury to others unless there is negligence, and the employer has employed a competent contractor to do the work and parted with all control over its execution, the contractor is solely responsible for injuries caused by execution of the work or by the negligence of his workmen. It makes no difference that the employer lends men to the contractor if such workmen are under the control and superintendence of the contractor.

If the employer retains control over the execution of the work or if he actually interferes with the contractor or his servants and actually directs the manner of doing the work, he places himself in the position of master and is liable to third parties for any injuries sustained by them or their property.

Where the work to be done is a statutory duty of the employer or where though the work is lawful it is inherently dangerous, it is the duty of the employer to see personally that proper precautions are taken to prevent damage, and he cannot divest himself of this responsibility by employing a contractor, no matter how competent, and stipulating that he take due care.

The logic of this distinction is clear. There is an obvious difference between committing work to a contractor to execute which cannot have injurious consequences if properly done, and handing over work from which injurious consequences will arise unless preventive measures are taken.

The employer can to a certain extent safeguard himself by taking indemnity from the contractor but this has no effect on the rights of third persons and he still remains liable to them.

Where the employer remains liable for injuries this does not absolve the contractor. Both are liable and both may be sued jointly, and, being joint tort-feasors, neither can obtain contribution from the other.

A contractor in his relations to his sub-contractors is in the same position respecting liability for negligence as is the employer in his relation to the contractor.

## C. Engineers and Architects

### I. Status

The general object for which an engineer or architect is employed is to prepare plans and drawings of the buildings or works in contemplation and to supervise their construction, and, depending on the terms of his contract, he is generally speaking in such respects the agent of the employer.

His authority as agent does not empower him to warrant that the plans or drawings are correct, or that the work can be carried out according to them, or that temporary constructional works are practicable, or that conditions will be varied or waived.

If there are omissions in the plans, drawings or specifications, he has no authority to order such omissions as extras. If the scheme is impracticable, he cannot order as extra work what is necessary to enable the works to be constructed.

Generally he has to supply detailed or working drawings as the work progresses. This duty however is only to be exercised for the purpose of directing the contractor as to the exact manner in which the work described generally in the plans and drawings is to be done.

Where he is authorized to secure tenders, he is entitled to use the customary means to obtain them. If tenders are submitted but not accepted, he may obtain others within the time limited, or if no time limited, then within reasonable time. An authority to receive tenders does not empower him to enter into a contract with a contractor, even if the tender is within the price the employer is prepared to pay.

It depends upon the terms of his contract whether he can dismiss the contractor, or designate persons as sub-contractors or to manufacture or supply special articles; or to order extras, or to vary or dispense with any conditions in the contract.

The contract of employment of an engineer or architect is a personal one and therefore there is an implied condition that the contract shall continue only so long as he remains alive and in sufficiently good health to perform his duties. For this reason his death, insanity, or continued disablement dissolves the contract, and neither party can bring an action for breach.

In the case of temporary illness, the omission to perform the required services does not entitle the employer to rescind the contract, except where constant personal supervision has been stipulated.

The employment of an engineer or architect, being a personal contract, may be terminated by the employer at any moment, with or without good cause. The only remedy against the employer is an action for damages, as the court will neither decree specific performance of a personal contract nor grant an injunction restraining the employer from engaging another engineer or architect.

Where the main contract provides that the engineer or architect named is alone to give decisions in a quasi-judicial capacity, the employer has no right to prevent him from so doing, even if he dismisses him from his service, and he cannot revoke the agreement to abide by his decisions. But, where the contract designates the person to render these decisions as "the architect or engineer for the time being," or other similar words, the employer can appoint another to so act.

In case the employer dismisses the engineer or architect and should prevent him from going on the site to measure and certify, the court will grant a mandatory order compelling the employer to so permit him for the purposes of valuation.

II. Duties

(1) *General:* Although at common law an engineer or architect does not require to possess a diploma or qualifying certificate, he is bound to possess a reasonable amount of skill in the profession he exercises, and to use a reasonable amount of care and diligence in performing work he undertakes, including the preparation of plans and specifications. He represents himself as understanding the subject and as qualified to act in the business he undertakes. The employer buys both skill and judgment. He ought not to undertake work if he knows it cannot succeed and he ought to know whether it will or not.

As to the amount of skill required he need not exercise an extraordinary degree of skill. He is not responsible if others of far greater experience or ability might have used a greater degree of skill, or even if he might have used a greater degree. The question always is whether there was such a want of competent care and skill, leading to a bad result, as to amount to negligence.

(2) *As Quasi-arbitrator:* In most contracts the engineer or architect, in addition to his duties as agent of the employer, has to perform functions of a quasi-judicial nature, such as deciding between the parties whether work or materials are as specified in the contract, valuing as between the parties, determining questions that arise between them, and certifying. In such matters as valuer and certifier he is in a position similar to an arbitrator or an average adjuster and is not liable to his employer either for want of skill, ignorance of law, or negligence.

(3) *As Arbitrator:* Many contracts provide for settlement of disputes between the parties by arbitration, and an arbitrator is designated who may be the engineer or architect. There is a distinction between valuing for the parties, or certifying for payments, and arbitration. Where by the terms of the contract valuing and certifying is left to the sole skill and judgment of the engineer or architect, in performing such duties he is not an arbitrator, and, in the absence of fraud his decision is not open to review of either a court or an arbitrator. The valuation and certificate are given to prevent a dispute arising. The arbitrator's functions do not arise until a dispute has arisen. Where a valuation or certificate are not by the contract made conclusive between the parties, they would be open to review on an arbitration.

It may happen, where the engineer or architect is also made the arbitrator that a dispute may arise in which the evidence will cover or overlap something he had formerly dealt with to some extent in his quasi-judicial capacity as valuer and certifier. In such a case he must act as impartially as he can and all he can do is to be honest. It has been held that the honest exercise of his functions of superintending and controlling the work does not disqualify him as arbitrator, nor will extremely strong prior expressions of opinion disqualify him, except where they show he is not open to argument. The parties have agreed on a tribunal which they know cannot be wholly impartial because of the twofold capacity and they must abide by their agreement. If an arbitrator misconducts himself however, or the court is satisfied he cannot deal fairly with the dispute, or if he is really adjudicating on his own neglect, the court may remove him.

(4) *Delegation of Duties:* As the employment of an engineer or architect is a personal contract, he cannot delegate his duties entirely. But he need not personally go into all details and may make use of others in the performance of his duties. He cannot be expected to be constantly on the site, supervising construction of every part of the works. So he can employ others such as resident engineers, etc. He is responsible for the acts and defaults of all subordinates however, and he is not entitled to rely solely on their judgment.

(5) *Liability to Employer:* If an engineer or architect acts without due care and skill he forfeits all remuneration for services rendered that are useless, and in addition is liable for all damages sustained by the employer by reason of the negligence.

The question of whether reasonable and proper care has been exercised is one of fact and the test is whether other persons in the profession and having experience and skill would have acted in the same way. It is evidence of unskilfulness and ignorance to act contrary to established principles.

It is a duty to ascertain and comply with the requirements of all public and local statutes affecting the works. The knowledge of law expected of an engineer or architect is not a minute and accurate knowledge but a knowledge of the general rules of law applicable to the profession.

Failure to submit plans to the proper authorities, or to give notices required by law, or to examine the site, and the circumstances affecting it such as nature of soil and strata, condition of buildings thereon and existence of easements and building restrictions, with the result that his plans are defective or impracticable, renders him liable for all loss thereby occasioned to the employer.

Liability in respect to plans may be due to their being defective or incomplete or through not being supplied in proper time to the contractor. The design may be defective or incomplete, as being not in accordance with the art and science of architecture, or as being opposed to sound principles of building or engineering, or as not being in accordance with the instructions of the employer, or as contravening statutes or by-laws, or as disregarding restrictions imposed on the land.

The mere approval by the employer does not exonerate the architect or engineer if the work is structurally defective or does not carry out his instructions.

An engineer or architect does not, in recommending acceptance of a tender, warrant the solvency or competency of the contractor, but it is his duty to disclose to the employer all knowledge he possesses respecting the contractor and he should make reasonable enquiries.

Supervision must be thorough, and it is not sufficient to pay only occasional visits and set right what defects he notices. His duty is to give such an amount of supervision as will enable him to give an honest certificate whether or not the work has been done in accordance with the contract. While his supervision may in matters of detail be partly entrusted to subordinates he is liable for their negligence.

No engineer or architect or any other agent may receive a secret commission. If he does he forfeits his contract and all remuneration under it, and the employer can also recover the commission.

(6) *Liability to Contractor:* As there is no contractual relationship between engineer or architect and contractor, there can be no liability to the contractor for negligence or want of skill, and he cannot be sued by the contractor in any respect so long as he acts honestly and within the scope of his authority as agent of the employer. He does not in any way warrant that his employer is solvent and can pay, or that he will act reasonably, or that he will observe the terms of the contract.

If, however, he actually exceeds his authority and causes the contractor to provide work or materials for which the employer is not liable, he is liable to the contractor for damages for breach of warranty of authority, whether he honestly believed he had authority or not. If the assertion of authority was fraudulent, that is was made knowing it was untrue, or carelessly, not caring whether it was true or not, he is liable for punitive damages for deceit.

If, however, the contractor knew or could have known the limits of the engineer's or architect's authority, as for instance the terms of the building contract, there is no liability for breach of warranty of authority.

The amount of damages for breach of warranty of authority is the sum required to put the contractor in the same position as if the work had been authorized, that is its cost plus a reasonable profit.

The architect or engineer does not warrant that the plans, drawings or specifications are practicable. The contractor must satisfy himself in that connection.

Similarly there is no warranty to the contractor that the quantities are correct, whether they have been prepared by a quantity surveyor or by the engineer or architect himself.

(7) *Remuneration*

(*a*) *When Work Completed:* We have seen that under the Ontario law where the contract of the engineer or architect is with a municipality and the formalities of seal and by-law were not complied with, no sum whatever can be recovered from the municipality. In all other cases, where the work has been completed, whether the contract was in writing or oral, the engineer or architect recovers the remuneration stipulated by the contract. If no remuneration was set by the contract, or if by the contract the employer was to fix the amount, reasonable remuneration must be paid.

Similarly, where the contract fixes the remuneration for the stipulated work, but extras, variations, or extensions have been ordered by the employer, without the basis of remuneration of the same having been agreed upon, a reasonable remuneration must be paid.

(*b*) *When Work not Completed:* Where the engineer or architect has partly performed the services for which he was employed, and the employment is terminated by the employer, the engineer or architect is entitled to sue either for damages or on a "quantum meruit" for the value of what he has done. If he was so negligent however that the employer derived no benefit from his services, or part of them, no remuneration for them, or the part affected by his negligence, can be recovered.

Where the non-completion was due to the death or insanity of the engineer or architect while the contract in so far as it concerns future work is at an end, the personal representative is entitled to recover instalments that have fallen due; and, unless the contract stipulated that payment was only to be made on completion, he can recover the value of completed work.

In the event of bankruptcy of the engineer or architect during the progress of the work, all moneys due to him under his contract pass to his trustee-in-bankruptcy to whom also pass his rights of action for breach of contract and wrongful dismissal. If he was employed on a salary however, the salary does not pass to the trustee. It may be comforting to know that after bankruptcy the trustee cannot compel an engineer or architect to work.

(*c*) *Amount of Remuneration:* When the contract is completed and it sets forth the remuneration it governs of course, and in the event of non-payment the engineer or architect can sue for that sum.

When the contract does not stipulate the remuneration, or when work is done beyond the stipulated work, or when the contract is terminated by the employer wrongfully, various questions arise.

While engineers and architects have an official tariff, when the contract does not stipulate the remuneration for the work or part of it, there is no implied contract that the remuneration shall be on the tariff basis—the rule being that what is reasonable remuneration must be paid. The position of the tariff in the courts is that while it is not binding on the court the court may consider it for its guidance in deciding what is a reasonable remuneration.

Where the contract is wrongfully terminated by the employer, the engineer or architect sues for damages or on a "quantum meruit," generally putting forth both claims in the alternative so that the trial judge may bite that side of the apple which appeals to him most.

The general rule of damages is that such sum is to be awarded as would put the parties in the same position as if no breach had occurred. Disbursements which the engineer or architect would have had to pay out during uncompleted work are generally deducted from the sums he would have received, as those disbursements are salvaged.

As respects a "quantum meruit" claim, the value of the work performed is in practice generally ascertained by consulting the official professional tariff. This as you know gives two main ways of arriving at the value—first on a percentage of cost basis and secondly on a per diem allowance plus disbursements basis. One way of arriving at what is reasonable remuneration is to allow the entire contractual percentage less that portion which by the tariff is applicable to the incompleted part of the work.

It is to be noted that where the contract was wrongfully terminated by the employer the engineer or architect is no longer bound by the remuneration stipulated in the contract, whether it be on a percentage basis or otherwise, and is entitled to put his entire claim on a "quantum meruit" basis.

(8) *Lien:* An engineer or architect has a lien on the plans and drawings prepared by him and need not deliver them up till he is paid.

Under the Mechanics and Wage Earners Lien Act in Ontario he is also entitled to register a lien against the lands upon which the building and works are erected, the lien covering his entire services to the owner.

This lien must be registered not later than thirty days after the last day's service by him. It may be filed during the progress of the work or even when the contract is made. (I only personally know of one case where a lien was filed as soon as the contract was made, and, if I may be pardoned for the expression, "hell is popping yet.")

The lien is enforced without writ merely by delivering and filing in the Supreme Court of Ontario, a statement of claim in the statutory form, and registering a certificate of action, both of which must be done within sixty days after the lien was registered or within ninety days after the last day's service, whichever is the last. An action so commenced by any lien claimant keeps alive all other liens, and the other claimants need do nothing. An appointment to try the action of all lien holders is taken out with the Assistant Master, whose judgment covers not only personal judgment for the money due against the employer but gives right of sale of the lands and premises to the lienholders whose liens he finds valid. Wage-earners have priority over other lien holders. The lien of an engineer or architect is classed with those of contractors.

An owner who did not make a personal contract with a lien claimant is liable only for a percentage, the percentage being up to 20 per cent according to the contract price.

The lien takes priority over all judgments, executions, assignments, attachments, garnishments and receiving orders issued or made against the employer and owner.

### D. Surety Bonds

#### I. In General

These bonds fall into two classes—indemnity bonds and guarantee bonds. While the student of law must be acquainted with the various technical distinguishing characteristics attached to each such class of bonds, most of those points are too academic for our general purpose. I shall therefore restrict my remarks to a few points of practical utility.

In every indemnity and guarantee there are at least three parties—a principal debtor who contracts with his creditor to do something, such creditor, and a surety.

In an indemnity the surety's promise to the creditor is unconditional—he undertakes to pay the creditor's loss or damage.

In a guarantee the surety's promise is conditional—he undertakes with the creditor to do something if the debtor fails to do so.

Apart from this great distinguishing feature the general rules of law are equally applicable to both an indemnity and a guarantee.

Perhaps the chief kinds of bonds with which you as engineers or architects come in contact in your professions are indemnity bonds against loss or damage, performance bonds or bonds guaranteeing performance by the contractor of his contract with your employer, bonds guaranteeing the finances of the contractor, and bonds guaranteeing payment to the contractor.

The bonds in common use to-day are very carefully drawn to provide against many of the legal points that have arisen in the past. Some of the terms are very cogent, indeed, and, with the greatest respect, I suggest that in your practice you should take the precaution of perusing those terms in each of your retainers where a bond is in operation. You will find your legal duties and obligations to your employer and your general interest in advising your employer are considerably affected by those terms.

I concluded that a discussion of the law of bonds most practical for your purposes concerns the rights and liabilities of the surety, that is, what will cost your employer the loss of the security of a bond.

#### II. Position of Surety

(1) *Before issue of bond:* A surety is a favoured debtor. While he is not, as an insurer is, entitled to "uberrima fides" or the utmost good faith, there must not be any fraud or fraudulent non-disclosure of material facts. Thus, proof of fraud to secure his bond will release him from liability under the bond. This fraud may consist in either (*a*) false representations by the creditor to induce him and actually inducing him to issue the bond, or similar false representations made by the debtor with the creditor's knowledge, or (*b*) fraudulent concealment of material facts.

Fraudulent concealment may consist in not disclosing facts in answer to the surety's questions, or facts which the creditor should voluntarily disclose. A creditor must disclose any facts which make his position with the debtor different from what the surety would naturally expect. While a creditor need not tell all about a debtor's credit which affects the risk, nevertheless very little need be wrongfully said, or left unsaid when it ought to have been said, to invalidate the bond contract. For instance, the creditor should disclose to the surety any private contract he has with the debtor which affects the surety's liability and it is often necessary to disclose a contract between the creditor and a third party. In general however, the surety must inquire and it is, for instance, no defence for him to say the debtor had been guilty of previous defaults and that the creditor ought to have mentioned the fact.

(2) *After issue of bond:* A surety being a favoured debtor is entitled to the strictest adherence to his contract set forth in his bond, and, as the contract between creditor and debtor is made a part thereof, he is also entitled to the strictest adherence to its terms.

This is why I say you should study and closely follow all stipulations in the bond and see that your employer does so. Again, since any material alteration in the contract between the contractor and your employer without the surety's consent relieves the surety from all liability under the bond, and since building contracts are so naturally liable to be altered, you can see the very real obligation you have. The reason the surety is discharged by any material alteration in the contract between employer and contractor is that it is no longer the contract he guaranteed.

Thus, an increase in the amount of work to be done, or an extension of time for completing the work, will discharge a surety if he did not consent to such alteration. Decreasing the amount of work will not, however, release the surety as he is not prejudiced.

A payment made by the employer to the contractor before payment is due will release the surety, if made without his consent.

As a surety upon payment or other requisite performance of his bond liability is entitled to the benefit of any securities of the debtor held by the creditor, whether those securities were held before issue of the bond or were obtained by the creditor afterwards, loss or impairment of those securities to the prejudice of the surety releases him.

Any active omission by the creditor to do something he was bound to do for the protection of the surety will release the latter either wholly or partly according to the circumstances. Any unreasonable delay by the creditor in informing the surety of the debtor's default so that meanwhile assets of the debtor change hands and become lost to the surety, or anything that occurs that increases the surety's loss, releases the surety either wholly or partly according to the circumstances. It is to be noted however that this rule does not apply to a Crown department. Under our law the King can do no wrong. Here "the King" includes his Ministers and his employees. Hence, under the bureaucratic form of government we have to-day a member of a Crown department can be as negligent as he pleases to the prejudice of a surety without the surety having any adequate redress.

A surety has also the right to investigate all the circumstances and can set up any defence that could have been set up by the debtor. Hence, any act of the employer that releases the contractor wholly or partly from his liability similarly releases the surety.

#### Conclusion

In conclusion may I say that while I am fully aware that this discussion has been sketchy it would really be impossible on an occasion like this, where the time is necessarily limited, to cover all the ground or any of it in detail. I therefore close with an expression of my thanks for your courteous and attentive hearing.

# The Development and Operation of a Company-Owned Industrial Town

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**Paper presented before the Ottawa Branch of The Engineering Institute of Canada, October 26th, 1933.**

SUMMARY.—The paper outlines briefly the development of a company-owned industrial town, dealing with site, layout, housing, water supply, fire protection and requirements for schools, hospitals, stores and recreation.

Less than sixteen years ago the townsite on which Temiskaming is located was a section of forest at the southern end of Lake Temiskaming in the province of Quebec.

The selection of this site by the Riordon Pulp and Paper Company for expansion of its sulphite pulp industry was not haphazard, and was decided upon only after a detailed survey of its natural advantages.

The decision of the company to expand at Temiskaming was made on the recommendation of its Technical Director, Mr. C. B. Thorne, M.E.I.C.

The immediate objective in this expansion was to meet the demand for a viscose pulp which would satisfy the requirements of the rapidly growing rayon industry.

The fact that this unit, now owned by the Canadian International Paper Company, supplies over fifty per cent of the world's consumption of viscose pulp indicates that the objective has been attained.

This paper, however, is not intended to deal with the industrial development, but only with its adjunct, the town, which provides accommodation for the employees.

When an industrial company faces the problem of expansion, there are two main requirements, viz.:

1. An ample supply of raw material with a visible market of sufficient duration to absorb the capital cost of the plant.
2. The best site for cheapest and continuous manufacture of its product.

Definite proportional numerical values must be assigned to the various essentials that control the cost of production. Each industry will place its own values on every item affecting its own cost of production and marketing. Generally, without including special industrial features, the most important factors to be thus valued are the following: Cost of raw materials, labour supply, fuel, power, living conditions, transportation, water supply, climate, cost of maintenance supplies, taxes and legal requirements, plant site, and cost of construction.

It is apparent that different values will be attributed to each item by different industries; but, when determined, these values will provide a scale for comparison of locations. The numerical total will show the most advantageous locality.

The site selected for Temiskaming was tributary to extensive areas of pulpwood which could be water-borne to the plant. Here also ample power could be developed cheaply from the Kipawa lake area. This water also, being clear and low in alkalinity, was especially adapted for boiler use and for the manufacture of viscose pulp. The Canadian Pacific Railway offered good transportation facilities for moving supplies and product, and the site was naturally suited for the location of plant and town. Climatic conditions were normal for the industry, and the laws and taxes in force could not unduly affect the cost of production. There was, however, neither labour supply nor accommodation for employees.

This shortage was entirely offset by the natural advantages, and the company undertook to provide these essentials. Hence the origin of the town of Temiskaming.

Realizing that contented employees are the cheapest type of labour, it was decided that the completed town should be a model industrial community which would attract and hold the best class of men.

When this decision was made, a department known as the Town Department was formed and the author placed in charge of organizing and executing the undertaking. Similar developments in Canada, in the United States, and in Europe, were examined with a view to benefiting by the experiences of all.

In the preparation of the final plans leading consultants were retained with a view of producing an economical and modern scheme.

Naturally, that portion of the location selected which was most adaptable for the construction of the industrial plant was taken for that purpose. This, however, left several alternative sites available for the townsite, the relative merits of which all had to be considered and appraised.

The controlling considerations, which also apply in other cases, were briefly as follows:—

(*a*) Geological structure.
(*b*) Topographical conformation.
(*c*) Proximity to potable water supply.
(*d*) Exposure to sun and prevailing wind.
(*e*) Proximity to plant.
(*f*) Available building material.
(*g*) Natural beauty.

To supplement what could be observed from surface exposures, test pits were sunk in various locations to determine the general sub-surface conditions. From these accurate estimates were formed of the suitability of the sites for the erection of buildings and of the construction costs based on the materials encountered.

Topographical surveys were then made of all areas that could reasonably be considered, and the plans studied as to their respective merits for the proposed townsite.

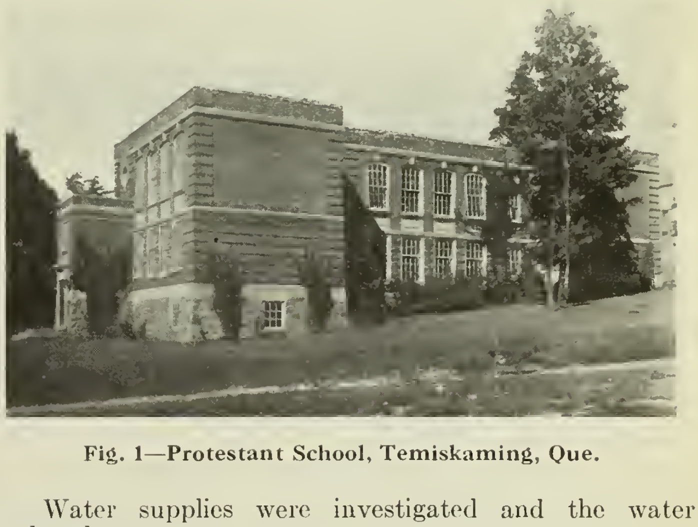

**Fig. 1—Protestant School, Temiskaming, Que.**

Water supplies were investigated and the water analyzed.

The proximity of the town to the plant afforded a field for much thought and study. Here the experience of other industrials was of great benefit. Investigation indicated that employees who have an option in this do not like to live too close to their work. When their work is over they do not wish the plant to be a constant reminder. It was also found that the auto and autobus had increased the employee's latitude and had permitted his living some distance away where he could rent or buy for himself a house where the land was cheaper, and, by securing more land and cultivating a kitchen garden, could reduce his living expense. Consideration was given to exposure to sun and to the nuisance from smoke and gas.

It was quickly apparent that building material costs would be about equal in all possible locations.

Each section had its particular scenic value and natural beauty spots, which in valuation were practically equal, except that in the one finally selected Lake Temiskaming offered a waterfront for the town.

After a careful study of these points a site was selected to the northwest of the plant. This was a heavily wooded series of steep slopes and narrow inclined plateaus. The underlying geological formation was granite, which was exposed in many places, but was generally covered with glacial drift, containing fifty to sixty per cent of boulders varying from man-size to many yards in content.

Admittedly, this was far from a cheap site upon which to build a town. However, the additional annual charges for the above-normal costs were relatively minor matters compared to the other manufacturing advantages of the whole location.

With the definite decision made as to site, a careful topographical survey was completed. On account of the abrupt changes in the slope and the narrowness of many of the plateaus, accuracy was of prime importance in order that full advantage could be taken of the natural topography to secure economical locations for both building lots and streets. On the completed plan the townsite was laid out and later definitely located on the ground and marked with permanent concrete monuments.

It is well here to point out that on account of the number of boulders the engineering work was difficult and intricate, as practically all the streets had to have curved boundaries in order to conform to the principal topographical features. The town plan, therefore, is not symmetrical; nevertheless its development through construction has produced a convenient, interesting, and attractive layout.

From the natural steepness of the slopes it was evident that a six per cent grade would have to be considered the minimum controlling grade for the principal arteries, and that secondary street grades up to fourteen per cent would be necessary.

So far as could be reasonably foreseen, the population of the town would never exceed ten thousand. It was therefore decided to limit the width of primary streets to 60 feet, to make secondary streets 50 feet wide, and purely residential streets 40 feet wide. The general slope, too, had considerable bearing on this decision.

The blocks in the town plan are necessarily irregular in shape; but in each case an attempt has been made to follow the principle outlined in Fig. 2, which shows a typical block layout plan. It will be seen that a lane has been provided immediately adjoining the rear of the houses with outlets to the streets at appropriate places. The space between the lanes has been divided into kitchen-garden plots, each duly numbered to correspond to the house to which it belongs. Further, an enclosed children's playground is incorporated in the plan in such a position that the housewife may keep an eye on the son and heir while attending her daily duties.

It is believed that this layout is original; and, though lanes as commonly known are decried and often avoided, this arrangement holds many advantages for the particular case in question, and would doubtless be adaptable to other situations. Among its good points are the convenience for wood, coal, and other deliveries, the reduced cost of garbage collection, and the ease of its disposal by the householder.

The point may be raised that there would be difficulty in preparing a description of the property if a sale were to be made. When this general plan was devised, it was proposed that only the lot on which the house was located would be sold, but that the purchaser would also acquire the right to cultivate a specific garden plot. On his failure to do so, or to take proper care of it, it could be turned over to some one who would appreciate the advantage.

The streets along which the buildings have been erected have been graded and gravelled. Concrete sidewalks have been laid on at least one side of the street, while cinder walks have been provided on the other. A concrete curb and gutter is laid on all the principal streets and on many with excessive grades to prevent erosion.

The water supply comes from the Kipawa lake watershed and is taken from the 8- and 13-foot diameter wood stave pipe lines which convey water for power purposes from the dam at Lumsden's Mills to the power house situated on Lake Temiskaming. Kipawa lake is situated in a practically unsettled area, but is liable to occasional pollution from lumbering operations. Consequently, the supply is passed through pressure filters, and, as an added precaution, is chlorinated.

The water enters the pumping station under a static head of 20 pounds per square inch from the pipe lines, and, passing through pressure filters, is chlorinated, and is then pumped into the distribution system by a motor-driven centrifugal pump having a capacity of 600 g.p.m. against a head of 240 feet.

For emergency service and fire protection a gasoline engine directly connected to another pump of equal capacity has been installed as a stand-by unit.

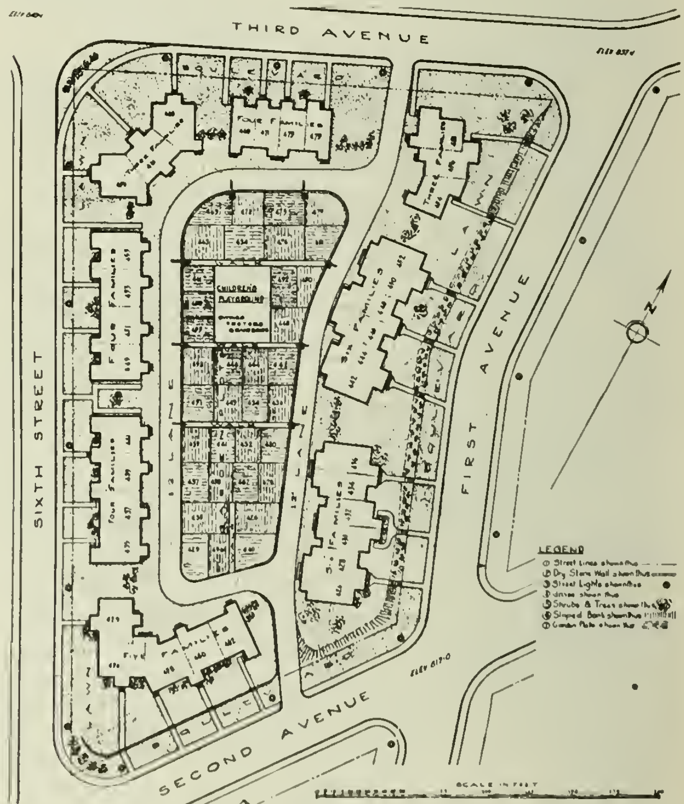


Fig. 2—Typical Block Layout.

The motor-driven unit is equipped with no load and overload cutouts. Consequently, the station requires no attendants or operators other than to provide regular oiling and inspection. This plant has been operating continuously for fourteen years under these conditions.

Daily water samples are forwarded to the Superior Board of Health of Ontario for analysis—a service furnished free of charge by the provincial government.

The distribution system is entirely cast iron pipe 10 inches to 6 inches in diameter and a liberal installation of valves provides excellent control in emergency.

Owing to the location of the town on a steep hillside where prospective consumption might be taken anywhere between elevation 625 and 900, the pumping station was located at approximately elevation 740, and reducing valves installed to regulate the pressure below elevation 700. By-passes are installed at each reducing valve for use in case of emergency. These valves, however, have operated automatically and satisfactorily even during bad fires.

Fig. 3—Group of Mechanics' Houses.

One-inch galvanized iron pipe was used for all ordinary water services and as yet no service has been renewed after fourteen years' use.

Owing to climatic conditions, all water mains have a minimum of 5 to 6 feet of cover, and, due to the heavy cost of excavation, were laid in the same trench as the sewers, which naturally contribute some frost protection. The services have at least 6 feet of cover except where there is a good sod covering when it has been found possible to reduce this to 5 feet of cover.

An ever-present fire hazard exists in the adjoining forest and therefore, as auxiliary protection, the town of Temiskaming has supplemented the company's water system by the purchase of three bush fire pumps and four thousand feet of 1½-inch cotton hose. This equipment can be speedily transported to a fire originating in the immediate vicinity of the town; but neither it, nor any other equipment, can control a fire which originates miles away and reaches the intensity that wiped out Haileybury some years ago. Against such fires man and equipment are impotent, and only rain or change of wind will extinguish them or prevent a catastrophe.

Owing to the high cost of excavation, a combined domestic and storm sewage system was decided upon and installed. This is laid entirely in vitrified terra cotta pipe varying in diameter from 10 to 36 inches. At points where the run-off would be excessive for the diameter of the pipe, overflow outlets have been placed to relieve the mains and prevent back-flooding of cellars. All ordinary services are 6 inches in diameter. So far no difficulty has been experienced with sewers laid on grades up to fifteen per cent.

Although no long distance phone connection is available, an automatic telephone system has been installed for inter-departmental service and for the convenience of the people. A hundred-line unit has been placed in a fireproof building and arranged for extension when and as required.

The construction of houses, schools, and commercial buildings has been the largest single item of expenditure.

Housing presented the problem of providing for people of many nationalities and stations in life, and involved consideration of climatic conditions and the relatively high cost of construction.

In approaching this problem the first step was a decision upon a classification for housing that would best meet the local needs. Four general classes were settled upon, viz. officials,' mechanics,' mechanics' helpers, and labour houses.

No officials' houses have as yet been built, and each will be designed as a separate unit. Officials in the meantime have occupied machanics' houses, and will continue to do so until funds can be allocated for their construction without sacrificing more pressing needs.

The general plan adopted for mechanics' houses was a building with six rooms, three bed-rooms, bath, living room, dining-room, and kitchen, each having an approximate ground floor area of 625 square feet. Typical layouts for this type are illustrated in Fig. 4. An examination of this plan will show that a very small percentage of area is absorbed by halls and stairs. It consequently is an economical house to build for the accommodation it provides.

Mechanics' helpers' houses were similar in general plan, but the ground floor area was kept within the limits of 500 to 550 square feet. Figure 5 illustrates one of the most representative and economical types in this class.

Labour houses have the ground floor area tentatively fixed at 450 to 500 square feet; but in this classification more variation in type has been necessary than in either of the others, due to the variable size of families and to the modern conveniences expected by the tenant. Figure 7 shows a typical and economical arrangement for a small house of this type. This plan is particularly adaptable to change of grade or to fit unusual conformation of ground, as its separate units can be moved about to meet these conditions.

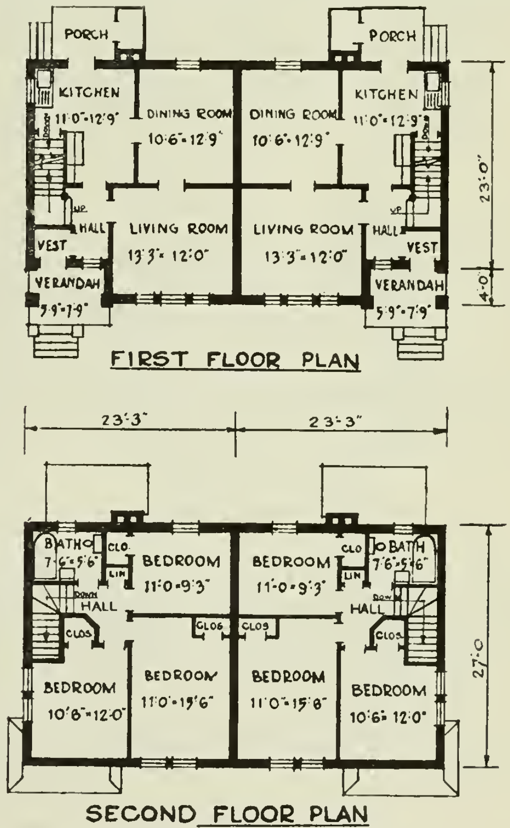


Fig. 4—Typical Houses for Mechanics.

The first consideration in all housing design is to provide proper accommodation for the family. Definite standards as to size of room, light, ventilation, and heating were established and maintained.

Each house has water and sewer service, a combined kitchen sink and wash-tub, toilet, and other plumbing fixtures in keeping with the standard of living expected by the tenant. Each house is fully wired for electric light, and at least eighty per cent of all cooking is done by electricity. This utility is furnished at a low rate for light, cooking, and hot water heaters, and is one of several appreciated features tending to lessen the labour turnover.

Mechanics' and mechanics' helpers' houses are all heated with hot air furnaces and the construction is such that it is possible to keep the heating bill very low in spite of the climatic conditions. It may be of interest here to state that the average fuel consumption for a mechanics' house is approximately five cords of sixteen-inch hardwood and five tons of anthracite coal per year. It was also found that four inches of cork insulation placed on the ceiling above the bedrooms reduced the heating bill nearly twenty per cent, as well as having other advantages referred to later.

All houses have permanent foundations constructed of rubble masonry made from the boulders found in the excavation. The superstructure is what is commonly called balloon frame, and is brick veneered, or stuccoed. Several types of roofing have been tried, but roofs of asphalt shingles, slate surfaced, have proved the most economical and satisfactory. Even these, in the author's opinion, leave much to be desired both in appearance and durability.

Careful study has been given to the grouping of houses, which, generally, are either semi-detached or in rows. Some very interesting facades have been worked out to take care of the steep grades; but the effect striven for has been harmony without monotony along every street.

As previously noted, full advantage was taken of the topography to obtain reasonable street grades; consequently, due to the winding and curved streets, the block plan is irregular. Nevertheless, the gradually changing vistas enhance materially the appearance of the town.

The snow on the roofs and the icicles formed at the eaves have been a real problem, and at times a menace to

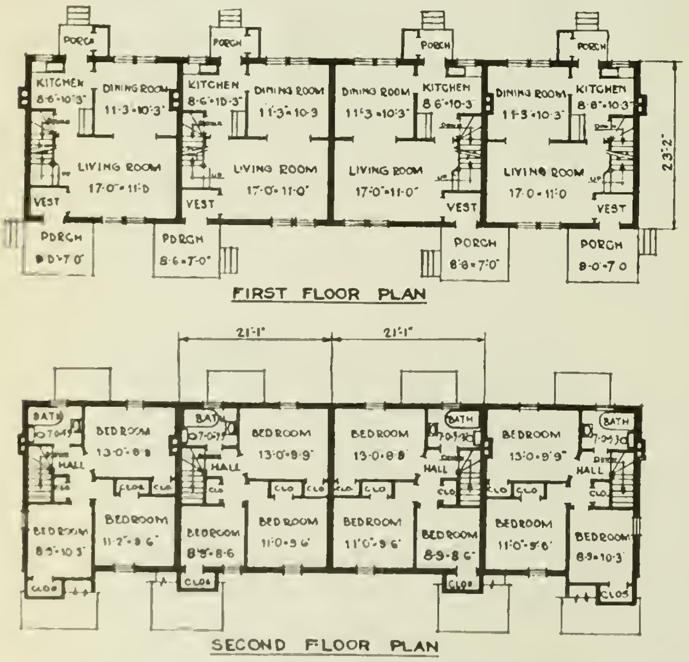


Fig. 5—Typical Houses for Mechanics' Helpers.

the safety of persons. The snow melting on the upper roof due to interior heat runs down on the projecting unheated eave and freezes, gradually accumulating a great weight of ice.

Experience indicates that each eave projection should be boxed in and so arranged that the air in the exterior partition may circulate in this eave, and that all ceilings should be insulated with 4 inches of ground cork. The projection of the eave should not be less than 18 inches. When this has been done, the icicle nuisance has been overcome.

Next to housing, education is doubtless the most important requisite for a contented people. Realizing this, and also the value of educated employees, the company has continued a policy of providing absolutely free education to the children of all residents of the town irrespective of whether or not they had company affiliations—this without request to the provincial government for assistance.

Two fully modern, solid brick schools have been erected and equipped to give education up to and including matriculation. Domestic science and manual training have been provided for in another building, and the company is now about to offer this vocational training to the adult population.

The supervision of the schools is left to the Advisory School Boards appointed by the company. It may be of interest to state that the present school attendance is four hundred and the annual cost to the company for each pupil is approximately $90.00.

A hospital is a very important consideration for any isolated community. This has been provided and equipped so that any major operation is undertaken. Its location is ideal, on the hillside facing Lake Temiskaming. It overlooks the lower town and mill, and offers a beautiful and interesting outlook for the convalescent. This institution, with its doctors and nurses, has given valuable aid in emergencies and doubtless saved many lives which otherwise would have been lost due to the distance from other hospitals.

When the town was first established, it was difficult to interest business men with capital to invest in necessary stocks and supplies to establish themselves in the community; so this obligation also fell upon the company. However, as private individuals could be found who would undertake these enterprises, they have been turned over to them to conduct, the company merely retaining such portions of the business as would permit them to keep the cost of living at a satisfactory level.

Naturally, their whole interest was to maintain this at the lowest point consistent with the health and comfort of the people.

Situated as Temiskaming is in a wilderness with geological conditions prohibitive of the private production of dairy and farm products so essential to the people, the company purchased the only suitable area and established a dairy farm to meet this need. Otherwise, a milk supply would not have been available within a radius of 40 miles, and that only by rail, as there is no highway connection.

As amusements are essential to contentment, an athletic field for baseball and football was provided. Here, too, an endeavour has been made to avoid paternalism by encouraging and supporting an organization known as the Temiskaming Athletic Association, which controls and supervises all sport in town. This association is a board of directors formed by representatives of all the sporting clubs. Grants are made to this board, who in turn allocate the money to the individual clubs. Through the united effort of this association, the town council, and the company, the town possesses four splendid tennis courts, ski jump, motor boat landing, diving stage, a nine-hole golf course, dressing-rooms and equipment for a large out-door hockey rink, and a splendid concrete-lined wading pool for children.

A moving picture hall with a seating capacity of three hundred was one of the first buildings completed. Recently this was equipped with the most modern type of sound reproduction apparatus.

In addition to the above amusements, the natural location provides canoeing, motor boating, swimming, fishing, and hunting. Game and fish abound in the surrounding country and lakes.

It unfortunately appears that nature objects to clearing a space in the forest for a townsite, as it has been impossible to save the many beautiful and stately trees that were carefully protected during the progress of construction. Experience here indicates that when adjoining trees are removed from those which it is desired to save the specimens gradually succumb. Whether this be due to added exposure in winter, or to the higher rate of evaporation from the soil, or to both, it is not possible to state. However, young trees of similar varieties may be planted and will continue to prosper.

After the removal of the original forest the townsite presented a desolate aspect much intensified by innumerable boulders of all shapes and sizes. These were utilized for all forms of construction and broken up for concrete aggregate, for which they are naturally suited. Consequently, today one finds that the lots are practically cleared of all except those which have been deliberately left for landscape purposes.

Coincident with the inauguration of the above policy, through a definite plan, trees, shrubs, and vines have been planted, and by sponsored competitions attempts have been made to interest each householder in improving his own home. From a small beginning these competitions have been the means of producing gardens and home surroundings which ten years ago would have been deemed impossible.

Today the centre of the town may be viewed as one garden; but investigation shows that it is made up of the individual gardens of the various householders, so harmoniously blended, however, that it is impossible to realize that the whole is the product of individual effort.

The officials of the company feel that the resulting appreciation of the beautiful has done much to stabilize labour. It has, at least, developed loyalty and pride in the town, so that people who located here less than ten years ago now speak of it as "home," and that is the essence of contentment.

In keeping with this policy, the town of Temiskaming undertook as an unemployment measure the construction of an extensive rock garden, a feature to which the natural situation of the town easily lends itself. As a result, the town possesses now a very fine example of this type of landscaping, and has a splendid collection of rock garden plants that is gradually attracting attention to the community as a whole.

The town council has established and continuously supported a public library.

In 1928 the citizens raised funds to erect a memorial to Mr. Thorne and this monument now stands at the

Fig. 6—Group of Mechanics' Helpers' Houses.

entrance to Thorne avenue. A further indication of his interest in the citizens is shown by Mr. Thorne in his presentation to the town in 1930 of an antique marble fountain and well-head brought from Florence, Italy.

A description of the boarding houses, hotel, cafeteria, etc., provided and operated for the accommodation of the single employees would unduly extend this paper but the same detailed study has been given to this as to every other phase of the development.

On the original plan definite sites were allocated to all principal religious denominations for churches; and, though temporary accommodation has been provided for services, each denomination is expected to raise funds for its own permanent structure. The Roman Catholic congregation has already succeeded in this, and has erected a beautiful rubble masonry structure from the boulders broken on the site. The architect in executing this plan used Laprairie red brick for corners, returns, and reveals, thus avoiding the expense of cut stone, and adding warmth to the completed structure.

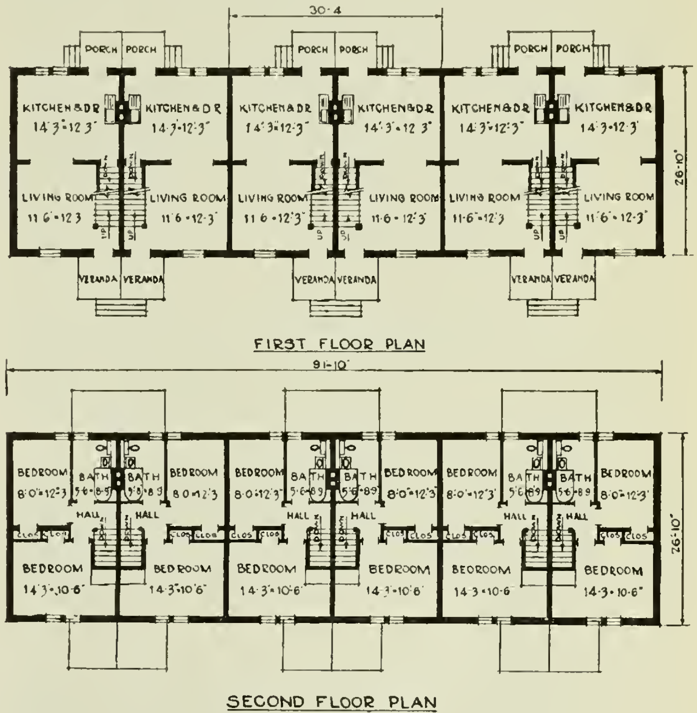


Fig. 7—Typical Houses for Labour.

This paper would be quite incomplete without some reference to the general policy governing the operation of this company-owned town.

There is no doubt that the original intention of establishing a model industrial town has in a very large measure been fulfilled. Obviously such an undertaking as this can be assumed only by a large and financially powerful organization with sufficient output to absorb the operating costs.

Another point of interest is that the company has only rented and never sold any of its houses. Much can be argued for and against this decision. However, after fifteen years of experience it is felt that the best of employees would not have it otherwise. During the past depression they have had no worries of accumulating payments, enjoyed a below normal rental, and have had no investment to tie them to the locality if opportunity offered betterment.

The company has at all times endeavoured to avoid paternalism. Its local regulations are based on the belief that the interest of the whole community supersedes that of the isolated individual.

Rents have not attempted to cover interest and upkeep of houses. This deficit is absorbed in the cost of production. Utility rates are fixed as nearly as possible to the average cost of operation.

The whole project is operated by a department called the Town Department, whose responsibility finally consists of maintaining a contented community and seeing that the cost of living is as low as is consistent with maintaining a healthy and satisfied people.

So stands Temiskaming today, an isolated but fully modern town, which provides modern living conditions for a population which varies with the activities of the mill from twenty-two hundred to thirty-two hundred persons.

# THE BROADWAY BRIDGE, SASKATOON

*C. J. Mackenzie, M.E.I.C.*[1]

## DISCUSSION

R. DeL. French, M.E.I.C.[2]

Professor French stated that he had had the privilege of presenting this paper in the unavoidable absence of its author, Dean Mackenzie, a privilege perhaps the more appreciated as his engineering interests lay along lines quite different from the subject of the paper. The following comments were therefore offered from the point of view of one familiar only in a general way with the subject.

The author was to be congratulated upon a satisfactory solution of a difficult architectural problem. His success but emphasized the old truth that a pleasing effect could be secured in any structure and with any material if one adhered to the well-established principles of functional design.

Careful engineering planning and supervision were evidenced by the high quality and reasonable cost of the work, both the more notable because the bridge had been built within a not too adequate time limit and under the twin handicaps of a severe northern Saskatchewan winter and the use of unskilled relief labour.

The careful measurement of temperatures at various points in the structure merited commendation. Not only must these be interesting in themselves to all concerned with the design of similar structures, but they served to stress how easy it was to seize the opportunity to amass engineering data of real value. He ventured to guess that these temperature measurements added very little to the cost of the bridge.

If engineers generally would follow the lead of the author, it would shortly be found unnecessary to make so many assumptions as to the fundamentals upon which far too many designs were now perforce based. Because these assumptions had led to safe designs was not in itself any indication that better ones could not be formed. With economy the watch word, as it was today and as it was likely to be for years to come, a critical examination of "standard" assumptions seemed indicated; if these were to be modified, it should be in the light of actual measurements so far as possible.

A. W. Haddow, A.M.E.I.C.[3]

In commenting on the excellent engineering structure which had been produced, Mr. Haddow remarked that he had had the opportunity of visiting this work during construction and the photograph Fig. 2 showed clearly the pleasing appearance of this structure.

The bridge had been built under winter conditions, utilizing relief labour. This sentence conveyed a volume of meaning to the engineers who had had to carry on work under similar conditions.

The information contained in the paper, particularly that dealing with the temperatures of setting concrete and pier rotation and arch deflection, had been very thoroughly taken and recorded.

C. D. Howe, M.E.I.C.[4]

Mr. Howe observed that the author's paper described the most creditable undertaking chargeable to unemployment relief that had come to his attention in western Canada. A needed municipal improvement had been built at a surprisingly low cost. Methods used provided for the maximum employment of labour, while excellent supervision made possible a high standard of efficiency that obtained full value for wages paid.

The results obtained bore out his observation that construction costs were more frequently raised than lowered by the installation of an elaborate construction plant. The tendency among successful contractors in the competitive field was to keep plant expense to a minimum consistent with required speed of progress, and cost results usually justified this procedure.

He had had some experience with pouring concrete under winter conditions in Saskatoon, and believed that more difficult conditions were seldom found anywhere.

The rather extensive system for obtaining temperature readings in the concrete mass as pouring took place had been fully justified as a means of eliminating risk in obtaining concrete of required strength before progress of setting of the concrete could be arrested by extreme cold weather. This system had enabled the author to obtain temperature ranges in the finished structure that would form a valuable addition to the designing data available for future work of this class.

Having in mind the fact that local conditions had made necessary a minimum gradient of four per cent for the roadway, the architectural effect of the design bore out the soundness of the reasoning that led to its adoption. Engineering features had been analyzed in careful detail and by the most advanced methods. The testing laboratory had been used to supply accurate data on which to base engineering analysis.

The author's paper should help to justify a relief programme based on construction of needed public works. It was to be hoped that the necessity for efficient engineering planning and supervision could be brought home to those in responsible charge.

H. A. Lumsden, M.E.I.C.[5]

Mr. Lumsden remarked that the difficulties encountered in the design of the bridge due to the difficult

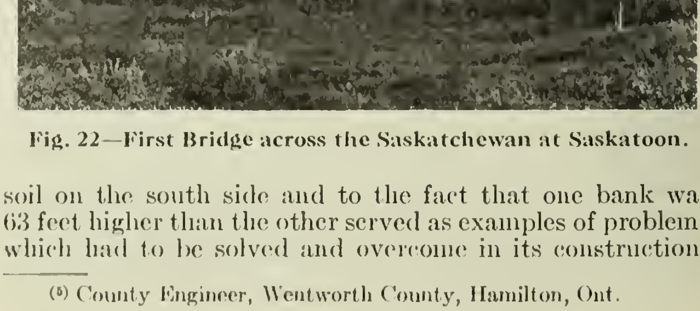

Fig. 22—First Bridge across the Saskatchewan at Saskatoon.

soil on the south side and to the fact that one bank was 63 feet higher than the other served as examples of problems which had to be solved and overcome in its construction.

[1] Paper presented before the Annual General Professional Meeting of The Institute, and published in the January, 1934, issue of The Journal

[2] Professor of Highway and Municipal Engineering, McGill University, Montreal.

[3] City Engineer, Edmonton, Alta.

[4] Managing partner, C. D. Howe and Company, Port Arthur, Ont.

[5] County Engineer, Wentworth County, Hamilton, Ont.

What a boon this work must have been to the city was realized when one heard that $324,000 had been paid out in wages. The cost of $10.20 per cubic yard for the concrete work was most reasonable and the fact that fifteen hundred and ninety-three men had been employed for varying periods during the work should be noted.

He particularly wished to comment on the manner in which the paper had been prepared as it had given an unusual amount of information, without going too much into detail, and proved intensely interesting throughout. As a paper it was a model which could well act as a guide when a record of other large works were being compiled.

As illustrating the contrast between the present time and forty-four years ago he wished to show a few views made from photographs taken by his father, the late H. D. Lumsden, M.E.I.C., who in 1890 was supervising engineer of both the Qu'Appelle Long Lake and Saskatchewan Railway, Regina to Prince Albert and the Calgary and Edmonton Railway. Figure 22 was a view from the north-east of the first bridge across the Saskatchewan at Saskatoon built in 1890 which stood on the site of the present Canadian National Railways bridge. It consisted of a series of timber Howe trusses resting on piers. In the background could be seen the station and beyond a white line which was in reality a pile of buffalo bones some 6 or 7 feet in height. These bones which stand on the site where Saskatoon stands to-day were awaiting shipment by train and he understood were later to have been converted into charcoal and used in the sugar refining industry.

Professor I. F. Morrison[6]

Professor Morrison observed that in the design of a reinforced concrete arch bridge, one must face the selection of a temperature range and the division of that range into two parts by the selection of some mean temperature at which the arch ring was to be closed. A number of records were available of observations on structures exposed to relatively moderate temperatures, but these were not comparable to those which obtained throughout the northern part of this continent. The official records for the mean air temperature were available at many localities and it seemed logical to use for design purposes those records which gave the mean daily temperature at the station. Cold spells lasted usually from three to six days; that shown in Fig. 16, December 6th to 12th, being quite typical. He would suggest that the maximum and minimum design temperatures be selected as a percentage of the mean air temperatures for hot and cold spells at the locality taken over a period of from three to six days. There were, of course, local variations, but it was difficult to take these into account.

The coldest part of the author's records occurred between December 5th and 12th, 1932. The six-day mean for this period was $-16.3$ degrees F. and the corresponding lowest temperature reached at the crown of the arch at a depth of 19 inches had been $-12$ degrees F., which was 74 per cent of the six-day mean. The lowest temperature reached in Edmonton during the last five years had been $-52$ degrees F. with a four-day mean of $-35$ degrees F. In the arch ring, judging from the records of the crown 19 inch thermometer, there appeared to be a lag of from two to two and a half days. In Fig. 16, the influence of the rise in temperature on December 8th and 9th was shown in the curve for crown 19 inch, and had this not occurred, the arch ring temperature would have probably gone to around $-17$ degrees F. This rise of mean air temperature was characteristic, however, of cold spells, and for that reason the basis of a three- to six-day mean air temperature had been suggested above.

[6] Professor of Applied Mechanics, University of Alberta, Edmonton, Alta.

The percentage of the mean air temperature range to be taken in design depended on a number of factors, the chief of which was the thickness of the arch ring. He would suggest, as a general guide, that the percentage could be taken as $\left(\dfrac{100}{1+\dfrac{D}{300}}\right)$ in which $D$ was the thickness in inches of the arch ring at the crown for open spandrel structures and as $\left(\dfrac{80}{1+\dfrac{D}{300}}\right)$ for filled spandrel structures.

The minimum four-day mean for Edmonton was $-35$ degrees F. and the maximum $+76.5$ degrees F., giving a range of 111.5 degrees F. The range used in the design of the Wellington Ravine bridge* had been 110 degrees F. The arch ring was 24 inches thick at the crown, which would give a range of 102 degrees according to the above suggested formula, so that the range used in design was perhaps too high by 8 degrees. However, since this bridge ran east and west, and was exposed on one side to the sun, which had been estimated to give a rise in average arch-ring temperature of roughly 10 degrees F.,† the range would then be 112 degrees F., which was close to the 110 degrees F. actually used.

After the range had been decided upon it remained to divide it into two portions, depending upon the temperature at which the arch ring was to be closed. This matter seemed to the writer of sufficient importance to warrant careful consideration. At this stage in the computations, the dead and live load stresses had been determined. Since the effect of a drop in temperature caused bending moments of such character as to produce a tension stress at the intrados at the crown and at the extrados at the abutment—obviously a rise in temperature would produce the opposite effect—it was an easy matter to select the proportionate amount of fall and rise in temperature which would combine with the dead load stresses—or whatever dead plus percentage of live load stresses seemed advisable—to the best advantage. In this way the mean temperature could be determined and it so turned out in many cases that the larger proportion should be a fall in temperature.

Many specifications called for an equal amount each way.‡ The Wellington Ravine bridge had been designed for a rise of 40 degrees F. and a drop of 70 degrees F. and the mean temperature of closing was 40 degrees F. The author had stated that the temperature range used in the design of the Broadway bridge was 120 degrees F. but did not indicate how this was divided and further on put the extreme range of temperature at Saskatoon as "from 110 to minus 60 degrees F. . . .over a long period." This statement appeared remarkable as it was contrary to what occurred in Edmonton where these extremes were never reached, and where the highest and lowest temperatures were of short duration. Exposure to sun could raise the temperature considerably above the air temperature, but, in so far as an arch ring was concerned, it could at best strike only two faces.

A detailed study of the records for the years 1900 to 1931 showed that the maximum and minimum air temperatures for Edmonton were $+98$ and $-52$ degrees and for Saskatoon $+103$ and $-55$ degrees F. The maximum and minimum four-day means for this period for Edmonton were $+76.5$ and $-35.0$ degrees F. and for Saskatoon $+74.3$ and $-35.4$. These data did not appear to sustain the author's statement quoted above. The night tempera-

* See Canadian Engineer, Nov. 28, 1933, page 9.

† See Handbuch für Eisenbetonbau (Vol. XI, page 143).

‡ For example see Hool, Reinforced Concrete Construction, Vol. III, page 38.

tures were always much lower than the day, which gave a mean value lower than the maximum daily air temperature.

There were several methods of securing the assumed mean temperature of the arch ring, but there was not space for details. Among these methods, the pouring of all but one or two small sections of the arch and closing the ring at the proper temperature, with the use of jacks, in case it was desirable to remove the centring at an earlier date, was perhaps the obvious and most common. Another possibility was the construction of the arch as a three-hinged arch and its conversion into the hingeless type at a later date. This permitted the completion of the bridge without delay and it might be opened to traffic at controlled reduced loads. After shrinkage, and settlement of the abutments, had taken place, the ring could be converted at a definite temperature.

Another matter of importance in connection with the computation of temperature stresses was the selection of a suitable modulus of elasticity. A value of $2 \times 10^6$ pounds per square inch was often used and for a reinforced concrete structure was probably too low for two reasons: (*a*) the modulus of elasticity of concrete as determined from test cylinders, such as described in Bulletin 5, Structural Materials Research Laboratory, Lewis Institute, was too low. This was due to the fact that the gauge points were too close to the ends of the cylinder and that the assumed uniform distribution of stress near the ends of the cylinder was not fulfilled in the test; the effect of which was to give a reduced modulus of elasticity; (*b*) the modulus of elasticity used should be for the combination of steel and concrete and not for concrete alone. Tests on reinforced concrete columns indicated that a modulus of $4 \times 10^6$ pounds per square inch, and possibly greater, should be used.

In this matter, the movement of abutments must also be considered. A decrease in temperature tended to pull the abutment forward and any slight movement would tend to decrease the temperature stresses rapidly. On the other hand, when the temperature rose again, the arch might not be able to effect the same displacement of the abutment back to its original position; as in the case of a railroad bridge with a fill at each end which became compacted while the abutments were pulled forward. Such action was equivalent to a change downward in the mean temperature of closing of the arch ring. It was impossible to discuss all possibilities but there was likely to be some movement of the abutments and the effect of this was always to decrease the stresses which tended to cause it. Since it was usually impossible to estimate such movement it must of necessity be left out of account but might be looked upon in a general sense as a justification for the use of a lower modulus of elasticity which might well be chosen to suit different foundation conditions.

The use of hinged rockers was not common on this continent though extensively used in Europe. He could not agree with the detail as shown in the paper, Fig. 8. In his opinion the rods should not extend through from the rocker to the beam or to the abutment. The expansion of the 45-foot floating span amounted to .447 inches based on computations depending on the data for expansion given on page 14. This would cause a rotation of the rocker of 1 degree —04′ and further computation showed that this would stress the one-inch steel bars far beyond the yield point of mild steel. The consequent effect would be strain hardening of the steel and after several movements back and forth fracture would likely occur. There was always the tendency on the part of a designer to anchor down such joints but all that was necessary was to prevent slipping. Numerous details for such rockers would be found in Gehler's Balkenbrücken.

Professor Morrison further stated that he had used hinges of this type in the design of the three-hinged arch in the 109th Street subway at Edmonton. There, however, the angular movement was small and no difficulty had been experienced, although a slight rise and fall of the crown from summer to winter had been observed.

C. M. Morssen, m.e.i.c.[7]

Mr. Morssen stated that the natural and other difficulties which this undertaking had to overcome were of great interest. The bridge was a relief job, and there had been only one month available between the time the bridge had been authorized and the letting of the contract in December 1931. In addition the contractor had been allowed the choice of only one foreman, one superintendent and the accountant, all other labour had been taken from relief organizations and each labourer had been limited to earnings of $25.00 in one month.

The undertaking constituted a further proof that important engineering structures in reinforced concrete might be carried to a successful end in any place with local unskilled labour.

Over 9,000 cubic yards of concrete had been poured under sub-freezing conditions with perfect results. He had always been of the opinion, that when reasonable precautions were taken, very good concrete might be made in winter and its quality might in certain cases be superior to concrete made during the hot summer season. The heated materials and the heat generated during the process of the setting, maintained the inner temperature of the concrete above the outside, and as heat accelerated setting, the concrete would start to set from the inside to the outside, which was an advantage.

When concrete was setting it was eliminating certain impurities of the cement which accumulated on the surface as a buttery non-resistant substance known as laitance which had to be carefully removed. He had always noticed that in winter the amount of laitance so eliminated was far greater than in summer and it would be interesting to know, if during the pouring of the concrete in Saskatoon, laitance had to be taken care of and how it had been done.

According to the quantities given in the paper there were about 12,000 cubic yards of concrete above the springing lines of the arches and about 1,000 tons of steel had been used for reinforcing. Assuming that most of the steel had been used above the springing line, there would be about 96 per cent of concrete and 4 per cent of steel reinforcing. Similar proportions were generally maintained in all reinforced concrete structures and it was a good policy to supervise carefully the making and the placing of the concrete as the most important part of the whole structure.

Mr. Morssen had often noticed the contrary. The reinforcing steel was carefully bent and the spacing was checked to within 1/16 of an inch and special spacing bars and chairs had been used to keep the steel in place but the making and placing of the concrete had been left to the foreman and his gang.

Certainly the engineering organization on the Broadway bridge should be favourably commented upon for the adequate measures which had been taken to supervise the concrete. One practical technician with three assistants, all engineers of experience, had analysed the pit run of materials from hour to hour and the consistency had been regularly checked by the slump test. Testing cylinders had been made from the buggies every two hours and the quality of concrete had been well maintained above that specified. The average compressive strength of the test cylinders had been 2,460 pounds against the specified one of 2,250 pounds per square inch.

[7] 353 St. Nicholas Street, Montreal.

The arrangements made to measure the interior temperatures of the concrete and keep records must be commented upon. This had been done not only during construction but for a long period after. The conclusions arrived at and described were both surprising and interesting.

It was well known that the internal stresses developed in structures through temperature and humidity changes were very important and already several different devices had been used by prominent engineers to measure these.

When in Europe last year he had the opportunity of seeing instruments which were imbedded in the concrete and were used to measure over long periods the interior temperature and stresses which developed inside the concrete.

The most interesting had been the sound extensometer invented by Mr. André Coyne, chief engineer of bridges and roads in Paris and now in charge of the construction of an important circular dam at La Haute Dordogne, France, and already successfully used on several important dams and other structures.

This sound extensometer was based on the following principles:

If, between two points of a structure, a light sonorous cord was stretched, any variation in lengths between the two points of attachment would vary the vibrating frequency of the cord and change its sound which could be listened to and used for measurements.

The Coyne extensometer was manufactured by the Etablissements Henry-Lepaute, Paris, France, and was made as follows:

A light steel cord was stretched in a water tight metal tube provided with two bands whose distance represented the basis of measurements, generally 8 inches. The tube itself was elastic and was covered with a tarred jute in such a manner as to solely protect the cord without introducing any parasitic strain. An electric magnet placed in the tube at about the middle of the cord served to produce its vibration. The excitation of the magnet was produced by means of a condenser discharge. Listening was made possible by means of a lamp amplifier and loud speaker. (See Fig. 23.)

A number of such extensometers might be imbedded in different places of a structure and then connected to a central listening station for measurements and recording.

The same apparatus could also be utilized for measuring the temperature of the interior of the structure by measuring the electrical resistance of the listening coil.

By the use of his extensometer Mr. Coyne in collaboration with Mr. Pfaff, engineer of Public Works of the French government, had already made interesting measurements on concrete dams and the results had been presented by him at the International Convention on dams held in Stockholm in 1933.

The introduction of the sound extensometer might even lead to the construction of one which, once imbedded in the concrete, would sound an alarm when the interior stresses reached a dangerous limit. That could be accomplished by a synchronized motor and electric clock which would excite the electro magnet at certain regular intervals and the sound of the cord so produced might then, when its pitch reached a certain limit, sound an alarm. Such extensometers should be useful for large dams and retaining walls.

The measuring over long periods of interior stresses of a structure due to temperature and humidity changes was still in its infancy, but as the knowledge of these stresses were of interest to the engineer it was being studied. The dispositions which had been adopted for the measuring of temperatures in the Broadway bridge were an excellent start in that direction in Canada.

E. M. Proctor, M.E.I.C.[8]

Mr. Proctor observed that in general, papers which described the construction of bridges dealt with the problems met in construction and erection, together with the design. This paper went further and gave to the bridge engineer not only the ideas of the designer and the constructor, but observations made on the bridge after its construction.

The designer had handled the problem, which was not an easy one, in a very pleasing manner. The arrangement of the different length arches with their varying rises to fit the 4 per cent grade was one that entailed a considerable amount of additional work, but the aim of the designer had been attained and a beautiful structure completed.

In his opinion the portion of the paper which dealt with the movement of the bridge and with temperature data collected was the most interesting. In an exposed situation, the extreme variations of temperature and consequent movements in the spans, particularly in a reinforced concrete structure of this nature, were very important and the data would be of material assistance to other designers.

[8] President, James, Proctor and Redfern, Ltd., Toronto, Ont.

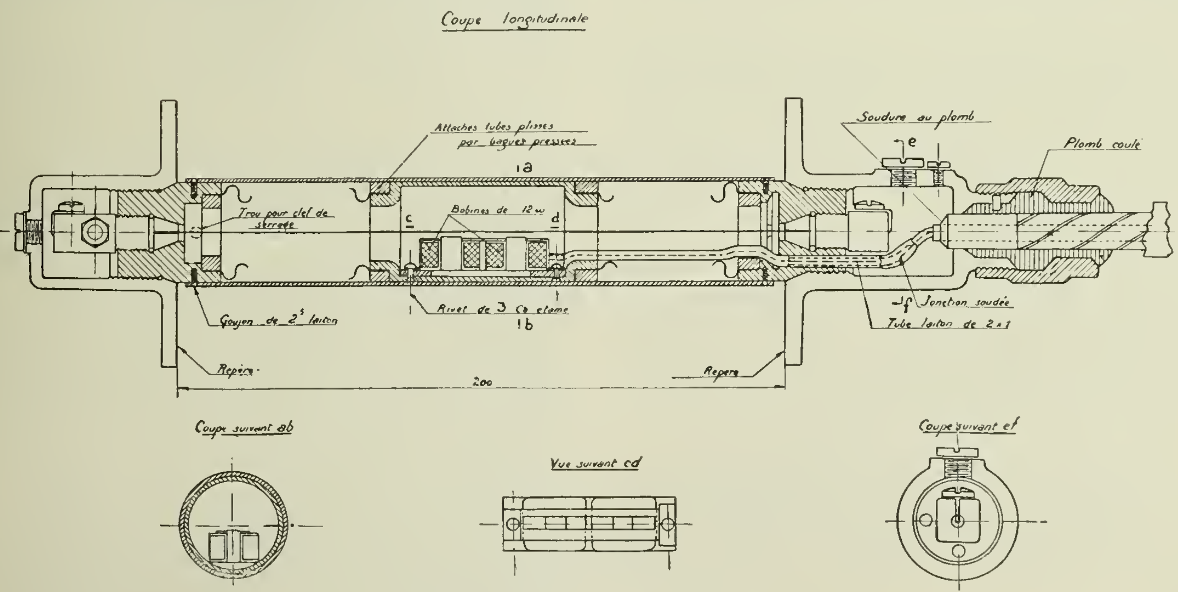


**Fig. 23—Sound Extensometer.**
By courtesy of L'Expérience et la Détermination des Contraintes.

If work of this kind could be carried out successfully, there seemed to be no limit to the construction of reinforced concrete structures even in the severest climates. In the province of Ontario there were still some engineering staffs who prohibited reinforced concrete construction during the winter, their idea being that the work was too hazardous to undertake. Surely with this outstanding example such arguments were conclusively answered.

The only criticism he wished to offer, and this was not one of the designing engineer, was in reference to the live loads used. In his opinion, four lines of 20-ton trucks, or two lines of 50-ton street cars with two lines of trucks together with impact, seemed altogether too high a loading, and one that would rarely, if ever, be encountered. In Ontario the operation of 10-ton trucks on highways was prohibited by law, and with this fact in mind, it seemed unreasonable that bridges had to be designed to take loads of such a severe character. If such a condition of loading ever did develop, it was hard to figure that four lines of 20-ton trucks would be moving across the bridge with sufficient speed to create any impact. It would, therefore, seem that if 20-ton truck loading were used in the design, that at least the impact requirements might be eliminated. However, these were the specifications that were set for the bridge designer and he must follow them. Of course the question of local members that derived their size from one vehicle was another problem.

The designer had to some extent allowed for the severity of the loading specifications by using high stresses in steel and concrete, which he believed quite permissible.

The solution of the problem of the approaches where the ground was of a precarious nature and difficulty had been encountered due to high banks sliding had been well thought out and was quite satisfactory. This was a point in bridge engineering which had not always been properly taken care of, and there were numerous examples throughout the country of sliding banks destroying an otherwise satisfactory structure.

He thought that a more pleasing effect could be obtained, from the viewpoint of the traveller over a bridge, by adopting an open type of handrail so that the scenes up and down the river could be enjoyed. This generally meant the adoption of a combination ornamental steel and concrete handrail similar to that used on the Hamilton high level bridge. More people saw a bridge from the deck than from any other angle, and it was as important to please from this viewpoint as from a side view.

E. Viens, M.E.I.C.[9]

Mr. Viens remarked that considering the short time allowed for construction, the time of the year, the severe weather, and other difficulties encountered, it had to be admitted that those in charge not only showed great engineering skill but much ingenuity, and were to be complimented, particularly as to the manner in which the concrete had been handled.

The phase of the paper which he wished to discuss was in connection with the waterproofing of 6,795 square yards of concrete at a cost of $8,154. This was a subject to which he had given considerable thought both in laboratory investigation, in the field, and also in committee work. There were two methods in common use, namely,—

(a) By use of integral compounds.
(b) By surface waterproofing.

The latter (b) might be done in different ways; by the membrane method, by the application of cement mortar renderings, by the application of various bituminous paints and proprietary applications. He would confine his remarks to three of the above, namely integral compounds, cement mortar renderings, and the membrane method.

*Integral Compounds*—The Standard Specification for Concrete and Reinforced Concrete of the Canadian Engineering Standards Association, clause 47, read—"No integral compound can be recommended." As one of the committee of the above specification, he had opposed the use of integral compounds and his opposition had been based on many tests of various compounds. But granted that such compounds had some beneficial effects, which, to his knowledge, they had not, they would not overcome the troubles encountered on the average construction. Generally the leaks were at construction joints, fill-planes, or at points where segregation had taken place. No integral compound would overcome bad construction methods, and, if water passed through the concrete at other points than through construction joints, fill-planes, or where bad segregation had taken place, it was generally because too little cement had been used. Cement would render concrete waterproof at less cost than integral compounds, and, at the same time, would give added strength and durability.

As an illustration of this when the Confederation building at Ottawa had been built, the specification called for a mixture based on definite proportions of 1:2½:5 for the walls of the foundation, but had also called for an integral waterproof compound. The contractor had been asked to submit a sample of the waterproofing compound to be used, and, at his suggestion, to state the cost per pound. By actual test with the aggregates to be used, it had been determined that one and one-third sacks of cement could be used per cubic yard of concrete for the cost of the waterproofing compound. It had then been agreed between the contractor and the Department that the waterproofing compound would be left out and that the contractor would use cement for its value. A 3,000-pound concrete had been secured and the foundation had been built in sections, each section being completed in one operation to avoid any leaky fill-planes, and no sign of moisture had ever appeared through that concrete in spite of the fact that the trenches around the walls of the building, before being filled, on one occasion had been full of water for a period of two weeks. One could go on multiplying instances of 100 per cent waterproof concrete.

*Application of Cement Renderings*—In 1920, the laboratory of the Department of Public Works had developed a method of waterproofing concrete foundations from the inside of the building. The method was as follows: First, the concrete was brushed clean of any loose material, then the surface was wetted either with a hose or a brush to near saturation. Dry neat cement was then dashed on the wet concrete and immediately after the cement had turned dark in colour, owing to the moisture from the wall penetrating it, a cement mortar was pressed into the neat cement paste sticking to the wall, thus making a perfect bond between the old concrete and the mortar by giving every grain of sand of the mortar a chance to embed itself in the neat cement film or paste adhering to the wall. This method had been used in numerous government buildings with satisfaction, and had also been applied to the pump chamber of the Esquimalt dry dock, a chamber which was under water during certain operations, and had shown no leaks or signs of moisture since it had been made waterproof in this manner.

*Membrane Method*—This was the method that had been used on the Broadway bridge, Saskatoon, to waterproof 6,795 square yards.

The standard Specification for Concrete and Reinforced Concrete of the Canadian Engineering Standards Association, clause 48, read—"Where added protection is desired for basements, pits, etc., membrane waterproofing *may* be

[9] Director, Testing Laboratories, Department of Public Works, Ottawa, Ont.

used." Much discussion had taken place in committee about the value of this method of waterproofing, and, of the two methods given in the C.E.S.A. specification, he believed that the membrane method was the better of the two, but he wondered if it was as satisfactory as it would have been to make in the first place a water-tight concrete, which, to his mind, could be made. No-one had ever seen a concrete structure which leaked through its entire area. As a rule it was only a patch here and there that gave trouble. The leaky spots or patches were due to construction defects or to defective concrete. Were not concrete waterproof in itself, then the entire surface would leak, and if the greater part of the concrete was waterproof, why not the whole? The cost of membraning would go a long way towards overcoming these defects in concrete structures. Much more cement could be used per cubic yard and part of the cost of membraning could be applied to better methods of the application of concrete.

Construction joints could generally be made waterproof either with strips of copper sheeting or some other mode. Fill-plane joints could generally be avoided if a whole section of concrete was carried right up to the top in one operation, but should the operation have to be stopped before a section was completed a waterproof joint could be made as described in the C.E.S.A. specification, clause 44.

Segregation of the materials of concrete which was often the cause of leaky concrete could easily be prevented by the use of properly designed concrete and proper methods of placing it.

Some of the difficulties of membrane waterproofing were: proper adhesion of the membrane to the concrete; the application of the membrane on damp or wet concrete, which, at certain times of the year, was very inconvenient, and its application in cold weather. Some had also questioned the permanency of such membrane. Some of the dangers of membrane waterproofing were: that it might be punctured when other materials were applied against it, or that it might be caused to break by the movement of materials placed upon it, and if the adhesion of the membrane to the material to which it was applied was not what it should be, water would find its way between the membrane and that material and would cause trouble somewhere.

Membrane waterproofing might have to be resorted to in certain cases and especially in repair works, but his plea in this discussion was that concrete in itself, properly designed and of a given strength, say 3,000 pounds or over, when properly laid and matured, was water-tight, and that in such cases there was no need to resort to any other way of waterproofing.

C. J. Mackenzie, M.E.I.C.[10]

The author observed that he was pleased with the interest and discussion which his paper had evoked and appreciated the favourable comments and the valuable criticism offered.

Professor I. F. Morrison had raised some interesting points in connection with design theories and the interpretation of temperature data. In calculating stresses in arch rings it was assumed that there would be a temperature rise of 30 degrees F. above and a fall of 90 degrees F. below the normal air temperature of 68 degrees. Allowances were also made for the effect of deck articulation on temperature stresses. These assumptions were undoubtedly on the safe side and in the light of recent studies and observations the author would modify them for future designs, as he did not feel the same confidence as Professor Morrison seemed to in the reliability of the general elastic theory as applied to shrinkage and temperature stresses in reinforced concrete arches. Realizing that the matter was controversial, he rather inclined to the view of Whitney,*

(*a*) that plastic flow of concrete eliminated to a large degree initial bending stresses;

(*b*) that, due to plastic flow, high setting temperatures had little effect on concrete stresses and that temperature stresses in such cases could be safely computed for an equal rise and fall equal to one-half the maximum range regardless of the temperature during construction. As a consequence he felt that the centre of the arch rib should follow the dead load pressure line as nearly as possible; it was also felt that the use of jacks, temporary hinges and such devices had no value commensurate with their expense, except in particularly long or flat arches, or where the piers were liable to excessive horizontal movement.

In discussing temperature data Professor Morrison had submitted two interesting formulae for use in determining arch temperature ranges from air temperatures. The criticism the author would make of these formulae was that no account was taken of the very real effect of the transmission of heat from the piers. As stated in the original paper, the thickness of a member was by no means the only important factor. During 1932 temperature tests were made on the 40-inch crown of one of the 150-foot arches on the 25th Street bridge, Saskatoon, and concurrent tests were also made on a block of concrete 36 inches by 36 inches supported on a wooden frame above the ground and thus practically isolated thermally. The coldest period of that winter lasted from January 24th to February 2nd and the average five-day temperature was approximately −20 degrees F.; the temperatures in both block and arch ring reached their minima on February 2nd. The following table showed the variations in temperature for the last twenty-four hours of the cold spell.

| Time | | Outside Temp. | 40″ Arch Ring 3″ depth | 40″ Arch Ring 20″ depth | Isolated 36″ Block 3″ depth | Isolated 36″ Block 9″ depth | Isolated 36″ Block 18″ depth |
|---|---|---|---|---|---|---|---|
| February 1 | 20 p.m. | −25 | −12 | −8 | −16 | −13 | −11 |
| February 2 | 2 a.m. | −35 | | | −26 | −24 | −24 |
| | 9 a.m. | −21 | −18 | −10 | −28 | −29 | −26 |
| | 11.30 a.m. | −20 | −13 | −9 | −25 | −28 | −27 |
| | 14.30 p.m. | −9 | −10 | −6 | −13 | −16 | −21 |
| | 20.00 p.m. | −8 | −8 | −4 | −11 | −13 | −15 |
| | Midnight | −5 | −7 | −5 | −8 | −10 | −12 |

It would be seen that the centre temperature of the isolated blocks became lower than the five-day mean and was actually only two degrees higher than the mean of the coldest day of the five. If these tests could be taken as indications it seemed to the author that the temperature of an isolated block of 36 inches would have a yearly variation approximately equal to the difference between the means of the days of extreme temperatures, and if the block was subjected to the direct rays of the sun the block temperature range would probably exceed that of the air means. It was for the above reason that he had given a probable maximum range for isolated blocks. It was also evident from the above table and also from data in the original paper, that for arch crowns of approximately the same size which were in contact with river piers, the yearly range would be from 20 to 25 degrees less than the range of daily air means and it was felt that a general formula which did not take into consideration the height and length of span and the thermal environment of pier must be open to question.

With regard to the rocker design as shown in Fig. 8 of the paper, the economy and desirability of anchorage in the stringer and base appealed strongly to the author. To calculate the actual stresses in the reinforcement due to bending, assumptions which were uncertain must be

[10] Dean of Engineering, University of Saskatchewan, Saskatoon, Sask.

* See Journal American Concrete Institute, March 1932, page 515.

made as to radius of curvature. When it was considered that these bars would have very heavy direct compression stresses and that excess stresses would probably be compression in nature and that in addition a complete alternation only occurred once a year, it was difficult to feel that the possibilities of fatigue failure were alarming. Again if failure of steel did occur it seemed to the author that the situation would be little worse than if the bars had never been so anchored. The rockers could be easily inspected and it would be interesting to observe their action over the years.

In answer to Mr. Morssen, no trouble was experienced with laitance; during the winter the piers only were poured and as the pouring was done continuously night and day and a very dry mix used, little if any excess liquid gathered on the surface. The author was very interested in Mr. Morssen's description of apparatus used in Europe for making readings of expansion and temperature and agreed with him that such valuable work was only in its infancy in Canada and that the infant would well repay nourishment and attention.

Mr. Proctor very properly questioned the possibility of a bridge of this nature ever having to carry a load of two continuous lines of 50-ton street cars flanked by two lines of 20-ton trucks. On the floor system over arch spans, due to panel spacing, one vehicle in each lane only was used and over the girder spans two vehicles following each other. The arch rings were designed for a uniform load without impact allowance, which was less than the average weight of trucks and cars. The author felt that for arches the maximum possible loading would probably be due, not to vehicles but to people: a situation which might occur at "openings" or other ceremonials. The heaviest load which this bridge had had to carry to date was on August 1933 when the Traveller's Parade was held in connection with the Saskatoon Exhibition. On the high end of the bridge ten fairly full street cars were parked end to end, and on the shortest span during a stoppage in traffic flow, observers estimated that there was a load, made up of vehicles and people, of about 45 pounds per square foot. In Saskatoon there are at present several trucks with a gross weight of about 15 tons.

With Mr. Vien's comments on waterproofing, the author found himself in substantial agreement, and realized that well made concrete was practically water-tight. However it was well known that laboratory uniformity could not be obtained on a large job and it was found that, particularly on the road slab where there was heavy reinforcement, even with constant supervision of mixing and tamping, patches did occur that were not water-tight. As many cases were known where seepage through the street railway trackways on bridges had caused serious trouble, it was thought wise to add waterproofing as an extra precaution. For the same reason the retaining wall on the north approach was protected with membrane waterproofing. A park surrounded this portion and while copper strips were used at expansion joints and precautions taken to obtain a waterproof concrete, nevertheless it was felt that any seepage would be aesthetically objectionable and the cost of extra protection seemed warranted.

## THE LAKE ST. LOUIS BRIDGE

*Authors: C. F. Draper, J. A. Lalonde, A.M.E.I.C., and W. Chase Thomson, M.E.I.C.*[1]

## DISCUSSION

H. B. Stuart, A.M.E.I.C.[2]

Mr. Stuart observed that it was refreshing to learn of an engineer who applied geodetic refinements to measurements required for construction purposes. The ratio of precision obtained by so doing and the comparative ease of giving sights by the use of the targets so ingeniously set beforehand must have contributed materially to the smooth, speedy and efficient prosecution of the work.

Mr. Draper had not stated the type of theodolite used, but it would appear that readings had been taken on both sides of but one vernier and that each angle had been repeated twice in both the forward and reversed positions of the telescope. Assuming the usual type of instrument with opposite verniers on the horizontal circle he preferred to read both verniers in order to reduce possible errors of centring of the circle, of opposition of the verniers and of graduation. It must be admitted, however, that with the method used by the author, there had been no necessity for the observer to move from his position at the eye end of the telescope which was a distinct advantage when set-up on unstable ground or in a cramped position. Again he liked to repeat all angles whose values lie between 0 degrees and 30 degrees at least twice as often as those whose values lie between 30 degrees and 45 degrees, because, by so doing, one had a more precise value of those angles whose sines changed most rapidly.

He could not but envy the author his peace and comfort of mind upon having obtained a closed figure adjusted to a ratio of precision of less than one in one hundred and fifty thousand.

During the levelling operations were the rod graduations checked against a calibrated steel tape?

C. F. Draper[3]

In reply to Mr. Stuart, the author stated that the angles for the triangulation were mostly read with a Wild instrument and later a Zeiss theodolite No. 2 was used for checking the survey and for the setting out work. In both these modern instruments the necessity of reading the verniers at the two horizontal circle reading points was obviated by the angle scales being optically superimposed one over the other, and the microscopic vernier which could be read without the observer changing his position, giving directly the reading of the mean of these two readings, a great advance in accuracy, convenience and speed.

With such an instrument in the hands of a careful observer, with a base line carefully measured, there was no reason why the results obtained should not readily be repeated.

There was really no necessity to check the levelling rod graduations directly with steel tapes inasmuch as all the levelling was done with the rod, and the finer work necessary in the levelling of the bridge seats was done from the nearest complete pier.

Where the south viaduct connects with the steel superstructure, the difference in elevation of the concrete deck of the viaduct and of the bridge seat of pier 14 was checked by steel tape. This was, of course, an indirect check between the rod and tape measurements.

Should there have been any minute differences in elevation as between the approaches and the river crossing, they would have been taken care of by the concrete slab and asphalt wearing surface.

The author knew of no worthier object for the application of methods of precision than in the case of a large bridge. Such a structure, moreover, should be an incentive

(1) Survey Work for the Lake St. Louis Bridge, C. F. Draper.
The Substructure and Approaches of the Lake St. Louis Bridge, J. A. Lalonde, A.M.E.I.C.
The Steel Superstructure for the Lake St. Louis Bridge, W. Chase Thomson, M.E.I.C.
These three papers were presented at the Annual General Professional Meeting of The Institute, and published in the March 1934 issue of The Journal.

(2) Field engineer, Hamilton Bridge Works Co. Ltd., Hamilton, Ont.

(3) Lake St. Louis Bridge Corporation, Montreal.

to the younger engineers to practise exactitude throughout the work in all the measurements that were significant.

He thought it would be admitted by those of experience that the slight additional trouble and even if it should be so, expense, would be more than compensated for by the satisfactory nature of the results.

He had always been of the opinion that the precise methods used in the bridge shops should be matched in the field.

Major A. R. Ketterson, A.M.E.I.C.[4]

Major Ketterson referred to the preliminary investigation described by Mr. Lalonde, and observed that the author had stated that test borings were made along a line from 200 to 300 feet upstream and downstream from the site finally selected in order to determine the best location for the bridge, and that the elevation of the base of the various piers was obtained by interpolation between these borings.

Since the river bottom and the rock line at the C.P.R. bridge, which was about 1,500 feet upstream, was at a much higher elevation than at the site selected, it was presumed that the reason for placing the highway bridge in a location where the water was so much deeper and where there was so much over-burden between river bed and rock line had been primarily controlled by the location for the approaches to the bridge.

The type of construction trestle which had been developed by Mr. Englander—the resident engineer in charge of the river work— was very ingenious. Its use must have proved of great advantage, not only in expediting the work, but in the economy of its construction and in maintenance throughout the progress of the contract.

Major Ketterson stated that one of the features which occurred to him in connection with these piers was the narrow caissons and the very small step between the side of the caisson and the pier shaft. The size of this step allowed very little leeway for caissons which had to be sunk through the depth of overlying material, which existed at the majority of the piers, and provided very little allowance for a slight drift, either longitudinally or laterally. This fact called for great care in landing the caisson in the first place and also keeping it in a proper position during sinking. While the precautions taken by providing such efficient and stable deflectors to secure still water facilitated the work of landing the caisson in its proper position on the river bed, the actual sinking, owing to the narrow width, called for unusual care throughout the whole process, and it reflected great credit on the contractor's organization that so many piers had been sunk through a considerable depth of overburden to rock without their getting out of line to any appreciable extent.

In connection with pier No. 10, the author had stated that the size of the caisson originally intended for this pier was 14 feet wide by 60 feet long. However, when it was discovered that the rock was 18 feet lower than expected, thus making the height of the pier from the rock 90 feet instead of 72 feet, it was decided to increase the size of the caisson to 18 feet by 72 feet for a height of 46 feet above the cutting edge. This appeared to be a most advisable change, especially the widening from 14 feet to 18 feet.

Instead of simply placing steel protection strips on the nose and shoulder of the cutwaters, it would have been advisable, in his opinion, to completely iron-clad the upstream cutwater to a height above high water level. By making the steel protection continuous around the nose and shoulder the hazard of having the protection torn off by ice was very much diminished.

B. O. Boissonnault, S.E.I.C.[5]

Mr. Boissonnault remarked that he would like to secure the opinion of others as to the efficiency of grouting according to methods now generally used. In his opinion the pipes usually become clogged during the concreting operations which renders them useless for grouting.

R. E. Chadwick, M.E.I.C.[6]

Mr. Chadwick observed that to attain the object in view the number of pipes available were more than sufficient and the objection was more theoretical than practical. He also stated that in his opinion the proper way to concrete was to drop the concrete down through the air lock, thereby creating impact forces which would most effectively puddle the concrete and pack the working chamber. He had had no experience at any time with the settlement of piers due to pockets having been left in the ceiling of the working chamber.

C. F. Draper

Mr. Draper stated that in any analysis of this question, consideration must be given to the strength of the pier at the plane of the roof of the working chamber.

The concrete in the area outside the roof, which was considerable, was placed in the open air without any interference. Having in view the above as well as the large preponderance of strength in the pier at this plane compared with its bearing capacity at the foundation, it was difficult to see how a pier could fail with a pocket covering even the entire roof.

It was undoubtedly a satisfaction to know that the voids in a pier where they were not intended were reduced to a minimum. He would, however, support Mr. Chadwick's contention for a continuous pour through the shafts instead of stopping below the roof of the working chamber as was sometimes done.

By the latter method a further laitance plane was added for a doubtful certainty of a better seal at the roof.

He would like to see the roof pitched slightly or otherwise modified from the usual horizontal plane, to more surely remove air pockets, also the form of the walls designed to give a more positive bearing and better bond with the concrete mass in the working chamber.

J. A. Lalonde, A.M.E.I.C.[7]

The author, in reply to Mr. Boissonnault, pointed out that if the pipes were plugged during concreting operations, it clearly showed that the concrete had not only filled the working chamber completely, but had also started to fill the pipes.

The large number of pipes used, 9 to 13, of various sizes, and distributed equally over the area of the roof, offered a large factor of safety so that no pockets of air were left on the roof of the working chamber, and grouting was done as an extra factor of safety.

He further stated that the danger point was around the cutting edge and if special precautions were taken to place and pack the concrete in that area, the ceiling of the working chamber should give no trouble.

Brig.-General C. H. Mitchell, C.B., C.M.G., M.E.I.C.[8]

General Mitchell enquired if any trouble had ever been encountered in sinking the caisson past large boulders.

J. A. Lalonde, A.M.E.I.C.

The author stated that some trouble had been encountered with boulders but nothing which would really interfere with the work.

In some cases where boulders were met on the surface, it was necessary to prepare the bottom by building up with sand bags rather than attempt to remove the high spots.

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(4) Assistant engineer of bridges, Canadian Pacific Railway Company, Montreal.

(5) Lake St. Louis Bridge Comm., Montreal.

(6) President, The Foundation Company of Canada, Limited, Montreal.

(7) Chief engineer, A. Janin and Company Limited, Montreal.

(8) Dean of the Faculty of Applied Science, University of Toronto, Toronto, Ont.

S. Blumenthal, A.M.E.I.C.[9]

Mr. Blumenthal enquired if the Canadian Pacific Railway bridge afforded the new bridge any considerable protection from field ice, and whether this had been taken into account when designing the new bridge.

C. F. Draper.

Mr. Draper observed that the question of ice pressure was a very interesting one, or should be, to bridge engineers in Canada, and he had made general observations on this subject for some years and particularly during the last fourteen months. In the case under discussion, the Canadian Pacific Railway bridge did act as a bulwark to the new bridge against field ice and the ice field was now solid to a point about 1,000 feet from the north shore, that is, it covered the area of low velocity.

R. E. Chadwick, M.E.I.C.

Mr. Chadwick remarked that he had had considerable experience with bridge piers that had failed due to ice pressure, and this was usually preceded by scouring; but he had never seen a failure when piers were sunk below the surface of and keyed into the rock.

P. B. Motley, M.E.I.C.[10]

The chairman, after remarking on the interesting subject matter of the paper and the method of presentation, observed that the bases of failure always showed that no provision had been made for shear or sliding.

D. C. Tennant, M.E.I.C.[11]

Referring to the paper by Mr. Chase Thomson, Mr. Tennant stated that his first impression of the artist's drawing of this bridge had been from an aesthetic point of view and it was easily the most satisfying of all the St. Lawrence river bridges. This had been a move in the right direction and had been emphasized by the author. In order to accomplish this and at the same time avoid difficulty and expense in the erection of the steelwork it was necessary to introduce splayed trusses both at the main arch

Fig. 15—Welded Pier Members.

and at span 3 where the future lift span was contemplated. This splaying had introduced differences in various members in the trusses, bracing and floor system which would otherwise have been duplicates and this had entailed some additional expense, but the situation had been very skilfully treated so that aesthetic considerations were preserved and the average observer would not find anything to mar the beauty of the structure. However, it would seem that the smoothness of the profile in the side view might have been further enhanced by the introduction of adequate vertical curves in the roadway grade at each end where the horizontal grade on the main central portion of the bridge met the incline on the concrete approaches.

The substitution of one special truss span instead of the two originally intended at the north end had been a specially happy solution and well executed, moreover a saving had apparently been effected by this change though

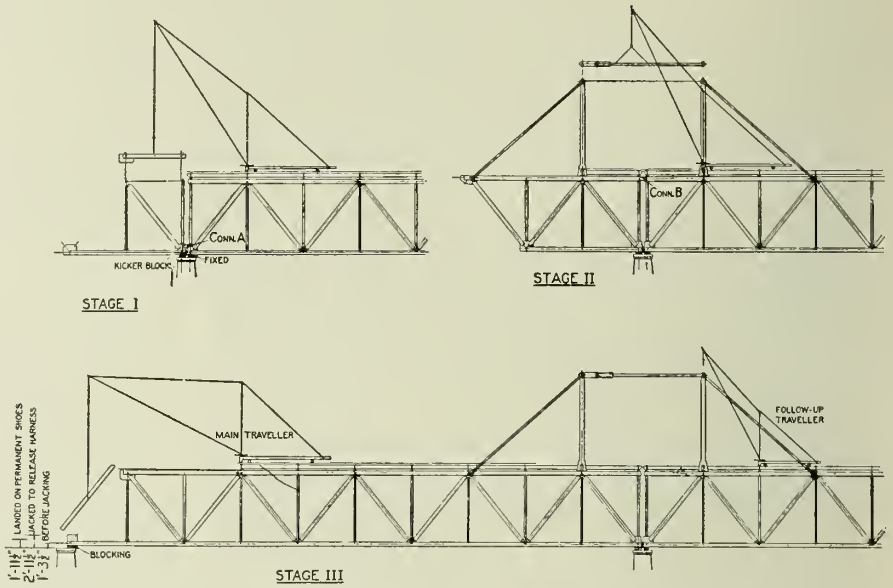


Fig. 16—Typical Erection Procedure.

the amount was not indicated. It would be interesting also to know in what respects the specifications of the province of Quebec and the Canadian Engineering Standards Association had been modified for this bridge. Details of these modifications might serve as a guide on similar structures in future.

From the paper by Mr. Draper it might be assumed that cycloidal pintles were used in the roller nests in the pier members on the regular spans, but this seemed to be the only reference in any of the papers to the pier members. Further, the papers did not include drawings showing stresses or loads or the make up of the more important members. However, it would be interesting to note in what respects the main sections had been modified to ensure all material being obtainable from Canadian rolling mills.

On the Kane trusses that reinforced the concrete approach spans all joints had been welded and it would be of interest to record the practice, procedure, and results in the welded connections which had been used in the pier members, handrailing and perhaps other details on the main steel spans themselves. The purpose of the erection traveller and cantilever erection harness for the main spans had been clearly explained. Welded connections had been used in a most ingenious manner in the construction of the traveller itself, resulting in a considerable saving in weight which had been important on this bridge where the live load was small and the duplication considerable.

Mr. Thomson had stated that a further paper might be expected dealing with the design and construction of the main arch and its flanking spans and in his opinion this should prove a valuable record. It was hoped that some account might also be made available outlining the preliminary steps in the Lake St. Louis bridge project, such as the considerations governing its location, choice of materials, cost, and proposed tolls; also the contribution it was expected to make towards the solution of the traffic problem on Montreal island and the alterations or additions

[9] Assistant engineer, Bridge Department, Canadian Pacific Railway Company, Montreal.

[10] Engineer of bridges, Canadian Pacific Railway Company, Montreal.

[11] Designing engineer, Dominion Bridge Company, Montreal.

to existing approach arteries that might be necessary to ensure the best results. These were considerations that were of the utmost interest to all engineers.

W. Chase Thomson, M.E.I.C.[12]

The author in reply to Mr. Tennant observed that the brief references to many important features were due to the limited time given for the preparation of the paper; also to the necessity of making it as short as practicable.

Although not shown on the general plans of the bridge, vertical curvature of the profile, at points of change in grade, had been provided for in the detail drawings, and the concrete structures had been built accordingly. The floor on the steel superstructure was level throughout.

The net saving due to the elimination of pier 2 and the substitution of a single span to replace the two shorter spans had been small, but the exact amount was not yet available.

The specifications of the Department of Public Works for the Province of Quebec included the Canadian Engineering Standard Association Standard Specification for Steel Highway Bridges. The only departures from these specifications had been the adoption of two motor-trucks abreast on the roadway, instead of three; and a change in the height of the hand-railing from 4 feet to 3 feet 9 inches to align with the parapet railings on the concrete portions of the bridge.

The pier members were generally of flat-slab construction and were provided with disc bearings. For spans 2 and 4, the bearings on piers 3 and 4 were fixed and had been designed to carry the heavy concentrations of the future lift span. With their integral discs the bottom slabs for these members were about 9½ inches thick and about 54 inches square. Rolled-steel slabs of such dimensions could not be obtained in Canada; in consequence, cast-steel slabs had been used in their place. These castings were of excellent quality, and might be depended upon to perform their function satisfactorily.

For expansion bearings, the rollers were 6¼ inches in diameter. They were effectually restrained from skewing by substantial pintles, secured to the upper and lower bearing plates and engaging with slots at the extreme ends of one roller in each set.

The fixed bearings had the same total height as the expansion bearings to permit the construction of bridge seats at a uniform elevation.

The bottom members of these bearings were of cellular construction, and all joints had been made with continuous welding on both sides. The machine finishing of these bearings had been done after welding.

The large bearings at piers 12 and 13 for the continuous tied arch were similar to those for the other spans, but of much heavier construction. Instead of disc bearings for these members, pin bearings had been provided, to permit of the necessary rotation during erection. At pier 13, the expansion rollers were 8 inches in diameter, and two rollers in a set were provided with pintle guides.

O. O. Lefebvre, D.Sc., M.E.I.C.[13]

Dr. Lefebvre remarked that the conditions met with in constructing the bridge were as expected except in one pier and this had expedited the work considerably.

The difference between the cost of work as estimated and the final estimates was expected to be very little. In the case of the river work there was an increase which amounted to about $55,000 or $60,000.

[12] Lake St. Louis Bridge Corporation, Montreal.

[13] Chief engineer, Quebec Streams Commission, Montreal.

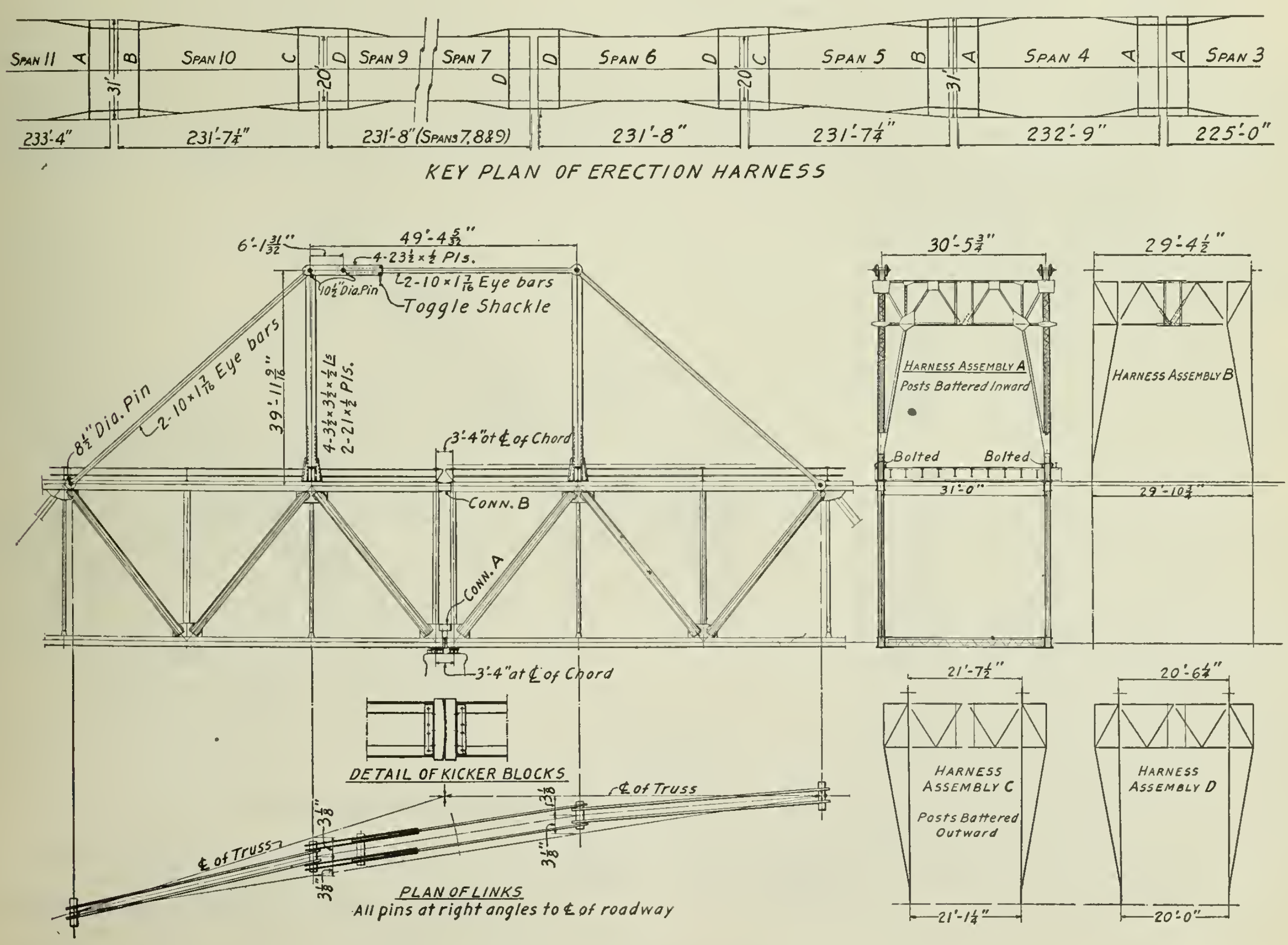


**Fig. 17—Design of Erection Harness and Key Plan.**

In reply to the possible question as to why the bridge was narrowed in some sections, he stated that the roadway was 27 feet wide from end to end of bridge, but where provision was made for navigation, the only solution was a through truss and at this point the sidewalks were constructed on the outside of the truss.

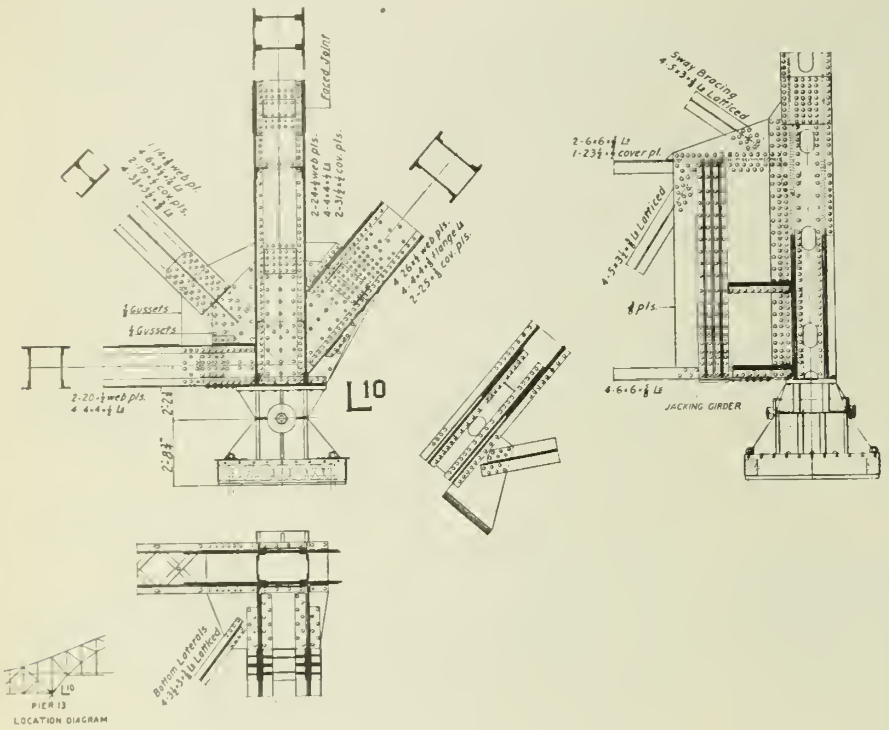


Fig. 18—Continuous Tied Arch—Details at L10.

Further, if the St. Lawrence Waterway was constructed, a through truss would have to replace the present fixed span at the north end.

With regard to probable tolls it was his hope that these would be made sufficiently high at the start to prevent a deficit. The annual revenue necessary was approximately $225,000 and it was preferable to fix comparatively high tolls at the beginning and then lower them if possible rather than be faced with the necessity of increasing them.

The Lake St. Louis Bridge Corporation had arranged with the provincial highway department for the necessary improvements at the south end and with Ville La Salle at the north end of the bridge.

A. S. Wall, M.E.I.C.[14]

Mr. Wall observed that the pier members for the bridge were made of steel plate, the parts having been joined together by the electric arc method of welding, covered electrodes being used throughout, to form the conventional type or shape generally associated with a steel casting.

The problems, or difficulties, associated with this method of construction, were intensified by the use of steel parts from 1½ to 2½ inches thick, together with fillet welds as the connecting medium. The fillets themselves had relatively small cross sections compared with those of the plates which they connected and the operation of welding tended toward a concentration or summation of residual stresses in the weaker parts. (Fig. 15.)

Probably the most interesting point in this particular class of construction concerned the development work necessary to weld such thicknesses successfully and the train of responsibility considered necessary to control the product.

Before attempting to weld together such heavy parts, a great deal of experimental work had been done over a period of years by the engineering staff and more particularly by the metallurgist and the welding engineer co-operating with the shop personnel. Development work had been done on rod coatings, joint type, welding procedure, etc., in order to establish the proper technique for this class of work. The quality of weld wanted was that required by the American Society of Mechanical Engineers Code for the manufacture of pressure vessels which requires the special qualification of the operators.

The construction of these pier members had been under the direct control of the welding engineer.

The train of responsibility, which could not be too highly stressed, commenced with the chief engineer, then the departmental engineers, shop inspection and operating staff to the operator. Nothing had been left to the operator alone or to any other single individual.

The result, in his estimation, had been a better pier member than could be obtained otherwise; supplied to the customer at no greater cost than the conventional cast steel type.

D. B. Armstrong, A.M.E.I.C.[15]

Mr. Armstrong stated that spans 4 to 11 inclusive had been erected by cantilevering from pier to pier without the use of falsework.

Under the circumstances this had been considered the safest and most economical method to follow, having many distinct advantages over the more common falsework method.

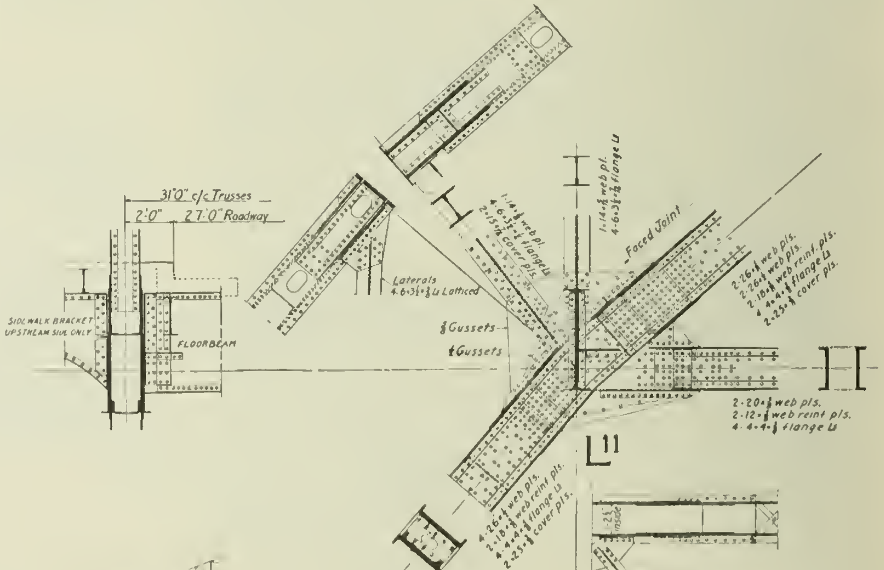


Fig. 19—Continuous Tied Arch—Details at L11.

The use of falsework always involved several unavoid-

(14) Dominion Bridge Company Ltd., Montreal.

(15) Erection engineer, Dominion Bridge Company Ltd., Montreal.

able risks, such as the uncertain and variable condition of the river bottom, hazards from floating ice, swift water and river craft. By keeping all work clear of the water these hazards were eliminated.

Once the first span had been cantilevered, the operations became more or less routine, resulting in increasing efficiency and lower costs as the erectors became familiar with the method.

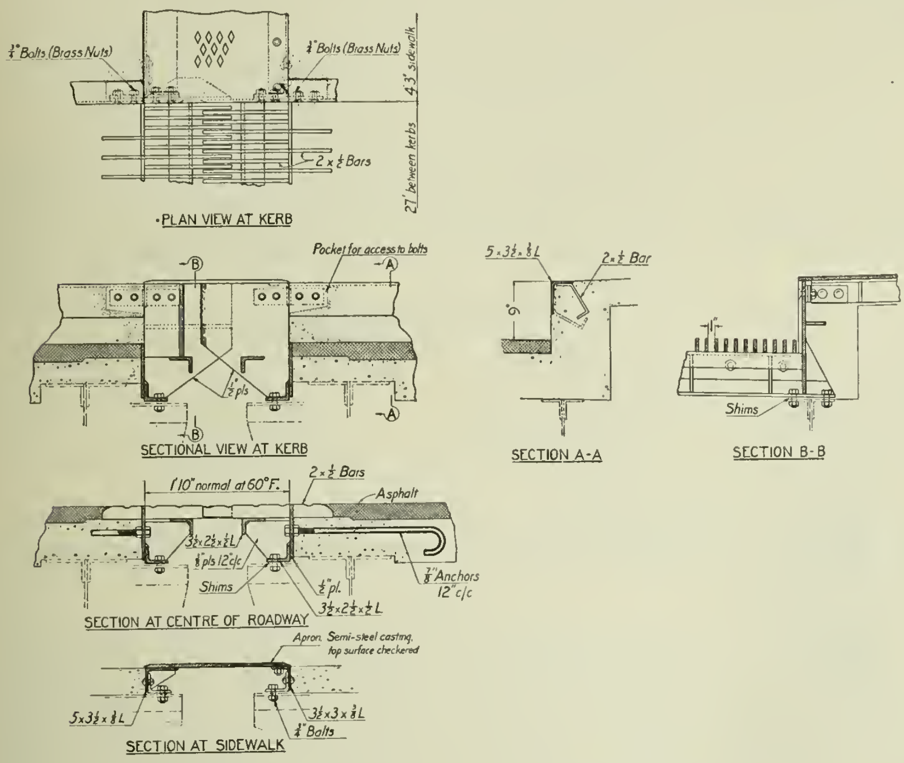


**Fig. 20—Typical Expansion Joint for Roadway and Sidewalk.**

Where several spans were to be erected, the cost of special cantilevering equipment was small compared to the cost of material and labour in setting, removing and continually altering falsework to suit succeeding spans.

The erection procedure could be laid out in the office during the designing stage and any modifications to the steelwork could be incorporated at that time at little additional cost.

Relatively short spans were usually cantilevered by inserting thrust blocks between the end bottom chords and by having the end top chords of adjacent spans fabricated in single pieces, continuous over the piers. When the cantilevered span had been landed and jacked up at its forward end, the connecting top chords were severed and the thrust blocks removed.

However, for spans as long as those of the Caughnawaga bridge (235 feet) the chords at and adjacent to the piers were usually too weak to take care of the erection stresses. To remedy this condition, without adding superfluous material to the finished structure, a temporary saddle or harness had been utilized, its effect being to increase the truss depth over the pier and to keep the maximum erection stresses within safe limits.

The accompanying diagrams (Figs. 16 and 17) showed the harness used on the Caughnawaga spans. Its development had been somewhat complicated by the fact that the bridge trusses, which started off at 31 feet centres at the north end, splay inwards to 20 feet in span 5, and then outwards again to 31 feet in span 10 (as indicated in the key plan, Fig. 17).

The general form of the harness as shown in elevation and the different arrangements of the bents, to suit the varying widths were shown in section in Fig. 17.

The eyebars (which had first been used in a similar manner on the Montreal Harbour bridge, and later for the combined railway and highway bridge at Nipawin, Sask.) were of medium heat treated steel having a yield of 50,000 and an ultimate strength of 80,000 pounds per square inch.

Being bored for 10½-inch pins it had been necessary to bush their lower ends for 8½-inch pins, this being the largest size that could be conveniently used in the Caughnawaga chords.

The posts were of box section, terminating in bases which straddled the floorbeams and bore through the top chord cover plates on the gusset plates of the trusses. Connections to the top of the floorbeam were also provided, for lateral stability before the bracing was assembled. The posts were battered 3⅛ inches in their height (as shown in section) to accommodate the splayed spans, their height having been determined by the length of eyebars available.

An attempt had been made to indicate the arrangement of the eyebar chain, as assembled to erect a splay span. In plan (Fig. 17) the inclined eyebars lay parallel to the line which bisected the angle contained between the centre line of truss and a line joining the end pins of the chain.

Thus the eyebars had an offset of 3⅛ inches in their length, which produced slight but negligible bending stresses in them. To maintain equal lengths of the inner and outer eyebar chains it had been necessary that all pins be set normal to the bridge axis.

The sections (Fig. 17) showed the four ways in which the bents were assembled to accommodate the various widths between trusses.

Assembly "A" was for the parallel trusses at 31 feet centres.

By telescoping the bracing and engaging a second set of holes on the centre plate, arrangement "B" was obtained. By revolving the posts through 180 degrees and inverting the bracing, arrangements "C" and "D" were arrived at. The key diagram (Fig. 17) indicated the points at which the various assemblies had been used.

Another slight complication had arisen on span 3 due to the fact that the panel lengths were somewhat shorter than those of the 235-foot spans. This made it necessary to shorten the horizontal distance between the chord pins and the bent, which had been compensated for by the insertion of stools under the posts.

The procedure followed in erecting a typical span was shown in Fig. 16.

Stage I. The end bottom chords with thrust blocks attached, were landed on their shoes and connected to the anchor span gussets by temporary plates (connection A). The jacking struts, laterals, truss members and end sway bracing were then erected as shown.

Stage II. The top chords were then connected to those of the anchor span (connection B) after which connection A had been removed.

The main erection traveller then proceeded to erect the span and harness as shown. The horizontal eyebar chain having been placed, the load had been transferred from connection B to the harness by means of the toggle provided.

Stage III. The main traveller then passed through and the follow-up traveller filled in the sway bracing in the bents. The end bottom chords were blocked on the pier as soon as erected. When the end diagonals and jacking struts were in place and securely bolted, the forward end of the span had been jacked up an amount of 20 inches to allow the harness to be disconnected. The permanent shoes were then set and the end of the span lowered onto them. The harness had been dismantled by the follow-up traveller which then proceeded to place all remaining floor steel and fences, which had been omitted to decrease the weight of the cantilever.

THE
ENGINEERING JOURNAL
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THE ENGINEERING INSTITUTE
OF CANADA



VOLUME XVII MAY 1934 No. 5

## Western Professional Meeting of The Institute

### To be Held in Vancouver, B.C.,

*with*

## The Annual Convention of The American Society of Civil Engineers

It is always a pleasure when members of The Institute are able to welcome members of sister engineering societies from the United States at a meeting on Canadian soil. Such an opportunity will occur in July of this year when the American Society of Civil Engineers will hold its Sixty-fourth Annual Convention in Vancouver on the same days and at the same place as the 1934 Western Professional Meeting of The Institute The headquarters of both organizations will be in the Hotel Vancouver, and the meetings will be held from the 11th to 14th of July.

On three previous occasions the Society has held its annual convention in Canada; in Montreal in 1881, in Quebec in 1897 and in Ottawa in 1913, and in 1925 the fall meeting took place in Montreal. The Society's members are, therefore, no strangers to Canada. This year's convention, however, will be especially noteworthy as the first to be held in Western Canada, and the first to be held jointly with a professional meeting of The Engineering Institute of Canada. This is an innovation which it is hoped will often be repeated.

The detail arrangements for the meeting and convention are being worked out by an active local committee, consisting of members of both organizations, and it will be noted from the tentative programme, as printed on another page, that while the professional and purely business sessions will be held separately, members of both societies will join in a series of attractive social events and visits of inspection.

An important feature of the gathering will be a joint discussion on a matter which is of international engineering interest, namely, the utilization of the resources of the Columbia River Valley. This question is just now under consideration in connection with certain development schemes which are proposed as public works by the United States government. Authoritative papers will be presented on both the Canadian and American aspects of this matter.

Members of The Institute will devote a whole day to professional sessions, at which papers on a number of important engineering developments in the Canadian west will be presented and discussed. While these sessions are being held, members of the American Society will be attending the meetings of their several technical divisions.

The local committee handling the joint arrangements is as follows:

*Chairman:* E. A. Cleveland, M.E.I.C., M.Am.Soc.C.E.
*Secretary:* J. C. Oliver, Jun.Am.Soc.C.E.

| | |
|---|---|
| I. C. Barltrop, A.M.E.I.C. | H. B. Muckleston, M.E.I.C. M.Am.Soc.C.E. |
| C. E. Blee, M.Am.Soc.C.E. | W. H. Powell, M.E.I.C. |
| C. Brakenridge, M.E.I.C. | J. Robertson, A.M.E.I.C. |
| P. H. Buchan, A.M.E.I.C. | W. O. Scott, A.M.E.I.C. |
| E. E. Carpenter, M.E.I.C., M.Am.Soc.C.E. | H. L. Swan, M.E.I.C. |
| A. H. Finlay, Assoc.M.Am.Soc.C.E. | G. A. Walkem, M.E.I.C. |
| A. E. Foreman, M.E.I.C. | C. E. Webb, A.M.E.I.C. |
| J. R. Grant, M.E.I.C., M.Am.Soc.C.E. | A. S. Wootton, M.E.I.C. |
| Frank Lee, M.E.I.C., M.Am.Soc.C.E. | G. R. Wright, A.M.E.I.C. |
| H. N. Macpherson, A.M.E.I.C. | |

*Ladies:* Mrs. E. E. Carpenter

It is not too early to make plans for visiting Vancouver during the week of July 8th, and it is understood that very favourable rates will be offered to travellers from the east by both Canadian railways. A considerable attendance of members of the American Society is expected, not only from the western states, but also from points further east, and it is hoped that a number of the eastern visitors will be able to accept the invitations which have been extended by The Institute Branches at Winnipeg, Calgary and Victoria, to stay over for a day or two in each of these centres, and take the opportunity of inspecting engineering works as well as Canadian scenery.

The Institute meeting will be under the auspices of the Vancouver and Victoria Branches. Members who were able to attend the Western Professional Meeting of The Institute in Vancouver in 1928 will recall the Western welcome which they received. There is every assurance that the forthcoming gathering will fully maintain the reputation of British Columbia in this respect.

## The By-laws and The Ballot

From the ballot figures given on another page it will be noted that the recent vote on the amendments to the by-laws has failed to show a majority sufficient to approve Council's proposals.

The amendments on which the vote was taken were based on the original work of the Committee on Development, modified as a result of extensive discussion by correspondence, at branch meetings, by branch executive committees, at a Plenary Meeting of Council held specially for that purpose, and finally at an Annual General Meeting of The Institute. Thus consideration of this matter has continued over a period of nearly three years. The many letters and communications received from individual members, as well as branches, during this time, showed that the proposals aroused widespread interest. It is, therefore, surprising, and somewhat disappointing, to find that a more decisive verdict has not been rendered, and that the vote was so small. In fact, only 818 ballots in all were cast by a voting corporate membership of some 2,600.

It is possible, however, that these unexpected features were not due to lack of interest in The Institute but to a general feeling of indecision caused by the difficulty of weighing the advantages and disadvantages of so large a number of issues of such varying degrees of importance. No doubt there was also a feeling on the part of some members that the present was not an opportune time for experiment, particularly as regards the one or two proposals of major importance. The result of the vote certainly indicates a reluctance to make any considerable changes in the constitution of The Institute at the present moment.

The question which naturally suggests itself now, is how to utilize, for the best interests of The Institute, the large amount of valuable work which has been done by the committees and by Council in connection with this matter of development. This is the problem which Council now has to consider and which will form one of the principal topics on the agenda at the next meeting of that body. Before that date councillors will have time for consideration and for consultation with their branch constituents regarding the best means for promoting the end which all have in view, namely, the fullest possible development of the activities of The Institute.

## Civil Service Classification in the Province of Saskatchewan

In the fall of 1933 the Saskatchewan Public Service Commission issued the first classification of the Provincial Civil Service as provided for under the Public Service Act of 1930.

A study of this classification by the executive committee of the Saskatchewan Branch of The Institute indicated that its provisions did not give adequate recognition to the engineering profession, either as regards classification or remuneration, and it was felt necessary to bring this circumstance to the attention of the Public Service Commission, and to ask the assistance of the Council of The Institute. The co-operation of the Saskatchewan Association of Professional Engineers was also sought.

The Council of The Institute, at its meeting on January 16th, 1934, appointed a special committee under Mr. Fraser S. Keith, M.E.I.C., and this committee was able to supply valuable information which has proved of great assistance in dealing with the matter. Consultation was also arranged between Mr. D. A. R. McCannel, M.E.I.C., councillor for the Saskatchewan Branch, Past-President S. G. Porter, M.E.I.C., and the officers of the Branch and of the Association of Professional Engineers.

On March 16th the representatives of these bodies were accorded an interview with the Saskatchewan Public Service Commission, and took the opportunity of filing two memoranda, one on behalf of the Council of The Engineering Institute of Canada, presented by Mr. McCannel, and the second jointly from the Saskatchewan Branch of The Institute and the Saskatchewan Association of Professional Engineers, presented by Mr. P. C. Perry, A.M.E.I.C., chairman of the Branch, and Mr. G. D. Archibald, president of the Association.

The memorandum from the Council of The Engineering Institute outlined the principles which it was felt should govern basic requirements in the classification of professional employees in the Civil Service, and pointed out that the remuneration proposed was in many cases less than that assigned elsewhere to positions of similar classification. It was also urged that in the classification suggested, the importance of certain positions did not seem to have been adequately recognized, and that in these cases higher grades of classification than those proposed would be advisable.

The brief presented by the Saskatchewan Branch and the Association of Professional Engineers submitted a suggested schedule based on that of the Royal Commission on Technical and Professional Services, and dealt in detail with a number of outstanding cases where the remuneration proposed was not in keeping with that generally recognized as being adequate for the responsibilities involved. It was also noted that the proposed classification differentiated between employees in revenue producing and non-revenue producing departments.

The representatives were able to discuss in detail with the Commission several of the points which they raised, and believe that their application will result in an appreciation on the part of the Commission of the necessity for fuller recognition of the engineering profession in the future. Owing to present economic conditions it is possible that the desired results may be somewhat delayed in general application, but it is hoped that early improvement may follow in some of the more urgent cases.

## The Forthcoming Construction Programme

The work of the National Construction Council in promoting the adoption of a national construction programme by the Dominion government is at last bearing fruit.

The Institute is, of course, one of the principal constituent bodies of that Council, and our representatives have taken a leading part in its activities. Engineers, like architects, have been vitally affected by the present depressed condition of the construction industry, and The Institute's Council has accordingly been an active supporter of the proposals for a government programme of public works. Further, The Institute's officers and representatives upon the Council have been able to direct the government's attention to the desirability of utilizing wherever possible the services of unemployed engineers, particularly those in private practice and young graduates, in connection with the preparation of the plans and estimates for the proposed works.

Since December of last year, when the Prime Minister announced that a construction programme of some kind would be brought down in the spring of the year, all interested in the industry have been waiting patiently for an official announcement as to its character and extent.

As a result of enquiries made in Ottawa, it may be said on good authority that the staff of the Public Works Department, both as regards engineering and building construction, have been busy for some months on details connected with this programme. On April 13th Hansard contained the following statement from Mr. Bennett: "The special public works undertakings that will be dealt with in a bill are works along the line of the suggestions that were made by the construction association and other industrial groups throughout the country during the last few months, with which I dare say the hon. gentleman is familiar."

We do not yet know the date on which this government bill will be introduced; possibly its contents will be public property before this issue of The Journal reaches its readers. There is no doubt, however, that if, as Mr. Bennett states, the suggestions of the National Construction Council have been followed, the programme will be wide-spread in character and of uniform proportions throughout the various provinces.

Such action by the Dominion government will create an excellent impression in construction circles, indicating as it will do the faith of the government in the future prospects of the country. It is to be hoped that the government's action will be followed by similar effort on the part of private individuals and corporations.

It is somewhat unfortunate that during the past few weeks figures have been quoted in the press and elsewhere which appear to indicate a sharp advance in the volume of construction in Canada. The figures which have been used for the purpose of these statistics, however, include the cost of many of the relief measures which are being carried out by cities and municipalities all over the country under the Relief Act and with assistance from the provincial and Dominion governments. This class of work is practically useless as a stimulant to regular construction forces, for it is carried on under relief conditions and not on the real economic basis which it is understood will underlie the construction programme of the Dominion government.

If relief figures are disregarded, it will be found that the value of effective construction work during the first three months of 1934 was not very different from that of last year, and as yet is less than 10 per cent of the rated capacity of the industry. In other words, the pressing need for the rehabilitation of the construction industry is as urgent as ever and the contemplated action of the Dominion government will be heartily welcomed as a remedy for this stagnation.

## Ballot on Amendments to By-laws, 1934

The scrutineers appointed by Council canvassed this ballot on April 17th and their report was submitted to Council and accepted at its meeting on April 24th.

They certify the following results:

Vote (A), amendment to Section 1 of the By-laws as proposed by Council—

In favour of Council's proposal—483
Against —316
Total valid ballots cast —799

Affirmative votes required under Section 75 of the By-laws (⅔ of 799), 533.

Council's proposal therefore fails to carry (lacking 50 votes), and the present Section 1 remains unchanged.

Vote (B), adoption of Sections 2 to 65 as proposed by Council—

In favour of Council's proposals—505
Against —289
Total valid ballots cast —794

Affirmative votes required (⅔ of 794), 529.

Council's proposals therefore fail to carry (lacking 24 votes), and the present Sections 2 to 75 remain unchanged.

## The Past-Presidents' Prize 1933-1934

The subject prescribed by Council for this competition for the prize year July 1st, 1933, to June 30th, 1934, is

**"The Engineering Features of City Management."**

The rules governing the award of the prize are as follows:

The prize shall consist of a cash donation of the amount of one hundred dollars, or the winner may select books or instruments of no more than that value when suitably bound and printed, or engraved as the case may be.

The prize shall be awarded for the best contribution submitted to the Council of The Institute by a member of The Institute of any grade on a subject to be selected and announced by the Council at the beginning of the prize year, which shall be July first to June thirtieth.

The papers entered for the competition shall be judged by a committee of five, to be called the Past-Presidents' Prize Committee, which shall be appointed by the Council as soon after the Annual Meeting of The Institute as practicable. Members and Honorary Members only shall be eligible to act on this committee.

It shall be within the discretion of the committee to refuse an award if they consider no paper of sufficient merit.

All papers eligible for the competition must be the bona fide work of the contributors and must not have been made public before submission to The Institute.

All papers to be entered for the competition must be received **not later than June 30th, 1934,** by the General Secretary of The Institute, either direct from the author or through a local Branch.

## Students' and Juniors' Prizes

Students and Juniors of The Institute are reminded that five prizes each of the value of twenty-five dollars, may be awarded to Students and Juniors of The Institute for the prize year 1933-1934 as follows:

The H. N. Ruttan Prize in the four Western Provinces.

The John Galbraith Prize in the Province of Ontario.

The Phelps Johnson Prize for an English Student or Junior in the Province of Quebec.

The Ernest Marceau Prize for a French Student or Junior in the Province of Quebec.

The Martin Murphy Prize in the Maritime Provinces.

Papers in competition for these prizes must be received by Branch Secretaries before June 30th, 1934. Further information as to the requirements and rules may be obtained from the General Secretary.

# OBITUARIES

## William States Lee, M.E.I.C.

The membership of The Institute will learn with regret of the death of William States Lee, M.E.I.C., which occurred at his home in Charlotte, North Carolina, on March 26th, 1934.

Mr. Lee was born at Lancaster, South Carolina, on January 28th, 1872, and was educated at the South Carolina Military Academy, from which he graduated in June 1894.

In 1896-1897, Mr. Lee was employed as instrumentman and later as resident engineer on the construction of the Carolina Midland Railway, Barnwell, S.C., and from March to November 1897 he was resident engineer for the Anderson Water, Light and Power Company at Anderson, S.C. From that time until March 1898, Mr. Lee was with the Pickens Railway Company at Pickens, S.C., in the same capacity. He was later in the same year assistant engineer on the staff of the United States Engineering Department on coast defence in South Carolina, and from then until January 1900 was resident engineer with the Columbus Power Company at Columbus, Ga. In January

W. S. LEE, M.E.I.C.

1900 Mr. Lee was appointed chief engineer of the same company. In October of that year he became vice-president and chief engineer of the Catawba Power Company, Charlotte, N.C. This company was a subsidiary of the Southern Power Company, and in 1905 Mr. Lee became chief engineer of the latter company. Later he received the appointment of vice-president and chief engineer, which position he held for about fifteen years. At the time of his death, Mr. Lee was vice-president and chief engineer of the Duke Power Company at Charlotte, N.C.

# WESTERN PROFESSIONAL MEETING

OF

# The Engineering Institute of Canada

## VANCOUVER—JULY 11th to 14th, 1934

THE AMERICAN SOCIETY OF CIVIL ENGINEERS is holding its ANNUAL CONVENTION at the same time and place as The Institute meeting. In the following programme, events marked * are joint functions in which delegates from both organizations will take part. The Headquarters of both bodies will be at the Hotel Vancouver.

(*Programme subject to minor changes*)

**Wednesday, July 11th**

9.00 a.m. *Registration* (separate for each Society).

*10.00 a.m. *Joint meeting*, called to order by the Chairman of the Local Joint Committee—E. A. Cleveland, M.E.I.C., M.Am.Soc.C.E.

Welcome to all delegates by His Worship the Mayor of Vancouver.

*10.10 a.m. Welcome to Am. Soc. C.E. delegates by the President of The Engineering Institute of Canada, F. P. Shearwood, M.E.I.C., M.Am.Soc.C.E.

Reply, and annual address, by the President of the American Society of Civil Engineers, Harrison P. Eddy, M.Am.Soc.C.E., M.E.I.C.

*12.30 p.m. *Luncheon.*

*Chairman:* The Chairman of the Vancouver Branch of The Engineering Institute of Canada.

*Speaker:* A. S. Gentles, M.E.I.C., President of The Association of Professional Engineers of British Columbia.

*Subject: The Growth and Work of the Association of Professional Engineers in British Columbia.*

* 2.30 p.m. *Joint Technical Session* (both Societies.)
*Chairman:* The President of The American Society of Civil Engineers.

*Subject: The Development of the Columbia River Drainage Basin.*

Presentation and Discussion of the following papers:

(*a*) *Power and Navigation Features of the Columbia River below Snake River, with particulor reference to the Bonneville Project*, by Major C. F. Williams, District Engineer of the U.S. Engineer Office, Portland, Ore.

(*b*) *Reclamation Features of the Columbia River Drainage Basin, with particular reference to the Columbia Basin Project and the Grand Coulee Development*, by Frank A. Banks, Assoc.M.Am.Soc.C.E., Construction Engineer of the U.S. Bureau of Reclamation, Almira, Wash.

(*c*) *The Canadian Aspects of the Columbia River Drainage Basin*, by J. C. MacDonald, M.C., M.E.I.C., Comptroller of Water Rights, Province of British Columbia.

* 3.00 p.m. For the ladies a motor trip will be arranged around Stanley Park Marine Drive and to the grounds of the University of British Columbia at Point Grey, followed by tea.

* 7.00 p.m. *Dinner.*

*Chairman:* The President of the American Society of Civil Engineers.

*Speaker:* His Honour Judge F. W. Howay.

*Subject: The Work of the Royal Engineers in British Columbia.*

**Thursday, July 12th**

The Engineering Institute and the Technical Divisions of the Am.Soc.C.E. will hold separate professional sessions for the presentation and discussion of papers.

For The Institute these will be as follows:

9.00 a.m. *First Technical Session, E.I.C.*

(*a*) *Town Planning Aspects of Vancouver and Fraser River Harbours*, by W. G. Swan, D.S.O., M.E.I.C., Consulting Engineer, Vancouver.

(*b*) *The English Bay Interceptor*, by G. M. Gilbert, Engineer of the Vancouver and District Sewerage Board.

2.00 p.m. *Second Technical Session, E.I.C.*

(*a*) *The Highway System of British Columbia*, by Patrick Philip, M.E.I.C., Chief Engineer, Department of Public Works, Province of British Columbia.

(*b*) *The Ghost Development ond Hydraulic Fill Dom*, by G. A. Gaherty, A.M.E.I.C., President, Calgary Power Company, and T. H. Hogg, D.Eng., M.E.I.C., Chief Hydraulic Engineer, H.E.P.C. of Ontario.

Ladies are left free during morning and afternoon sessions.

* 7.30 p.m. *Informal Dinner and Dance* (Grouse Mountain Chalet).

**Friday, July 13th**

* 9.00 a.m. *All day excursion by steamer*, through Gulf of Georgia and Malaspina straits to Powell River (seventy-two miles). Inspection of pulp and news print mill (650 tons per day capacity) and hydro-electric plant of the Powell River Company. Arrive Vancouver about 9.00 p.m.

**Saturday, July 14th**

Morning No formal functions arranged.
Golf can be arranged for those who desire it.

* 2.00 p.m. *Motor drive* on north side of Vancouver harbour through the catchment area controlled by the Greater Vancouver Water District.

*Tea* at Seymour Canyon and Falls.

Drive to Capilano Canyon and Whytecliff; thence back to Vancouver.

NOTES:—Unless otherwise stated, ladies are expected to participate in all functions and inspection trips.

Members are recommended to make their Hotel reservations well in advance.

Both railways offer special return rates for groups of ten or more. For details see later announcement.

Among Mr. Lee's other connections were the following: president of the W. S. Lee Engineering Corporation; president and chief engineer of the Piedmont and Northern Railway Company; vice-president and chief engineer and director, Duke Power Company, Wateree Power Company, Western Carolina Power Company, Catawba Manufacturing and Electric Power Company; director, American Cyanamid Company; and vice-chairman and trustee of the Duke Endowment. Mr. Lee also engaged in practice as a consulting engineer with offices in New York City and Charlotte, N.C.

Mr. Lee's interest in Canadian work was originally due to his association with the late James B. Duke in the activities of the Duke-Price Power Company, and he was in charge of the construction of that company's development at Isle Maligne on the Saguenay river. This Canadian connection was followed by his engagement in connection with the power development of the Beauharnois Light Heat and Power Company on the St. Lawrence river at Beauharnois, Que.

Mr. Lee acted for many years as consulting engineer for the Hydro-Electric Power Commission of Ontario, and served in the same capacity for a number of Canadian organizations. He was a vice-president and chief engineer of the Quebec Development Company.

Mr. Lee, who was recognized as one of the pioneers in high-tension hydro-electric power development, was president of the American Institute of Electrical Engineers in 1930-1931.

He joined The Engineering Institute of Canada as a Member on May 19th, 1914.

### John Athalmer Aylmer, M.E.I.C.

General regret, we are sure, will be felt at the announcement of the death at Peterborough, Ont., on April 11th, 1934, of John Athalmer Aylmer, M.E.I.C., one of the senior members of The Institute.

Born at Quebec on August 28th, 1847, he received his early education at St. Francis College, Richmond, Que., serving his apprenticeship under the late J. G. Lippell, C.E., chief engineer of the lower St. Lawrence canals. From 1872 to 1879 he was engaged as an assistant engineer on the construction of Lachine canal enlargements, and was subsequently employed until 1881 in the same capacity on the construction of the Ste. Annes canal on the Ottawa river. Following this for some years he was resident engineer on the Trent canal system, his work embracing surveys and plans and estimates for some two hundred miles of canal, lake and river navigation. Mr. Aylmer was later connected for a time with the firm of Manning and McDonald of Toronto, and finally became a member of the firm of Brown, Love and Aylmer, located at Peterborough, Ont. Mr. Aylmer retired from active practice about fifteen years ago.

Widely recognized throughout Ontario and Quebec as an outstanding member of the profession, Mr. Aylmer completed many important public works contracts, including sections of the Trent canal and other large enterprises.

Mr. Aylmer joined the Canadian Society of Civil Engineers on its formation, having become a Member on January 20th, 1887. He was made a Life Member on April 2nd, 1929.

### Samuel Martin Green, M.E.I.C.

It is with regret that we place on record the death at Springfield, Mass., on March 2nd, 1934, of Samuel Martin Green, M.E.I.C.

Born at Benton Harbor, Mich., on April 13th, 1864, Mr. Green graduated from the Worcester Polytechnic Institute in 1885.

Following graduation he was until 1899 connected with the F. E. Reed Company of Worcester, Mass., the Deane Steam Pump Company of Holyoke, Mass., the John T. Noye Company of Buffalo, N.Y., and the Merrick Thread Company at Holyoke, Mass., and from that time until 1907 was chief mechanical engineer of the American Thread Company, being in charge of the mechanical equipment, power plants and buildings of all the American plants of that company. In 1897 the Samuel M. Green Company was incorporated, and Mr. Green became president and treasurer, which connection he retained until the time of his death. Mr. Green held many important commissions throughout the eastern and southern states, Canada, Finland, Norway, Germany, Australia, Sweden, Japan and India, his overseas work being largely the designing of chemical plants. During the world war Mr. Green was in charge of the erection of a record size chlorine soda plant as a unit of the poison gas plant at the government arsenal at Edgewood, Md.

He was associated with many societies, being a member of the American Society of Civil Engineers, the American Society of Mechanical Engineers, the Engineering Society of Western Massachusetts and the American Geographical Society.

Mr. Green became a Member of The Institute on October 14th, 1911.

### George Arthur Johnson, M.E.I.C.

Regret is expressed in recording the death of George Arthur Johnson, M.E.I.C., in New York, on April 1st, 1934.

Colonel Johnson was born at Auburn, Maine, on May 26th, 1874.

In 1895-97 he was engaged on investigating methods of water purification at Louisville, Ky.; in 1898-99 at Cincinnati, Ohio, and York, Pa.; in 1899 at Norfolk, Va., and Washington, D.C. In 1900 Colonel Johnson was associate director of a special city department at St. Louis, Mo., studying water problems, and in 1901 was engaged on the study of water filtration at Philadelphia, Pa. In 1902 he was in charge of the operation of filtration works at Little Falls, N.J., and in 1903 was field director in charge of a sanitary survey of the Hudson river watershed for New York City. In 1904-1905 he became engineer in charge of studies on the purification of water supply and sewage at Columbus, Ohio, and in the following year was abroad on professional work. In 1907-1910 Colonel Johnson was principal assistant engineer, and later a member, of the firm of Hering and Fuller, and in 1911 became senior partner of the firm of Johnson and Fuller, consulting engineers. In 1918 Colonel Johnson was in the Quartermaster Corps National Army of the U.S.A., in the construction division in the maintenance and repair branch, at Washington, D.C. At the time of his death he was engaged in consulting engineering as the George A. Johnson Company at New York, N.Y.

Colonel Johnson became a Member of The Institute on April 20th, 1915.

### Harry Brooke Aylmer, A.M.E.I.C.

Harry Brooke Aylmer, A.M.E.I.C., died at Melbourne, Que., in July 1933.

Mr. Aylmer was born at Melbourne, Que., on November 12th, 1854, and from 1872 to 1877 was employed as an assistant on the Geological Survey of Canada. In 1879 he was engaged as assistant on township surveys in the province of Quebec, and in 1880 was occupied on the same work in the province of Manitoba, being in charge of party. In 1881 Mr. Aylmer was assistant engineer in the location of the Canada Atlantic Railway, and the following year was on its construction. In 1882-1883 he was an assistant to Mr. Wm. Crawford, C.E., on general engineering work in Manitoba, and following this was until 1885 on the location, and construction of the mountain division of the Canadian Pacific Railway as assistant engineer. In 1887 Mr. Aylmer was with the Algoma Eastern Railway Company at Little Current, Ontario, and in 1913 he returned to Melbourne, Que., where he remained until the time of his death.

Mr. Aylmer joined The Institute (then the Canadian Society of Civil Engineers) as an Associate Member on June 25th, 1887.

## PERSONALS

Leonard H. Birkett, A.M.E.I.C., is now sales manager of the Combustion Engineering Corporation Limited, Montreal. During the year 1914-1915, Mr. Birkett was engaged on a special apprenticeship course with the Canadian Pacific Railway, and from June 1915 to April 1919 he was overseas with the Canadian Expeditionary Force in

LEONARD H. BIRKETT, A.M.E.I.C.

the infantry and with the Canadian Engineers, holding a commission. Returning to Canada in 1919, he was attached to the mechanical department of the Canadian Pacific Railway until April 1921, when he joined the staff of The Superheater Company Limited, Montreal, as sales engineer in charge of industrial sales and engineering.

Lieut.-Colonel R. E. Smythe, A.M.E.I.C., Director, Technical Service Council, Toronto, Ont., has been elected chairman of the Toronto Branch of The Institute.

G. P. F. Boese, A.M.E.I.C., has been appointed chairman of the Calgary Branch of The Institute. Mr. Boese is assistant engineer, Department of Natural Resources, Canadian Pacific Railway Company, Calgary, Alta.

D. Ross Eastwood, A.M.E.I.C., is now assistant engineer on the staff of Canadian Celanese Limited at Drummondville, Que.

J. B. Clark Keith, A.M.E.I.C., chief engineer, the Essex Border Utilities Commission, Windsor, Ont., was elected chairman of the Canadian Section of the American Water Works Association at the fourteenth annual meeting of the Association held in Toronto, recently.

H. A. Thompson, A.M.E.I.C., is now connected with the E. B. Eddy Company at Hull, Que. Mr. Thompson was for some time assistant engineer with the Lethbridge Northern Irrigation District, Lethbridge, Alta.

A. B. Anglin, S.E.I.C., who graduated from Queen's University in 1933 with the degree of B.Sc., is now on the refinery staff of the British American Oil Company at Toronto, Ont.

F. C. C. Lynch, A.M.E.I.C., has been appointed director of the Bureau of Economic Geology under the division of the geological survey in the Mines Department, Ottawa. Mr. Lynch entered the service of the Dominion government in April 1906, when he became technical clerk, Railway Lands Branch, Department of the Interior. In April 1911 he was appointed assistant superintendent and in April 1912 superintendent of the same Branch, which office he held until 1917, when he joined the Natural Resources Intelligence Branch as superintendent. Mr. Lynch subsequently became Director of that Branch, which office he has held up to the time of his present appointment. Mr. Lynch is most active in the affairs of The Institute, having been the Secretary-Treasurer of the Ottawa Branch for a number of years.

## Recent Additions to the Library

### Proceedings, Transactions, etc.

Canadian Institute of Mining and Metallurgy: Transactions, vol. 36, 1933.
American Society of Mechanical Engineers: Transactions, April 1934.
The Society of Engineers, Inc.: Transactions, 1933.

### Reports, etc.

*Canada, Civil Service Commission:*
25th Annual Report, 1933.
*New Brunswick Electric Power Commission:*
14th Annual Report, 1933.
*Saint John Harbour Commissioners:*
Report 1933.
*Canadian Radio Broadcasting Commission:*
Interim Report for 1933.
*Port of New York Authority:*
13th Annual Report 1933.
*Canada, Department of the Interior, National Parks Branch:*
Report of the Commissioner, 1933.
*Quebec Bureau of Mines:*
Annual Report for the year 1932, Part C.
*Hydro-Electric Power Commission of Ontario:*
List of Electrical Equipment Approved, 1934.
*Royal Aeronautical Society:*
List of Members, 1934.
*Société Ingénieurs Civils de France:*
Annuaire de 1934.
*City of Winnipeg Hydro-Electric System:*
Annual Report, Dec. 31st, 1933.
*National University of Ireland:*
Calendar 1933.
*Canada, Mines Branch, Dept. of Mines:*
The Mineral Industries of Canada.
*Canada, Dept. of Marine, Radio Branch:*
Radio Induction Interference, Supplement A to Bulletin No. 2.
*Canada, Geodetic Survey:*
Publication No. 55, Triangulation in Southeastern Ontario and Montreal Area.

### Technical Books, etc.

Bethlehem Rolled Steel Wheels, Steel Axles and Locomotive Forgings,
Bethlehem Tool Steels,
Mayori Pig Iron,
Bethlehem Rolled Steel Circular Products,
Bethlehem Structural Shapes.
(Five publications listed above published and presented by the *Bethlehem Steel Company.*)

## BULLETINS

*Car Washers*—A 4-page folder received from the Worthington Pump and Machinery Corp., Harrison, N.J., illustrates and describes car washer units for modern garages, wash racks and service stations. The units are made in four sizes.

*Waggon Drill*—The Worthington Pump and Machinery Corp., Harrison, N.J., have issued a 4-page folder which gives particulars regarding an improved type waggon drill. The new machine incorporates an adjustable drill steel centralizer and a levelling device, permitting the adjustment of the drill tower to the vertical position when the rig is set on uneven ground. The drilling engine can be readily demounted from its detachable feed slide.

*Industrial Research*—Forty-five prominent manufacturing organizations contributed the data that is contained in the 30-page report issued by the Policyholders Service Bureau, Metropolitan Life Insurance Company. The material deals with the organization and administration of an industrial research department, the question of cost estimates, the methods of budgeting in use, and other sections consider standardized research procedure, cost keeping and control, and the review and reconsideration of research projects. Copies may be secured from the Policyholders Service Bureau, Metropolitan Life Insurance Company, 180 Wellington Street, Ottawa, Ont.

# BOOK REVIEWS

## Arc Welded Steel Frame Structures

*By Gilbert D. Fish, McGraw-Hill Book Company, Inc., New York, 1933. 6 by 9¼ inches, 401 pages. Figs., tables, photos. $5.00. Cloth.*

Reviewed by C. M. Goodrich, M.E.I.C.*

The author, in the preface, has clearly outlined the aims of the volume in the following sentence: "The book is intended for engineers, architects, contractors, inspectors and students who are now, or may become, concerned with welded structures. The guiding motive is to assist all groups to combine economy with safety." He further states that his subject is welded structures rather than welding processes, and he devotes the opening chapter to a brief review, with photographs, of steel structures which have been erected or reinforced by the welding process. The closing chapter is a critical comment on the experience gained by the author from those structures with which he was connected.

In the early chapters, the author deals with elementary matters of welding and stress analysis, and reprints the American Welding Society's code for fusion welding and gas cutting, as well as his own specification for the reinforcement of bridges. These chapters are introductory to those which treat of detail design, strength calculations and economical layout for welded joints.

The author discusses at length all the usual types of connections met in the fabrication of steel structures. He has compiled a number of tables of the allowable loads, etc., for the different types of welds in accordance with his design data.

There is an important chapter dealing with detail drawings and the author stresses the importance of having clear drawings of the weld details showing the field welding separately from that to be carried out in the shop, as if both details are on the one set of drawings there is a tendency to cause confusion.

The method of estimating used by the author is clearly set out, together with various factors in the design of the connections which affect the welding cost, such as the position of the welds, their accessibility, and the speeds of deposition for the various types and classes of welds.

The author's calculations are based on the use of bare electrodes and although he states that he believes covered electrodes will supersede the bare, it is to be regretted that he does not include any comparative data on the results obtained from the use of covered as against bare electrodes.

Inspection, welders qualifications, and contractors' equipment is dealt with and the book should prove a useful guide to those who are interested in the application of welding for the erection or strengthening of steel structures.

*Canadian Bridge Company Limited, Walkerville, Ont.*

## The Technical Man Sells his Services

*By Edward Hurst, S.B., McGraw-Hill Book Company Inc., New York, 1933. 5½ by 8 inches, 239 pp., $2.00. Cloth.*

The purpose of this book is to assist technical men to find positions by outlining the analytical methods of the problem. The author without theorizing shows the reader how by selling his services instead of asking for a job, he can convert the employer's "no" into a "yes." The author, an engineer engaged in manufacturing, has for eight years as an avocation been assisting engineering students to obtain positions, and this book sums up his experience. He illustrates by a series of examples the application of successful methods in securing employment. Among the occupations covered in these cases are those of mechanical, chemical, electrical, sales, construction and production engineers, the machine designer, architect and cost accountant. Any technical graduate, recent or otherwise, who is in search of employment may consider this book well worth reading.

## Triangulation in Southeastern Ontario and Montreal Area

### Being Geodetic Survey Publication No. 55

*By J. E. R. Ross. 152 pages. Noel J. Ogilvie, Director, Ottawa. The King's Printer, 1934. Price $1.00.*

Reviewed by Professor J. Weir, A.M.E.I.C.*

This publication completes a series of seven reports—of which numbers 29 to 35, inclusive, have appeared in recent years—containing the results of all triangulation established by the Geodetic Survey of Canada in eastern Canada. The area, of which this series treats, is that of the older and more settled portion of Canada, extending easterly from Lakes Huron and Erie in Ontario to the St. Lawrence river, thence along the river valley through Quebec, and finally throughout the Maritime provinces to the southwestern portion of Newfoundland.

The Index Map of Publications included in the report shows the areas covered in these numbers; and also those areas west of Lake Superior to Prince Rupert on the Pacific coast, and those in Northern Ontario and Quebec, for which results are unpublished but may be had by applying to the Director.

This particular report No. 55 presents the final results, on the North American datum, of the triangulation executed by the Geodetic Survey in that area bordering on the St. Lawrence river from about 30 miles east of Montreal, Quebec, westerly to about 25 miles west of Belleville, Ontario, with portions of the Ottawa and Gatineau river valleys. A notable feature is the addition of the control in Montreal City and District area. The main scheme has an axial length of about 250 miles and an average width of 50 miles. The field work of this scheme was prosecuted during the years 1907-1913, the first important accomplishment of this Survey after its inception in 1905, and the results were first given in G.S.C. Publication No. 2, by W. M. Tobey, which is not now extant.

In each report, Mr. Ross has given a description of the triangulation methods of the Survey. The methods of adjustment are well illustrated, and the precision of the final results attained must impress even the most casual. On replacement of the geometrical figures of the triangulation scheme by a single line, the ratio of the error to the length is 1 part in 519,000, or 1 foot in 98 miles. (See page 29.)

The triangulation of the Geodetic Survey of Canada, in harmony with that of Mexico and the United States, is based on a common standard, the "North American datum," and calculations are based throughout on the Clarke Spheroid (1866). As a result, there are avoided the complications of overlap along the International Boundaries, and advantages of mutual co-operation ensue.

The results of the Montreal area triangulation form a major feature of the report. The city engineers of Montreal, long feeling the need of an accurate base map for civic planning, enlisted the services of the Geodetic Survey in 1919 for the extension of a rigid net of triangulation control from the primary net of the surrounding area. The resulting work places this area foremost in Canada in density of triangulation control.

The net adopted, based on the line Mount Royal-St. Hilaire, has twelve main stations on commanding points, from which control points were established by intersections from three or four of the main stations. The positions of many church spires, flagpoles, etc., were thus fixed, and for convenience, positions of bolts on the streets were also determined.

With about 45 primary control marks thus made available, the city staff has put in hundreds of intermediate points and computed their co-ordinates. Eight hundred permanent monuments will constitute the complete work. Precise levels also make these bench marks available for vertical control.

A very convenient system of rectangular co-ordinates allows all points in Montreal to have their departures and latitudes given from the one origin, the primary station Royal. The axes are parallel and at right angles to the direction of St. Lawrence Main, in azimuth 302°55′27″.2.

A complete list of descriptions and marking of all stations in the book renders positive identification on the ground possible, and a seven-page index completes the report of a monumental work well done.

*Assistant Professor of Geodesy, McGill University, Montreal.*

# CORRESPONDENCE

The Editor, Fort William, Ont., April 21st, 1934
The Engineering Journal

Dear Sir:

I know it is voicing the appreciation of many other readers of The Journal as well as my own in acknowledging the pleasure experienced and speculative thought induced through reading Mr. Eric G. Adams' essay on "The Relations of Economics to Engineering." In the light of present day conditions the subject is topical, entertaining and instructive for any engineer who gives more than passing thought and interest to a situation in which we all, engineers especially, are enveloped. One cannot conceive any subject which could be of more interest and productive of more ultimate value to the younger engineers to-day than would an open well-directed discussion of Mr. Adams' paper by every Branch across the Dominion.

It is the writer's opinion that the future of engineering as a profession, rather than a trade, rests basically on an appreciation by engineers of the fact that a broad knowledge of economics and the application of its principles to engineering works and enterprises is essential to the attainment of the higher status. However, Mr. Adams has enunciated this much better and more clearly than I can.

In the endeavour, Mr. Editor, to act on your plea for more active help from the membership towards broadening interest in The Journal, I submit the following for consideration, and, I trust, comments from other members:

That each Branch appoint or elect a Journal correspondent, not the Secretary. That his duty be to submit local items of interest to engineers regularly, and not less than two more extended resumés, short articles or comments, during his year of office, on some subject or work in his area in which the membership might be interested. He should preferably, be of the younger group, and his services in digging out his material should be recognized by remitting the annual dues.

As professional ethics has been to the fore recently one is prompted to enquire what attitude The Institute would take on the proposition that it is not good business and it is unethical for any engineer on his own account, or at the behest of his employer or client, to take advantage of distress conditions to hire common and skilled labour at distress wages. Undoubtedly a subject more properly discussed within than without the profession. A little moral backing on the part of The Institute in respect to this would no doubt be welcomed by some of the members.

P. E. Doncaster, M.E.I.C.

# BRANCH NEWS

## Calgary Branch

*J. Dow, M.E.I.C., Secretary-Treasurer.*
*H. W. Tooker, A.M.E.I.C., Branch News Editor.*

The competition open to Junior and Student members of the Calgary Branch, carrying with it a substantial cash prize, for the best paper on an engineering subject, personally presented, was held at the Board of Trade rooms during the evenings of March 1st and 2nd, 1934.

The papers, in order of presentation, were as follows:

Thursday, March 1st:

(1) The Application of Heavisides Operational Calculus to Engineering Problems, by I. A. Abramson, Jr.E.I.C.

(2) Construction and Principles of Operation of the New Sewage Disposal Plant at Bonnybrook, by J. S. Neil, S.E.I.C.

Friday, March 2nd:

(3) Railway Construction in the Peace River Block, by J. L. Pidoux, S.E.I.C.

(4) Recent Development in Radio Receiver Design, by D. C. Fleming, S.E.I.C.

Judging of the contest was conducted by a committee of which J. H. Ross, A.M.E.I.C., was the chairman. The committee based their award on the following points: completeness, 50 marks; originality, 10 marks; appropriateness, 10 marks; and for the manner of presentation, including language, delivery and logical sequence, 30 marks.

Mr. D. C. Fleming was the successful competitor, with a total of 77 marks, Mr. J. L. Pidoux was second, Mr. J. S. Neil third, and Mr. I. A. Abramson fourth.

ANNUAL MEETING

The annual meeting of the Calgary Branch of The Institute was held in the Board of Trade rooms on March 10th, 1934, at 2 o'clock p.m., there being present the chairman, H. J. McLean, A.M.E.I.C., and sixteen members.

Following the reading of the minutes of the last annual meeting, scrutineers of the ballot on the election of officers for the year 1934-1935 were appointed.

G. P. F. Boese, A.M.E.I.C., in reporting the activities of the Programme committee commented on the necessity of the members attending the meetings, thus encouraging those who have prepared lectures.

Mention was made of the departure from usual procedure in having the large number of nineteen general meetings illustrated by moving pictures, which greatly enhanced the popularity and interest of the papers.

The hope was expressed that members would endeavour to have their friends who are eligible and attending the meetings to associate themselves with The Institute.

A. Griffin, M.E.I.C., in presenting the report of the Prize committee, emphasized the good results of the Students' contest and the gratifying interest taken by members as well as the public.

Colonel F. M. Steel, M.E.I.C., reported on the Unemployment committee which has been exceptionally active during the year and in cooperation with the Professional Engineers of Alberta endeavoured to put unemployed engineers in touch with employers. The committee also kept in close touch with the National Defence Relief Schemes and employment was found for several. A word of warning was given against exploitation by employers, particularly on the so-called temporary jobs, so that there will not be a general devaluation in engineering services.

Reports were also made by the committees on Policy, Receptions and Attendance and Membership.

The report of the Secretary showed a gain of one member during the year and regretted the loss of three valuable members in the passing on of Major C. C. Richards, W. D. Armstrong and W. J. I. Bennett. The Executive met fifteen times and there were nineteen general meetings, with a gratifying increase in the attendance.

The Treasurer's report showed total disbursements of $395.16 and assets amounting to $1,000.38.

Mr. McLean, the chairman, gave the report of the activities of the Branch and stated that the two salient points necessary to bring members in close touch with each other were playing together and working together. He suggested that less technical data should be encouraged in lectures and more general information given, thus stimulating the general education.

Past-President S. G. Porter, M.E.I.C., gave a resume of the annual meeting of The Institute in Montreal which he had attended, and observed that in his address the Premier, Mr. R. B. Bennett, was particularly encouraging to the young engineer.

Mr. Boese, in accepting the chairmanship of the Branch, thanked the members for their confidence in electing him, and paid tribute to Mr. H. J. McLean.

## Hamilton Branch

*Alex. Love, A.M.E.I.C., Secretary-Treasurer.*
*V. S. Thompson, A.M.E.I.C., Branch News Editor.*
*Reported by J. A. M. Galilee, Affil.E.I.C.*

The regular get-together meeting of the Toronto Section, American Institute of Electrical Engineers, and Hamilton Branch, Engineering Institute of Canada, was held in the Westinghouse auditorium, Hamilton, on April 6th, 1934. H. B. Stuart, A.M.E.I.C., chairman, welcomed the visitors to Hamilton and turned the meeting over to G. D. Floyd, chairman of the Toronto Section, A.I.E.E.

*By courtesy of Canadian Airways Ltd.*

**Stanley Park and Harbour Entrance at Vancouver, B.C., the location of the forthcoming Western Professional Meeting of The Engineering Institute of Canada.** *(See announcement page 239.)*

Mr. Floyd introduced Dr. Joseph Slepian, speaker of the evening, consulting engineer in the Research Laboratories of the Westinghouse Electric and Manufacturing Company at East Pittsburgh.

Circuit Interruption

Dr. Slepian's subject was "Circuit Interruption," and its relation to much research work that has been done recently in studying arc phenomena and allied subjects.

He showed that the original attempts to break contacts have been based on the false assumption that the arcs thus formed were: (1) flames and must be "extinguished" or "quenched," that (2) they can be cut, such as a rope, and (3) they can be drawn out much in the same manner as molasses candy to such a point that they separate to a mere insubstantiality. It was in a study of the fundamental reasons of the formation of arcs that Dr. Slepian evolved his De-ion principle of circuit interruption.

The speaker then explained the mechanism of the extinction of an arc in an A.C. circuit and its re-ignition, dealing with both the short and the long A.C. arc.

Dr. Slepian pointed out that in the original introduction of the De-ion principle in connection with circuit interruption, it was thought possible to be able to eliminate the use of oil in all circuit breakers.

The "De-ion Grid" is essentially a stack of plates built up of multiple units. Each unit consists of several insulating plates and one magnetic iron plate. There is a long, narrow slot in all the plates and when assembled together these slots form a groove in the complete stack. It is in this groove or slot that the contacts move vertically and the arcs are drawn, generating (in the iron circuit) magnetomotive forces which act on the magnetic field around the arc. This drives the entire length of the arc rapidly into intimate contact with the oil body in the slot and towards the closed end of the slot. The fresh un-ionized gas generated in this way is forced through the entire length of the arc stream. This gas acts as a de-ionizing agent and is most effective in causing interruption after the current zero of the alternating wave is reached. The longer the arc persists the more units are brought into action to interrupt it. This gives a reserve rupturing ability. The number and size of the units is made to suit the various applications. The grids and contacts are located in the oil at the bottom of the bushings. A very simple high pressure contact is used.

It was shown that with oil soaked fibre or fullerboard plates as used in the De-ion grid, the volts ruptured per inch length of gap was about ten times more than would be ruptured if a refractory material such as porcelain were used. The un-ionized oil gas given off by the fibre helps to rupture the arc. The material, being filled with oil, does not deteriorate.

Pictures were shown of various control equipment on test with and without de-ionizing plates and the comparative lack of flame and other manifestations of that nature all pointed to the correct application of the de-ionization principle.

Dr. Slepian's extremely lucid explanation of difficult problems fascinated the large audience which numbered over 200. Following the address, a considerable discussion took place, which gave Dr. Slepian a further opportunity of demonstrating his facile manner of explaining electrical phenomena.

A vote of thanks to the speaker was proposed by A. E. Davison, of the Toronto Section, A.I.E.E., and seconded by Mr. Paulin, M.E.I.C. Thanks were given to the Canadian Westinghouse Company for their hospitality. Refreshments were served at the conclusion.

## London Branch

*H. A. McKay, A.M.E.I.C., Secretary-Treasurer.*
*Jno. R. Rostron, A.M.E.I.C., Branch News Editor.*

The regular monthly meeting of the Branch was held in the City Hall auditorium on March 21st, 1934.

Frank C. Ball, A.M.E.I.C., chairman of the Branch, presided and the speaker of the evening was Mr. Charles G. Hunter, who was introduced by D. M. Bright, A.M.E.I.C.

Modern Principles of Air Conditioning

Mr. Hunter spoke on "Modern Principles of Air Conditioning" and gave "Ionization," the underlying principle of air conditioning, as a vital factor of interest not only to the architect or builder but also to the physician, the physicist, the chemist and all concerned with the normal health of individuals.

He described the atoms which are present in the atmosphere—so small that 50,000,000 are required to make up one linear inch of space. The atoms themselves contain a positive charge of electricity and each is surrounded by electrons containing a negative charge.

He stated that scientists maintain they will be able to lengthen the average span of human life from five to seven years and will be able to cure many ailments such as high blood pressure and arthritis simply by correcting their metabolisms. The secret lies in ionization which is the process of breaking up the atom and separating the electrons or negative charges by cosmic rays, electrical discharges and other scientific means and so producing "ions." Mr. Hunter stated that these "ions" raise the vitality of human beings in a proportion to the amount administered.

In nature preserving its balance "ions" become apparent after thunder storms when a heavy negative charge is brought to earth with rain and lightning, he pointed out, and stated that the cool exhilarating feeling that follows such a storm is in reality the building up of the vitality.

Only recently has man been able to measure "ionization" definitely. It is inhaled into the body chiefly as a sort of energy and this is when the principles of air conditioning come in. As a result science has invented an apparatus to increase it by mechanical means.

Until a few years ago medical authorities were unable to reproduce synthetic secretions similar to those of the ductless glands. They are now beginning to understand that this is a purely electro-chemical process in which "ions" play a great part.

With civilization came many maladies that the medical world was unable to correct It has been found that the ductless glands were not functioning properly under average conditions. Also that people living a simple life walking about in their bare feet were not afflicted with the sicknesses of their more civilized brethren.

The speaker asserted that a temperature of 60 to 70 degrees and a humidity of between 30 and 45 units was best for people.

A chart prepared by the Harvard School of Public Health showed that patients who had been given an "ionization" treatment responded remarkably. Also the response was 50 per cent greater when the patient was grounded to a suitable conductor. Deaths were the highest when "ionization" was at an ebb while the death rate was at its lowest when the atmosphere was most heavily charged with "ions."

He predicted that there would be great changes in architecture and that homes, offices and factories would be built so that each floor was a "ground" to enable the residents to receive the most benefit from the conditioned atmosphere.

A hearty vote of thanks and appreciation was made to the speaker by J. A. Vance, A.M.E.I.C., of Woodstock, and seconded by Major S. W. Archibald, A.M.E.I.C., and unanimously carried by those present, numbering about 40.

## Moncton Branch

*V. C. Blackett, A.M.E.I.C., Secretary-Treasurer.*

"The Contribution of the Aeroplane to Canadian Industrial Development" was the subject of a very interesting address delivered before the Branch, on March 14th, 1934, by Mr. W. B. Burchall, advertising manager, Canadian Airways, Ltd., Montreal. J. G. Mackinnon, A.M.E.I.C., vice-chairman of the Branch, presided. The meeting was open to the public and the attendance was unusually large. Special invitations to be present were sent to members of the Moncton Flying Club and to pupils of the Aberdeen High School.

Mr. Burchall described the part played by aviation in mining, fishing, the fur trade, forestry and engineering. Of particular interest is the service rendered in northern areas. Transport of men and materials, which a few years ago tested human endurance to the limit, is now carried on in comfort and safety. Many of the inhabitants have never seen a train or an automobile, but to them the aeroplane is a common sight. In fact, in the extreme north it is the only means of mechanical transport. Mr. Burchall's remarks were illustrated with numerous slides.

At the conclusion of the address, the chairman called on Mr. W. S. Dalziel, who spoke a few words of appreciation on behalf on the Moncton Flying Club.

A vote of thanks was tendered Mr. Burchall, moved by T. H. Dickson, A.M.E.I.C., seconded by G. E. Smith, A.M.E.I.C.

Sackville Meeting

On March 20th a very instructive address on "Engineering Estimates" was delivered by H. J. Crudge, A.M.E.I.C., before a combined meeting of Moncton Branch and the Engineering Society of Mount Allison. The meeting was held in the Eurhetorian hall of Mount Allison University at Sackville. C. Baggs, president of the Engineering Society, presided.

Estimating, declared Mr. Crudge, is more an art than a science. There are no formulae that can be applied repeatedly except, of course, those that pertain to computation of volumes or quantities of materials. There is never any guarantee that because certain conditions existed on a previous project, they will also be exactly the same on a later one. Webster defines an estimate as "an opinion, as to the value of, formed from imperfect data." The term "imperfect data" is very appropriate, and an estimate is at most times a guess tempered with experience.

Projects, however, cost money and those who provide the funds expect to be told in advance the amount thereof. Demands for accuracy are often most unreasonable, but these the engineer must do his best to satisfy. Handbooks should be used with caution. A lively imagination backed by experience is an invaluable asset.

Take, for example, a concrete job. It is not enough to calculate the concrete and excavation quantities, arbitrarily assign unit costs and let it go at that. Instead, every possible contingency involving the spending of money must be considered. The engineer may first enquire as to the excavation. Is it of a sandy nature or is it clay? Will water be encountered? If so, it must be removed and then there is the question of the cost of, say, a gasoline pump, suction hose, flume, gas, oil and pump attendant, and possibly rubber boots for workmen, Perhaps the excavated material must be removed from the site, another item of expense. With regard to the concrete, there will be the cost of freight on cement, sand and gravel, truckage from railway siding to site, water supply, storage of cement, possible heating of materials in cold weather, etc. These are but a few of the cost items to be considered, but enough to show that the engineer must visualize every operation from start to finish of a project and use judgment in estimating the probable cost of each.

In conclusion, Mr. Crudge spoke briefly on the various types of bids, lump sum, cost plus percentage and cost plus a fixed fee.

A vote of thanks to the speaker was moved by J. K. Kerr, seconded by Robert Pike.

## Ottawa Branch

*F. C. C. Lynch, A.M.E.I.C., Secretary-Treasurer.*

"The Northwest State Railways of India" was the subject of a noon luncheon address at the Chateau Laurier before the local Branch on March 8th, 1934. Colonel E. J. C. Schmidlin, Director of Engineer Services of the Department of National Defence, a graduate of the Royal Military College who spent several years of his career in the Mechanical Engineering Department of the above-mentioned railways, was the speaker.

Colonel Schmidlin was introduced by Alan K. Hay, A.M.E.I.C., chairman of the local Branch. Additional head table guests, all of whom were also graduates of the same institution, were: Brigadier C. F. Constantine, Brigadier A. C. Caldwell, Major-General H. A. Panet, Major Walter Blue, A.M.E.I.C., F. H. Peters, M.E.I.C., Colonel N. O. Carr, Colonel W. F. Hadley, A.M.E.I.C., Colonel H. E. Boak, Major E. L. M. Burns and Major K. M. Holloway.

Northwest State Railways of India

The railways of India, stated the speaker, have a total track mileage of about 42,000 miles. Some 74 per cent are state-owned, while nearly 50 per cent are state-managed. In the Punjab area, lying along the northwest frontier of India, the Northwestern Railway, with its 7,100 miles of track, is state-owned and operated, comprising a system not only of commercial importance but also of great stategic importance from a military standpoint. It forms a network over the whole Punjab with spurs reaching into Baluchistan to the very border of Afghanistan and also up to the summit of the famous Khyber Pass.

In the Punjab proper, the country is flat or gently rolling, the railway grades being easy. In the northwestern part and in Baluchistan, foothills and mountain spurs have had to be contended with so that the grades are as steep as 3 per cent in places and curves as sharp as 8 per cent. Much tunnelling has also been necessary. In some of these outlying parts, a 2 foot 6 inch gauge has been used, the greater part of the railway, however, being the standard Indian gauge, 5 feet 6 inches. The roadbed is first class throughout, the rail used being of a type familiar in this country, but held down with screw spikes on wooden ties.

Many of the great bridges of the Northwestern Railway were originally built forty years or more ago, with native labour constituting 80 to 90 per cent of the working force and under the most severe climatic conditions, and the greatest credit was due to the engineers of that day. It was the deeds of these men that inspired in Rudyard Kipling his great admiration for the engineering profession and provided him with material for some of his finest poems and stories.

Except in dimensions and in certain modifications required by climatic conditions, the rolling stock on Indian railways largely follows English practice. Passenger classification is used, as in England, with a corresponding range in fares. There are four classes: first, second, intermediate and third. Accommodation, on long-distance trains at least, is very good. The third class traffic is heavy on most lines, the total number of passengers carried on all Indian railways being over 600 millions per year. As the native does not mind being crowded, it has been possible to keep fares for third class well below one cent per mile.

Up to the present, the lack of roads has kept the problem of competition from motor-vehicles in the background. Its possible arrival has not been forgotten, however, and the Railway Board has been studying the problem in Europe and America, with a view to preventing in India the conflict of interests which has been so serious in the western countries.

## Peterborough Branch

*H. R. Sills, Jr.E.I.C., Secretary.*
*W. T. Fanjoy, Jr.E.I.C., Branch News Editor.*

Contribution of the Aeroplane to Canadian Industrial Development

William B. Burchall, advertising manager of Canadian Airways, Limited, addressed the Peterborough Branch at their regular meeting, Thursday evening, April 12th, 1934.

Mr. Burchall received his technical education at Manchester Technical College and his first connection with aviation was with the Sopwith Aviation Company, Kingston-on-Thames, England, from 1915-1919. He joined the staff of Western Canada Airways (now Canadian Airways, Limited) in 1927.

In discussing the contribution of the aeroplane to Canadian industrial development, Mr. Burchall stated that it was to the mining industry that aerial transport had made its greatest contribution. Less than ten years ago the first air route was established for the regular conveyance of passengers, mails and freight. This was to serve the gold fields at Rouyn. Later, in 1926, services were instituted at Red Lake, Ont., and these are still in operation. In the intervening years, over 393,000 pounds of mail, 13,153 passengers and 3,576,182 pounds of freight have been carried by Canadian Airways in the Red lake mining area.

Distance from rail head no longer precludes exploitation, for mining activity is prevalent almost to the shores of the Arctic ocean. In the newer productive mining areas the aeroplane alone provides speedy mail and passenger service.

Not only to mining, but to other primary industries—the fur trade, fishing, forestry, engineering—the aeroplane has rendered valuable assistance.

Air freighting of fresh fish from the lakes of northern Manitoba and Saskatchewan is a new development. The fish are caught in the winter time and have to be transported into the United States without being frozen. Over 60,000 pounds of fresh fish have been transported by air from the Lake of the Woods area during the present winter.

The aerial survey is being used by well informed civil engineers to solve many varied problems connected with town planning, preliminary surveys for the construction of hydro-electric projects, railroad and transmission line location.

## Quebec Branch

*Jules Joyal, A.M.E.I.C., Secretary-Treasurer.*

On Monday evening, March 12th, 1934, the Quebec Branch had the privilege of being addressed by Mr. H. P. Burrell, vice-president and general manager of Franki Compressed Pile Company of Canada, Limited.

J. M. H. Cimon, M.E.I.C., chairman of the Branch, presided, and introduced the speaker.

The Evolution of the Cast-in-Place Concrete Pile

The speaker first said that piles are used to provide proper foundations, and he traced their use to the time of the Egyptians. The piles used at that time consisted merely of sand filling a hole dug in clay or similar soil; however these served their purpose and were capable of transmitting considerable loads to firmer ground. As sand piles were unable to resist horizontal forces, the timber pile was introduced, and later, due to the short life of timber above the ground water level, the concrete pile was introduced.

The first engineer to use a concrete pile was Mr. Hennebique, a Frenchman, who in 1897 used a pile of concrete reinforced with steel and moulded before being driven into the ground. This precast pile had the advantage of being rot and fireproof, but it had certain disadvantages, and to overcome these a number of cast-in-place piles were developed.

The first concrete pile used in America was driven in 1905 by Mr. A. A. Raymond, his pile being the first cast-in-place pile.

Various types of concrete cast-in-place piles were described and commented upon by Mr. Burrell, viz. the Raymond, the Simplex pile, the Pedestal, the Thornley and the Vibro piles. All these piles are really variants of the timber pile, and as a contrast, the last pile described by Mr. Burrell, the Franki pile, was a radical departure. This pile, of Belgian origin, was introduced into North America about two years ago.

The present method of driving Franki piles consists of placing a charge of concrete in a steel tube of great strength; this charge is then compacted by a drop hammer which falls inside the tube pushing the concrete against the tube walls until the two form a single unit, then the hammer drives the concrete plug, which is still unset, into the ground and the plug pulls the tube with it. When a firm stratum is reached, the tube is anchored to the driver by means of cables and the concrete plug is driven out while small charges of concrete are added as driving proceeds.

By this means an enlarged base is formed at the bottom of the pile and when the concrete is so dense that the driving force tends to lift the tube out of the ground, the bulb may be considered as finished.

A charge of concrete is then placed in the tube, the hammer rested on it, the tube slightly withdrawn and the hammer is used to drive the concrete as already described and so on. The weight of the hammer is 3 tons and drops up to 30 feet are not unusual.

On extremely soft ground where no firm bottom can be reached, a different type of pile has been evolved which consists of forming an artificial stratum of conglomerate for the pile to rest on. The tube is sunk in the ordinary way to 20 or 30 feet; the tube is then anchored and the plug driven out, large stones or other material of similar nature coated with cement grout are put in the tube and driven out by means of a hammer; thus a mass of coarse material of perhaps 5 or 6 cubic yards is driven out.

Louis Beaudry, A.M.E.I.C., moved a hearty vote of thanks to the speaker.

## Saint John Branch

*S. Hogg, A.M.E.I.C., Secretary-Treasurer.*
*C. M. Hare, S.E.I.C., Branch News Editor.*

On Tuesday evening, March 13th, 1934, in the Admiral Beatty hotel the Saint John Branch of The Engineering Institute of Canada, with the chairman, G. A. Vandervoort, A.M.E.I.C., in the chair, heard Mr. W. B. Burchall of the Canadian Airways Ltd. give a very interesting address on "The Contribution of the Aeroplane to Canadian Industrial Development."

About forty members and guests were present. The lecture was illustrated with approximately one hundred slides, depicting the activities of Canadian Airways in the north and elsewhere.

THE CONTRIBUTION OF THE AEROPLANE TO CANADIAN INDUSTRIAL DEVELOPMENT

In a foreword Mr. Burchall explained the way in which the usefulness of heavier than air machines had expanded. The aeroplane, at first regarded as a military scout, developed rapidly during the war. With the coming of peace, this increased knowledge of the different types was put to good use in the field of exploration, survey and transport.

In the immediate post-war period, before the specialized types of to-day had developed, the aeroplane was used largely in new services which did not compete with ground services then in existence. With the gradual specialization of types, services became more diverse, and the speaker classed them as services exclusive to aircraft, such as, aerial sketching, vertical and oblique photography, dusting, and forestry patrol; and others competing directly with land services, such as transportation of mails, passenger and express.

The slides were then shown while the speaker described details of aircraft work.

At the conclusion of the address Mr. Burchall answered members' questions. A vote of thanks was moved, seconded, and tendered to the speaker by the chairman. On motion the meeting adjourned at 10.30 p.m.

## Saskatchewan Branch

*S. Young, A.M.E.I.C., Secretary-Treasurer.*

SEVENTEENTH ANNUAL MEETING

The seventeenth annual meeting of the Saskatchewan Branch was held in the Hotel Champlain, Regina, Friday evening, March 16th, 1934, being preceded by a dinner at which thirty-eight members and guests were in attendance.

Immediately following the dinner, P. C. Perry, A.M.E.I.C., chairman, welcomed the guests, after which several items of business received attention.

The chairman then introduced the speaker of the evening, S. E. Slipper, chief geologist, Canadian Western Natural Gas, Light, Heat and Power Co., Calgary, Alberta, the subject of his address being "Gas and Oil Possibilities in Saskatchewan."

Mr. Slipper briefly outlined the possibilities of gas and oil as falling under four heads, namely, sufficient source, sufficient metamorphosis, sufficient porosity and sufficient structure.

Petroleum is dissimilar in origin to coal, resulting from marine deposits of which it may be said that southern and western Saskatchewan is plentifully supplied.

After explaining the effect of static and dynamic metamorphism, Mr. Slipper proceeded to explain the effects of these forces on the formation of petroleum. Static metamorphism results ultimately in methane gas and carbon at a depth of approximately 20,000 feet. Consequently the formation of petroleum in Alberta and Saskatchewan must have resulted from dynamic metamorphism caused by lateral pressure from the building up of the Rocky Mountains. Tracing the various types of petroleum in Alberta eastward towards Saskatchewan one must conclude that only heavy oil and dry gases will be found in Saskatchewan.

The speaker then described the several types of structure of sufficient porosity (reservoir), including in these sands, sandstones and dolomitic limestones.

If there is insufficient structure, he stated, the reservoir capacity is of little or no commercial value.

Mr. Slipper concluded his address by stating that Saskatchewan is not as well off in petroleum possibilities as Alberta. On the other hand there are possibilities which he classified as follows:—

| | Saskatchewan | | | |
|---|---|---|---|---|
| | S.W. | N.W. | Central | S.E. |
| Sufficient source | G. | G. | G. | G. |
| Sufficient metamorphosis | M. | M. | P. | P. |
| Sufficient porosity | M. | M. | M. | M. |
| Sufficient structure | M. | M. | M. | F. |

Note: G—good. M—fair. P—poor.

During the discussion, in which several members and guests took part, he explained the several geophysical methods of discovery.

A hearty vote of thanks was tendered the speaker on motion of D. A. R. McCannell, M.E.I.C., and C. J. McGavin, A.M.E.I.C.

The scrutineers then reported the newly elected officers for the ensuing year.

## Toronto Branch

*W. S. Wilson, A.M.E.I.C., Secretary-Treasurer.*
*O. Holden, A.M.E.I.C., Branch News Editor.*

On February 1st, 1934, the Toronto Branch of The Engineering Institute of Canada met in the Debates room of Hart House, following an informal luncheon.

VALUATION AND DEPRECIATION

The meeting was presided over by A. B. Crealock, A.M.E.I.C., chairman of the Toronto Branch, who introduced the speaker, Mr. W. G. Moulton-Redwood. Mr. Moulton-Redwood presented a most interesting and instructive paper on the subject of "Valuation and Depreciation." Following a few introductory remarks, the speaker emphasized the necessity of co-operation between the engineer and accountant to show fair values. He then showed an interesting curve of "Average price trend," extending from the year 1912 to 1932, also a valuation form used in his own practice for collecting the engineering and accounting data. Mr. Moulton-Redwood pointed out that the aim of the work is to "convince all interested parties of the fairness and impartiality of the work." The speaker described depreciation as being a combination of wear and tear, and inadequacy or obsolescence. He outlined his method of arriving at depreciation based on original costs, which he stated was a method generally followed. Mr. Moulton-Redwood outlined the various methods of setting up depreciation for accounting purposes, and showed a table used in his practice to obtain uniformity in the collecting of data.

The subject was discussed by various members present, and a number of interesting points were brought out. Following the discussion, a hearty vote of thanks was tendered the speaker.

## Victoria Branch

*I. C. Barltrop, A.M.E.I.C., Secretary-Treasurer.*
*Kenneth Reid, Jr.E.I.C., Branch News Editor.*

The Victoria Branch of The Institute held its third annual bridge party on Saturday evening, April 7th, 1934, and through the kindness of Mr. and Mrs. F. C. Green their commodious home on Foul Bay road was again offered for the occasion. Ten tables of bridge were placed in the living room, the players comprising members of the Victoria Branch, their wives and friends.

Auction bridge was played from 8.30 to 11.30 followed by a buffet supper served in the adjacent dining room, tea and coffee being poured by Mrs. I. C. Barltrop and Mrs. Owen Smith. The table and living room decorations consisted of bowls of tulips and other flowers. The prizes for the evening were graciously presented to the respective winners by Mrs. Green.

An exceedingly enjoyable evening was concluded with a hearty vote of thanks being extended to Mr. and Mrs. Green for their kind hospitality by Major H. L. Swan, M.E.I.C., on behalf of the guests, this being the third consecutive occasion that such had been enjoyed by the Branch.

## Winnipeg Branch

*E. W. M. James, A.M.E.I.C., Secretary-Treasurer.*
*E. V. Caton, M.E.I.C., Branch News Editor.*

At the regular meeting of the Winnipeg Branch of The Engineering Institute of Canada, held on Thursday evening, March 1st, 1934 in Theatre "A," University building, A. J. Taunton, A.M.E.I.C., in the chair, a paper was given by Mr. J. W. Tomlinson on "Electric Soil Heating."

Mr. Tomlinson was particularly well qualified to speak on this matter, as in addition to being a graduate electrical engineer, he has had actual commercial experience in market gardening and marketing of farm produce. He dealt with actual results obtained from experiments carried on at the Manitoba Agricultural College, and under commercial conditions (of which he was in charge) which was sponsored by the Winnipeg Electric Company.

The speaker stated that electric soil heating is the application of electricity to horticulture. It is the use of electricity to supply heat directly to the soil to promote quicker and more uniform plant growth in hotbeds, on greenhouse benches and even in the open field. The heat is supplied by means of a low temperature soil heating cable which is buried in the soil. The amount of heat supplied is regulated to requirements by hand or preferably by an electric thermostat.

The use of electricity in this way was first introduced in Norway in 1927 and has spread from there to Sweden and to most other northern European countries and thence to the United States and Canada.

Only partial records are available but they indicate that upwards of one million kilowatt hours of electricity were used for electric soil heating in the United States in 1932. By the end of May, 1933, two thousand soil heating thermostats and three hundred and thirty thousand feet of soil heating cable were sold; and the power consumption was four times that for 1932. Climatic conditions and low power rates make Canada an exceptionally suitable field for electric soil heating.

The logical method of introducing this new agricultural tool to the grower is to operate typical installations in the territory where it is to be sold. In 1932 numerous installations were started in the market gardening districts around Montreal, the Shawinigan Power Company being the chief sponsor. In Ontario the Hydro-Electric Power Commission has taken an active interest in several installations. In Manitoba the Winnipeg Electric Company is sponsoring test installations, and in British Columbia the B.C. Electric Company has undertaken to prove its practical value. The fact that the power companies have been behind most of the experimental installations leads to the conclusion that electric soil heating must constitute a desirable load. Some of its desirable features are: 1, 100 per cent power factor; 2, high load factor; 3, 70 to 75 per cent night load; 4, peak consumption during early spring months; 5, mostly connected to underloaded rural distribution feeders.

The advantages to the grower are equally outstanding, the principal one being a clean, reliable and readily controlled source of heat which can be applied directly to the soil.

The meeting closed with a hearty vote of thanks being tendered to Mr. Tomlinson.

# Preliminary Notice

### of Applications for Admission and for Transfer

April 27th, 1934

The By-laws provide that the Council of The Institute shall approve, classify and elect candidates to membership and transfer from one grade of membership to a higher.

It is also provided that there shall be issued to all corporate members a list of the new applicants for admission and for transfer, containing a concise statement of the record of each applicant and the names of his references.

In order that the Council may determine justly the eligibility of each candidate, every member is asked to read carefully the list submitted herewith and to report promptly to the Secretary any facts which may affect the classification and selection of any of the candidates. In cases where the professional career of an applicant is known to any member, such member is specially invited to make a definite recommendation as to the proper classification of the candidate.*

If to your knowledge facts exist which are derogatory to the personal reputation of any applicant, they should be promptly communicated.

**Communications relating to applicants are considered by the Council as strictly confidential.**

The Council will consider the applications herein described in June, 1934.

R. J. Durley, Secretary.

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* The professional requirements are as follows:—

**A Member** shall be at least thirty-five years of age, and shall have been engaged in some branch of engineering for at least twelve years, which period may include apprenticeship or pupilage in a qualified engineer's office, or a term of instruction in a school of engineering recognized by the Council. The term of twelve years may, at the discretion of the Council, be reduced to ten years in the case of a candidate for election who has graduated from a school of engineering recognized by the Council. In every case the candidate shall have held a position in which he had responsible charge for at least five years as an engineer qualified to design, direct or report on engineering projects. The occupancy of a chair as a professor in a faculty of applied science of engineering, after the candidate has attained the age of thirty years, shall be considered as responsible charge.

**An Associate Member** shall be at least twenty-seven years of age, and shall have been engaged in some branch of engineering for at least six years, which period may include apprenticeship or pupilage in a qualified engineer's office or a term of instruction in a school of engineering recognized by the Council. In every case a candidate for election shall have held a position of professional responsibility, in charge of work as principal or assistant, for at least two years. The occupancy of a chair as an assistant professor or associate professor in a faculty of applied science of engineering, after the candidate has attained the age of twenty-seven years, shall be considered as professional responsibility.

Every candidate who has not graduated from a school of engineering recognized by the Council shall be required to pass an examination before a board of examiners appointed by the Council. The candidate shall be examined on the theory and practice of engineering, with special reference to the branch of engineering in which he has been engaged, as set forth in Schedule C of the Rules and Regulations relating to Examinations for Admission. He must also pass the examinations specified in Sections 9 and 10, if not already passed, or else present evidence satisfactory to the examiners that he has attained an equivalent standard. Any or all of these examinations may be waived at the discretion of the Council if the candidate has held a position of professional responsibility for five or more years.

**A Junior** shall be at least twenty-one years of age, and shall have been engaged in some branch of engineering for at least four years. This period may be reduced to one year at the discretion of the Council if the candidate for election has graduated from a school of engineering recognized by the Council. He shall not remain in the class of Junior after he has attained the age of thirty-three years, unless in the opinion of Council special circumstances warrant the extension of this age limit.

Every candidate who has not graduated from a school of engineering recognized by the Council, or has not passed the examinations of the third year in such a course, shall be required to pass an examination in engineering science as set forth in Schedule B of the Rules and Regulations relating to Examinations for Admission. He must also pass the examinations specified in Section 10, if not already passed, or else present evidence satisfactory to the examiners that he has attained an equivalent standard.

**A Student** shall be at least seventeen years of age, and shall present a certificate of having passed an examination equivalent to the final examination of a high school, or the matriculation of an arts or science course in a school of engineering recognized by the Council.

He shall either be pursuing a course of instruction in a school of engineering recognized by the Council, in which case he shall not remain in the class of Student for more than two years after graduation; or he shall be receiving a practical training in the profession, in which case he shall pass an examination in such of the subjects set forth in Schedule A of the Rules and Regulations relating to Examinations for Admission as were not included in the high school or matriculation examination which he has already passed; he shall not remain in the class of Student after he has attained the age of twenty-seven years, unless in the opinion of Council special circumstances warrant the extension of this age limit.

**An Affiliate** shall be one who is not an engineer by profession but whose pursuits, scientific attainments or practical experience qualify him to co-operate with engineers in the advancement of professional knowledge.

The fact that candidates give the names of certain members as reference does not necessarily mean that their applications are endorsed by such members.

#### FOR ADMISSION

BECK—HUMPHREY CAMPBELL, of Sandringham, Norfolk, England, Born at Wyton, Huntingdonshire, England, Dec. 20th, 1905; Educ., Diploma in Electrical Engineering Sciences, Swiss Federal Technical University, Zurich, 1928; 1926 (3 mos.), workshop experience at Ateliers de Construction Mécaniques de Vevey, Switzerland; 1927 (2 mos.), workshop experience, and 1928-32, mercury arc rectifier dept., Brown Boveri & Co., Baden, Switzerland. Execution of various contracts in Great Britain and Canada. Design of stations and ordering of apparatus. Completing works and putting in operation; 1932-34, res. engr. in Canada for same company (Compressors, steam turbines, rectifiers. Inspection, sales, mtce.). Now returning to company's head office in Baden, Switzerland.

References: K. B. Thornton, F. T. Kaelin, F. S. Keith, N. H. A. Eager, J. H. Thompson, L. E. Krebser.

CORNER—EDWARD PONSONBY, of Montreal, Que., Born at Georgetown, Demerara, British Guiana, Mar. 6th, 1888; Educ., Glasgow Technical College, 1906-11; (formerly Assoc. Member, Inst. M.E. (Gr. Britain); 1906-12, apprenticeship, 3 years general shops, 2 years 2 mos. drawing office, Glasgow, Scotland (John McNeil & Co., and A. & A. W. McAnie); 1914-17, erection and operation, including design of several large chemical plants for manufacture of pyroligneous products, acetone, formaldehyde, ether-alcohol distillation, etc., Blair, Campbell & McLean, Govan, Scotland; 1917, chief engr., electrolytic zinc extraction plant at Swansea, Wales, for British Metals Extraction Corpn., completed new power installn., Babcock boilers, Williams & Robinson engines, coal-conveyor equipment, etc.; 1917-19, drawing office, Fawcett Preston & Co., Liverpool, England; 1919-30, technical representative for British West Indies on behalf of Fawcett Preston & Co.; 1930 to date, representative, Province of Quebec, Hamilton Gear and Machine Co., Toronto, Ont.

References: C. B. Hamilton, Jr., C. D. Woolward, K. G. Cameron, W. Griesbach, W. B. McLean, R. W. Farmer, R. J. Mattson.

GILBERT—GORDON MACDONALD, of Vancouver, B.C., Born at Ottawa, Ont., June 2nd, 1899; B.Sc. (C.E.), Univ. of Man., 1926. Member of B.C. Assn. of Prof. Engrs. by exam.; since graduation in 1926, continuously employed by the Vancouver and District Joint Sewerage and Drainage Board, as asst. to the chief engineer; Resident engr. on different constrn. jobs, at present acting engr. and supt. of the Board.

References: E. A. Cleveland, W. H. Powell, J. R. Grant, R. Rowe, W. O. Scott.

GILCHRIST—JOHN, of 6 Weredale Park, Westmount, Que., Born at Glasgow, Scotland, July 31st, 1907; Educ., B.Sc. (E.E.), Univ. of N.B., 1932; 1922-24, ap'tice, machine and fitting shops, Barr & Stroud, Glasgow, Scotland; 1926-29, control survey, International Paper Co., field and office work, Quebec, N.B. and Nfld.; 1930 (summer), summer course in signalling and communication, R.C.C.S., Camp Borden, Ont.; 1931 (summer), boiler survey re location of stokers, E. S. Stephenson & Co., Saint John, and concrete inspection, Saint John Harbour Commission; 1932 (summer), instrument work on road constrn., City of Saint John, N.B.; Oct. 1933 to date, designer and dftsman., General Steel Wares, Montreal, Que.

References: J. Stephens, A. F. Baird, A. C. D. Blanchard, G. N. Hatfield, D. A. Duffy, E. O. Turner, W. J. Johnston, G. G. Hare.

HJERTHOLM—OSWALD, of 90 Arlington Ave., Westmount, Que., Born at Durban, South Africa, Jan. 11th, 1906; Educ., Diploma of Electro-Technical course at Bergen Technical School, Norway; Four months surveying for Norwegian Govt.; 1924-26, dftsman for E. Helmers-Olsen, Bergen, Norway; 1926-28, dftsman., The Aluminum Co. of Canada; at present, estimator and dftsman., for P. Hjertholm, general contractor, Montreal, Que.

References: L. H. Burpee, A. T. Bone, E. R. Smallhorn, H. R. Wake.

MacGREGOR—KENNETH ROY, of Eganville, Ont., Born at Eganville, Nov. 6th, 1901; 1924 (6 mos.), instr'man and asst. engr., Renfrew County Highways; 1925 (May-Aug.), instr'man., hydrographic survey, Lake Nipigon; 1925-27, instr'man on prelim. layout and power house constrn. for H.E.P.C. of Ontario, at Hydro, Ont.; 1928-29, engr. and constrn. supt., Abana Mines, Dupuy, Que.; 1929-30, field engr. for Carter Hall Aldinger Co. at Seven Sisters power development, Manitoba; 1930-32, chief instr'man in charge of all layout for City of Winnipeg Hydro at Slave Falls, Man.; at present, foreman in charge, Race Horse Camp, Petewawa, Ont.

References: W. P. Wilgar, J. N. Stanley, W. L. LeRoy, J. W. Sanger, J. L. H. Bogart.

RICHES—CLARENCE HAROLD JOHN RICHARD, of Toronto, Ont., Born at Toronto, April 29th, 1901; Educ., 1921-26, Univ. of Toronto (Dept. of Metallurgical Engrg). Completed attendance in 3rd year, but passed only in 2nd year; 1924-25 (summers) and 1926-31, with the American Smelting and Refining Co., as follows: 1924, experimental work; 1925, foreman, copper inspection; 1926-27, research chemist; 1927-28, shift foreman, copper refinery; 1928-29, asst. supt., copper refinery; 1929-31, supt. secondary metals; 1931-32, with Canadian Copper Refineries Ltd., foreman, silver refinery and copper casting dept.; 1932 to date, with Charles H. Riches & Sons, Patent and Trade Mark Attorneys, at present partner in firm. Engaged in preparation and prosecution of patent applications, approx. 50% of the work being on metallurgical and mining subjects.

References: T. R. Loudon, H. E. T. Haultain, R. E. Smythe, A. T. Byram, W. B. Redfern, W. H. M. Laughlin.

STEPHENS—DONALD McGREGOR, of 522 Richmond St., Winnipeg, Man., Born at Reston, Man., Nov. 17th, 1903; Educ., B.Sc. (C.E.), Univ. of Man., 1931; 1928 (summer), rodman, Man. Good Roads; 1929 (May-July), dftsman and calculator, Underwood & McLellan, The Pas; 1929 (July-Oct.), asst. to H. F. Lambart, D.L.S., A.M.E.I.C., surveys, Churchill River area; 1930 (May-Oct.), asst. on control traverse, same area; also June-Sept. 1931; 1932-33 (summers), asst., topog'l. survey and townsite subdivn.; Sessions 1931-32 and 1932-33, instructor in civil engrg., Univ. of Manitoba; (In case of subdivn. work in 1932-33 in charge of all office work, including design, setting grades, etc.); at present, technical dftsman., surveys branch, Dept. Mines and Natural Resources, Winnipeg, Man.

References: G. H. Herriot, J. N. Finlayson, S. E. McColl, R. A. McLellan, D. N. Sharpe.

STIRLING—JOHN BERTRAM, of Montreal, Que., Born at Dundas, Ont., Nov. 29th, 1888; Educ., B.Sc., Queen's Univ., 1911; R.P.E. of N.B.; 1911-16, asst. engr. with Willis Chipman (Chipman & Power), Toronto and Winnipeg; 1917, overseas, C.E.F.; for the past 16 years to date, field engr. and supervising engr. on many contracts with E. G. M. Cape and Company, and for the past 6 years a partner of this firm. In responsible charge of many large works throughout Canada.

References: E. G. M. Cape, J. M. R. Fairbairn, A. Gray, D. C. Tennant, G. R. MacLeod, C. J. Desbaillets.

TAYLOR—ANDREW, of 346 Union Ave., Winnipeg, Man., Born at Edinburgh, Scotland, Nov. 2nd, 1907; Educ., B.Sc. (C.E.), Univ. of Man., 1931; D.L.S. 1932; M.L.S. 1933; 1929-30 (summers), asst. on survey in Peace River, Dept. of Interior; 1931 to date, field asst. and at present plan calculator and examiner, Surveys Branch, Dept. of Mines and Natural Resources, Manitoba Govt.

References: S. E. McColl, G. H. Herriot, D. N. Sharpe, J. N. Finlayson, A. E. Macdonald.

### FOR TRANSFER FROM THE CLASS OF ASSOCIATE MEMBER TO THAT OF MEMBER

EVANS—EDWIN RONALD, of Lewisville, N.B., Born at Hampton, N.B., Aug. 1st, 1891; Educ., 1907-08, School of Applied Science, Mount Allison Univ.; Diploma in Municipal, Railroad and Civil Engrg., I.C.S.; Diploma in Struct'l Engrg., Wilson Engineering Corporation, Cambridge, Mass.; R.P.E. of N.B. 1920; 1909 (Aug.-Dec.), in charge and instr'man., Montreal Gen. Contracting Co., deepening All Candn. Channel, St. Lawrence River, Kingston to Brockville; 1910-11, as above with one asst.; 1912 (Jan.-Apr.), engr. in charge of party and instr'man., Hydrographic surveys, proposed car ferry wharves, etc., between N.B. and P.E.I.; 1912-15, engr. in charge party, rly. surveys, Buctouche to Loggieville, N.B., Prelim. and location, Design and erection trestle M. & B. Ry., Engr. in charge realignment surveys, plans, etc., Engr. in charge mtce. of way and supt.; 1915-19, overseas. C.F.A., Capt.; 1919 to 1933, with Can. Nat. Rlys., as follows: 1919-25, asst. engr. in charge constrn. (field supervision) Moncton yard and engine facilities (except bldg.), Moncton and Island yard rearrangement, Buctouche River rly. bridge, substructure of concrete abutments and piers; 1925-30, asst. engr. in charge field constrn., Bridgewater engine and boiler houses, Halifax Ocean Terminal transit sheds (later part), Halifax Ocean Terminal immigration facilities, C.N.R. Hotel and station foundations, Halifax. Res. Engr. for rly. on superstructure being erected by contractor; 1930-31, acting harbour engr., Moncton, in charge of reconstrn. of ferry terminal work at Cape Tormentine and Port Borden incl. wharf constrn. and installn. of fuel oil storage system at Port Borden; 1931-32, res. engr., constrn. of Saint John Rly. Station; 1932-33, res. engr., reconstrn. of Pier No. 4, Saint John River Bridge, Fredericton, N.B.; at present, private practice, civil and structural engr., Lewisville, N.B.

References: F. H. Fay, C. B. Brown, H. T. Hazen, H. J. Crudge, C. S. G. Rogers, A. S. Gunn, E. G. Evans.

GAHERTY—GEOFFREY ABBOTT, of Montreal, Que., Born at Dickenson's Landing, Ont., April 3rd, 1889; Educ., B.Eng., Dalhousie Univ., 1909; 1909-12, asst. engr., 1913-14, designing engr., Western Canada Power Co. Ltd.; 1914-19, overseas, C.E.F., Capt.; 1919-20, surveys and mill designs for Keeley Silver Mines, Ltd.; 1920 to date, with Montreal Engineering Co. Ltd., from 1922, chief engr. of this company, and from 1923, chief engr. of Calgary Power Co. Ltd., and at present President of both companies. (*A.M. 1921.*)

References: D. Stairs, J. H. McLaren, A. C. D. Blanchard, J. T. Farmer, J. V. Angus, R. E. C. Chadwick, T. H. Hogg, O. O. Lefebvre.

### FOR TRANSFER FROM THE CLASS OF JUNIOR

O'HALLORAN—JAMES, of Quebec, Que., Born at Montreal, May 27th, 1900; Educ., B.Sc., McGill Univ., 1921; 1917 (summer), dftsman for J. B. McRae, M.E.I.C., Ottawa; 1918 (summer), survey party, Dept. of Mines; 1920 (summer), asst. engr., Abitibi Power & Paper Co. Ltd., Iroquois Falls; 1921-24, asst. engr., with same company; 1924-27, asst. engr., Price Bros. & Co. Ltd., Kenogami, Que.; 1927 to date, engr. in charge of all mtce. and constrn. work, Anglo-Canadian Pulp & Paper Mills Ltd., Quebec, Que. (*S. 1919, Jr. 1922.*)

References: A. A. MacDiarmid, C. M. McKergow, E. Brown, C. N. Shanly, F. S. B. Heward.

SEXTON—JACK KENNETH, of Seebe, Alta., Born at London, England, Oct. 4th, 1904; Educ., B.Sc. (C.E.), Univ. of Sask., 1928; R.P.E. Alta.; 1925-26 (summers), chainman; 1927 (summer), instr'man in charge of municipal surveying party, Phillips, Stewart & Lee, Saskatoon, Sask.; 1928-31, with Calgary Power Company Ltd., asst. engr. on dam repair work; field engr. during constrn. of Ghost water power project; asst. to production supt., supervising mtce. and improvement, constrn., investigating proposed power schemes, testing hydraulic turbines, hydraulic studies of hydro-electric production for maximum efficiency, etc.; 1931-33, full time member of Faculty of Applied Science, Univ. of Alberta, demonstrating and instructing in civil engrg. subjects; at present employed at hydro-electric plant at Seebe, Alta., for Calgary Power Company. (*S. 1927, Jr. 1929.*)

References: R. S. L. Wilson, H. J. McLean, C. J. Mackenzie, G. H. Thompson, H. R. Webb, B. Russell, G. A. Gaherty.

WAY—WILLIAM RUSSELL, of 4564 Draper Ave., Montreal, Que., Born at North Bay, Ont., May 29th, 1896; Educ., B.Sc. (E.E.), McGill Univ., 1918; 1914-17 (summer work), rodman, C.P.R., underground surveying, Hollinger Gold Mines, dftsman., Nor. Electric Co.; 1918 to date, with the Shawinigan Water & Power Company, Montreal, as follows: 1918-23, asst. engr.; 1923-28, chief system operator; 1928-30, system operating engr.; 1930 to date, asst. supt. of operation. (*S. 1916, Jr. 1919*).

References: G. R. Hale, A. S. Runciman, F. S. Keith, J. A. McCrory, J. Morse, C. V. Christie, E. Brown.

### FOR TRANSFER FROM THE CLASS OF STUDENT

COWAN—ELIJAH, of Dolbeau, Que., Born at Middlesborough, Yorks, England, March 6th, 1900; Educ., B.A.Sc., Univ. of Toronto, 1923; 1923-25, dftsman., St. Lawrence Paper Mills; 1925-26, dftsman., Price Bros. & Co. Ltd.; 1926-27. designer on second extension, St. Lawrence Paper Mills; 1927-33, with International Paper Co., New York, 4 years, designing engr., 2 years asst. engr., mfg. dept.; at present, control man, Lake St. John Power & Paper Co. Ltd., Dolbeau, Que. (*S. 1921.*)

References: R. L. Weldon, A. A. MacDiarmid, G. F. Layne, F. O. White, J. F. Plow.

HALTALIN—CLIFFORD PAUL, of 636 Toronto St., Winnipeg, Man., Born at Winnipeg, Dec. 28th, 1906; Educ., B.Sc. (E.E.), Univ. of Man., 1929; 1927 (summer), refrigeration layouts, etc., Tully Ice Machine Co., Winnipeg; 1928 (summer), dfting mill layout for Flin Flon Mines with General Engineering Co. of New York, consltg. engrs. for Hudson Bay Mining & Smelting Co., Winnipeg; 1929 to date, with Winnipeg Electric Co., Winnipeg, Man., 1929-32, substation design, transmission line and water power calculations, 1932-34, design, layout and installn. of electric pumping equipment and electric boilers, and at present, asst. engr. in charge of dfting office. (*S. 1928.*)

References: E. V. Caton, L. M. Hovey, E. P. Fetherstonhaugh, J. N. Finlayson, T. H. Kirby.

LORD—GEORGE ROSS, of Toronto, Ont., Born at Peterborough, Ont., Feb. 2nd, 1906; Educ., B.A.Sc., Univ. of Toronto, 1929. M.Sc., Mass. Inst. Tech., 1933; 1933-34, German engrg. universities; 1927 (summer), Peterborough Utilities Commn.; 1928 (summer), General Motors of Canada Ltd., Oshawa, and from Apr. 1929 to June 1930, with same company in charge of cost control, tools and gauges for inspection dept.; 1930-31, instructor, hydraulic lab., Univ. of Toronto; 1931-32, with Technical Service Council, Toronto; 1932-33 (15 mos.), Freeman Traveller from the American Soc. of Civil Engrs., study of hydraulic methods in Europe; Jan. 1934 to date, lecturer in mech'l. engrg., Univ. of Toronto, Toronto, Ont. (*S. 1927.*)

References: R. W. Angus, C. H. Mitchell, R. E. Smythe, R. L. Dobbin, W. S. Wilson.

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## Ways to Kill a Society

1. Don't come to the meetings.
2. But if you do come, come late.
3. If the weather doesn't suit you, don't think of coming.
4. If you do attend a meeting, find fault with the work of the officers and other members.
5. Never accept an office, as it is easier to criticize than to do things.
6. Nevertheless, get sore if you are not appointed on a committee, but if you are, do not attend committee meetings.
7. If asked by the chairman to give your opinion regarding some important matter, tell him you have nothing to say. After the meeting tell everyone how things ought to be done.
8. Do nothing more than is absolutely necessary; but when other members roll up their sleeves and willingly, unselfishly use their ability to help matters along, howl that the association is run by a clique.
9. Hold back your dues as long as possible or don't pay at all.
10. Don't bother about getting new members. Let the secretary do it.
11. When a banquet is given, tell everybody money is being wasted on blowouts which make a big noise and accomplish nothing.
12. When no banquets are given say the association is dead and needs a can tied to it.
13. Don't ask for a banquet ticket until all are sold.
14. Then swear you've been cheated out of yours.
15. If you do get a ticket, don't pay for it.
16. If asked to sit at the speaker's table, modestly refuse.
17. If you are not asked, resign from the association.
18. If you don't receive a bill for your dues, don't pay.
19. If you receive a bill after you've paid, resign from the association.
20. Don't tell the association how it can help you; but if it doesn't help you, resign.
21. If you receive service without joining, don't think of joining.
22. If the association doesn't correct abuses in your neighbour's business, howl that nothing is done.
23. If it calls attention to abuses in your own, resign from the association.
24. Keep your eye open for something wrong and when you find it, resign.
25. At every opportunity threaten to resign and then get your friends to resign.
26. When you attend a meeting, vote to do something and then go home and do the opposite.
27. Agree to everything said at the meeting and disagree with it outside.
28. When asked for information, don't give it.
29. Cuss the association for the incompleteness of its information.
30. Get all the association gives you but don't give it anything except h—.
31. **When everything else fails, cuss the Secretary.**

—*Brooklyn Engineers' Club Bulletin and Cleveland Engineering.*

## Motor Car Silencing

It will be remembered that in 1932 the subject of noise came before Section G (Engineering) of the British Association, and that as a result of discussion arising out of Dr. G. W. Kaye's paper on the subject a committee was appointed to consider the practicability of reducing noise resulting from engineering developments. This was followed up by a paper in 1933 by Mr. R. S. Capon which dealt mainly with the reduction of noises in and arising from aeroplanes. Since the Leicester meeting the committee's attention has been directed to the question of reducing street noises due to motor traffic.

Although matters are still in a somewhat early stage, we are able to state that at the Aberdeen meeting considerable prominence will be given to this question. The programme is likely to find place for two or three papers on the subject, one dealing with motor-car and motor-cycle silencing, one with the measurement of noise, and a third with objectionable horns. In addition, the committee hope to be able to arrange for a practical demonstration during one of the afternoons, at which, if plans can be carried out, a motor-car of the sports type and a motor-bicycle will be run over a course unsilenced and then fitted with silencers of different design.

It is a fact that though efforts have been made to check motor noise, so far the results have remained disappointing, and it evidently requires the development of a strong public feeling on the matter before it will be taken in hand properly by the authorities. The organization of the demonstration will be in the hands of Professor T. R. Cave-Brown-Cave, C.B.E., University College, Southampton.—*Engineering.*

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It has been noted that the *Canadian Ohio Brass Co. Ltd., Montreal,* moved their offices on May 1st to 1107 Dominion Square Building, 1010 St. Catherine St. West. They were formerly located in the Canada Cement Building. Their telephone number at the new address is Harbour 2343.

# EMPLOYMENT SERVICE BUREAU

**The Service is operated for the benefit of members of The Engineering Institute of Canada, and for industrial and other organizations employing technically trained men—without charge to either party.**

*All correspondence should be addressed to*

**The Employment Service Bureau, The Engineering Institute of Canada**
**2050 Mansfield Street, Montreal**

## Situation Vacant

ENGINEER, required by a progressive Canadian company for sales and service work. Should be a graduate in chemical or mechanical engineering and have experience in combustion work or the operation of metallurgical or reheating furnaces. Apply to Box No. 984-V.

CIVIL ENGINEER. An established general contractor and engineer in Quebec would like to get in touch with a young engineer (civil preferably), having business and construction ability and a knowledge of French and estimating; of saving habits and pleasing personality, willing to undertake any work and able to partially finance himself to begin with and later, if satisfactory, to take an interest in the company. Apply to Box No. 1005-V.

## Situations Wanted

MECHANICAL ENGINEER, Canadian, with technical training and executive experience in both Cansdian and American industries, particularly plant layout, equipment, planning and production control methods, is open for employment with company desirous of improving manufacturing methods, lowering costs and preparing for business expansion. Apply to Box No. 35-W.

MECHANICAL ENGINEER, A.M.E.I.C. Married. Experience in machine shops, erection and maintenance of industrial plant mechanical and structural design. Reads German, French, Dutch and Spanish. Seeks any suitable position. Apply to Box No. 84-W.

PURCHASING ENGINEER, graduate mechanical engineer, Canadian, married, 34 years of age, with 13 years' experience in the industrial field, including design, construction and operation, 8 years of which had to do with the development of specifications and ordering of equipment and materials for plant extensions and maintenance; one year engaged on saie of surplus construction equipment. Full details upon request. Apply to Box No. 161-W.

CIVIL ENGINEER, age 44, open for employment anywhere, experience covers about 20 years' active work, including 7 years on municipal engineering, 2 years as Town Manager, 3 years on railway construction, 3 years on the staff of a provincial highway department, 2 years as contractor's superintendent on pavement construction. Apply to Box No. 216 W.

REINFORCED CONCRETE ENGINEER, B.Sc., P.E.Q., eight years experience in construction design of industrial buildings, office buildings, apartment houses, etc. Age 30. Married. Apply to Box No. 257 W.

ELECTRICAL ENGINEER, B.Sc., '28, Canadian. Age 25. Experience includes two summers with power company; thirteen months test course with C.G.E. Co ; telephone engineering, and the past thirty months with a large power company in operation and maintenance engineering. Location immaterial and available immediately. Apply to Box No. 266-W.

MECHANICAL ENGINEER, age 28, nine years allround experience, Grad. Inst. of Mech. Engs. England, S.E.I.C. Technical and practical training with first class English firm of general engineers; shop, foundry and drawing office experience in steam and Diesel engines, asphalt, concrete machinery, boilers, power plants, road rollers, etc. Experience in heating and ventilation design and equipment; 18 months designing draughtsman with Montreal consulting engineers. 2½ years sales experience, steam and hot water heating systems, power plant equipment, machinery, oil-burning apparatus. Canadian 4th class Marine Engineers Certificate; C.N.S. experience. Available at short notice. Apply to Box No. 270-W.

DESIGNING DRAUGHTSMAN, experience in layout of steam power house equipment and piping. Wide experience in mechanical drive and details of machinery, gearing, and hoists. Accustomed to layout of small mill buildings of steel and timber, structural design and details. Good references. Present location Montreal. Apply to Box No. 329-W.

PLANE-TABLE TOPOGRAPHER, B.Sc., in C.E. Thoroughly experienced in modern field mapping methods including ground control for aerial surveys. Fast and efficient in surveys for construction, hydro-electric and geological investigations. Apply to Box No. 431-W.

ELECTRICAL ENGINEER, B.Sc., A.M.E.I.C., Am.A.I.E.E., age 30, single. Eight years experience H.E. and steam power plants, substations, etc., shop layouts, steel and concrete design. Location immaterial. Available immediately. Apply to Box No. 435-W.

CIVIL ENGINEER, B.A.Sc., and C.E., A.M.E.I.C., age 30, married. Experience over the last ten years covers construction on hydro-electric and railway work as instrumentman and resident engineer. Also office work on teaching and design, investigations and hydraulic works, reinforced concrete, bridge foundations and caissons. Location immaterial. Available at once. Apply to Box No. 447-W.

SALES ENGINEER, M.A.Sc. Univ. of Toronto, wishes to represent firm selling building products or other engineering commodities, as their representative in Western Canada. Located in Winnipeg. Apply to Box No. 467-W.

## Situations Wanted

CIVIL ENGINEER, B.Sc., A.M.E.I.C., with six years experience in paper mill and hydro-electric work, desires position in western Canada. Capable of handling reinforced concrete snd steel design, paper mill equipment and piping layout, estimates, field surveys, or acting as resident engineer on construction. Now on west coast and available at once. Apply to Box No. 482-W.

MECHANICAL ENGINEER, B.Sc. Age 28, married. Four and a half years on industrial plant maintenance and construction, including shop production work and pulp and paper mill control. Also two and a half years on structural steel and reinforced concrete design. Available at once. Apply to Box No. 521-W.

CIVIL ENGINEER. Canadian, married, twenty-five years' technical and executive experience, specialized knowledge of industrial housing problems and the administration of industrial towns, also town planning and municipal engineering, desires new connection. Available on reasonable notice. Personal interview sought. Apply to Box No. 544-W.

ELECTRICAL AND MECHANICAL ENGINEER, B.Sc., A.M.E.I.C. Experience includes C.G.E. Students' Test Course and six years in engineering dept. of same company on design of electrical equipment. Four summers as instrumentman on surveying and highway construction. Several years experience in accounting previous to attending university. Desires position with industrial concern where the combination of technical and business experience will be of value. Apply to Box No. 564-W.

### Revision of Employment Registration File

If you have recently received a letter from The Institute Employment Service Bureau enquiring whether you are employed, it will be of assistance if you will reply without delay.

Letters have been sent to those registered and from whom no communication has been received for some time. From replies already in, it would appear that a number of members have recently secured work. However, where this is of a temporary nature the names are retained on the active file as available for permanent positions. This leaves any temporary jobs that may come to our attention for those whose needs are found to be the most pressing.

CIVIL ENGINEER, age 25, single, graduate. Creditable record on responsible hydro and railroad work in both Eastern and Western Canada. Apply to Box No. 567-W.

MECHANICAL ENGINEER, A.M.E.I.C., with twenty years experience on mechanical and structural design, desires connection. Available at once. Apply to Box No. 571-W.

MECHANICAL ENGINEER, B.A.Sc., '30, desires position to gain experience, and which offers opportunity for advancement. Experience in pulp and paper mill and one year in mechanical department of large electrical company. Location immaterial. Available immediately. Apply to Box No. 577-W.

DOMINION LAND SURVEYOR, and graduate engineer with extensive experience on legal, topographic and plane-table surveys and field and office use of aerophotographs, desires employment either in Canada or abroad. Available at once. Apply to Box No. 589-W.

MECHANICAL ENGINEER, Canadian, technically trsined; eighteen years experience as foreman, superintendent and engineer in manufacturing, repair work of all kinds, maintenance and special machinery building. Location immaterial. Available at once. Apply to Box No. 601-W.

CHEMICAL ENGINEER, S.E.I.C., B.Sc., University of Alberta, '30. Age 31. Single. Six seasons' practical laboratory experience, three as chief chemist and three as assistant chemist in cement plant; one year's p.g. work in physical chemistry; three years' experience teaching. Desires position in any industry with chemical control. Availsble immediately. Apply to Box No. 609-W.

DESIGNING ENGINEER AND ESTIMATOR, grad. Univ. of Toronto in C.E., A.M.E.I.C., twenty years experience in structural steel, construction and municipal work. Available at once. Apply to Box No. 613-W.

## Situations Wanted

CIVIL ENGINEER, A.M.E.I.C., R.P.E., Ontario; three years construction engineer on industrial plants; fourteen years in charge of construction of hydraulic power developments, tower lines, sub-stations, etc.; four years as executive in charge of construction and development of harbours, including railways, docks, warehouses, hydraulic dredging, land reclamation, etc. Apply to Box No. 647-W.

MECHANICAL ENGINEER, A.M.E.I.C., Canadian, technically trained; six years drawing office. Office experience, including general design and plant layout. Also two years general shop work, including machine, pattern and foundry experience, desires position with industrial firm in capacity of production engineer or estimator. Available on short notice. Apply to Box No. 676-W.

DIESEL ENGINEER. Erection and industrial engineer, A.M.E.I.C., technically trained mechanical engineer with English and Canadian experience in erection and operation of steam and Diesel equipment in power house and mines, pumping, rock drilling, air compressors. Experienced in industrial and steel works operations including rolling mills, quarries, sales. Open for position on maintenance, operation or sales engineer. Location immaterial. Apply to Box No. 682-W.

ELECTRICAL AND CIVIL ENGINEER, B.Sc., Elec., 29, B.Sc., Civil '33. Age 27. Jr.E.I.C. Undergraduate experience in surveying and concrete foundations; also four months with Canadian General Electric Co. Thirty-three months in engineering office of a large electrical manufacturing company since graduation. Good experience in layouts, switching diagrams, specifications and pricing. Best of references. Available immediately. Apply to Box No. 693-W.

MECHANICAL ENGINEER, B.Sc., '27, Jr.E.I.C. Four years maintenance of high speed Diesel engines units, 200 to 1,300 h.p. Also maintenance of D.C. and A.C. electrical systems and machinery. Draughting experience. Westinghouse apprenticeship course. Practical mechanical and electrical engineer with a special study of high speed Diesel engine design, application and operation. Location in western or eastern Canada immaterial. Apply to Box No. 703-W.

COMBUSTION ENGINEER, R.P.E., Manitoba, A.M.E.I.C. Wide experience with all classes of fuels. Expert designer and draughtsman on modern steam power plants. Experienced in publicity work. Well known throughout the west. Location, Winnipeg or the west. Available at once. Apply to Box No. 713-W.

ELECTRICAL ENGINEER, B.Sc., University of N.B., '31. Experience includes three months field work with Saint John Harbour Reconstruction. Apply to Box No. 722-W.

MECHANICAL ENGINEER, age 41, married. Eleven years designing experience with project of outstanding magnitude. Machinery layouts, checking, estimating and inspecting. Twelve years previous engineering, including draughting, machine shop and two years chemical laboratory. Highest references. Apply to Box No. 723-W.

CIVIL ENGINEER, B.Sc. (Alta. '31), S.E.I.C. Experience includes three seasons in charge of survey party. Transitman on railway maintenance, and concrete bridge designing Nature of work and location immaterial. Apply to Box No. 724-W.

YOUNG CIVIL ENGINEER, B.Sc. (Univ. of N.B. '31), with experience as rodman and checker on railroad construction, is open for a position. Apply to Box No. 728-W.

DESIGNING ENGINEER, M.Sc. (McGill Univ.), D.L.S., A.M.E.I.C., P.E.Q. Experience in design and construction of water power plants, transmission lines, field investigations of storage, hydraulic calculations and reports. Also paper mill construction, railways, highways, and in design and construction of bridges and buildings. Available at once. Apply to Box No. 729-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.Sc., Univ. of B.C. '30. Single, age 24. Sixteen months with the Allis-Chalmers Mfg. Co. as student engineer. Experience includes foundry production, erection and operation of steam turbines, erection of hydraulic machinery, and testing texropes and centrifugal pumps. Location immaterial. Available at once. Apply to Box No. 735-W.

CIVIL ENGINEER, M.Sc., A.M.E.I.C., R.P.E. (Ont.), ten years experience in municipal and highway engineering Read, write and talk French. Married. Served in France. Will go anywhere at any time. Experienced journalist. Apply to Box No. 737-W.

RADIO AND ELECTRICAL ENGINEER, B.Sc. '31, S.E.I.C. Age 27. Experience in installation of power and lighting equipment. Temporary operator in radio station; studio experience with part time announcing. Two summers in switchboard and installation department of telephone company, eight months on extensive survey layouts. Interested in sales work of electrical or radio equipment. Available on short notice. Location immaterial. Apply to Box No. 740-W.

CIVIL ENGINEER, graduate '29. Married. One year building construction, one year hydro-electric construction in South America, fourteen months resident engineer on road construction. Working knowledge of Spanish. Apply to Box No. 744-W.

SALES ENGINEER, B.Sc., McGill, 1923, A.M.E.I.C. Age 33. Married. Extensive experience in building construction. Thoroughly familiar with steel building products; last five years in charge of structural and reinforcing steel sales for company in New York state. Available at once. Located in Canada. Apply to Box No. 749-W.

## Situations Wanted

DESIGNING ENGINEER, graduate Univ. Toronto '26. Thoroughly experienced in the design of a broad range of structures, desires responsible position. Apply to Box No. 761-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. Queen's Univ. '29. Age 25. Married. Three years experience as construction eupt. and estimator for contracting firm. Experience includes general building, bridges, sewer work, concrete, boiler settings, eand blasting of bridges and spray painting. Available at once. Apply to Box No. 776-W.

CIVIL ENGINEER, B.Sc., '25, Jr.E.I.C., P.E.Q., married. Desires position, preferably with construction firm. Experience includes railway, monument and mill building construction. Available immediately. Apply to Box No. 780-W.

DRAUGHTSMAN, experience in civil engineering, forestry engineering, land surveying and house construction. Good references. Apply to Box No. 781-W.

ELECTRICAL AND SALES ENGINEER, S.E.I.C., grad. '28. Experience includes one year test course, one year switchboard design and two years switchboard and switching equipment sales with large electrical manufacturing company. Three summers Pilot Officer with R.C.A.F. Available at once. Apply to Box No. 788-W.

ELECTRICAL ENGINEER. Specializing in power and illumination reports, estimates, appraisals, contracts and rates, plans and specifications for buildings. Available on interesting terme. Apply to Box No. 795-W.

CIVIL ENGINEER, S.E.I.C., graduate '30, age 23, single. Experience includes mining surveys, assistant on highway location and construction, and assistant on large construction work. Steel and concrete layout and design. Apply to Box No. 809-W.

CIVIL ENGINEER, college graduate, age 27, single. Experience includes surveying, draughting concrete construction and design, street paving both asphalt and concrete. Available at once; will consider anything and go anywhere. Apply to Box No. 816-W.

CIVIL ENGINEER, B.E. (Sask. Univ. '32), S.E.I.C. Single. Experience in city street improvement; sewer and water extensions. Good draughtsman. References. Available at once. Location immaterial. Apply to Box No. 818-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. (Queen's '32), age 21. Three summers surveying in northern Quebec. Interested in hydraulics and reinforced concrete. Available at once. Location immaterial. Apply to Box No. 822-W.

CIVIL ENGINEER, B.Sc., A.M.E.I.C., with fifteen years experience mostly in pulp and paper millwork, reinforced concrete and structural steel design, field surveys, layout of mechanical equipment, piping. Available at once. Apply to Box No. 825-W.

ELECTRICAL ENGINEER, E.E.I.C., grad. '29, age 24, married; experience includes one year Students Test Course, sixteen months in distribution transformer design and eight months as assistant foreman in charge of industrial control and switchgear tests. Location immaterial. Available at once. Apply to Box No. 828-W.

CIVIL ENGINEER, B.A.Sc., D.L.S., O.L.S., A.M.E.I.C., age 46, married. Twelve years experience in charge of legal field surveys. Owns own surveying equipment. Eight years on technical, administrative, and editorial office work. Experienced in writing. Desires position on survey work, assisting in or in charge of preparation of house organ, on staff of technical or semi-technical magazine, or on publicity, editorial or administrative office work. Available at once. Will consider any salary, and any location. Apply to Box No. 831-W.

CIVIL ENGINEER, M.Sc., R.P.E. (Sask.). Age 27. Experience in location and drainage surveys, highways and paving, bridge design and construction city and municipal developments, power and telephone construction work. Available on short notice. Apply to Box No. 839-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. '32 (Univ. of N.B.). Age 25, married. Two years experience in power line construction and maintenance; one year of highway construction; one summer surveying for power plant site, location and spur railway line construction. Available at once. Location immaterial. Apply to Box No. 840-W.

CIVIL ENGINEER, B.Sc. '15, A.M.E.I.C., married, extensive experience in responsible position on railway construction, also highways, bridges and water supplies. Position desired as engineer or superintendent. Available at once. Apply to Box No. 841-W.

CIVIL ENGINEER, B.Sc. (Altn. '31), S.E.I.C., age 24. Experience, three summers on railroad maintenance, and seven months on highway location as instrumentman. Willing to do anything, anywhere, but would prefer connection with designing or construction firm on structural works. Available immediately. Apply to Box No. 846-W.

MECHANICAL ENGINEER, Jr.E.I.C., technical graduate, bilingual, age 30. Two years as designing heating draughtsman with one of the largest firms of its kind on this continent handling heating materials; three years designing draughtsman in consulting engineers' office, mechanical equipment of buildings, heating, ventilation, sanitation, power plant equipment, writing of specifications, etc. Present location Montreal. Available at once. Apply to Box No. 850-W.

BRIDGE AND STRUCTURAL ENGINEER, A.M.E.I.C., McGill. Twenty-five yeare' experience on bridge and structural staffs. Until recently employed. Familiar with all late designs, construction, and practices in all Canadian fabricating plants. Desirous of employment in any responsible position, sales, fabrication or construction. Apply to Box No. 851-W.

STRUCTURAL ENGINEER, B.A.Sc., A.M.E.I.C. Twenty-two years experience in design of bridges and all types of buildings in structural steel and reinforced concrete. Three years experience in railway construction and land surveying. Apply to Box No. 856-W.

MECHANICAL ENGINEER, B.Sc. '32, E.E.I.C. Good draughtsman. Undergraduate experience:—One year moulding shop practice; two years pipe fitting and sheet metal work; one year draughting and tracing on paper mill layout; six months machine shop practice; and eight months fuel investigation and power heating plant testing. Desires position offering experience in steam power plants or heating and ventilating design. Will go anywhere. Apply to Box No. 858-W.

MECHANICAL ENGINEER, age 31, graduate Sheffield (England) 1921; apprenticeship with firm manufacturing steam turbine generators and auxiliaries and subsequent experience in design, erection, operation and inspection of same. Marine experience B.O.T. certificate thoroughly conversant with Canadian plants and equipment. Available on short notice. Any location. Box No. 860-W.

CHEMICAL ENGINEER, B.Sc. (McGill '21), A.M.E.I.C., age 36, married; three years since graduation with pulp and paper mills; eight years in shops, estimating and sales divisions of well-known gas engineering and construction companies in the United States. Excellent references. Available on short notice. Apply to Box No. 866-W.

CONSTRUCTION ENGINEER (Toronto Univ. of '07). Experience includes hydro-electric, municipal and railroad work. Available immediately. Location immaterial. Apply to Box No. 886-W.

ELECTRICAL ENGINEER, graduate 1929, S.E.I.C. Single. Experience includes two years with electrical manufacturing concern and one on highway construction work. Available at once. Will go anywhere. Apply to Box No. 887-W.

CIVIL ENGINEER, B.Sc., Montreal 1930, age 26, single, French and English, desires position technical or non-technical in engineering, industrial or commercial fields, sales or promotion work. Experience includes three years in municipal engineering on paving, sewage, waterworks, filter plant equipment, layout of buildings, etc. Available immediately. Apply to Box No. 891-W.

ELECTRICAL ENGINEER, grad. Univ. of N.B. '31. Experienced in surveying and draughting, requires position. Available at once. Will go anywhere. Apply to Box No. 893-W.

CIVIL ENGINEER, B.A.Sc., Jr.E.I.C., age 29, single. Experience includes two years in pulp mill as draughtsman and designer on additions, maintenance and plant layout. Three and a half years in the Toronto Buildings Department checking steel, reinforced concrete, and architectural plans. Available at once. Location immaterial. At present in Toronto. Apply to Box No. 899-W.

DESIGNING ENGINEER, A.M.E.I.C. Permanent and executive position preferred but not essential. Fifteen years experience in designing power plants, engine and fan rooms, kitchens and laundries. Thoroughly familiar with plumbing and ventilating work, pneumatic tubes, and refrigeration, also heating, electrical work, and specifications. Apply to Box No. 913-W.

ENGINEER, B.Sc., A.M.E.I.C., R.P.E. (N.B.), age 35, married. Seven years' mining experience as sampler, assayer, surveyor, field work, and foreman in charge of underground development: two years as assistant engineer on highway construction and maintenance. Available on short notice. Apply to Box No. 932-W.

CIVIL ENGINEER, B.Sc., '25, McGill Univ., Jr.E.I.C., P.E.Q., age 32, married. Experience as rodman and instrumentman on track maintenance. Seven and one-half years with Canadian paper company, as assistant office engineer handling all classes of engineering problems in connection with woods operations, i.e., road buildings, piers, booms, timber bridges, depots, dams, etc. Apply to Box No. 933-W.

ELECTRICAL ENGINEER, Dipl. of Eng., B.Sc. (Dalhousie Univ.), S.B. and S.M. in E.E. (Mass. Inst. of Tech.), Canadian. Married. Seven and a half years' experience in design, construction and operation of hydro, steam and industrial plants. For past sixteen months field office electrical engineer on 510,000 h.p. hydro-electric project. Available at once. Apply to Box No. 936-W.

CIVIL ENGINEER, B.Sc., O.P.E. Experience includes several years on municipal work-design and construction of sewers, steel and concrete bridges, watermains and pavements. Available at once. Apply to Box No. 950-W.

ELECTRICAL ENGINEER, twenty years experience, desires position, either temporary or permanent. Experienced in design, construction, and operation of power and industrial plants, and supt. of construction. Apply to Box No. 974-W.

CIVIL ENGINEER, B.Sc. (Univ. of Sask. '33), S.E.I.C., age 28, single. Experience in testing hydro-electric equipment, draughting, surveying, city street, improvements, technical photography. Available at once. Location immaterial. Apply to Box No. 986-W.

ENGINEER SUPERINTENDENT, age 44. Engineering and business training, executive ability, tactful, energetic. Had charge of several large projects. Intimate knowledge of costs and prices, reports and estimates. Available immediately. Any location. Apply to Box No. 1021-W.

CIVIL ENGINEER, B.Sc. (Queen's 14), A.M.E.I.C., Dominion Land Surveyor, 5 months' special course at the University of London, England, in municipal hygiene and reinforced concrete construction. Experience covers legal and topographic surveys, plane tabling and stadia surveying, railway and highway construction, drainage and excavation work. Available at once. Apply Box No. 1035-W.

ELECTRICAL ENGINEER AND GEOPHYSICIST. Age 36. Married. Seven years experience in geophysical exploration using seismic, magnetic and electrical methods. Two years experience with the Western Electric Company of Chicago, working on equipment and magnetic materials research. Experienced in radio and telephone work, also specializing in precise electrical measurements, resistance determinations, ground potentials and similar problems of ground current distribution. Apply to Box No. 1063-W.

ELECTRICAL ENGINEER, B.A.Sc. Univ. Toronto '28. Experience includes Can. Gen. Elec. Co. Test Course. Also more than two years in the engineering dept. of the same company. Available on short notice. Preferred location central or eastern Canada. Apply to Box No. 1075-W.

ELECTRICAL ENGINEER, B.Sc. Married. Eight years electrical experience, including operation, maintenance and construction work, electrical design work on large power development, mechanical ability, experienced photographer, employed in electrical capacity at present. Available on reasonable notice. Apply to Box No. 1076-W.

INDUSTRIAL ENGINEER, B.A.Sc. in Chem. Eng. (Tor. '31), E.B. in Indust. Eng. (Mass. Inst. of Tech. '32), S.E.I.C. Age 25 years. Northern Electric Training Course. Construction and sales experience. Rockefeller Research Associate at McGill University in industrial engineering for past year and to date. Desire work in production or financial departments of a manufacturing plant. Apply to Box No. 1098-W.

CIVIL ENGINEER, age 27, graduate 1930, single. Experieuce includes detailing, designing and estimating structural steel, plate work and pressure vessels; also hydrographic surveying. Available at once. Apply to Box No. 1111-W.

ELECTRICAL ENGINEER, S.E.I.C., single, age 24 years. Four consecutive yeare at Univ. of N.B. in electrical engineering. Summer experience in bridge and road construction and auto repairing, desires position in industrial or power plant. Any locality. References on request. Apply to Box No. 1114-W.

CIVIL ENGINEER, B.Sc. Sask. '30. S.E.I.C. Age 24 years. Experience in municipal engineering, including sewer and water construction, sidewalk construction, paving, storm sewer design, draughting, precise levelling, and reinforced concrete bridge construction. Unmarried. Available at once. Will go anywhere. Apply to Box No. 1115-W.

ELECTRICAL ENGINEER, B.Sc.E.E. (Univ. of N.B. '31). C.G.E. Test Course included industrial control, induction motors and transformers; the transformer test included desk work for two months on computing losses, efficiencies, etc. Available at once. Apply to Box No. 1119-W.

MECHANICAL ENGINEER, B.A.Sc. (Univ. of B.C.), M.S. (Univ. of Pittsburgh). Canadian. Age 26. Single. One year graduate student course, W.E. and M. Co., East Pittsburgh. Three and a half years engineering research in mechanics with the same company. Location immaterial. Available at once. Apply to Box No. 1123-W.

GEODETIC AND TOPOGRAPHICAL ENGINEER, D.L.S., M.E.I.C. Experience in all kinds of geodetic and topographical surveys, especially photo-topography, well versed in all kinds of air photo surveys; Canadian and U.S. patent method of determining position and elevations of points from air photographs. Available at once anywhere in Canada or the United States Apply to Box No. 1127-W.

PETROLEUM CHEMIST, B.Sc. in Chem. Eng. Age 25, Single. One and a half years experience as assistant chemist. Capable of taking charge in small refinery. Wishes position anywhere in Canada. Apply to Box No. 1130-W.

ELECTRICAL ENGINEER B.Sc., Queen's '33. Single, age 23. Anxious to gain experience. Present experience installing small private hydro-electric plant. Location immaterial. Available at once. Apply to Box No. 1137-W.

## For Sale

Complete equipment for radio servicing. Used for five months. Burton-Rogers '32. Price $75.00. Analyzer and tube tester in one case. Adaptors for new tubes. New 610 Readrite analyzer and tube tester with case for tools, all in one. Oscillator with output meter. Approved by A.T. & T. Co. Complete set of tools. Apply to Box S-20.

# Purchasers' Classified Directory

## *A Selected List of Equipment, Apparatus and Supplies*

**For Alphabetical List of Advertisers see page 20.**

### A

**Acids:**
- Canadian Industries Limited.

**Aerial Survey:**
- Canadian Airways Ltd.

**Ammeters and Voltmeters:**
- Bepco Canada Ltd.
- Crompton Parkinson (Canada) Ltd

**Angles, Steel:**
- Bethlehem Steel Export Corp

**Ash Handling Equipment:**
- Babcock-Wilcox & Goldie Mc-Culloch Ltd.
- Combustion Engineering Corp. Ltd.

**Asphalt:**
- Barrett Co. Ltd.

**Axles, Steel, Forged:**
- Dominion Foundries & Steel Ltd.
- Dominion Steel & Coal Corpn. Ltd.

### B

**Ball Mills:**
- Dominion Engineering Works Limited.
- Wm. Kennedy & Sons Ltd.
- Foster Wheeler Ltd.
- Wm. Hamilton Div. Canadian Vickers Ltd.

**Balls, Steel and Bronze:**
- Can. S.K.F. Co. Ltd.
- Wm Kennedy & Sons Ltd.

**Barking Drums:**
- Canadian Ingersoll-Rand Company, Limited.

**Bars, Steel and Iron:**
- Bethlehem Steel Export Corp.
- Dominion Foundries & Steel Ltd
- Dominion Steel & Coal Corpn. Ltd.

**Bearings, Ball and Roller:**
- Can. S.K.F. Co. Ltd.

**Billets, Blooms, Slabs:**
- Bethlehem Steel Export Corp.
- Dominion Foundries & Steel Ltd.

**Bins:**
- Canada Cement Co. Ltd.

**Blasting Materials:**
- Canadian Industries Limited.

**Blowers, Centrifugal:**
- Can. Ingersoll-Rand Co. Ltd.
- B. F. Sturtevant Co. of Can. Ltd.

**Blue Print Machinery:**
- Montreal Blue Print Co.

**Boilers:**
- Babcock-Wilcox & Goldie-Mc-Culloch Ltd.
- Canadian Vickers Ltd.
- Combustion Engineering Corp. Ltd.
- Foster Wheeler Limited
- E. Leonard & Sons Ltd
- Vulcan Iron Wks. Ltd.

**Boilers, Electric:**
- Can. General Electric Co. Ltd
- Dominion Engineering Works Limited.
- Northern Electric Co. Ltd.

**Boilers, Portable:**
- Foster Wheeler Ltd.
- E. Leonard & Sons Ltd.

**Boxes, Cable Junction:**
- Northern Electric Co. Ltd.

**Braces, Cross Arm, Steel, Plain or Galvanized:**
- Northern Electric Co. Ltd.

**Brackets, Ball Bearing:**
- Can. S.K.F. Co. Ltd.

**Brakes, Air:**
- Can. General Elec. Co. Ltd.

**Brakes, Magnetic Clutch:**
- Northern Electric Co. Ltd.

**Bridge-Meggers:**
- Northern Electric Co. Ltd.

**Bridges:**
- Canada Cement Co. Ltd.
- Canadian Vickers Ltd.
- Dominion Bridge Co. Ltd

**Bucket Elevators:**
- Jeffrey Mfg Co. Ltd.

**Buildings, Steel:**
- Dominion Bridge Co. Ltd

### C

**Cables, Copper and Galvanized:**
- Northern Electric Co. Ltd.

**Cables, Electric, Bare and Insulated:**
- Can. Westinghouse Co. Ltd.
- Can. General Electric Co. Ltd.
- Northern Electric Co. Ltd.

**Caissons, Barges:**
- Dominion Bridge Co. Ltd.

**Cameras:**
- Associated Screen News Ltd.

**Capacitors:**
- Bepco Canada Ltd.
- Can. Westinghouse Co. Ltd.
- Lancashire Dynamo & Crypto Co. of Can. Ltd.

**Castings, Brass:**
- The Superheater Co. Ltd.

**Castings, Iron:**
- Babcock-Wilcox & Goldie-Mc-Culloch Ltd.
- Dominion Engineering Works.
- Foster Wheeler Ltd.
- Wm. Kennedy & Sons Ltd.
- E. Leonard & Sons Ltd.
- The Superheater Co. Ltd.
- Vulcan Iron Wks. Ltd.

**Castings, Alloy Steel:**
- Dominion Foundries & Steel Ltd.

**Castings, Steel:**
- Dominion Foundries & Steel Ltd
- Wm. Kennedy & Sons Ltd.
- Vulcan Iron Wks. Ltd.

**Catenary Materials:**
- Can Ohio Brass Co. Ltd.

**Cement Manufacturers:**
- Canada Cement Co. Ltd.

**Chains, Silent and Roller:**
- Hamilton Gear & Machine Co.
- Jeffrey Mfg. Co Ltd

**Channels:**
- Bethlehem Steel Export Corp.

**Chemicals:**
- Canadian Industries Limited.

**Chemists:**
- Milton Hersey Co. Ltd.
- Roast Laboratories Reg'd.

**Chippers, Pneumatic:**
- Canadian Ingersoll-Rand Company, Limited.

**Choke Coils:**
- Ferranti Electric Co.

**Circuit Breakers:**
- Can. General Elec. Co. Ltd.
- Can. Westinghouse Co. Ltd.
- Northern Electric Co. Ltd.

**Clarifiers, Filter:**
- Bepco Canada Ltd.
- Crompton Parkinson (Canada) Ltd.

**Clutches, Ball Bearing Friction:**
- Can. S.K.F. Co. Ltd.

**Clutches, Magnetic**
- Northern Electric Co. Ltd.

**Coal Handling Equipment:**
- Babcock-Wilcox & Goldie-Mc-Culloch Ltd.
- Combustion Engineering Corp. Ltd.

**Combustion Control Equipment:**
- Bailey Meter Co. Ltd.

**Compressors, Air and Gas:**
- Babcock-Wilcox & Goldie-Mc-Culloch Ltd.
- Canadian Ingersoll-Rand Company, Limited.

**Concrete:**
- Canada Cement Co. Ltd.

**Condensers, Steam:**
- Babcock-Wilcox & Goldie-Mc-Culloch Ltd.
- Canadian Ingersoll-Rand Company, Limited.
- Foster Wheeler Limited.

**Condensers, Synchronous and Static:**
- Bepco Canada Ltd.
- Can General Elec. Co. Ltd.
- Can. Westinghouse Co. Ltd.
- Crompton Parkinson (Canada) Ltd.
- Harland Eng. Co. of Can. Ltd.
- Lancashire Dynamo & Crypto Co. of Can. Ltd.
- Northern Electric Co. Ltd.
- Bruce Peebles (Canada) Ltd

**Conditioning Systems, Air:**
- B. F. Sturtevant Co. of Can. Ltd.

**Conduit:**
- Can. General Elec. Co. Ltd.
- Can. Westinghouse Co. Ltd.
- Northern Electric Co Ltd.

**Conduit, Underground Fibre, and Underfloor Duct:**
- Northern Electric Co. Ltd.

**Controllers, Electric:**
- Can. General Elec. Co. Ltd.
- Can. Westinghouse Co. Ltd.
- Northern Electric Co. Ltd.

**Couplings:**
- Dart Union Co. Ltd.
- Dresser Mfg Co. Ltd.

**Couplings, Flexible;**
- Dominion Engineering Works Limited.
- Dresser Mfg. Co. Ltd.

**Couplings, Flexible:**
- Wm. Hamilton Div. Canadian Vickers Ltd.
- Hamilton Gear & Machine Co.
- Wm. Kennedy & Sons Ltd.

**Cranes, Hand and Power:**
- Dominion Bridge Co.

**Cranes, Locomotive:**
- Dominion Hoist & Shovel Co. Ltd.

**Cranes, Shovel, Gasoline Crawler, Pillar:**
- Canadian Vickers Ltd.
- Dominion Hoist & Shovel Co. Ltd.

**Crowbars:**
- B. J. Coghlin Co. Ltd.

**Crushers, Coal and Stone:**
- Canadian Ingersoll-Rand Company, Limited.
- Jeffrey Mfg. Co. Ltd.
- Wm. Kennedy & Sons Ltd.

### D

**Dimmers:**
- Northern Electric Co. Ltd.

**Disposal Plants, Sewage:**
- W. J. Westaway Co. Ltd.

**Ditchers:**
- Dominion Hoist & Shovel Co. Ltd.

**Drills, Pneumatic:**
- Canadian Ingersoll-Rand Company, Limited.

**Dynamite:**
- Canadian Industries Limited.

### E

**Economizers, Fuel:**
- Babcock-Wilcox & Goldie-Mc-Culloch Ltd.
- Combustion Engineering Corp. Ltd.
- Foster Wheeler Limited
- B. F. Sturtevant Co. of Can. Ltd.

**Elbows:**
- Dart Union Co. Ltd

**Electric Blasting Caps:**
- Canadian Industries Limited.

**Electric Railway Car Couplers:**
- Can. Ohio Brass Co. Ltd.

**Electrical Repair Work:**
- Montreal Armature Works.

**Electrical Supplies:**
- Can. General Elec. Co. Ltd.
- Can. Ohio Brass Co Ltd.
- Can. Westinghouse Co. Ltd.
- Northern Electric Co. Ltd.

**Electrification Materials, Steam Road:**
- Can. Ohio Brass Co. Ltd

**Engines, Diesel and Semi-Diesel:**
- Canadian Ingersoll-Rand Company, Limited.
- Harland Eng. Co. of Can. Ltd.

**Engines, Gas and Oil:**
- Canadian Ingersoll-Rand Company, Limited.

**Engines, Steam:**
- Babcock-Wilcox & Goldie-Mc-Culloch Ltd.
- Canadian Vickers Ltd.
- Harland Eng. Co. of Can. Ltd.
- E. Leonard & Sons Ltd.

**Evaporators:**
- Foster Wheeler Limited.

**Expansion Joints:**
- Foster Wheeler Limited.

**Explosives:**
- Canadian Industries Limited.

### F

**Feed Water Heaters, Locomotive:**
- The Superheater Co. Ltd.

**Filtration Plants, Water:**
- W. J. Westaway Co. Ltd.

**Finishes:**
- Canadian Industries Limited.

**Fire Alarm Apparatus:**
- Northern Electric Co. Ltd.

**Floodlights:**
- Can. General Elec. Co. Ltd.
- Can. Westinghouse Co. Ltd.
- Northern Electric Co. Ltd.

**Floor Stands:**
- Jenkins Bros. Ltd.

**Floors:**
- Canada Cement Co. Ltd.

**Forcite:**
- Canadian Industries Limited

**Forgings:**
- Bethlehem Steel Export Corp.
- Dominion Steel & Coal Corpn. Ltd

**Foundations:**
- Canada Cement Co. Ltd.

### G

**Gaskets, Asbestos, Fibrous, Metallic, Rubber:**
- The Garlock Packing Co. of Can. Ltd.

**Gasoline Recovery Systems:**
- Foster Wheeler Limited.

**Gates, Hydraulic Regulating:**
- Canadian Vickers Ltd.
- Dominion Bridge Co. Ltd.

**Gauges, Draft:**
- Bailey Meter Co. Ltd.

**Gear Reductions:**
- Hamilton Gear & Machine Co.

**Gears:**
- Dominion Bridge Co. Ltd.
- Dominion Engineering Works Limited.
- Hamilton Gear & Machine Co.
- Wm. Kennedy & Sons Ltd.

**Generators:**
- Bepco Canada Ltd.
- Can. General Elec. Co. Ltd.
- Can. Westinghouse Co. Ltd.
- Crompton Parkinson (Canada) Ltd.
- Harland Eng. Co. of Can. Ltd.
- Lancashire Dynamo & Crypto Co. of Can. Ltd.
- Northern Electric Co. Ltd.
- Bruce Peebles (Canada) Ltd.

**Governors, Pump:**
- Bailey Meter Co. Ltd.

**Governors, Turbine:**
- Dominion Engineering Works Limited.

**Gratings, M. & M. Safety:**
- Dominion Bridge Co. Ltd.

### H

**Hangers, Ball and Roller Bearing:**
- Can. S.K.F. Co. Ltd.

**Headlights, Electric Railway:**
- Can. General Elec. Co. Ltd.
- Can. Ohio Brass Co. Ltd.
- Can. Westinghouse Co. Ltd.

**Heat Exchange Equipment:**
- Foster Wheeler Limited.

**Hoists, Air, Steam and Electric:**
- Canadian Ingersoll-Rand Company, Limited.
- Dominion Hoist & Shovel Co. Ltd.
- Wm. Hamilton Div. Canadian Vickers Ltd.

**Humidifying Equipment:**
- W. J. Westaway Co. Ltd.

### I

**Incinerators:**
- Canada Cement Co. Ltd.

**Indicator Posts:**
- Jenkins Bros. Ltd.

**Industrial Electric Control:**
- Can. General Elec. Co. Ltd.
- Can. Westinghouse Co. Ltd.
- Northern Electric Co. Ltd.

**Injectors, Locomotive, Exhaust Steam:**
- The Superheater Co. Ltd.

**Inspection of Materials:**
- J. T. Donald & Co. Ltd.
- Milton Hersey Co. Ltd.

**Instruments, Electric:**
- Bepco Canada Ltd.
- Can. General Elec. Co. Ltd.
- Can. Westinghouse Co. Ltd.
- Crompton Parkinson (Canada) Ltd.
- Ferranti Electric Ltd.
- Moloney Electric Co. of Canada, Ltd.
- Northern Electric Co. Ltd.

**Insulating Materials:**
- Canadian Industries Limited.

**Insulators, Porcelain:**
- Can. Ohio Brass Co. Ltd.
- Northern Electric Co. Ltd.

**Intercoolers:**
- Foster Wheeler Limited.

### J

**Journal Bearings and Boxes, Railway:**
- Can. S.K.F. Co. Ltd.

### L

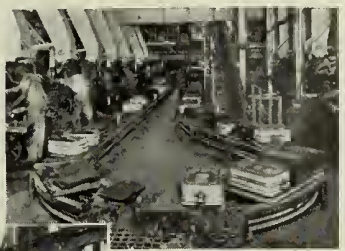
**Lacquers:**
- Canadian Industries Limited.

**Lantern Slides:**
- Associated Screen News Ltd.

**Leading Wire:**
- Canadian Industries Limited.

*Valuable suggestions appear in the advertising pages.*

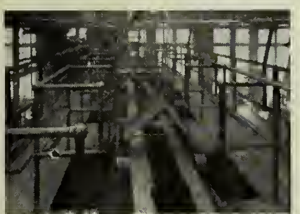
# Foundry Equipment by JEFFREY includes:



Floor Type Mold Conveyors

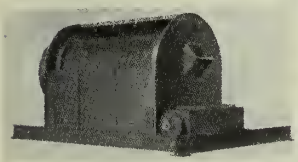
Pendant Type Mold Conveyors (below)

Scraper Conveyors



Belt Conveyors

Flask Fillers (overhead bin type)

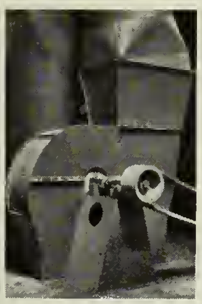


Screens


Aerators

Leak-proof Apron Conveyors (below)

Flask Fillers (Portable wall type)



Fans

Pulverizers and Crushers

*Also*

- Sand Reclaiming and Conditioning Equipment
- Portable Loaders
- Bucket Elevators
- Bins and Hoppers
- Chains, Wheels, and Buckets
- Transmission Equipment
- Bottom Dump Buckets
- Foundry Flask Knock-outs

Any one of these Jeffrey Units pictured here will cut your Foundry costs materially. Mechanical handling saves floor space, molders' time and flasks required, and effect many other economies. The extent of these savings is vitally affected by the type of equipment selected.

Large or small foundries . . . complete systems or small installations . . . Jeffrey has the proper equipment for your problem, backed by experience covering a long line of highly successful installations.

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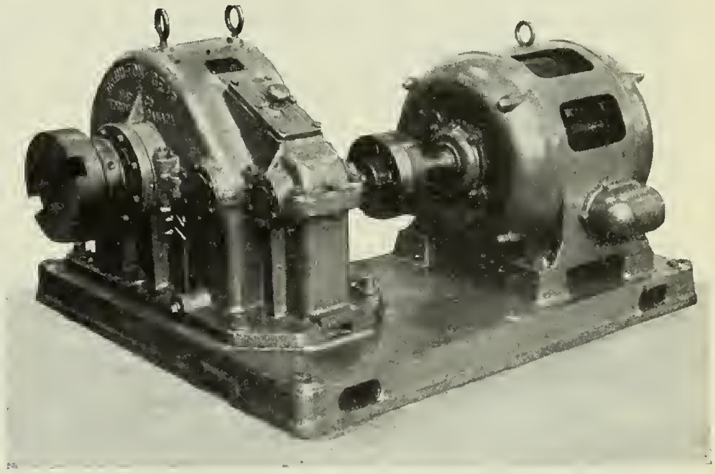
CUT GEARS

# Heavy Duty Herringbone Gear Speed Reducers



These heavy duty herringbone gear units are designed and built for continuous operation under full load for long periods. They are ideally suited to applications demanding the utmost in reliability.

Chester B. Hamilton Jr.

President

# Hamilton Gear & Machine Company

Industrial Cut Gear Specialists

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M

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# Use Street Lighting to Prevent Accidents

OF the 1,111 fatal accidents in Canada in 1932, 47 per cent. were during the dark hours that carry only 20 per cent. of the 24-hour traffic. In other words, the night hazard is 400 per cent. of the day hazard.

An official survey indicates that about 35 per cent. of all night traffic accidents are directly attributable to insufficient illumination. Correct lighting might have prevented hundreds of deaths. Property losses would have been reduced by thousands of dollars.

Canadian General Electric lighting specialists are qualified to recommend intensities, spacing and luminaires that will meet your safety requirements. Write the C.G.E. office nearest you or Canadian General Electric Co., Limited, 212 King Street West, Toronto, for the services of a specialist.

33-FG-2

## CANADIAN GENERAL ELECTRIC

COMPANY LIMITED

Head Office - Toronto—Sales and Engineering Offices in Principal Cities

# THE ENGINEERING JOURNAL

VOL. XVII
No. 6

JUNE
1934

*In this issue*



PUBLISHED MONTHLY BY

THE ENGINEERING INSTITUTE *of* CANADA

# ANNOUNCEMENT

In the belief that the interests of the public and the building industry will be served best by securing as wide an application as possible of the scientific principles involved in Modern Heating Methods, the following cooperative agreement has been entered into for that purpose.

JOINT STATEMENT C. A. DUNHAM CO., LIMITED
AND DARLING BROTHERS LIMITED REGARDING PATENTED
SYSTEMS OF STEAM HEATING

THROUGH MANY YEARS THESE COMPANIES, WORKING IN ASSOCIATION WITH THE C. A. DUNHAM COMPANY, CHICAGO, ILLINOIS, AND WARREN WEBSTER & COMPANY, CAMDEN, NEW JERSEY, HAVE MADE SIGNIFICANT CONTRIBUTIONS TO THE PROGRESS OF THE ART OF STEAM HEATING. ▪ ▪ IN RECENT YEARS THE MAJOR PROBLEM UPON WHICH BOTH COMPANIES AND THEIR AFFILIATES HAVE CENTERED THEIR ATTENTION HAS BEEN THAT OF PROVIDING A SYSTEM SO CONTROLLED THAT THE CORRECT AMOUNT OF STEAM MAY BE CIRCULATED UNDER VARYING WEATHER CONDITIONS TO OFFSET THE VARIABLE HEAT LOSS FROM A BUILDING. ▪ ▪ DEVELOPMENT TO THIS END HAS RESULTED IN A NUMBER OF CANADIAN PATENTS UPON METHODS AND APPARATUS WHICH ACCOMPLISH THE ABOVE DESIRED RESULTS. ▪ ▪ WE ANNOUNCE THAT THESE COMPANIES HAVE ENTERED INTO A CROSS-LICENSING AGREEMENT COVERING PATENTS RELATING TO HEATING SYSTEMS. ▪ ▪ EACH COMPANY WILL CONTINUE TO SPECIALIZE ON ITS RESPECTIVE SYSTEM, NAMELY—THE DUNHAM DIFFERENTIAL SYSTEM AND THE WEBSTER MODERATOR SYSTEM AS MANUFACTURED AND SOLD IN CANADA.

C. A. DUNHAM CO., LIMITED
(SIGNED) C. A. DUNHAM
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DARLING BROTHERS LIMITED
(SIGNED) EDWARD DARLING
PRESIDENT

*June 1, 1934*

# The Romance of the Construction Industry in Canada

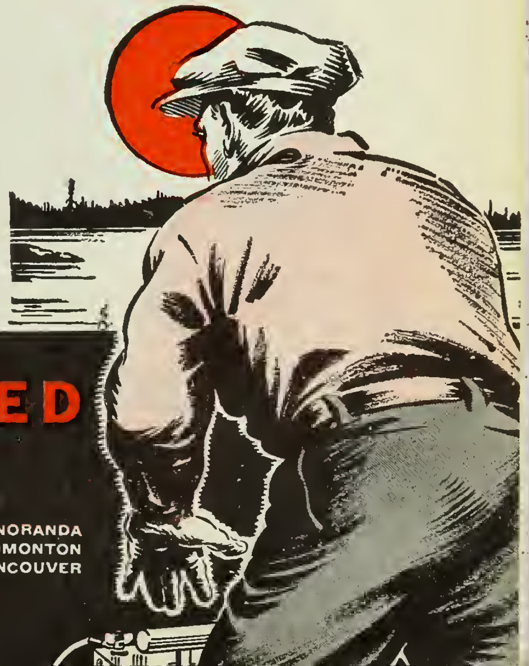
## Over deep ravines . . . spanning rivers . . . and adding to man's progress, bridges will ever be built.

*Lake St. Louis Bridge.*
*Photograph courtesy of A. Janin & Co. Ltd., Montreal, Que.*

Since the world began bridges, in some form or another, have decided the progress of man. In many cases the fate of wars have been decided by them.

In Canada we have one of the outstanding bridges of the world, namely, the Quebec Bridge, situated nine miles west of the city of Quebec. This bridge has a clear span of 1800 feet between piers. One of the recent bridges to be completed here is the new Lake St. Louis Bridge, spanning the St. Lawrence River about eight miles from the city of Montreal at the outlet of Lake St. Louis. This bridge provides direct access to provincial route No. 4, one of the main roads from the Province of Quebec into New York State.

C-I-L Explosives play their part in all construction activities. C-I-L Explosive Technicians are always glad to help you solve any problem that confronts you on blasting operations.



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"Everything for Blasting"

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# EFFICIENCY
# RELIABILITY
# GENERAL UTILITY
*of*
# TYPE "E" STOKERS
UP TO 700 NOMINAL H.P.

# 650,000 sq. ft. prove it!

In hundreds of leading industrial plants in Canada under 650,000 sq. ft. heating surface Type "E" stokers have proved their ability to operate with maximum efficiency and low upkeep with all types of coals.

## FEATURES

### Sliding Retort Bottom

Carries main ram and pushers. Feeds and agitates fuel in retort. No pusher rods to warp or buekle.

### Hollow Air-Cooled Firebars

Preheat a portion of the air for eombustion. Assure low maintenanee. Alternate bars have lateral, adjustable motion. Replaeement requires no dismantling of grate surfaee. Non-sifting.

### Proper Coal Distribution

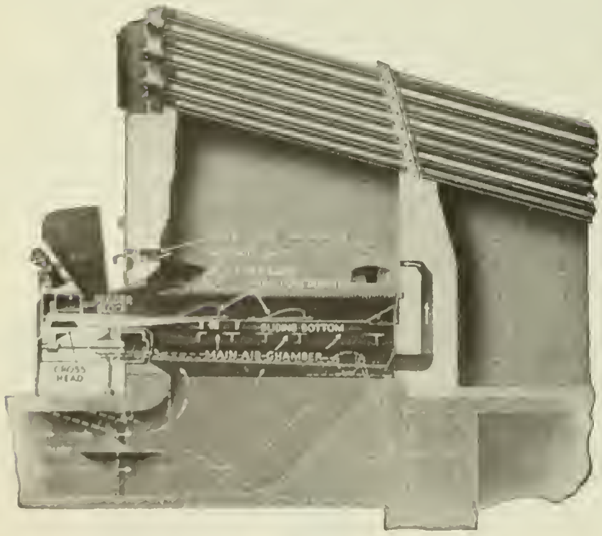
Assured by large throat opening to the retort, full stroke at all ratings and sliding bottom with auxiliary pushers. Lateral motion of firebars gives positive, gradual movement of the coal toward the dump grates.

### Complete Air Control

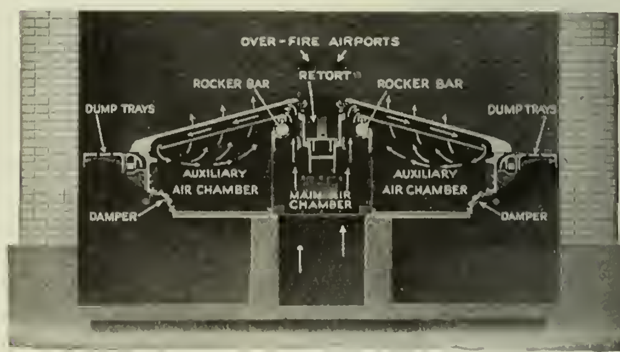
Furnished for entire grate area including dump grates. 100 per eent foreed draft surfaee divided into three pressure zones parallel to the retort. Separate control of air supply to grate surfaee, dump grates and over the fire. Air pressure is eompensated to the thiekness of the fuel bed, the greatest pressure being applied to the thiekest portion over the retort.

The foregoing, together with its integral steam operating cylinder drive, its smokeless operation, low maintenance cost and easy operation, are fully described in bulletins which will be sent gladly on request.

*Rear view showing retort, grate bars, dump grates and auxiliary windbox.*




*Longitudinal section showing air distribution. Air duct may enter from front or rear.*




*Cross-section showing air distribution. Air may be admitted to dump grates as required.*

# COMBUSTION ENGINEERING CORPORATION
LIMITED

TORONTO MONTREAL WINNIPEG VANCOUVER

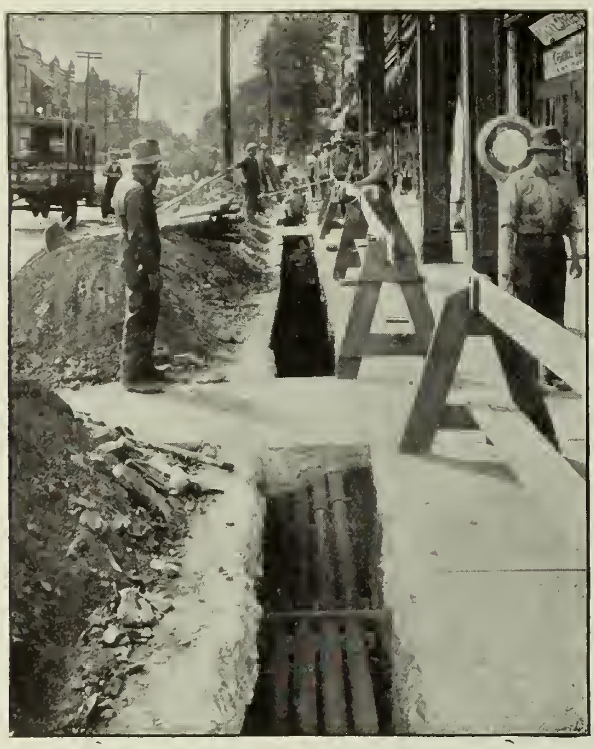
FIBRE MADE IN CORNWALL CANADA CONDUIT

## FIBRE CONDUIT, BENDS AND FITTINGS FOR UNDERGROUND ELECTRICAL DISTRIBUTION

Cornwall Fibre Conduit is used extensively by Power Companies, Telephone Companies and other Public Utilities for Underground distribution of the services. It is also installed in Power Houses at the time of construction for cables leading from the generators to the switchboards and generators to the transformers and switching stations. The high insulating qualities of Cornwall Fibre Conduit with its non-abrasive bore and special sleeve joint are among the many features which have made Cornwall Fibre Conduit a standard with most Public Utilities.

A few of the advantages gained in establishing a conduit construction programme are:—

All Electrical Services rendered immune from wind, lightning or sleet storms in the underground area. Improved appearance of the streets from which the poles have been removed. Decreased fire hazards. Provision can be made for expansion of the services to meet changing requirements.



A 16 duct run of Cornwall Fibre Conduit being installed on Park Avenue, Montreal, in August, 1933.

THE TAPERED SLEEVE JOINT

All Cornwall Fibre Conduit is finished with the superior tapered Sleeve Joint. Some of the advantages obtained by its use are:—

1. Its flexibility makes it possible to deviate from straight runs or pass minor obstructions in the trench and still maintain strong tight joints.
2. Rapidly installed as there are no male or female ends.
3. Less waste, as slightly damaged ends are protected by the coupling with no reduction in the tightness of the joints.

Manufactured in five foot lengths (one coupling supplied with each length of pipe) in the following sizes:

Inside Diameter

2½″ 3″ 3½″ 4″ 4½″

Standard Bends 45° and 90° (one coupling supplied with each bend).

| Inside Diameter | 2½″ | 3″ | 3½″ | 4″ | 4½″ |
|---|---|---|---|---|---|
| Radius | 24″-36″ | 36″ | 36″ | 36″ | 36″ |

Quotations furnished on special bends with radius other than standard above listed.

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A NATIONAL ELECTRICAL SERVICE

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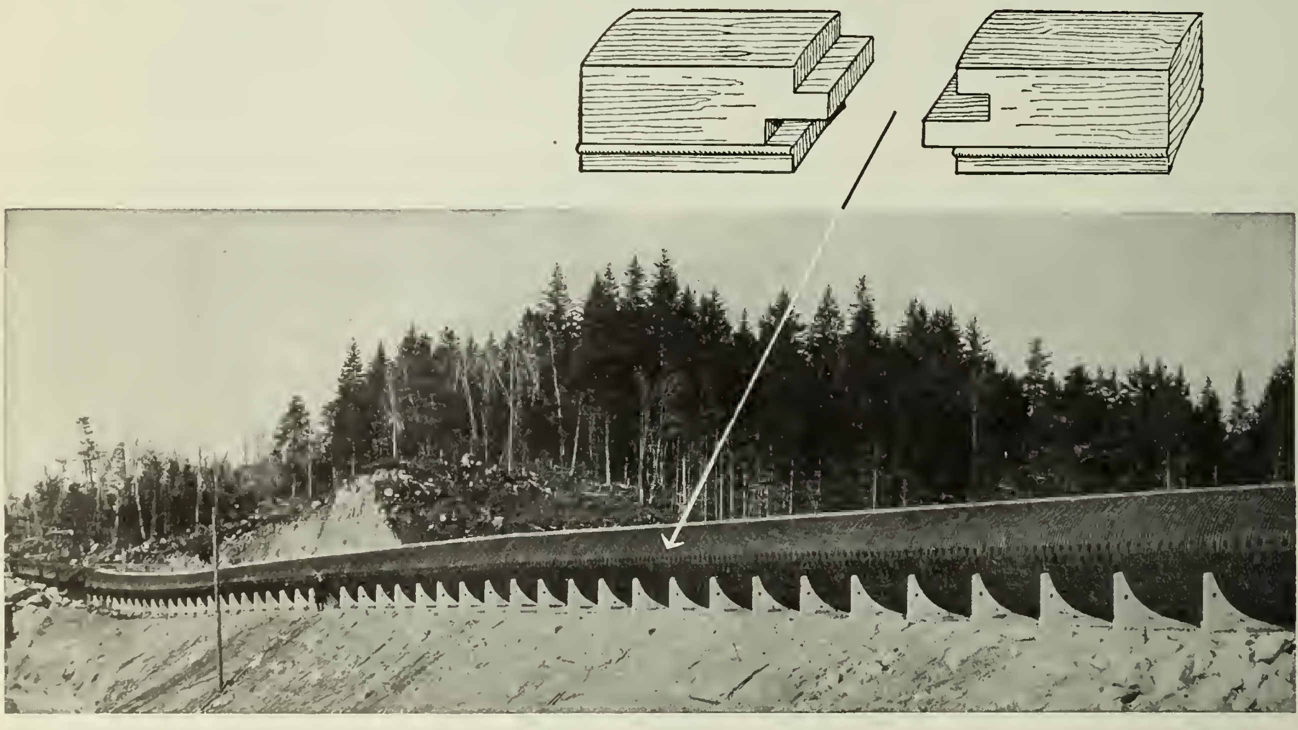
# New *Canadian* Wood Pipe BUTT JOINT



## MOST RIGID AND ECONOMICAL JOINT EVER MADE

The New "Canadian" Butt Joint gives the buyer of Canadian Wood Pipe the greatest improvement in the history of Wood Pipe manufacture. It is supplied without extra cost. Made entirely of wood, the CANADIAN BUTT JOINT will not rust or corrode. It is absolutely rigid, watertight and frost-proof.

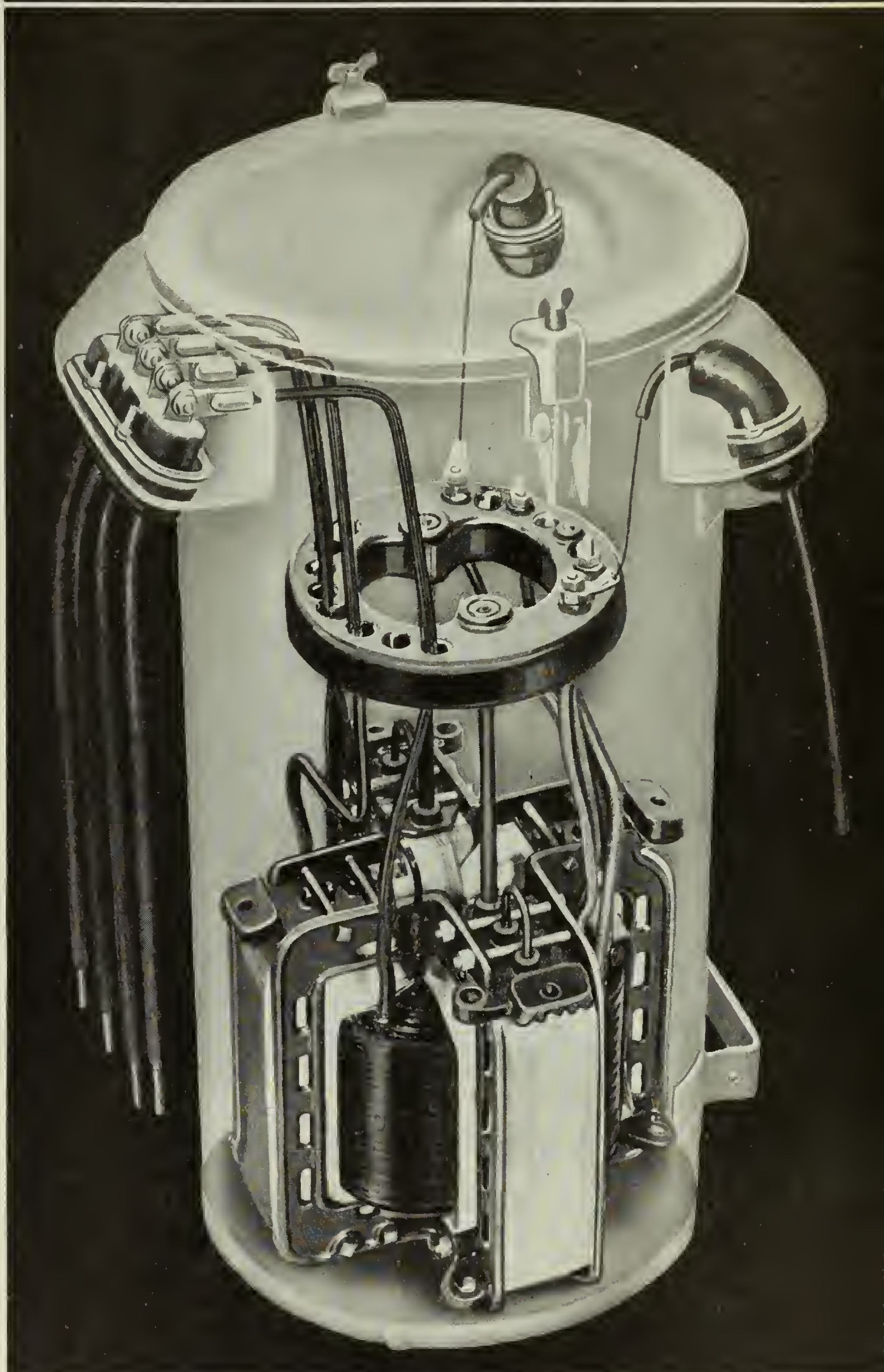
This new joint slides easily into exact position thus speeding up erection. There are no steel tongues to handle or become lost and nothing to work loose. The joint remains perfectly tight during the entire life of the pipe.

The patented double-tongue-and-groove construction has twice the strength of the old-type joint, and in tests withstood more pressure than any other part of the pipe. It was designed in our own plant after a long period of experiment and testing. We have worked out a very simple and economical method of manufacture—and these economies are passed along to the buyer.

To get the many advantages of the Canadian Butt Joint—which is available to you at no extra cost—specify Canadian Wood Pipe.

**Canadian Wood Pipe & Tanks**
**Limited**
**550 Pacific Street Vancouver B.C.**

30 YEARS IN BUSINESS



THE

# ENGINEERING JOURNAL

## THE JOURNAL OF THE ENGINEERING INSTITUTE OF CANADA

*"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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Access House, North Shaft.

# First Narrows Pressure Tunnel, Vancouver, B.C.

*W. H. Powell, M.E.I.C.,*

*Engineer, Greater Vancouver Water District, Vancouver.*

**Taken from a paper presented before the Vancouver Branch of The Engineering Institute of Canada, January 15th, 1934.**

**SUMMARY.—The following article consists of extracts from a paper presented before the Vancouver Branch of The Engineering Institute of Canada on January 15th, 1934. The author describes the construction of a tunnel carrying the water supply of the city under the entrance to Vancouver Harbour. The tunnel itself is 3,100 feet long, lined with steel-cylinder-reinforced concrete piping, having a clear waterway 7 feet 6 inches in diameter. The vertical shafts on the north and south shores are nearly 400 feet deep, and are similarly lined. Cost and progress figures are given.**

In 1886 a charter was granted the Vancouver Water Works Company to supply the new city of Vancouver with water.

The original supply was brought from an intake on Capilano river by a pipe line which crossed the First Narrows of Burrard Inlet as a 12-inch submerged pipe with flexible lead joints.[1] Even the early submerged pipes were not entirely dependable, and in 1893, two years after the city had taken over the system from the Vancouver Water Works, Colonel T. H. Tracy, city engineer, was instructed to report on the feasibility of a tunnel to carry pipe lines. In the same year a proposal for a suspension bridge to carry the water mains across the Narrows was made to the city council. However, neither the report nor the suspension bridge proposal was acceptable, and by 1924[2] the water supply system had been expanded so that there were three 18-inch and two 12-inch pipes at the First Narrows on the Capilano system and six 18-inch pipes in the Second Narrows on the Seymour system, supplying a population of over 200,000. Between 1904 and 1924 the submerged mains suffered seventeen breaks of which fourteen were caused by ships.

During this period there was a growing realization that the whole question of water supply to Vancouver and its surrounding cities and municipalities should be placed on a proper basis and at the session of the Legislature late in 1924 an act was passed which provided for the formation of the Greater Vancouver Water District. The Vancouver city council however did not then accept the legislation.

In 1925, after another serious interruption, Mayor Taylor arranged a conference with the Honourable T. D. Pattullo, and as a result, acceptable amendments to the act creating the Greater Vancouver Water District were granted. The question was then referred to the electors of the city, Point Grey, and South Vancouver, and the District was officially inaugurated.

In 1926, Dr. R. W. Brock, M.E.I.C., Dean of Engineering in the University of British Columbia, was asked to report upon the geological structure likely to be encountered if a tunnel were driven under Burrard Inlet. From Dr. Brock's report the following conclusions have been taken:—

1st. The present topography does not accurately express bedrock topography.

2nd. Only borings can determine the depth to bedrock and that only for the point where the bore hole has been put down.

3rd. As a general principle a fiord deepens seaward, but when it has been occupied and modified by glacial action, bedrock is not apt to maintain a uniform grade and will be gouged into basins. The amount of gouging depends upon the relative softness and other favourable physical features of the local rock and upon the pressure of the ice. The latter depends upon the volume and velocity of the ice.

4th. In Burrard Inlet there are only two points where there are any indications of rock having resistance superior to the general average, viz. north-east of Barnet and at Prospect Point.

5th. At Prospect Point the harder rocks may have retarded gouging and bedrock may be at a less depth than might otherwise be expected.

6th. Considering solely the geological factors the best tunnel site would be at Prospect Point, about 40 yards south-east of the lighthouse.

- (*a*) Because it is as far as possible from the Seymour glacier without coming into the area affected by the Capilano.
- (*b*) Because only part of the ice passed through the channel.
- (*c*) Because the rock is hardest at this point and would offer greatest resistance to ice action.

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[1]See Paper by Mr. H. B. Smith, Member Can. Soc. of Civil Engineers, published Proceedings, Vol. III, 1889.

[2]See Paper by Mr. E. A. Cleveland, M.E.I.C., published Journal of the American Water Works Association, Vol. 24, June 1932.

7th. A second location, much less favourable than the above site, but better than any other, is at Second Narrows, as far west of the North Arm as possible without coming into the area affected by the Seymour glacier.

The late Mr. J. Waldo Smith, consulting engineer to the New York Board of Water Supply, was consulted and he advised:

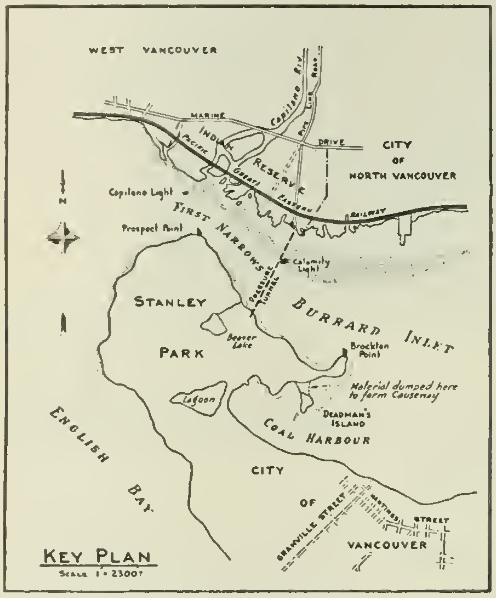


**Fig. 1—Key Plan.**

1st. Keep the water supply system independent of bridges or tunnels for other purposes.

2nd. Explore by drilling the foreshore regions at both First and Second Narrows, endeavouring to find bedrock at a depth not exceeding 115 feet.

### Start of Drilling Operations

Acting on the report of Dr. Brock, and with the knowledge of the results of previous drilling, the chief commissioner of the Board recommended that a contract be awarded for two drill holes at First Narrows and two drill holes at Second Narrows. It was expected that when this work was completed sufficient data would have been obtained to determine where other drilling and experimental work should be undertaken. Figure 2 shows the location of the proposed long and short tunnels and that of the pressure tunnel as constructed.

Because the work that the city had done on investigating the city's future water supply had been confined largely to the Seymour creek area, which could be developed at comparatively small cost to supply five times the then population of Vancouver, the first drilling was attempted at the Second Narrows, near the mouth of Seymour creek.

The first hole sunk there was on the north shore and gave results which discouraged further investigation, so that attention was transferred to the First Narrows. The first hole in that area, No. 1 (see Fig. 2), was drilled from the Water District's wharf, and holes were then sunk on the north shore. No. 2 went 161 feet through sand and gravels before striking rock. No. 8, near high water mark, was sunk 173 feet to rock, and No. 9, near low water mark, followed, reaching rock at a depth of 146 feet. This hole was finished on July 20th, 1927, more than twelve months after the contract was let.

### Geology

While this work was proceeding, Dr. Schofield, Professor of Geology at the University of British Columbia, was consulted and submitted a detailed report on the geology in the vicinity of the proposed tunnel.

He stated that the bedrock strata of Stanley Park are mainly of tertiary age and consist of conglomerates, sandstones, sandy shales and shales. These strata are cut by dykes of basalt. In the proposed pressure tunnel the rocks belong to the upper part of the Burrard formation.

The ridge-like form from Siwash Rock to Prospect Point is due to the presence of a hard rib of basalt which intrudes as a dyke the soft sandstone and shale which makes up the bedrock of Stanley Park. This ridge is separated from the north shore by the First Narrows of Burrard Inlet.

The sandstones and shales found in the drill cores from holes Nos. 1, 2 and 8 rest conformably on a thick stratum of conglomerate which in turn rests on an irregular floor of granite which belongs to the Coast Range batholith of Jurassic age. The depth of this granite beneath the First Narrows has not been determined, but it is more than 1,000 feet.

Resting on the bedrock strata in the vicinity of the north shore occur gravel and sands brought down by the Capilano river.

Dr. Schofield recommended that if possible the tunnel be driven in a bed of sandstone.

As the drilling previously described did not disclose bedrock within the required depth, viz. 115 feet, a second machine was set up and a hole (No. 1A) put down near Marine drive and another (No. 10) just north of the Pacific Great Eastern Railway—both on the line of the pipe line road. No. 1A did not reach bedrock and was sunk to a depth of 218 feet at a cost of $2,604 before it was abandoned. The other (No. 10) struck rock at 313 feet and was carried 175 feet into the rock. The time required to drill this hole was over three months.

Drilling was then started on a series of holes located on a line parallel to the Inlet and in the area between high and low water mark. West of the pipe line road, no positive results were obtained; towards the east slightly higher rock surfaces were found and at hole No. 17 the rock was reached at elevation −16.3 feet.

From the result of this drilling, in the spring of 1928, it was decided to go back to the outcrop near the confluence of Brothers creek and the Capilano. This decision was based on the facts that the tunnel would not be unduly long (6,800 feet); that the water had to be carried that distance in any case; that the north shaft, although deeper, would be much cheaper than one through the sands and gravels near the sea; and that there would be no interference with the proposed development of the harbour entrance.

In accordance with this scheme a line from proposed shaft to proposed shaft was surveyed, but before undertaking complete drilling along it an electrical process of determining bedrock depth was experimented with. This proved unsatisfactory under the conditions encountered and again the drilling machines for wash boring and diamond drilling were put to work. Seven holes were put down, at about 1,000 feet apart, the greatest depth to bedrock being 283 feet and the greatest total depth 714 feet. This part of the programme was completed in February, 1929.

With this change in tunnel location, Dr. V. Dolmage, consulting geologist, reported on the geology of the new route, and came to the following conclusions:—

Diamond drilling and the surrounding geology show that the tunnel will penetrate only two geological formations, a basalt dyke and a series of early tertiary (Eocene) sediments. The dyke is only about fifty feet wide and though the tunnel will cross it at an acute angle it is quite probable that only a very small proportion of the whole tunnel will be in the dyke.

The dyke consists of fine grained normal basalt and is therefore hard and strong though extensively jointed.

The tertiary sediments are part of a formation known as the Burrard formation which is made up of a basal conglomerate two hundred feet or more thick overlain by 1,350 feet of interbedded lenses of sandstone and shale, the latter constituting only about one quarter of the total volume. The beds strike east and west and dip about fifteen degrees to the south and have been folded and faulted to only a slight degree.

The northern part of the tunnel will pass through the conglomerate for several hundred feet and the remainder will be in the lower sandstone and shale beds.

The main portion of the tunnel will thus be in sandstone and shale lenses. The shales are comparable with the conglomerate in strength and hardness but are more compact and impervious. The sandstones occupy much the greater portion of the tunnel site and are perhaps the least competent rocks of the formation. The beds are fairly porous and would conduct a considerable amount

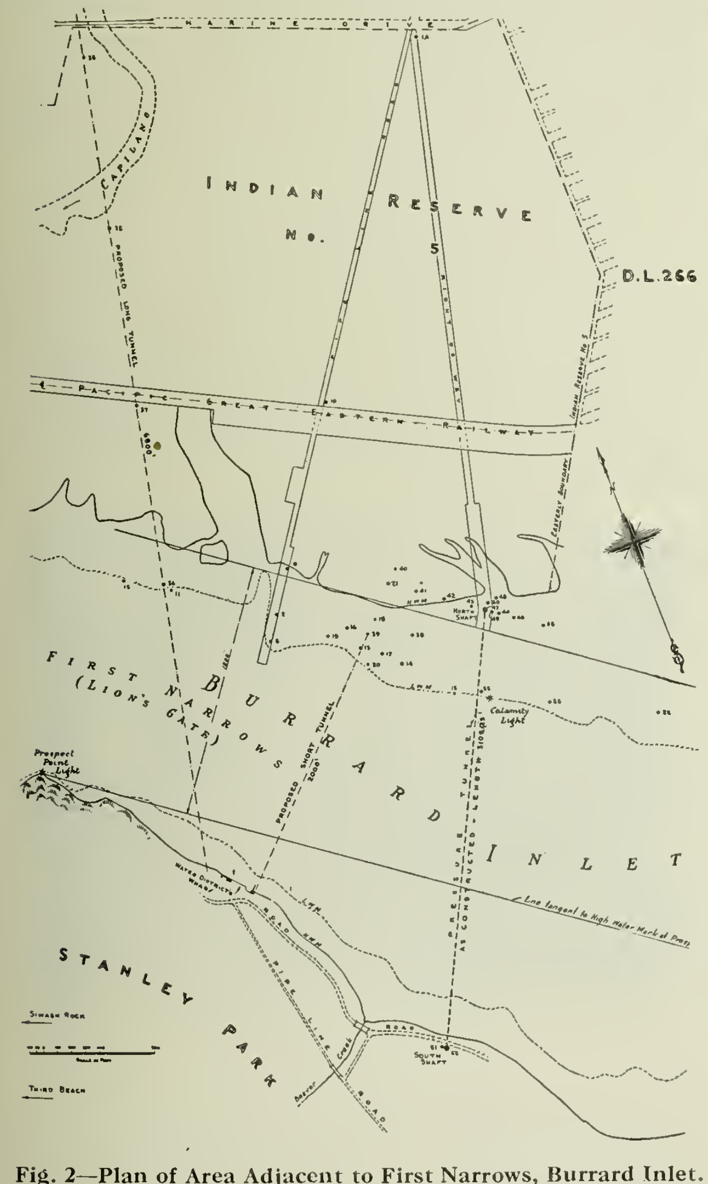


Fig. 2—Plan of Area Adjacent to First Narrows, Burrard Inlet.

of water, but, owing to their lenticular form and to their being interlayered with lenses of impervious shale, there is little danger of their conducting large quantities of water over great distances.

Like the other members of the formation, the sandstones are unusually free from joint cracks or other openings.

It is concluded from the above observations that a tunnel can be driven under the First Narrows with no extraordinary difficulties.

In December, 1929, before determination was finally made as to the general designs to be adopted for the tunnel, at Mr. Smith's request Mr. James Sanborn of New York examined the site of the proposed work. On account of the unreliability of the rock which the cores from the drill holes disclosed, Mr. Sanborn was of the opinion, concurred in by Mr. Smith, that in order to ensure safety the tunnel should be lined throughout with a continuous steel cylinder to form a water stop. The extra cost for this construction

Fig. 3—Drilling Hole No. 53, Calamity Light in Background.

with a tunnel 6,800 feet long was sufficient reason for again directing attention to the short tunnel route. After further drilling, shaft locations which seemed most suitable for the success of the undertaking were selected in the neighbourhood of hole No. 39 and hole No. 1, giving a length of tunnel of just over 2,000 feet.

Preliminary plans were made for this site and the Vancouver Harbour Commissioners approved of the site subject to the qualification that if the requirements of navigation twenty or twenty-five years hence demanded it, the north shaft should be moved farther north. Following the Federal election just at that time the Harbour Commissioners were changed and the new Board did not approve of the site.

As a consequence new drilling explorations were begun in a wide area on the north shore and at the fifth hole drilled, No. 48, bedrock was reached at a depth of 103 feet below ground level, elevation −14.0, and at hole No. 47 at a depth of 101 feet, elevation − 10.5. (See Fig. 3.) Further drillings disclosed no higher bedrock. As the location of a shaft near hole No. 47 was acceptable to the Harbour Board and bedrock was within the depth that could be reached by pneumatic methods the site was adopted for the location of the north shaft.

The selection of this location for the north shaft altered the earlier decision as to the site of the south shaft. A new position about 100 yards east of Beaver creek in Stanley Park was selected and a drill hole put down, which disclosed in the last 200 feet from 80 to 100 feet of sandstones so soft that for 32 feet no core was recovered and much of the balance was coarse and very poorly cemented. The drill hole was sunk a further 100 feet, but little change from the material of the upper portion was found. It was decided to draw the specifications so that the final decision as to the depth of the shafts could be made when the excavation had reached the 400-foot mark. The total cost of drilling at the First Narrows up to this time was over $75,000.

For the drilling operations, two plants were employed, one was steam driven and was better for deep work while the other was gasoline driven and more practical for shallow holes.

Different diameters of drill casing were used depending upon the depth anticipated:

6, 4 and 2 inches for a hole 150 feet deep.

8, 6, 4 and 2 inches for a hole 350 feet deep.

Each diameter was driven to what was considered an economical depth. When bedrock was reached it was chopped into for five or eight feet and then drilling was started using a shot drill, a calyx bit or a diamond bit. Core recovery for some lifts was almost 100 per cent, at others less than 20 per cent, and one length of sandstone for 32 feet gave no core at all.

The cores disintegrated very rapidly when left exposed but when housed in a dry place have not deteriorated and give a good section of the strata passed through.

For tabulation of depths of holes, costs, etc., see Appendix I.

### Tenders and Award

Tenders for the whole tunnel work were received on June 25th, 1931 from four contractors. (See Appendix II.)

Two of the contractors accompanied their tender by a letter containing the following: "Which is submitted upon the express condition that we shall not be required to enter into any contract that does not contain mutually satisfactory provisions.

"1. Relief in the event of impossibility of performance within the reasonable intendment of said contract.

"2. Payment of progress estimates.

"3. Arbitration."

The solicitor for the district ruled that the tenders were qualified and therefore informal and that only two tenders were in accordance with the specifications. The Board accordingly on July 6th awarded the contract to the Northern Construction Company and J. W. Stewart, Limited.

In the meantime the B.C. Electric high tension power line to West Vancouver was tapped and a transformer station erected and provision made for supplying 1,000 h.p. A cable was laid across the Narrows capable of carrying 500 h.p. The cost of this power installation was $6,541.12, less $427.06 salvage and whatever value there may be in 2,500 feet of cable. Electricity was supplied to the contractors at regular rates, i.e., $1.00 per month per h.p. of maximum demand plus 1 cent net per kw.h.

### Design Requirements

*Hydraulic*—The tunnel and shafts were designed to provide a conduit to carry the total supply of the Capilano system, estimated to average throughout the year about 200 million Imperial gallons per day, or say 360 cubic feet per second. Taking into consideration the top water elevation of a future reservoir above Capilano canyon and the terminal pressures and topography, the water delivery requirements resolved themselves into three cases, in which, using a Hazen-Williams co-efficient of 120, the calculated losses from valve chamber to valve chamber were as follows:

| Case | C.F.S. | Calculated Loss of Head |
|---|---|---|
| I | 280 | 5 feet |
| II | 390 | 11 feet |
| III | 570 | 22 feet |

The smoothness of the finished conduit suggests that a Hazen-Williams co-efficient of 140-150 may be expected and a considerably less loss of head than calculated may be found in practice.

*Structural*—The steel interlining for the south shaft above elevation −65 and for the north shaft above elevation −17.5 was designed for an unbalanced upward and bursting pressure of 312 pounds per square inch; for the remainder of both shafts the same bursting pressure and no consideration of upward pressure, and for the tunnel an unbalanced bursting pressure of 260 pounds per square inch. Where the rock was poor in the tunnel the use of a steel pipe one inch thick or its equivalent was required and the unbalanced bursting pressure was considered as 300 pounds per square inch. With these unbalanced bursting pressures, steel stresses, making no allowance for the supporting rock, are from 24,000 to 14,000 pounds per square inch.

### Surveys and Alignments

The surveys for the tunnel were extremely simple. As, on the surface, the centre of the south shaft was visible from the centre of the north shaft, the prolongation of the axis of the tunnel was easy. Sufficient concrete monuments were placed on this axis or its extension to ensure visibility from one to another.

The top of each monument carried a brass bar perpendicular to the axis and about 12 inches long, upon which the line was marked with a fine punch. Bars were used in preference to small plates, to facilitate the establishment of an offset if required. These bars were protected by a cover, easily removable, and lightly bolted to the monument. The measurement of the distance between shafts was done by triangulation, the nearest tenth being sufficient accuracy for that purpose.

The line for the tunnel was first established underground by stretching a string on the line of two No. 8 music wires about 9 feet apart hanging from the edge of a plank which had been placed on line across the top of the shaft. This line was used until the station at the bottom of the shaft was completed and the face was about 80 feet from the shaft. A scale was then set on the back wall of the station and another on the tunnel roof about 40 feet from the shaft, the distance between these scales being about 65 feet.

Accurate line was afterwards transferred from the monuments to these scales by transit sighting on the wires.

In this manner the line was actually carried down the north shaft once, and the south shaft six times, for tunnel purposes, and once each for setting the quarter bends. In the case of the south shaft the average of all six sets was used for the prolongation of the line into the tunnel.

Scales were set from the finally accepted position every 300 feet but never within 100 feet of the face. From these scales plugs with spads were set at about every 50 feet with one always within 80 feet of the face. Elevations, carried

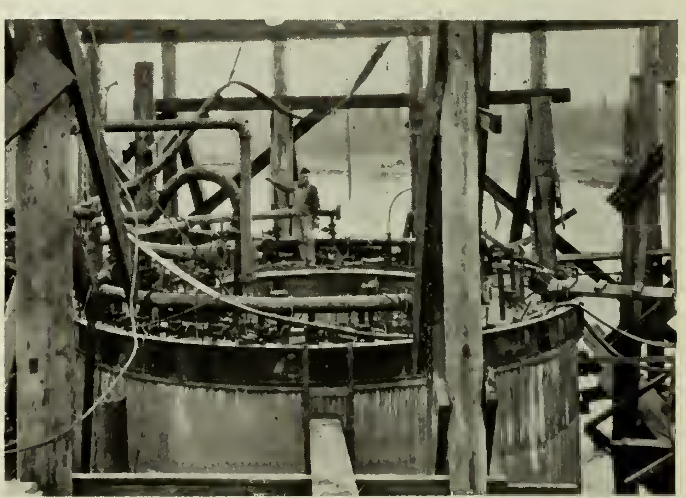

Fig. 4—Jetting Caisson.

down the shaft by an ordinary surveyor's tape, were taken on these plugs, and plummet lamp chains were adjusted to proper lengths for the two plugs nearest the face, by the use of which the miners set their centre on the face before drilling each round. In the final tie-in the levels checked exactly and the line within one inch.

### Commencement of Work

Excavation began on August 25th at the site of the south shaft in Stanley Park, the first 65 feet of the shaft, or to elevation 54.5, being in hard pan. To elevation 84.3 the side walls were timbered. This elevation determined the lower limit of the shaft cap and connecting castings, and below this it was decided to abandon the timbering and concrete a shell around the shaft in lifts of 5, 10, or 15 feet, depending upon the stability of the material. For this purpose about 610 cubic yards of concrete were used, the inside diameter being 16 feet for 45 feet, 12 feet 10 inches for 109 feet, and 9 feet 8 inches from there to the bottom.

Until the excavation of the shaft was completed and the tunnel driven some distance all the water was removed by baling. Then a centrifugal three-stage pump to lift 200 gallons per minute was installed and a triangular weir built to measure the water pumped, which was paid for at the rate of one cent per million foot pounds. (For progress on south shaft see Appendix IV.)

North Shore Preparation and Caisson Sinking*

At the same time that work was started on the south shore a dredge was put to work on the north shore and a channel dredged from the low water mark to the shaft site. At the shaft site an excavation was made to remove a layer of boulders 18 feet thick starting just below the surface. (See Fig. 4.) This excavation was made 30 feet deep and was refilled with pea gravel and a little heavy gravel and sand to a point about high water level, making an island. The caisson, 24 feet outside diameter, 14 feet inside, and the first lift 34.5 feet, was then built on this island within the supporting structure. Dredging from the inside of the caisson then started, using a 1½-yard clam shell or a 2½-yard orange peel bucket. Alternate building and dredging continued until the cutting-edge of the caisson had gone to elevation −5 and seemingly would go no farther. On examination by the diver large granite boulders, some of them containing three or four cubic yards, were discovered under the cutting edge. Some difficulty was experienced with sloughing exhibited on the surface by the sinking of pile work around the caisson. When elevation −10.5 was reached another lift of 8 feet was added to the caisson.

(For progress at north shaft see Appendix III.)

When the caisson reached the clay and soft shale bedrock a jet arrangement was made. A three-stage centrifugal pump capable of delivering 2,000 g.p.m. at 165 pounds per square inch pressure was installed and the caisson was jetted and sunk to elevation −27.5. The bottom was then cleaned up and five feet of concrete containing calcium-chloride was placed and left to set for four days when the pumps were reversed and the caisson emptied.

A seal was disclosed with only a few wet spots. A sump, 6 feet in diameter, was sunk 3 feet into the seal and about 1½ gallons per minute of water was collected. Grout holes were drilled, pipes sealed in and valves installed and grouting done. The hole was widened out to 10 feet in diameter and sunk below the original bottom for five feet. Underpinning was developed on two opposite quadrants and then the other two for about 8.5 feet from the centre of shaft. A welded steel watertight tube 14 feet long ⅜-inch steel and 9 feet 8 inches in diameter was placed central for the shaft position and concrete backing behind it placed and tamped. The seepage water was panned and the whole grouted. The caisson inclined 20½ inches per 100 feet towards the north and west from the perpendicular. The completed waterway was built so that its centre of gravity passed through the centre of gravity of the caisson in place.

After the caisson work was finished the shaft was sunk similarly to the south shaft using 335 cubic yards of concrete instead of the specified timber. Greater difficulty was experienced on this shaft than in the south on account of the presence of poor shales.

Tunnel Drifting

Tunnel drifting was not spectacular. The machines were ordinary jack hammers. Twenty-six holes per round were drilled and loaded with 100 to 175 sticks of powder and an advance of from 7 to 8 feet per round was made. The extra powder used broke the muck up very finely and facilitated handling. It disturbed material in place somewhat so that more trimming was necessary at some places to bring down loose or shattered rock. Through the sandstone little or no timbering was needed but in the shales a good deal was required, and when passing across the sandstone to shale contacts, which dipped southerly about 10 to 12 degrees, the progress was very slow and extreme care was necessary. A total of 876 feet

Fig. 5—Tunnel, showing Invert, Permanent Rails, Timbered Section and Gunite on Sidewalls.

of tunnel was timbered. About 14,000 square feet of tunnel wall, where the shales would disintegrate very rapidly, were covered with a coating of gunite ¼ to ½ inch thick. It protected the surface excellently. Payment was made for this gunite by arrangement as it did not coincide with the 2-inch thickness and timber sets required by the specification. A tunnel length of 3,069 feet was excavated from the centre line of the south shaft. A 35 h.p. storage battery motor was used to haul the muck, which was loaded into the muck car by hand labour.

There was no water in the shales, not much in the sandstone and only a small quantity even in the conglomerates. No running water whatever was encountered, and the maximum quantity pumped at any time was less than 60 gallons per minute.

On account of the grade of the tunnel falling from south to north all the water was pumped back to the south shaft sump and from there periodically to the surface. The water was quite salty and over any extended period would have had quite a rusting effect on unprotected steel pipe and equipment.

A construction station 85 by 9 by 9 feet was excavated north of the shaft for the tunnel pipe-placing equipment. This station was later thoroughly concreted and after the quarter bend was placed was filled up with concrete, the timber not having been withdrawn.

For details of progress in driving the tunnel see Appendix V.

On completion of the drift, men were immediately put at trimming and also concreting the invert, in which permanent 30-pound rails at 24-inch gauge, were laid to a precise grade. This took from May 27th to August 6th.

Tunnel and Shaft Lining

The specifications provided for a lining of steel pipe or steel-cylinder-reinforced concrete pipe equivalent in strength to the corresponding steel pipe. Different thicknesses of steel pipe were proposed dependent upon the nature of the rock. A steel plate ⅝ inch thick was taken as the base for tunnel lining and 11/16 inch thick for the shafts.

*See Engineering News-Record, July 6th, 1933, "Difficult Caisson Sinking for Vancouver Water Tunnel," by W. Smaill, M.E.I.C.

On account of the longitudinal stress due to upward pressure, in the upper 160 feet in the south shaft and 107 feet in the north shaft, riveted steel pipe $1\frac{1}{8}$ inch or $1\frac{1}{8}$ inch and 1-1/16 inch respectively, no alternative, was used. Below that the steel-cylinder-reinforced concrete pipe known as Bonna pipe was employed. Very little material change was made in the shafts, but in the tunnel the specifications anticipated only about 100 feet of heavy pipe whereas 1,530 were used. The sandstone was considered to have sufficient strength to be amply protected by the thinner pipe lining but the shale was deemed uncertain. Timber was used through the shale beds and the impossibility of withdrawing that timber when lining operations were proceeding was early foreseen.

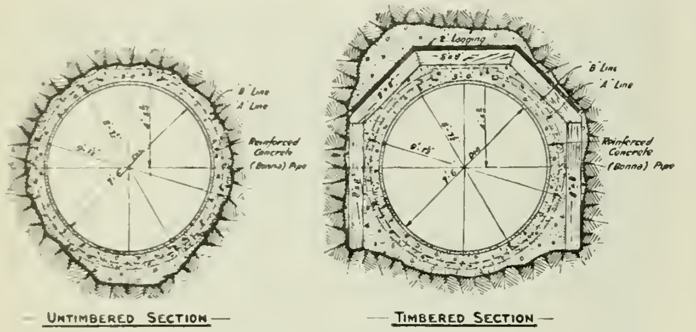


Fig. 6—Tunnel Sections.

For this reason the decision was made to use the heavy pipe specified equivalent to one-inch steel plate through the shale areas and to leave the timber in place and to grout as thoroughly as possible after the lining was placed. This heavy pipe has a steel stress of less than 10,000 pounds per square inch from the whole unbalanced pressure and has not more than 14,000 pounds per square inch where ample provision is made for surge or water hammer.

Primarily the steel-cylinder-reinforced concrete pipe consisted of a steel cylinder 5/32 inches thick on which were wound two or three tiers of $\frac{5}{8}$-inch steel reinforcing rods separated by $\frac{3}{8}$-inch steel rods longitudinally placed 8 inches apart and lined centrifugally with concrete. The outside concrete was not placed as it would have increased the weight of each section about 5 to 6 tons.

The theoretical shop length of a tunnel pipe section was 14 feet and of a shaft pipe 12 feet. The actual length was from $\frac{1}{4}$ to $\frac{3}{8}$ inch shorter.

Appendix VI contains information regarding the reinforced concrete steel cylinder pipe used for the lining of the tunnel.

The operating procedure in the shop during the manufacture of the pipe under the Bonna process included:—

(1) Shearing of the plate to required size.
(2) Rolling and flanging of the plate to required diameter.
(3) Fitting of the plates into a course.
(4) Assembly of the courses into a section and tack welding longitudinal and circumferential seams.
(5) Welding of the section.
(6) Testing of the welds.
(7) Placing spiral and longitudinal reinforcing done by wrapping machine.
(8) Placing grout pipes.
(9) Rolling and placing the interior reinforcing steel.
(10) Setting and adjusting the spinning rings.
(11) Spinning of the interior concrete lining.
  (a) Mix
  (b) Pour
  (c) Spin
  (d) Finish
(12) Curing of the concrete lining.
(13) Shipping by barge or truck.

### Material Tests and Inspection

Tests were taken throughout on all materials and workmanship, and steel and cement were inspected at the mills or at the manufacturer's plant.

A piece of concrete was removed from one pipe to determine whether the mix used appeared balanced and also if there was good bonding with the steel. This piece was cut and polished and showed a very dense concrete with just about the right proportion of sand to gravel, there being a slight excess of sand in order to allow a smooth finish to be given to the inside of the pipe. This concrete was tested for density and gave a weight per cubic foot of 157 pounds as against 150 pounds for the rodded concrete set without spinning.

The spun concrete being denser than the concrete test cylinders broken it is expected that the strength of the lining will be from 10 to 15 per cent greater than the strength of the cylinders made from the same batch.

All weld test specimens from the automatic welding machine broke in the material except those two noted below. Six circumferential and six longitudinal tests were made and of the ten deemed satisfactory the average breaking stress was 58,197 pounds per square inch. Full penetration of seams was insisted upon.

Bend and fracture tests were made, in addition to the tension tests, and all were found satisfactory.

Torpedo gravel, coarse and fine sands were used as aggregates for the concrete lining.

For a typical test of concrete aggregates which were not stored under cover and were subject to variations in climatic conditions see Appendix VII.

Throughout the work 3-inch by 6-inch test cylinders were taken from one of the batches of every pipe. These cylinders were not tested, only cured in damp sand, water spray or vapour to make curing conditions comparable to those of the section itself, and held for check tests of the larger cylinders in case of failure or doubt.

Every tenth pipe was selected for the regular test, in which two 6-inch by 12-inch standard test cylinders were taken and one tested at seven and one at twenty-eight days curing, alternately. This schedule was adhered to as closely as possible.

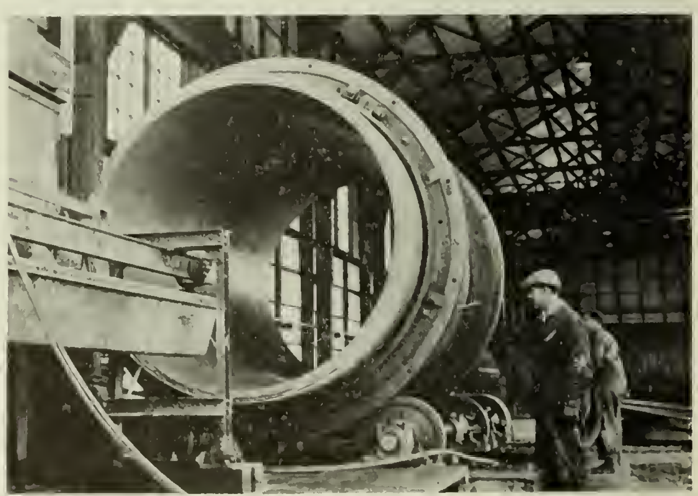

Fig. 7—Fabrication of Steel Cylinder Reinforced Concrete Pipe.

Results of tests showed a very dense concrete of low absorption.

Check tests were made on all cement, shipped from the tested bins at Bamberton, B.C., at the fabrication plant or at the warehouse before shipping to the plant.

### Hydrostatic Tests of Pipe

Two sections of tunnel type pipe were set up and welded together in the shop. The joint of the two sections was filled up by the finishing method used in the tunnel. A steel cylinder was then placed inside and bolted together, and the end rings welded to the inner and outer cylinders to make a watertight compartment about one inch in width between the cylinder and the section. Hydrostatic pressure was then applied at 195 pounds per square inch.

Several sweats showed in the welded seams, which served to show that under test conditions the cylinder and its surrounding spirals expanded away from the centrifugated concrete lining, that the water penetrated here

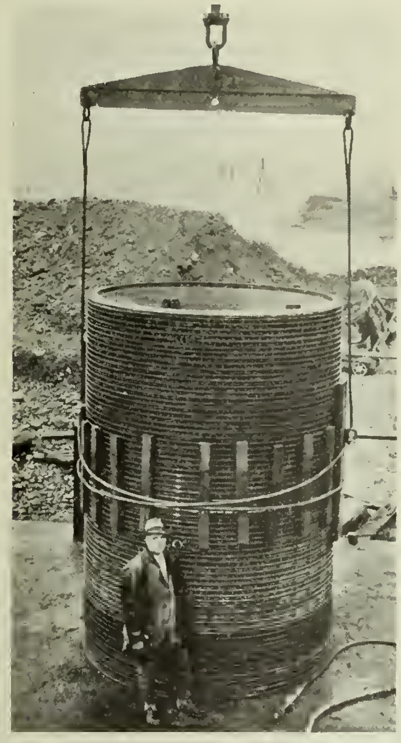

Fig. 8—Section of Tunnel Pipe Ready for Lowering.

and exerted its full pressure upon the 5/32-inch plate, which without its concrete backing deformed, and pores which could not be detected under the gasoline test showed a water percolation.

However, it was decided that the test was in no way fair to the type of pipe as tests already made had demonstrated the strength of the pipe. Further similar tests were therefore dispensed with.

### Laying The Tunnel Pipe

The pipes for the tunnel and the north shaft were moved from the fabrication plant to the shaft by barge, four lengths or more being shipped per trip. The eighteen lengths required for the south shaft were hauled by truck to Stanley Park.

When a tunnel pipe arrived at the north shaft it was spidered inside at three or four places with 4- by 6-inch struts and four 4- by 6-inch longitudinal timbers and lowered down the shaft by means of a stiff-leg derrick. At the bottom it was, for the first time since centrifugation was completed, lowered on to its side and a cantilever car picked it up and carried it to its place of installation in the tunnel.

Adjacent to the south shaft, between the first three pipes placed and the roof and side of the tunnel, there was ample room for workmen to move around. These three pipes were jacked into position and the concrete backing placed outside them in one operation.

The fourth and subsequent pipes were brought up to an approximate position. A centring spider in the last set pipe took the far end of the pipe and with motion in three planes available from the cantilever car and with the steadying effect of the centring spider, the pipe was quickly adjusted for line and grade, and blocked so that motion was impossible. Here the value of the concrete invert and the permanent set rails was apparent. A sandbag bulkhead was built and the first two yards of concrete of the section blown in from the bottom. It was found, by experiment, that gravity would not carry the backfilling concrete completely into the reinforcing bars on the bottom of the pipe, but the upward motion and the blast of air through the mixture when placed from the bottom excellently surrounded the reinforcing steel. The blower pipe was then transferred to the top of the section and the placing continued until the top of the reinforcing steel was covered to a depth of 3 inches. Time was then allowed for a slight set of the concrete and the slump of the mixture was changed from 10 or 11 inches to 5 inches and the balance was placed so as to fill the spaces as completely as possible between the pipe and the rock excavation.

Fifteen pipes were placed before the welding was started and then oxy-acetylene welding was tried, unsuccessfully. The joint could not be dried and consequently it was impossible to make other than a porous weld. The method was then changed and the weld was made immediately the pipe was placed in position and before the backing was placed. No great difficulty was then experienced. The welders later used more heat and it was then discovered that the expansion of the steel was breaking the bond between the steel and the concrete. The use of oxy-acetylene was then stopped and electric welding substituted. Not much trouble was found from that time, but much greater care had to be taken in the preparation of the joint for welding.

When the welding was finished the concrete backing was placed and it was sufficiently wet so that if there was any porosity in the weld a moisture showed, Finally a caulker was detailed to stand by every joint as the concrete was being placed and to caulk until dry or re-weld the porous spots. In all joints done after the procedure was changed very little difficulty was experienced with leaks but when the welding alone was completed there was scarcely a joint 100 per cent dry against all moisture. The backing concrete was placed by means of a Webb gun.

Fig. 9—Lowering Tunnel Pipe at Bottom of Shaft.

The concrete was mixed at the north shaft and brought to the gun in cars holding two batches each of 12 cubic feet. The bulkhead was left in place at least four hours, and no concrete was blown against that previously placed until the latter was six or eight hours old.

The greatest care was exercised in preparing the sandstone rock before the pipe was placed, and it is thought that in general the contact of backing to bedrock is very tight except of course at the top of the section.

Considerable study was given to the selection of the proper mix for the backing. Ten or twelve mixes with different cement content, water content and different admixtures were tested. Two experimental sections were used and remembering that the steel reinforcing was placed thirteen ⅝-inch rods to the linear foot on the inside tier and two tiers over that with 9 and 4 rods respectively, the fineness of the material used can be realized.

For a typical mix of concrete backing see Appendix IX.

**Fig. 10—Bulkhead in Place and Concrete Setting.**

In placing pipe and lining the men worked eighteen shifts per week and placed from twelve to a maximum of fifteen pipes per week.

In the tunnel lining the cycle of operation and the time occupied may be summarized as follows:

| | | |
|---|---|---|
| 1. | Clearing up, removing muck, drumming rock, air blasting the sides of the excavation and the invert | 4 hours |
| 2. | Bringing in and setting pipe, placing bulkhead | 1 hour |
| 3. | Welding joint | 2½ hours |
| 4. | Bringing in gun and adjusting blower | 1 hour |
| 5. | Blowing lower part of space | ½ hour |
| 6. | Changing over to upper section | ¼ hour |
| 7. | Blowing upper part of space | 2 hours |
| 8. | Time for setting | 2 hours |
| 9. | Complete blowing of top spaces | 1 hour |
| 10. | Awaiting setting of concrete backing before withdrawing sand bag bulkhead or blowing further concrete up against green concrete | 6 to 8 hours |

(Some of these operations run parallel with others)

Later the joint spaces in the inner lining of the Bonna pipe were concrete finished and the grout hole plugs set and also concrete finished.

### Quarter Bends

The quarter bends at the feet of the shafts were specials. The shaft part consisted of a cylinder 8 feet 8 inches diameter of one-inch steel, which went 4 feet below the floor of the tunnel in the south shaft and about 6 feet below the floor in the north shaft forming a permanent sump, and a taper 8 feet 8 inches to 7 feet 10 inches about 10 feet long. The taper was field connected to the cylinder by a double riveted butt joint, the joints in the strap being field welded. Special flanges were provided to connect the quarter bend to the tunnel and shaft pipes respectively. The quarter bends were built in two pieces, bolted together, riveted and caulked and then set to place and finally welded to the already set tunnel pipe. A grout hole was left in the centre of the bottom, through which, when the quarter bend was set, grout was poured up to the plate, to a depth of about 3 inches, the bottom of the sump having previously been concreted up to that level.

On account of the bad rock conditions at the junction of the north shaft and the tunnel, reinforcing rods were placed around the quarter bends, designed to stiffen the whole structure. The outside backing was then placed. There was plenty of space around for tamping the concrete.

The reinforcing for the inside of the quarter bend was set, saddled and tack welded or tied so as to be in its correct position in the inner lining. This reinforcing consisted of No. 10 galvanized wire mesh tied to hoops at 18-inch centres. Over the mesh was then placed the form shaped to develop the final waterway. The lining, consisting of a rather thick grout, fifteen sacks cement to the yard, was poured, the form being vibrated as much as possible during the process.

For test purposes, prior to placing this grout lining, a form was made and poured. On stripping four days after pouring, it was found that the shrinkage was very slight.

### Shaft Pipes

From the top of the quarter bends to elevation −66.66 south and elevation −20.83 north the shafts were lined with steel-cylinder-reinforced concrete pipes similar to those used in the tunnel, but of strength equivalent to varying thicknesses of steel pipe. (See Appendix VI.) The selection of the location of the pipe of different strengths was made originally from the borings and was somewhat amended as the excavation disclosed the true character of the rock passed through. Altogether the shaft reinforcing steel amounted to 21¾ tons more than was specified.

On an average about one length of pipe was set per day. The welding was done before concrete was poured

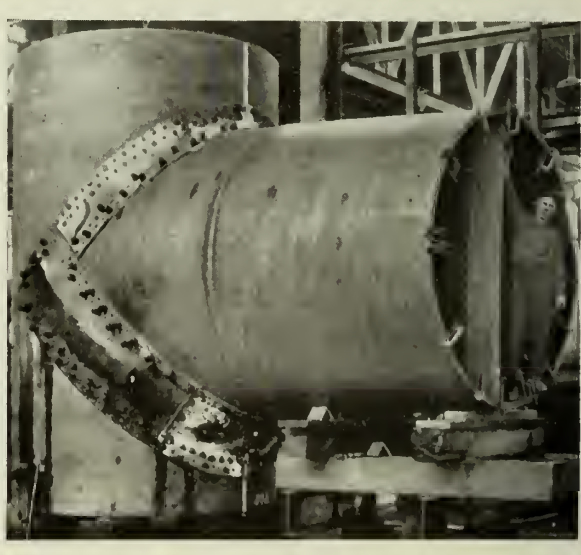

**Fig. 11—Quarter Bend being Assembled.**

but the water coming down inside the shaft lining prevented inspecting and caulking until after the upper steel pipe was set.

Grout holes were left near the top of the shaft pipes and these were grouted, as explained under the section on grouting.

The outside backing was similar to that placed behind the Bonna pipe in the tunnel.

### Steel Pipe Interlining

Above elevation −66.66 on the south shaft and above elevation −20.83 on the north, steel pipe interlining was used in order that the upward thrust due to pressure should be transferred into the concrete counter-weight, the heavy circular backing of the upper shaft section. The pipe used was 161.66 feet 1⅛ inch thick in the first case and 48.83 feet 1⅛ inch and 58.50 feet 1-1/16 inch thick in the latter. Each course of pipe was made from one plate, with a butt

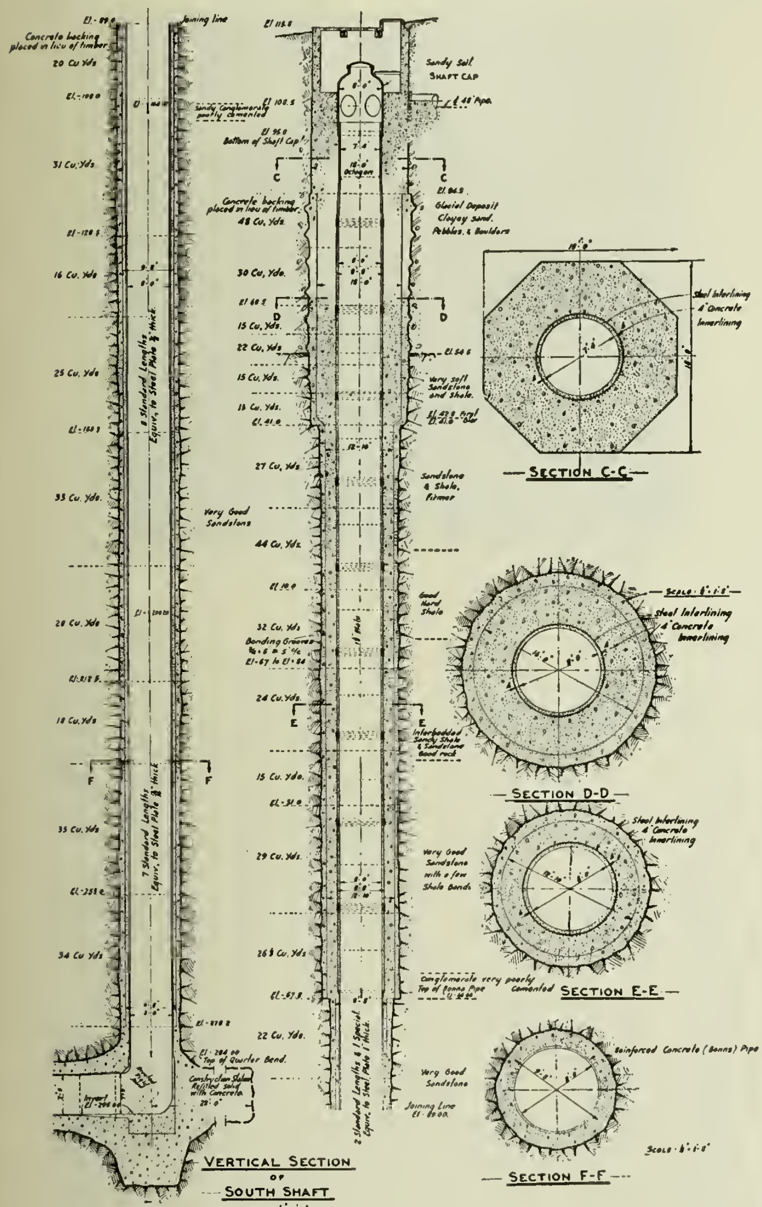


Fig. 12— Sections of South Shaft.

welded longitudinal joint. Two courses joined in the shop by a butt welded circular joint formed a section 16 feet long. The field connections were riveted butt joints, the straps being welded where joined. The seams as well as all rivet heads were caulked inside and out. The sections were shop erected and fitted, the rivet holes being drilled ⅛ inch undersize so as to provide for field reaming. The steel pipes were backed with a 2,500-pound concrete, maximum aggregate 1½ inches to 2 inches. To lower a pipe section down the shaft, set, fit, ream, rivet, caulk, weld and place concrete backing, erect staging and make ready to receive next length took seventy-two hours. In each shaft the whole of the steel interlining was placed and then the concrete interlining was carried up to within 8 feet of the shaft cap joint. The last portion of inner lining was placed after the shaft cap had been erected.

Grout holes were left and later grouted in the south shaft but in the north all the steel interlining being within the caisson no grouting was needed.

The inner lining was a cement, sand and bird's eye gravel mixture—twelve sacks cement to the yard. It had a 8-9 inch slump. It was 4 inches thick and reinforced with wire mesh No. 10 gauge, tied to hoops which were welded to the steel pipe. It was placed in 8- or 16-foot lifts and as soon as the forms were removed was rubbed and polished to a finish corresponding to that of the centrifugated pipe.

### Shaft Caps, Valves and Connecting Pipe Lines

The only outward indication of shaft or tunnel is the shaft cap at each end. The caps are made of cast steel 2½ inches thick, with four 48-inch outlets on each, to which are attached the 48-inch outlet pipes which go to the valve chamber. The flanges of the outlets are standard heavy pressure 48-inch flanges. The top of each shaft cap has a 48-inch removable head attached to the main body by studs. The connection to the steel interlining is a triple riveted lap joint.

Bolted to the shaft cap are steel castings consisting of straight pipe extension pieces, ⅛ bends and ¼ bends. Between the steel castings and the valves 48-inch welded steel pipe ¾ inch thick was used. Chrome-nickel bolts, studs and nuts were used throughout for these connections. All castings and pipes were coated inside and outside with Hermastic pipe coating.

Only two valves are at present installed, the other pipes being closed by bolted-on heads. The valves are of cast steel 48 inches in diameter, designed for 210 and tested to 425 pounds per square inch. Each weighs 21,000 pounds.

The north connecting pipe is 60 inches and the south pipe is 70 inches. At some future date the 70-inch pipe will be paralleled by an 84-inch and the 60-inch by three

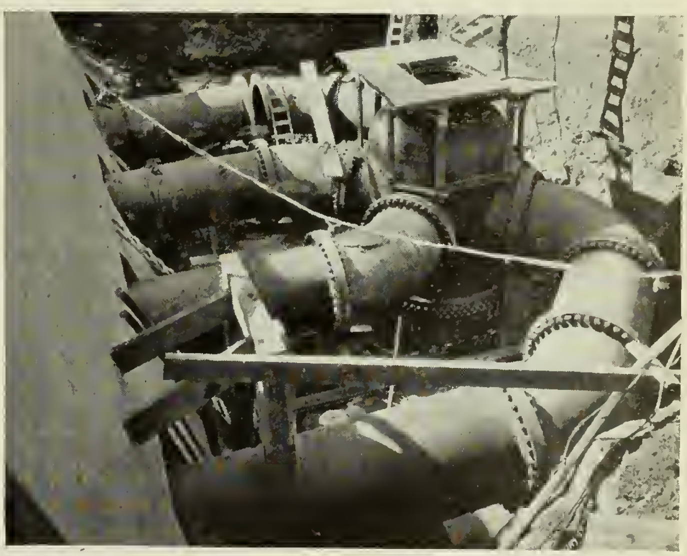

Fig. 13—Pipes Between South Shaft Cap and Valve Chamber.

60-inch or two 72-inch pipes. The tunnel and these pipe systems will carry the total yield of the Capilano system, estimated at over 200 million gallons per day.

### Grouting and Finishing

In each length of tunnel pipe there were placed on the top centre line two grout holes, one about 18 inches from the end and the other near the centre. Also two grout holes were placed in selected pipes about 18 inches from the end, one on each side of the pipe, and about 45 degrees from the bottom. These were only used where water conditions demanded it.

In the Bonna shaft pipe two grout holes were placed, one about 8 inches and the other 10 inches from the top.

In the steel pipe in the south shaft in order that the concrete backing might be brought to the proper length for support for the riveters the grout pipes were placed relatively in the same position but about 3 feet below the top of the pipe.

When the tunnel pipe laying had proceeded to station 20 + 00 grouting was started at station 11 + 74. This point was selected because it was in the shales and the grouting holes showed no water leaking into the tunnel. By starting here the grouting would form a plug so that residual water would not be forced into the otherwise dry areas.

Nipples and valves were placed on 10 or 12 holes and grouted to refusal at a pressure of 100 pounds per square inch. Theoretically the roof aperture should be open enough for the grout to flow from one hole to the next and further if the intervening valves are closed. This did not prove entirely true and very often it was nearly impossible to force any grout into the adjoining hole at the given pressure and the machine had to be connected with each individual aperture. This operation was carried right back to the quarter bend at the south shaft.

The total amount of grout used was 21.5 cubic yards. The maximum for any hole was 16 cubic feet and in some cases the quantity taken was scarcely measurable.

Returning over the same area, using a pump and a pressure of 200 pounds per square inch, another 3.50 cubic yards of grout was used and practically the whole of the leakage water was cut off.

From station 11 + 74 to the north shaft the grouting was carried on by first doing the main mass at 100 pounds per square inch and then following up later at 200 pounds per square inch. The grout holes at the quarter bends where special water conditions were encountered were panned and grouted from one to the other in the regular way.

Those joints that had not been welded until after the backing was placed were exceedingly difficult to get dry, frequently they were drilled and tapped and before putting the plugs in the tapped holes grout was forced in with a small pump.

In the shaft one grout hole was placed about two inches lower than the other, the horizontal distance apart being about two feet. In placing the backing the concrete was brought up to the top of the higher hole. After about four hours a sheet of No. 18 gauge galvanized iron was forced down into the hardening concrete about five inches. Concrete between this sheet and the original concrete shaft lining was removed so as to make a trench on a grade between one hole and the other around the shaft but not across the 2-foot intervening space, where a solid dam was left. Before next concreting started this drainage trench was filled with 1½-inch to 2-inch gravel and carefully covered with two layers of burlap snugly tucked at sheet and concrete face so that when the next concrete was placed this gravel drain carried away what water might collect in it, preventing the water from rising up through the green concrete.

The grouting of the shaft then consisted in forcing in grout at the lower hole and continuing the pressure until it flowed freely from the upper one. Only a small quantity was taken but it very effectively shut off the seepage water.

After the grout was set the plugs were screwed in and the aperture in the inner lining filled up with concrete and smoothly finished.

The operation of grouting may be described as particularly tedious, and uninteresting, but results are definite and satisfactory if the work is properly performed.

Where the welding was performed before the backing was placed, any porosity was disclosed before the concrete set by a dampness on the metal. A caulker attended to this and a watertight joint was the result. No finishing was placed until the finisher was sure of that watertightness. The joint finisher roughened the ends of the 2-inch concrete lining, set a reinforcing band of mesh 2 inches by 2 inches of No. 12 gauge and then plastered in the joint cavity, which was 4 inches wide, with 1 to 2 cement sand mortar. It was screeded to perfect alignment, finished with steel trowel and the joint can hardly be detected from the spun portion of the inner lining.

At the south valve chamber the connecting pipes were kept at an even temperature by a system of internal spray pipes and in this even temperature the pipes were grouted into their permanent positions through the north wall of the south chamber. The spray pipes were kept going until the tunnel was filled.

Fig. 14—Grout Holes Discharging Water.

At the north chamber the valve and heads were bolted into position and after the water had risen to the proper elevation to keep them full the grouting into the south wall of the north chamber was completed. Circulation was kept going throughout the period of grouting and setting.

The lead joints connecting the tunnel pipes to the north and south mains were poured and the wall castings grouted to final positions and the tunnel construction was ready for hydrostatic test.

### Hydrostatic Test of Tunnel

The pressure used was 210 pounds per square inch at pipe level in the south valve chamber and was maintained for thirty-six hours, the leakage water being measured.

For the last fourteen hours the total rate of pumping was at the rate of 288 gallons per twenty-four hours. The main south of the south valve was opened and the valve was drop-tight, likewise the blow-off valve in the south chamber. But the valve in the north chamber had not been as carefully closed and it was surmised that some water was passing it. A check was made which was not entirely conclusive but an estimate of 110 gallons per twenty-four hours was arrived at as escaping the valve. This was considered satisfactory under the specifications, and under the peculiar conditions then existing it was impossible to inspect that side of the valve. At a later time the test will be repeated and results noted.

During the test not a drop of water was visible at any exposed bolted joint. Three sand holes were discovered in the steel castings and were caulked and welded.

On June 3rd, after a final inspection was made, the tunnel was swept and washed. After baling out the washing water from the north shaft sump, the tunnel and shafts were filled with chlorinated water containing about 15 parts per million of free chlorine. Afterwards the tunnel was flushed for ninety-six hours before any water was turned into the distribution system, which was only done after the Medical Health Officer had reported the water free both from chlorine and from contamination.

On June 15th water was turned through the city pressure regulating valves into the distribution system and on June 30th the valves were fully opened and normally operated.

The contractors finished their work and removed all plant and equipment on July 8th, just two years after the award of the contract.

After the completion of the work done under the general contractors, the area used for construction purposes around the valve chambers and the access chamber in Stanley Park was filled, graded and seeded, and trees and shrubs planted. On the north shore an access house, octagonal in form, was built of reinforced concrete and located over the shaft.

The north and south pipe line connections to the tunnel were laid by the District's own forces, the mains across the Indian Reserve and across Stanley Park having been installed under separate contracts.

The whole construction work was, fortunately, very free from accidents, only four being at all serious.

The Greater Vancouver Water District was represented as follows: Mr. E. A. Cleveland, M.E.I.C., chief commissioner; the late Mr. J. Waldo Smith, M.Am.Soc.C.E., of New York City, consulting engineer, while Messrs. Sanborn and Bogert, also of New York City, represented him in detail studies; Mr. W. H. Powell, M.E.I.C., engineer; and Mr. Fred Stewart, resident engineer, from whom many of the details of this paper were obtained. Mr. Wm. Smaill, M.E.I.C., was chief engineer for the contractor.

The total cost of the work was $1,249,641.85, which for purposes of analysis may be thus detailed:

| | | |
|---|---|---|
| Preliminary investigations and bedrock exploration.... | | $ 91,540.17 |
| Northern Construction Company and J. W. Stewart, Ltd | | 924,715.64 |
| Ross and Howard Iron Works (steel pipe and bends).... | | 16,172.11 |
| Dominion Engineering Works—valves..... | $ 6,876.00 | |
| shaft caps.. | 19,756.89 | |
| | | $ 26,632.89 |
| Dominion Bridge Company (steel pipe)............... | | 5,464.40 |
| Vancouver Engineering Works (steel flanges, etc.)..... | | 3,043.72 |
| District's own forces.............................. | | 32,989.06 |
| Administration, engineering, testing and inspection. .. | | 78,340.10 |
| Interest during construction up to June 30th, 1933.... | | 70,743.76 |
| | | $1,249,641.85 |

## APPENDICES

### I

TABULATION OF COST OF DRILLING TEST HOLES AT FIRST NARROWS, SECOND NARROWS AND FALSE CREEK

| Hole No. on Plan | Location | Dates | Labour Man Days | Total Cost of Hole | Depth Driven Feet: In Overburden or from Platform | Depth Driven Feet: In Rock | Depth Driven Feet: Total | Total Cost Per Foot |
|---|---|---|---|---|---|---|---|---|
| "A" | | | | | | | | |
| 0 | Second Narrows, Burrard Inlet | Nov. 17/24-Feb. 10/25 | ... | $3,956.61 | 374 | ... | 374 | $15.79 |
| "B" | | | | | | | | |
| 3 | Second Narrows south | Aug. 26/26-Dec. 14/26 | 200 | $1,627.32 | 5 | 400 | 405 | $ 4.01 |
| 4 | Second Narrows north | July 9/26-Dec. 27/26 | 738 | 7,863.83 | 449 | ... | 449 | 17.50 |
| 5 | Kitsilano Indian Reserve | Dec. 15/26-Jan. 21/27 | 64 | 537.33 | 32 | 98.5 | 130.5 | 4.14 |
| 6 | Kitsilano bridge | Jan. 25/27-Mar. 1/27 | 54 | 517.01 | 26.5 | 103 | 129.5 | 4.00 |
| 7 | False Creek-Jervis street | Mar. 2/27-Apr. 21/27 | 151 | 1,483.80 | 48 | 320 | 368 | 4.04 |
| 1 | First Narrows south | Apr. 22/27-July 8/27 | 256 | 2,405.90 | 5 | 493 | 498 | 4.83 |
| 2 | First Narrows north | Jan. 3/27-Mar. 28/27 | 269 | 2,482.64 | 161 | 339 | 500 | 4.96 |
| 8 | First Narrows north | Mar. 29/27-May 31/27 | 272 | 2,350.00 | 180 | 270 | 450 | 5.22 |
| 9 | First Narrows north | Jan. 1/27-July 20/27 | 242 | 3,663.31 | 126.5 | 351 | 477.5 | 7.68 |
| 10 | Capilano pipe line road | July 29/27-Nov. 3/27 | 531 | 4,918.00 | 325 | 176 | 501 | 9.81 |
| 16 | First Narrows, Burrard Inlet | Nov. 22/27-Dec. 5/27 | 64 | 740.00 | 111.5 | 10 | 121.5 | 6.09 |
| 18 | First Narrows, Burrard Inlet | Dec. 6/27-Dec. 14/27 | 48 | 824.00 | 114 | 32 | 146 | 5.64 |
| 21 | First Narrows, Burrard Inlet | Dec. 28/27-Jan. 10/28 | 66 | 952.00 | 128 | 32 | 160 | 5.59 |
| 22 | First Narrows, Burrard Inlet | Feb. 15/28-Mar. 13/28 | 79 | 824.00 | 118 | 19 | 137 | 6.00 |
| 23 | First Narrows, Burrard Inlet | Mar. 14/28-Apr. 6/28 | 65 | 928.00 | 147 | 14 | 161 | 5.78 |
| 24 | First Narrows, Burrard Inlet | Apr. 13/28-Apr. 25/28 | 66 | 872.00 | 117.5 | ... | 117.5 | 7.35 |
| 30 | First Narrows, Burrard Inlet | Oct. 1/28-Jan. 12/29 | 241 | 4,240.00 | 20 | 555 | 575 | 7.37 |
| 35 | First Narrows, Burrard Inlet | June 1/28-Sept. 24/28 | 547 | 5,817.00 | 283 | 418 | 701 | 8.30 |
| 36 | First Narrows, Burrard Inlet | Sept. 25/28-Dec. 1/28 | 348 | 4,830.00 | 248 | 466 | 714 | 6.76 |
| 37 | First Narrows, Burrard Inlet | Dec. 3/28-Feb. 16/29 | 387 | 4,565.00 | 274 | 341 | 615 | 7.42 |
| 38 | First Narrows, Burrard Inlet | Jan. 2/30-Jan. 24/30 | 74 | 1,012.00 | 127 | 19 | 146 | 7.00 |
| 39 | First Narrows, Burrard Inlet | Jan. 27/30-Feb. 20/30 | 94 | 1,080.00 | 118 | 17 | 135 | 8.00 |
| 40 | First Narrows, Burrard Inlet | Nov. 22/30-Dec. 5/30 | 78 | 908.00 | 136 | 10 | 146 | 6.22 |
| 41 | First Narrows, Burrard Inlet | Dec. 5/30-Dec. 12/30 | 62 | 859.00 | 126 | 12.5 | 138.5 | 6.20 |
| 42 | First Narrows, Burrard Inlet | Dec. 13/30-Dec. 22/30 | 69 | 846.00 | 125 | 12 | 137 | 6.17 |
| 43 | First Narrows, Burrard Inlet | Dec. 23/30-Jan. 2/31 | 62 | 806.00 | 120 | 11.5 | 131.5 | 6.13 |
| 44 | First Narrows, Burrard Inlet | Jan. 2/31-Jan. 14/31 | 111 | 812.00 | 116.5 | 20 | 136.5 | 5.95 |
| 47 | First Narrows, Burrard Inlet | Jan. 14/31-Feb. 21/31 | 167 | 2,067.00 | 111 | 291.5 | 402.5 | 5.13 |
| 49 | First Narrows, Burrard Inlet | Jan. 21/31-Jan. 29/31 | 70 | 786.00 | 120 | 6.5 | 126.5 | 6.21 |
| 50 | First Narrows, Burrard Inlet | Jan. 30/31-Feb. 5/31 | 60 | 744.00 | 108.5 | 10 | 118.5 | 6.28 |
| 52 Extension | First Narrows, Burrard Inlet | Apr. 15/31-May 16/31 | 254½ | 2,870.00 | ... | 172 | 172 | 16.69 |
| 53 | First Narrows, Burrard Inlet | Feb. 23/31-Mar. 16/31 | 159 | 2,186.00 | 129 | 273 | 402 | 5.44 |

Total cost based on first 100 feet...$ 6.00 per foot
second 100 feet... 8.00 per foot
third 100 feet... 12.00 per foot
Sandstone drilling... 4.00 per foot
Work ordered by engineer paid for under contract provision for extra work.

I—Continued

TABULATION OF COST OF DRILLING TEST HOLES AT FIRST NARROWS, SECOND NARROWS AND FALSE CREEK

| Hole No. on Plan | Location | Dates | Labour Man Days | Total Cost of Hole | Depth Driven Feet: In Overburden or from Platform | Depth Driven Feet: In Rock | Depth Driven Feet: Total | Total Cost Per Foot |
|---|---|---|---|---|---|---|---|---|
| | | | "C" | | | | | |
| 1A | Marine Drive | July 13/27-Aug. 22/27 | 196 | $2,604.00 | 218 | ... | 218 | $11.94 |
| 11-15, 17, 19, 20 | First Narrows | Sept. 26/27-Jan. 19/28 | 591 | 9,384.75 | 1076 | 415 | 1491 | 6.30 |
| 30 | Capilano Creek at First Narrows | May 25/28-May 29/28 | 32.5 | 402.87 | 17 | 24 | 41 | 9.85 |
| 31 | Capilano Creek at First Narrows | May 29/28-May 31/28 | 26 | 332.37 | 22 | 22 | 44 | 7.55 |
| 32 | Capilano Creek at First Narrows | June 1/28-June 6/28 | 48 | 674.88 | 48 | 36 | 84 | 8.03 |
| 33 | Capilano Creek at First Narrows | June 6/28-June 18/28 | 113 | 1,523.38 | 130 | 22 | 152 | 10.02 |
| 45 | At First Narrows | Jan. 2/31-Jan. 14/31 | 83 | 920.00 | 100 | 40 | 140 | 6.57 |
| 46 | At First Narrows | Jan. 17/31-Jan. 21/31 | 41 | 884.00 | 131 | 9 | 140 | 6.31 |
| 48 | At First Narrows | Jan. 22/31-Jan. 26/31 | 36 | 752.00 | 113 | 12 | 125 | 6.01 |
| 51 | At First Narrows | Jan. 15/31-Jan. 19/31 | 18 | 2,749.50 | 60 | ... | 60 | 5.75 |
| 52 | At First Narrows | Jan. 27/31-Feb. 17/31 | 147 | | 66.5 | 35.5 | 418 | |

Total cost based on day shift...$45.00
Night shift... 40.00
Grave yard shift... 35.00

II

TABULATION OF TENDERS

| Tenderer | Total | Remarks |
|---|---|---|
| Northern Construction Co. and J. W. Stewart Ltd. | $ 957,144.50 | If Bonna pipe used in contracts Nos. 35 and 36, deduct $15,000.00. |
| | $1,003,584.50 | If air locks required as called for in specifications add $50,000.00. |
| Smith Bros. and Wilson Limited. | $ 926,804.83 | If Bonna pipe used in contracts Nos. 35 and 36, deduct $15,000.00. |
| | $ 925,639.59 | Three qualifications of specifications: (1) Relief in event of impossibility of completion. (2) Payment of progress estimates. (3) Arbitration. |
| | $ 981,680.52 | No experience sheet. |
| Pacific Engineers Ltd. | $1,020,447.50 | If Bonna pipe used in contracts Nos. 35 and 36, deduct $15,000.00. |
| | $1,026,827.50 | Three qualifications of specifications: (1) Relief in event of impossibility of completion (2) Payment of progress estimates. (3) Arbitration. No experience sheet. |
| Stuart Cameron Ltd. | $1,320,540.21 | If Bonna pipe used in contracts Nos. 35 and 36, deduct $15,000.00. |
| | $1,371,677.53 | |
| | $1,348,488.13 | |
| | $1,385,493.25 | |

NOTE: Contract No. 35—First Narrows pressure tunnel.
Contract No. 36—Stanley Park pipe line.

III

PROGRESS ON NORTH SHAFT

| Week ending Saturday | Caisson constructed (feet) | Caisson sunk (feet) | Elevation of toe of cutting edge (feet) |
|---|---|---|---|
| 1931 | | | |
| Sept. 12 | Cutting edge set and reinforcing started | | |
| " 19 | 10.5 | .... | 96.9 |
| " 26 | 8.0 | .... | 96.9 |
| Oct. 3 | 16.0 | 4.9 | 92.0 |
| " 10 | 8.0 | 15.4 | 76.6 |
| " 17 | 16.0 | 15.0 | 61.6 |
| " 24 | 24.5 | 24.7 | 36.9 |
| " 31 | 16.0 | 31.4 | 5.5 |
| Nov. 7 | 12.5 (9-inch walls inside and outside) | 8.0 | − 2.5 |
| " 14 | .... | 2.7 | − 5.2 |
| " 21 | .... | 1.1 | − 6.3 |
| " 28 | .... | .6 | − 6.9 |
| Dec. 5 | .... | .... | − 6.9 |
| " 12 | .... | .... | − 6.9 |
| " 26 | .... | .... | − 6.9 |
| 1932 | | | |
| Jan. 2 | .... | 3.1 | −10.0 |
| " 16 | 10.0 (9-inch walls inside and outside) | .8 | −10.8 |
| " 23 | .... | .5 | −11.3 |
| " 30 | .... | 1.7 | −13.0 |
| Feb. 6 | .... | 4.0 | −17.0 |
| " 13 | .... | 5.0 | −22.0 |
| " 20 | (Filled up 13 feet between 9-inch walls) 6.0 (9-inch walls inside and outside) | .... | −22.0 |
| " 27 | .... | 5.5 | −27.5 |
| Mar. 5 | Poured about 120 yards concrete in bottom plug. | | −27.5 |
| " 12<br>" 19 | Cut hole down through concrete plug, underpinned from elevation −29.5 to elevation −34.6. Drilled prospect holes and grouted, put in steel casing ⅜ inch thick from elevation −20 to elevation −34 | | −34.6 |

III

Progress on North Shaft—Continued

| Week ending Saturday | Shaft sunk (feet) | Elevation of shaft lining | Elevation of bottom of shaft |
|---|---|---|---|
| 1932 | | | |
| Mar. 26 | 10.0 | − 44.6 | − 44.6 |
| April 2 | 20.0 | − 60.0 | − 64.6 |
| " 9 | 31.9 | − 96.5 | − 96.5 |
| " 16 | 34.0 | −120.5 | −130.5 |
| " 23 | 40.5 | −171.0 | −171.0 |
| " 30 | 37.0 | −208.0 | −208.0 |
| May 7 | 38.2 | −246.2 | −246.2 |
| " 14 | 41.0 | −277.2 | −287.2 |
| " 21 | 13.0 | −300.0 | −300.2 |
| May 28 / June 4 | Shaft and sump at north shaft completed | | |

IV

Progress on South Shaft

| Week ending Saturday | Shaft sunk (feet) | Elevation of shaft lining | Elevation of bottom of shaft |
|---|---|---|---|
| 1931 | | | |
| Aug. 23 | (Elevation of top 115.0 feet) | | |
| " 30 | 21.0 | .... | 94.0 |
| Sept. 5 | 8.5 | 88.5 | 85.5 |
| " 12 | 22.0 | 63.5 | 63.5 |
| " 19 | 24.5 | 41.0 | 39.0 |
| " 26 | 33.5 | 10.0 | 5.5 |
| Oct. 3 | 40.5 | − 31.0 | − 35.0 |
| " 10 | 40.0 | − 67.5 | − 75.0 |
| " 17 | 31.0 | −103.0 | −106.0 |
| " 24 | 23.0 | −128.3 | −129.0 |
| " 31 | 36.3 | −165.3 | −165.3 |
| Nov. 7 | 49.7 | −212.5 | −215.0 |
| " 14 | 40.0 | −253.0 | −255.0 |
| " 21 | 40.0 | −278.2 | −295.0 |
| " 28 | Complete with sump | −278.2 | −303.0 |

V

Progress on Tunnel

| Week ending Saturday | Tunnel driven from station | Length | Length timbered | Face of drift on | Remarks |
|---|---|---|---|---|---|
| 1931 | | | | | |
| Nov. 21 | 0+05 | 10 | .. | 0+15 | Also construction chamber driven 22 feet south of centre line of shaft. |
| " 28 | 0+15 | 15 | 21 | 0+30 | |
| Dec. 5 | 0+30 | 56 | 16 | 0+86 | |
| " 12 | 0+86 | 114 | .. | 2+00 | |
| " 19 | 2+00 | 80 | .. | 2+80 | |
| " 26 | 2+80 | 70 | .. | 3+50 | |
| 1932 | | | | | |
| Jan. 2 | 3+50 | 85 | .. | 4+35 | |
| " 9 | 4+35 | 123 | .. | 5+57 | |
| " 16 | 5+57 | 161 | .. | 7+18 | |
| " 23 | 7+18 | 161 | .. | 8+79 | |
| " 30 | 8+79 | 161 | .. | 10+40 | |
| Feb. 6 | 10+40 | 170 | .. | 12+10 | |
| " 13 | 12+10 | 70 | 41 | 12+80 | |
| " 20 | 12+80 | 109 | 30.5 | 13+89 | |
| " 28 | 13+89 | 91 | 83.5 | 14+80 | |
| Mar. 5 | 14+80 | 95 | 97 | 15+75 | |
| " 12 | 15+75 | 103 | 97 | 16+78 | |
| " 19 | 16+78 | 99 | 97 | 17+67 | |
| " 26 | 17+67 | 95 | 85 | 18+62 | |
| April 2 | 18+62 | 127 | 46 | 19+89 | |
| " 9 | 19+89 | 140 | 16.5 | 21+29 | |
| " 16 | 21+29 | 124 | 75.5 | 22+53 | |
| " 23 | 22+53 | 142 | 41 | 23+95 | |
| " 30 | 23+95 | 185 | .. | 25+80 | |
| May 7 | 25+80 | 176 | .. | 27+56 | |
| " 14 | 27+56 | 174 | .. | 29+30 | |
| " 21 | 29+30 | 166 (2 gangs) | 75 | 30+96 | Complete. |
| | Small hole through at 30+69 at 11.50 a.m. May 21st, 1932. | | | | |
| May 28 / June 4 | Station driven 85 feet north from centre of north shaft. | | | | |

VI

Reinforced Concrete Steel Cylinder Pipe Used for the Lining of the Tunnel

| | Equivalent to steel pipes of thickness | Internal diameter | Thickness of centrifugal concrete lining | Thickness of steel cylinder | Spirals per 10 feet (⅝-inch steel rod) | | | Longitudinals between each spiral (⅜-inch steel rod) | Interior reinforcing | Total length used | Weight of steel per foot |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | First row | Second row | Third row | | | | |
| Shafts | 1 inch | 8 feet | 2 inches | 5/32 inch | 130 | 105 | 85 | 40 | 5/16 inch bars—30 spirals to 10 feet and 30 longitudinals | 61.66 | 1122 |
| | 15/16 inch | | | | 130 | 105 | 70 | 40 | | 79.05 | 1105 |
| | 7/8 inch | | | | 130 | 90 | 57 | 40 | | 153.45 | 998 |
| | 13/16 inch | | | | 130 | 80 | 45 | 40 | | 83.80 | 938 |
| | 11/16 inch | | | | 130 | 53 | .. | 40 | | 107.55 | 737 |
| Tunnel | 1 inch | 7 feet 6 inches | 2 inches | 5/32 inch | 130 | 86 | 50 | 40 | | 1530 | 911 |
| | 5/8 inch | | | | 90 | 40 | .. | 40 | | 1551 | 553 |

VII

Concrete Lining of Steel Cylinder Reinforced Concrete Pipe
Typical Test of Sand and Gravel

| Sand | Fine | Coarse |
|---|---|---|
| Retained on No. 4 mesh | Nil | Nil |
| Retained on No. 8 mesh | 1.0 per cent | 9.0 per cent |
| Retained on No. 16 mesh | 3.0 per cent | 27.5 per cent |
| Retained on No. 30 mesh | 15.0 per cent | 55.0 per cent |
| Retained on No. 50 mesh | 61.5 per cent | 86.0 per cent |
| Retained on 100 mesh | 92.5 per cent | 99.0 per cent |
| Fineness modulus | 1.73 | 2.77 |
| Moisture | 3.8 per cent | 3.6 per cent |
| Organic | O.K. | O.K. |
| Weight per cubic feet (damp loose) | 78 pounds | 89 pounds |

| Gravel | No. 1 | No. 2 |
|---|---|---|
| Retained on ¾-inch | Nil | Nil |
| Retained on ⅜-inch | 0.7 per cent | 1.3 per cent |
| Retained on ¼-inch | 53.0 per cent | 84.8 per cent |
| Retained on 8 mesh | 89.2 per cent | 97.7 per cent |
| Retained on 16 mesh | 98.1 per cent | 99.2 per cent |
| Retained on 30 mesh | 99.9 per cent | 99.8 per cent |
| Retained on 50 mesh | 100.0 per cent | 100.0 per cent |
| Retained on 100 mesh | 100.0 per cent | 100.0 per cent |
| Fineness modulus | 5.41 | 5.83 |
| Weight per cubic feet (damp loose) | 98 pounds | 102 pounds |

The weight per cubic foot of the two mixtures of 1½ cubic feet of coarse sand and 1½ cubic feet of each of the gravels dry rodded was the same, namely 122 pounds per cubic foot, using the above fine sand in each case.

By using less of the finer sand with sufficient No. 1 gravel to bring the total aggregate to three separate volumes, a much denser mixture was obtained, namely 132.5 pounds per cubic foot.

After adding 1 cubic foot of cement and making mixes of the same slumps, the weight per cubic foot was practically the same in each case.

After a few preliminary adjustments of size of batches, the following was adopted:

| | |
|---|---|
| Gravel .................. | 6 cubic feet |
| Sand .................. | 6 cubic feet |
| Cement .................. | 3½ sacks |
| Water .................. | Gauged by eye and checked on each mixer for slump of 2 to 3 inches. |
| Length of mixing time .... | 4 to 5 minutes. |

For each length of tunnel pipe it required 2 batches to fill a trough and about 4 troughs per pipe; a total of slightly over 2 cubic yards in all.

Spinning time while pouring—20 minutes approximately.

Spinning time after pouring at increased speed—45 minutes.

Speed of pipe 113 r.p.m. or 2,700 feet per minute.

VIII

Absorption Tests—Centrifugally Spun Concrete of Steel-Cylinder-Reinforced Concrete Pipe Lining

Specification American Society for Testing Materials

| Particulars of Test | Sample No. 1 | Sample No. 2 |
|---|---|---|
| 24 hours immersion in water at 70 degrees F | 3.58 per cent | 3.48 per cent |
| 48 hours immersion in water at at 70 degrees F. | 3.61 per cent | 3.58 per cent |
| 5 hours boiling and cooling in water to 70 degrees F. | 3.76 per cent | 3.90 per cent |
| Average | 3.65 per cent | 3.65 per cent |

IX

Backing for Tunnel and Shaft Reinforced Concrete Typical Test of Sand and Gravel

| "Birdseye" Gravel | Per cent retained | Total per cent coarser than given sieve |
|---|---|---|
| Remaining on No. 4 sieve | 9.00 per cent | 9.00 per cent |
| Remaining on No. 8 sieve | 59.40 per cent | 68.40 per cent |
| Remaining on No. 16 sieve | 23.00 per cent | 91.40 per cent |
| Remaining on No. 30 sieve | 5.40 per cent | 96.80 per cent |
| Remaining on No. 50 sieve | 2.40 per cent | 99.20 per cent |
| Remaining on No. 100 sieve | .80 per cent | 100.00 per cent |
| | 100.00 per cent | 464.80 per cent |
| Fineness Modulus — 4.65 | | |
| Sand | | |
| Remaining on No. 4 sieve | 00.00 per cent | 00.00 per cent |
| Remaining on No. 8 sieve | 3.00 per cent | 3.00 per cent |
| Remaining on No. 16 sieve | 20.00 per cent | 23.00 per cent |
| Remaining on No. 30 sieve | 30.00 per cent | 53.00 per cent |
| Remaining on No. 50 sieve | 30.00 per cent | 83.00 per cent |
| Remaining on No. 100 sieve | 15.00 per cent | 98.00 per cent |
| Passed the No. 100 sieve | 2.00 per cent | ..... |
| | 100.00 per cent | 260.00 per cent |
| Fineness Modulus — 2.6 | | |

| | |
|---|---|
| Moisture in sand— 3 per cent | Moisture in "Birdseye" — 2 per cent |
| Bulking in sand —24 per cent | Bulking in "Birdseye" —14 per cent |
| Organic test —O.K. | Loss by decantation — 1 per cent |

Mix: 9 sacks cement per yard—1 sack to 3 volumes, dry rodded mixed aggregate $\frac{3.00}{.92}$ = 3.26 volumes, measured separately.

$$\left.\begin{array}{l} 3.26 \times .68 = 2.20 \\ 3.26 \times .32 = 1.04 \end{array}\right\} \text{Nominal mix: 1-2.20-1.04}$$

$$\left.\begin{array}{l} 2.20 \times 1.24 = 2.73 \\ 1.04 \times 1.14 = 1.19 \end{array}\right\} \text{Field mix: 1-2.7-1.2}$$

For 4 sack batch cement—Birdseye gravel— 4.76 cubic feet
Sand —10.92 cubic feet

1 pint of Vasso per yard was used with this mix.

# The Operation of a Hydro-Electric Power System

## A SYMPOSIUM

*by*

*C. R. Reid, Assistant General Superintendent, W. R. Way, Superintendent of Operation, and E. W. Knapp, A.M.E.I.C., Service Research Engineer, The Shawinigan Water and Power Company, Montreal.*

**Papers presented before the Montreal Branch of The Engineering Institute of Canada, March 22nd, 1934.**

Foreword

*Due to the familiarity of the writers with the operations of the Shawinigan Water and Power Company, the following papers have been based mainly on the physical set-up and operating data of that organization. It is not desired to give any impression that these operating practices are considered superior to those of other similar organizations. Such practices are largely standardized and much of what follows will no doubt be familiar to other operating men.*

*An exhaustive treatment of the subject would require more time than is available, consequently the papers deal only with those features which were thought to be of particular interest to the members of The Engineering Institute.*

## The Operation of a Hydro-Electric Power System

*C. R. Reid*

The water flowing in a stream at a given point and time, as is well known, originated as rainfall on the watershed of the stream. Since rainfall is intermittent in character, it is only to be expected that the stream flow will be of the same nature. Fortunately, the natural storage capacity of the watershed serves to decrease the maximum run-off after a heavy rainfall and to supply ground water to the stream for long periods when there is no rainfall. Notwithstanding this equalizing effect exerted by the absorptive nature of the watershed, the seasonal variation in flow on practically all streams is considerable and must be taken into account in the development and operation of a power site.

A map of the St. Maurice river basin, some 16,000 square miles in area, is given in Fig. 1, on which there are also shown the various storage reservoirs which have been provided for regulation purposes. Figure 2 gives the hydrograph for the unregulated portion of the watershed for 1931 (curve $B$) with an addendum giving the total regulated flow (curve $A$) which of course shows a considerably greater degree of uniformity.

The consumption of energy on a power system undergoes a considerable seasonal variation. This can be attributed to variation in daylight hours affecting the lighting load, additional tramways' load during the winter, electric heating and other causes of minor importance.

The diagram of Fig. 3 shows the annual curve of weekly kilowatt-hour primary power output on the Shawinigan system for 1931 (curve $D$) with the secondary power curve superimposed (curve $C$).

From the above it is apparent that the natural flow of streams in eastern Canada does not conform very well to the annual load curve of a power system. By the use of stored water a much greater conformity may be secured. If a secondary power load is available, it may be utilized to fill the valleys of the primary power load and to make it correspond to the power available as represented to a certain extent by the modified hydrograph of the stream.

In addition to the general management and utilization of the stream flow, a certain amount of control may be exercised at the individual power developments. Thus, if there is a considerable amount of pondage available at the site, this may be utilized on a weekly basis by carrying an excess load during the week and drawing down the pond level. The Sunday load on the system, being of the order of 50 per cent of the week-day load, will permit the pond levels to be restored to a maximum. In the case of a power development with small pondage, this may be used to carry excess load during the daytime and be replenished at night. The results of such control are shown in Fig. 4, in which curves *A*, *B* and *C* give the headwater levels during a week when no spill occurred, at Grand'Mere, Shawinigan Falls and LaGabelle, respectively. The lower curve *D* is a record of the hourly rate of flow through the power house at Grand'Mere.

It is of importance to arrange the loading of the units in a power house so as to obtain the maximum efficiency in the use of the water passing through the plant. It will be noted from Fig. 5 that the propeller type of hydraulic turbine attains its maximum efficiency at full load or close to it. Consequently, in a plant containing this type of unit only, an attempt is made to operate the units at full load by shifting load between plants and by shutting down units a part of each day. Since the efficiency of the Francis type unit is high over a wide range, these units are best adapted to take care of load variations on the system and to adjust the load to best efficiency on the propeller type units.

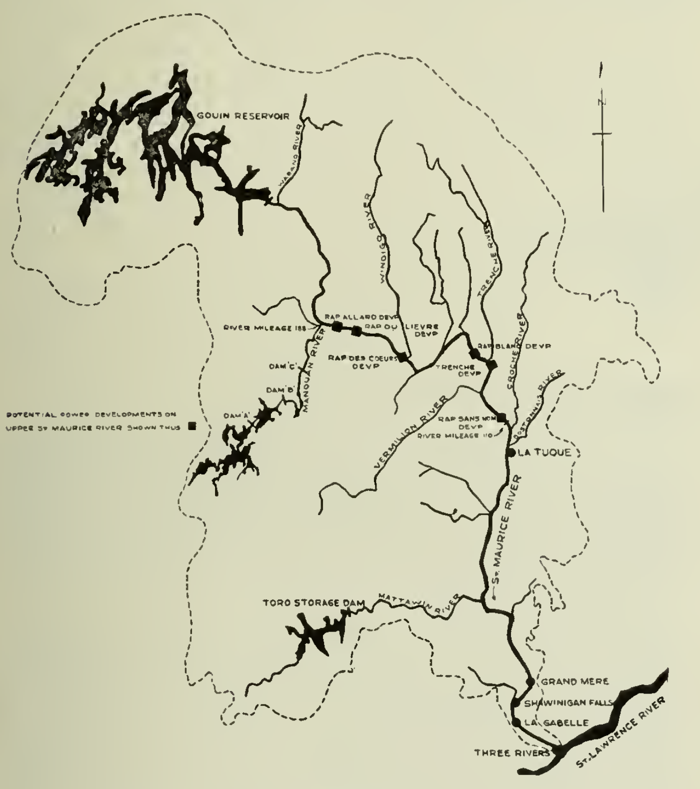


**Fig. 1—Map of St. Maurice River Basin.**

In case a power system consists of a single development containing propeller type units, it is desirable to install one or more Francis type turbines in order to obtain the most efficient use of the water.

A system of lines for the transmission of power is, as a usual thing, planned in its ultimate completeness, but tends to grow more or less as the branches of a tree spread out from the stem. Whenever a new load is available to add to the system, the tendency is to connect it to the existing lines at a minimum cost.

With the growth of load on a system, additional main lines must be built from time to time. At such times, as indeed at any time when extensions are undertaken, an effort is made to forecast future growth and to make extensions and alterations to the system in such a way that they will have the greatest permanent usefulness.


**Fig. 2.**

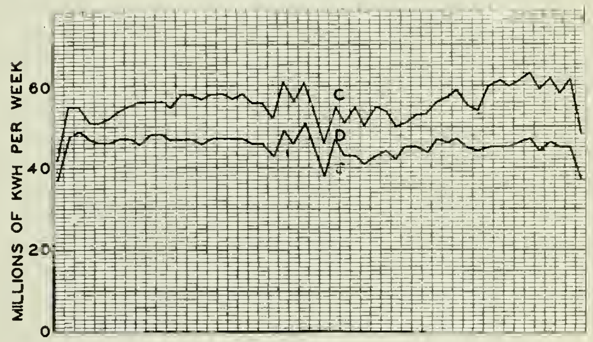


**Fig. 3.**

In order to supply to the customer the best service consistent with a reasonable cost, various devices have come into general use on power transmission systems. On radial lines in which circuit breakers are installed, in series so to speak, at varying distances from the power house, it is found desirable to make use of what is known as distance relaying. This is an arrangement whereby line troubles beyond the second switch will not cause the first switch

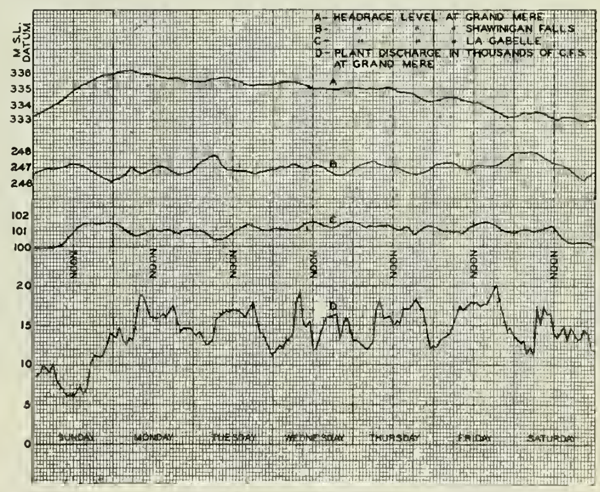


**Fig. 4.**

to open, and so on to the farthest point on the line. This means that a trouble on a radial branch of the line will be cleared off that branch only and not interrupt service as a whole. Radial lines are also well adapted to automatic reclosing. Unfortunately, it is not often that automatic reclosing can be utilized without certain changes to the control equipment on the customer's premises.

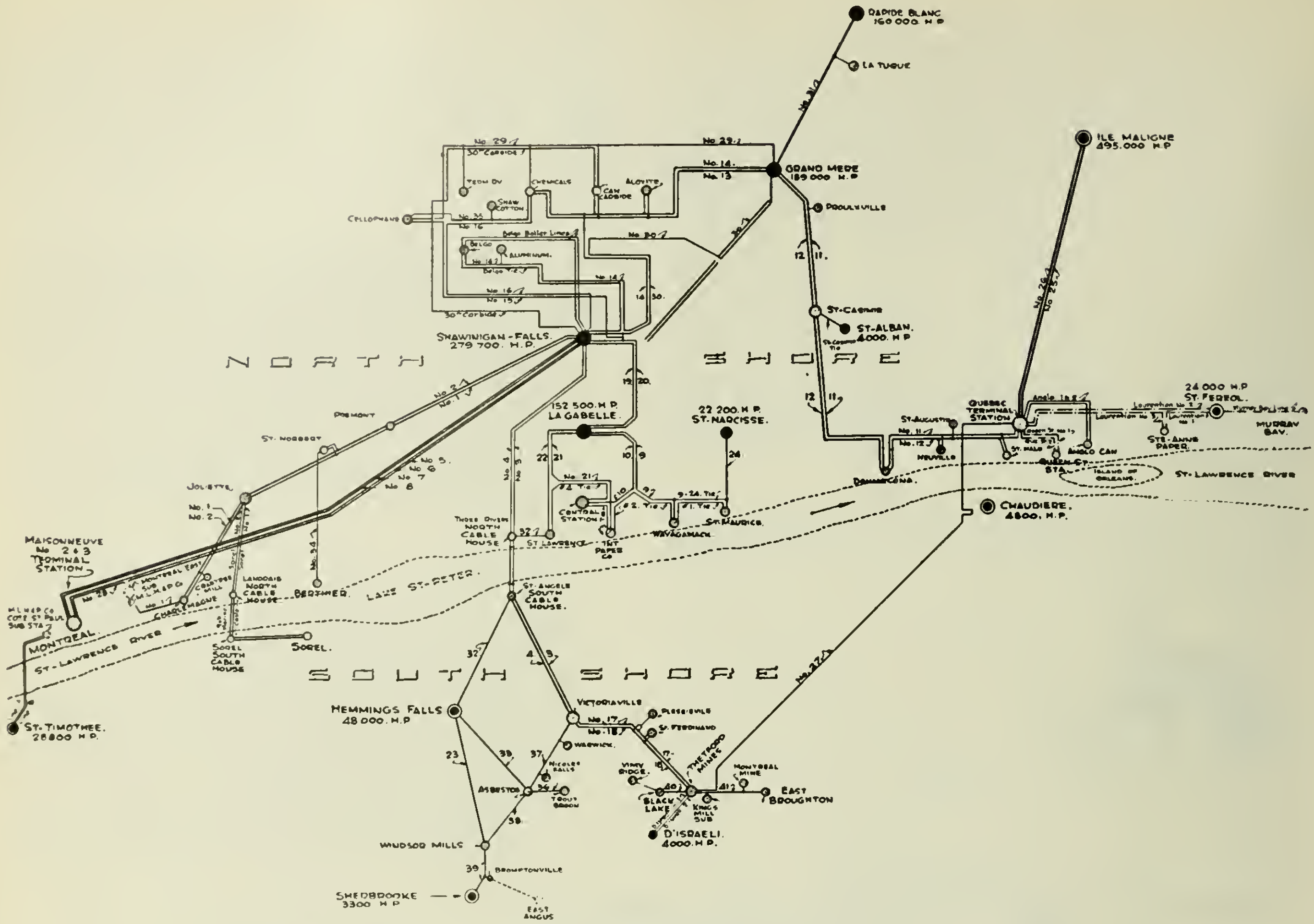


Fig. 6—Main Transmission Lines of The Shawinigan Water and Power Company.

The continuity of service to a customer is safeguarded by multiple feed. This ordinarily takes the form of parallel lines running to or past the customer's premises. Reasonable freedom from interruption may be secured by providing automatic circuit breakers with selective relaying.

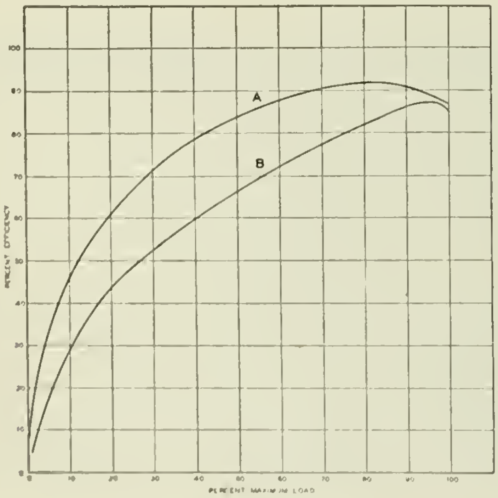


Fig. 5.

Hand operated switches will insure prompt resumption of service by transferring from one line to another.

An alternative to the parallel line system of multiple feed is secured by the network system. The relaying of such a system is apt to be more complicated than in the case of parallel lines. However, such a system is well adapted to cover a large territory where there are no concentrated heavy loads.

A combination of the radial and network systems of transmission consists of a direct line from the powerhouse to each of several large customers together with loop lines between customers. If the customer's plants are not too far apart, the loop lines can be economically protected by pilot wire installation.

Due to the desire on the part of the customer of late years to obtain low cost power even at the expense of continuity, there is an increasing tendency to rely on single lines for carrying loads of considerable importance and magnitude. A special effort is made to render such lines as proof against interruptions as possible. In this connection there has been great progress of late in constructing lines that are reasonably lightning proof. The other causes of interruptions are also being overcome to a great extent.

A plan of part of the main transmission system of the Shawinigan Water and Power Company is given in Fig. 6, and illustrates some of the points mentioned above.

With the growth of a power system, certain difficulties arise which tend to limit the complete flexibility of system set-up which might be desirable from the system operator's standpoint. One of these difficulties is that, with increasing generating capacity, the rupturing capacity of the switch gear originally installed may be exceeded. This must either be provided for by installing heavier switch gear or by a certain amount of segregation in the system set-up.

Another difficulty which may arise with system growth is that transmission lines which were originally used to tie together parts of the system may not have the transmitting capacity to hold together large generating stations. This may require the system to be split into sub-systems for parallel operation.

It will be apparent from the foregoing, that operating conditions on a hydro-electric system are continuously changing. Constant study and care are required to provide adequate service and at the same time to obtain the maximum output available.

## Load, Frequency and Time Control on Interconnected Systems

*W. R .Way*

Regulation and control of load, frequency and synchronous time on a large interconnected electric system is a matter requiring constant supervision. These three factors are closely interrelated, but very often this interrelation is not fully appreciated, since the problem must be viewed from a system standpoint, rather than from a company standpoint.

By load control is meant the regulation of the kilowatt load between units, generating stations and systems. On any one system, load regulation between units or plants is necessary so that efficient operation may result. This is especially true where two or more plants are located on the same river with limited pondage. Load regulation between systems is also very important, since where one company is purchasing power from another, it is advisable and economical to obtain as many kilowatt-hours as possible, and load must be regulated with this end in view.

Good frequency is essential on an electric system primarily to enable motors to be operated at correct speeds for manufacturing processes, and to allow accurate control of the transfer of power between units, stations and systems. Motor-driven centrifugal pumps, for instance, are very sensitive to speed changes, and their output will vary at a far greater rate than the frequency.

In regard to frequency, many terms are used, and proper definitions must be made. Consider a 60-cycle system, for instance; the term "constant frequency" would indicate any fixed frequency, such as 59.8 cycles, which would not be desirable. An "average" frequency of exactly 60 cycles might be obtained over a day's run, but during the day, many swings might have occurred, either continuously or at numerous periods, and this could not be considered good frequency regulation. The aim should be, therefore, to obtain correct average frequency, limiting the departures from normal at any instant to as small a value as possible. If this latter condition can be obtained, synchronous time regulation will disappear, and correct synchronous time will be obtained as a natural result of good frequency. Synchronous time is that indicated on the so-called electric clocks which are directly driven from alternating current systems. It bears a direct relation to system frequency, and shows any cumulative error from normal. On a system which is regulating synchronous time, correct average frequency should coincide with correct standard time.

In the early days of the electrical industry, the matter of voltage regulation was generally considered of more importance than frequency. Regulation of voltage by hand soon gave place to the many devices for controlling voltage automatically. Lighting load predominated, as only a comparatively small percentage of the load used rotating machinery. As the various classes of industry became motorized, manufacturers demanded better frequency, so that they could turn out uniform products at a steady rate of production. Textile firms were particularly interested, since variations in frequency resulted in the fabrics being of uneven colour and texture.

As the years progressed, the large increase in industrial load involving rotating machinery exerted a steadying influence on the system frequency, due to the fact that the inertia of the system, or fly-wheel effect, increased at a greater rate than did the normal load variations. Coincident with this growth of load, additional generating stations were built, systems were interconnected, and governors were improved, all of which tended to increase the normal system stability from a frequency-regulating standpoint.

The interconnection of large electric systems, however, brought out new problems of load control between systems

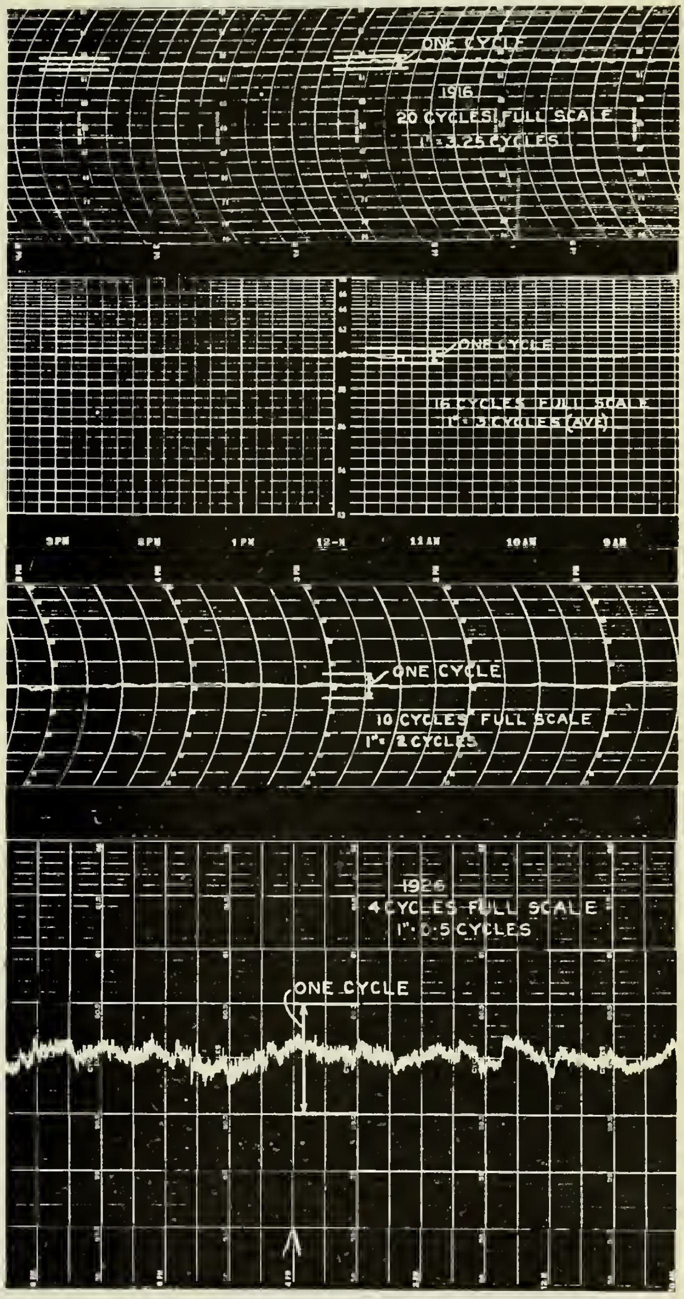


Fig. 7—Improvement in the Sensitivity of Graphic Frequency Meters.

which affected frequency control, and during the past eight or ten years, resulted in the development of commercial frequency meters which permitted an accurate large scale graph of the frequency variations to be recorded.

The introduction of the modern type of frequency meter, sensitive to .01 cycle, made it possible for the problem to be studied more fully, and allowed a great improvement in frequency control to be made over that which had previously existed. Figure 7, which reproduces sample records, indicates the greatly increased sensitivity of the present frequency meter as compared with earlier models.

Among the many new devices brought out, one of the most important was the Warren master clock. The introduction of the master clock was a distinct step forward, since it provided a means whereby the integrated departure of frequency from normal was visible at all times to the operating staff.


Fig. 8—Type "A" Warren Master Clock.

The type "A" Warren master clock, in its simplest from, consists of an instrument having a large dial, in front of which are two concentrically mounted hands of different colours. The gold hand is operated by means of a synchronous motor connected to the system to be regulated, and is suitably geared to denote exact time based on normal frequency. The black hand is actuated from an extremely accurate pendulum clock, which is checked for accuracy twice daily, using observatory time signals. Having once been properly set, the two hands move together around the dial, and remain one over the other as long as the frequency is correct. Any variation in average frequency from normal can immediately be noted, and corrective measures applied, since it will cause the gold hand to lead or lag behind the black hand, according to whether the integrated departure from normal is above or below the normal value. On a 60-cycle system, an average departure above normal of 1/10 cycle for one hour results in the synchronous clocks gaining six seconds during the period.

As electric systems installed master clocks, and average frequency was held within fairly close limits, advantage was taken of the fact to develop synchronous clocks for general use. Due to the fact that such clocks consume power of the order of only 2 watts, no great increase in load resulted for the power company, the maintenance of correct time simply being an additional service rendered to the consumer. One of the advantages of the synchronous clock over the pendulum or spring-wound clock is that the error is non-cumulative, and the accuracy is much better than usually obtained by non-electric clocks.

Turning now to the practical aspects of the problem, due consideration must be given to some of the characteristics and limitations of the hydraulic turbine governor.

It is well known that any prime mover requires some governing device to control speed under various load conditions. The governors used in hydro-electric units are of the centrifugal head type, driven either electrically or mechanically from the respective units. In order to secure satisfactory and stable parallel operation of alternating current generators, it is essential that the governors should have a drooping speed-load characteristic, so that the speed drops as the load increases. If this is the case, and there is a definite relation between load and speed, it is possible to obtain a proper division of load among the many units of different makes and capacities which are operating in parallel. The drop in speed from no load to full load, expressed as a percentage of the no load speed, is called the inherent speed drop, and usually lies between the limits of 2 and 5 per cent. Such drooping characteristics are shown in Fig. 9, where curves *A* and *B* refer to two generators having respectively 2 per cent and 4 per cent inherent speed drop.

On this basis, therefore, during load changes, if no adjustment were made to the governors, the speed, and, therefore, the frequency, would vary inversely as the load, to the extent of possibly 3 cycles, from no load to full load, on a 60-cycle system. Since load changes are almost continually taking place, causing temporary changes in frequency, some adjustment must be made to the governor setting from time to time, either manually or automatically, to insure correct frequency being obtained. The governor synchronizing motor provides this means of adjustment. The operator may bring the frequency back to normal by actuating the governor synchronizing motor control when necessary. This has the effect of raising or lowering the speed-load characteristic curve of the governors, and causes the unit or units to pick up or drop off load as the case may be.

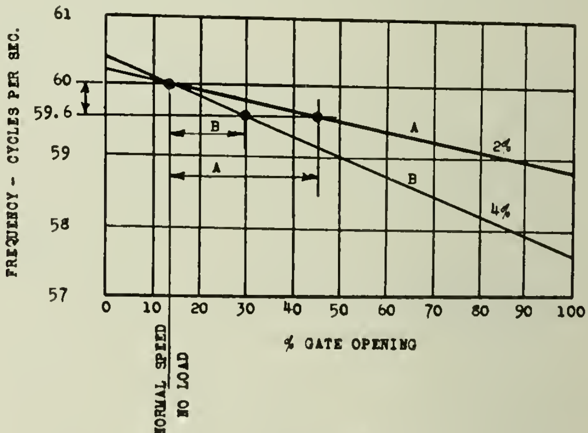


Fig. 9—Typical Inherent Speed Drop Curves.

This is done by changing the linkage between the floating lever and restoring mechanism of the governor, when the inherent speed drop curve is raised or lowered, as shown in Fig. 10, while retaining the same percentage drop. Thus a unit can be made to carry any desired proportion of its full load while running at normal speed.

From the above, the conclusion may be drawn that the governors only tend to maintain constant frequency if no load change has taken place, or conversely, *the governors themselves cannot maintain constant frequency during load changes.*

Most modern governors for hydro-electric units are equipped with a load-limiting device which can be set so that normally the load on the unit will be automatically maintained at any selected maximum figure. The load-limit control furnishes a very stable means for base load adjustment, but obviously cannot be used if the governor is required for frequency-regulating purposes.

Where load-limiting control is not available or not used, the tendency of the operating staff is often to operate a number of the units wide open by adjusting the governor motors, and leave one unit operating at partial gate opening, since it is much easier for the operator to watch and adjust one unit than several. This results in inefficient plant operation, at the same time tending to aggravate the difficulties of frequency regulation.

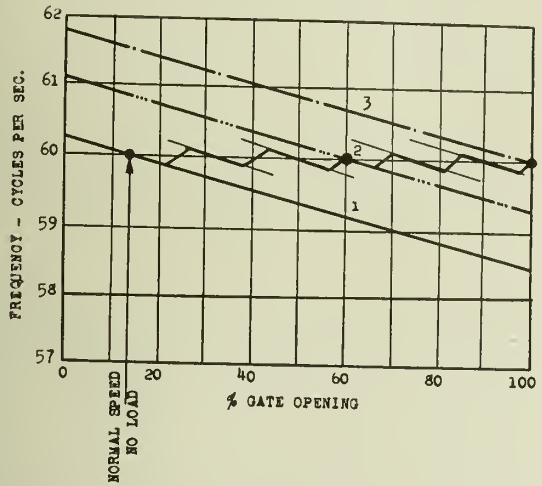


Fig. 10—Effect of Raising Speed-Load Curve.

To bring out some of the practical operating problems involving the interrelation between load and frequency, consider for the moment two power systems, each supplying a load area, and tied together through a tie line. Any change in load in either area will cause a corresponding change in frequency, and if all units are on governor control, the effect of the change in frequency will be felt on all power stations. Should no understanding exist as to frequency-control, the operators on either system may attempt to restore normal frequency. If one system succeeds in restoring normal frequency, power will flow over the tie line, and possibly upset interchange agreements, which the operators of the other system will immediately attempt to correct. By correcting the tie line loading, the frequency would be abnormal again, and the whole process might have to be repeated several times, with many adjustments being made, until normal conditions prevailed.

The result would be, therefore, a constant conflict between systems, with large swings in frequency and tie line load, and inability to maintain contractual relations.

To overcome such occurrences, the system having the greatest proportion of the system generating capacity generally must bear the responsibility of frequency regulation, the other systems regulating their plants to hold tie line loading within definite limits, both between plants and between systems. Ordinarily very little attention is paid to the variations on tie line loading between plants on the same system until some physical limitation of the tie line is reached. At interchange points between systems, however, changes in power flow affect contractual agreements, and care must be taken to regulate the load so that maximum benefits are obtained from the contract without exceeding its provisions.

With one system regulating frequency, and the remaining systems regulating tie line loading, fairly good results are obtained, but some degree of co-ordination between systems is still necessary, particularly if major load changes are made either too quickly or without the frequency-regulating system being advised beforehand. It would seem, however, that this method imposes a rather undesirable obligation on the frequency-controlling system for at least two reasons:—

1. The system controlling frequency must keep sufficient excess active generating capacity available to handle the major part of all the instantaneous load changes that may occur on the entire interconnected network.

   This may result in very inefficient plant operation under normal water conditions, as well as loss of revenue during periods of excess water, especially where off-peak power, such as electric boiler power, is being sold.
2. A considerable burden must be carried by the operating staff of the frequency-regulating system, since they must be making adjustments continually, and are at all times subject to criticism for poor frequency, irrespective of the cause. This is often difficult to determine without making a complete investigation.

   In this connection, it should be kept in mind that load regulation is primarily a local system problem, while frequency control affects the whole interconnected network.

To obtain satisfactory results using the hand-control method just reviewed, certain essential requirements stand out:—

1. All governors should be kept in good repair and adjustment, particular attention being paid to the elimination of lost motion in the linkage.
2. As far as possible, the percent inherent speed drop of all governors should be approximately the same. This is desirable so that all plants and units may share equally when load variations occur.
3. On the frequency-regulating system, load limit devices should not be excessively used, since addi-

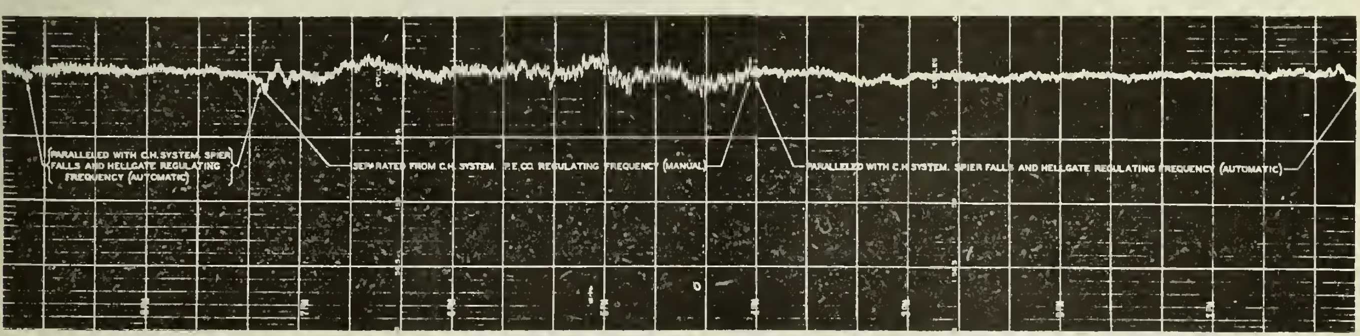


Fig. 11—Manual and Automatic Frequency Control on Large Interconnected System.

tional duty is imposed on all other governors used for speed-regulating purposes.

4. An approved set of operating instructions should be made up so that complete co-ordination may exist between the operating departments of the various companies forming the interconnection.
5. Each power station should be equipped with a modern, large scale type of frequency meter, located in the station in such a position that the indication may be readily observed by the operator when adjusting the governor motor of any unit.

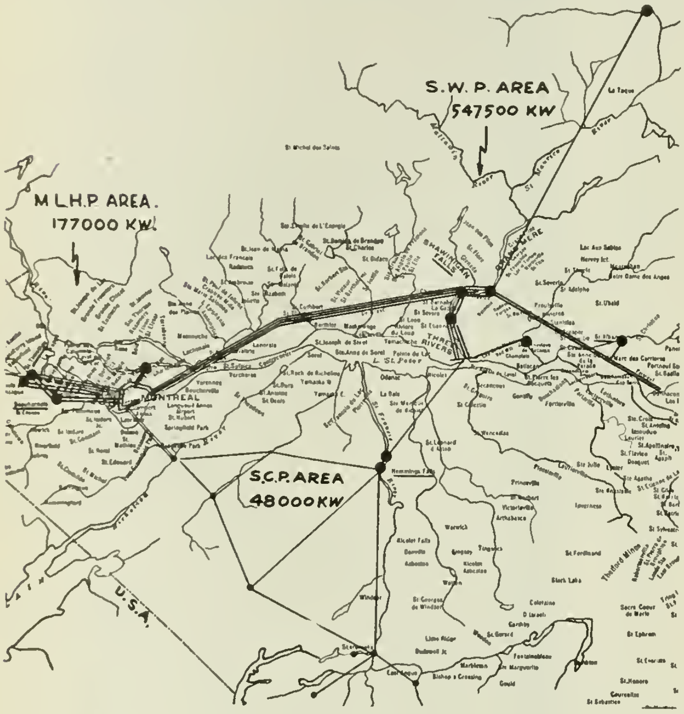


Fig. 12—Maximum Generator Capacity, Location of Generating Stations and Main Transmission Lines of S.W. & P. Co.

To obtain this result, in some stations it may be necessary to provide a large scale secondary frequency meter actuated by Selsyn motor control, or other similar means, from the switchboard meter.

6. In case of extreme or continued departure of frequency from normal, an understanding should exist that *all* stations should immediately assist to some extent in restoring normal frequency. Load adjustments may be made later when the cause of the trouble has been located.
7. The load-regulating systems controlling tie line loading should at any time adjust their governors to maintain correct frequency, if such adjustment will tend to correct tie line loading.
8. If synchronous clocks are being extensively used, each company should be provided with necessary apparatus to regulate time on its own system during periods when tie connections are open for any reason.
9. Frequency meters on the various systems should be checked periodically, and the understanding exist that the meters of the system controlling frequency and time be considered as standard to avoid discussion between company system operators as to whose meters are correct.

In concluding this phase of the subject, it may be said that it has always been the aim of public utility companies to provide an improved service to the customer. It would seem that the hand-control method of regulation has definite limits, and eventually must give way to more modern methods. If the frequency band can be regulated very closely, good synchronous time is obtained, there are less unnecessary power swings between systems, and load control is considerably simplified.

Automatic load and frequency control offers considerable promise as a final solution, and several manufacturers have developed devices for this purpose. The main function of all automatic frequency control devices is the sending of impulses at intervals to the governor motor to raise or lower the frequency, and thus obviate the necessity of the operating staff having to be continually watching the frequency meter. If, however, automatic frequency control exists on only one system, all the load changes will finally be taken up on the units or plants so controlled, and the problem of load changes between systems is not solved. Automatic frequency control on each system might be worked out successfully, or possibly combined with automatic tie line control between systems. The selection of the proper scheme will probably be dictated by the system characteristics.

In the case of automatic tie line control, whereby the governor motors of a selected plant are actuated from a wattmeter element on the tie line, the frequency-regulating system is relieved of the major load changes on the other system. This results in each company forming the interconnection controlling its own load variations to a great extent, and combined with automatic frequency control, makes it possible to maintain frequency and time with negligible errors, at the same time accurately controlling the flow or power between systems. Using these principles, several of the large interconnected systems in the United States normally hold frequency to ± .05 cycles on 60-cycle systems, and synchronous time to a maximum daily error of ± 2 seconds. (See Fig. 11.)

The foregoing touches briefly on a few of the outstanding points on the general subject. It might be of interest to outline the status of the subject as it affects the interconnected network shown in Fig. 12.

This interconnected system is entirely a hydro-system comprising the plants controlled by the Montreal Light Heat and Power Consolidated, Southern Canada Power Company and the Shawinigan Water and Power Company, with a maximum connected generator capacity of the order of 772,500 kw., and consisting of some 59 units.

On the Montreal Light Heat and Power system, there are usually connected to this system two 37,000-kw. units at Beauharnois, six 8,000-kw. units at Cedars and five 7,000-kw. units at the Back River plant. In addition, the Shawinigan Water and Power Company operates the Canadian Light and Power Company's plant at St. Timothee, consisting of four 5,000-kw. units, which ties in with the Montreal Light Heat and Power system at Montreal. This group of plants is tied in with the Shawinigan Water and Power Company's main system through two 30,000-kv.a. transformer banks at Montreal. From here, the tie connection to Shawinigan Falls consists of four nominal 110-kv. circuits 90 miles long.

The Shawinigan Water and Power Company main system consists essentially of the four plants, namely, Shawinigan Falls, Grand'Mere, LaGabelle and St. Narcisse stations, consisting of a total of twenty-four units and 451,500 kw. rating, all of which are located within a radius of 20 miles of Shawinigan Falls. To this must be added the recently constructed plant at Rapide Blanc 100 miles from Shawinigan, consisting at present of three 32,000-kw. units. The Southern Canada Power Company's system has a maximum generator capacity of approximately 48,000 kw., consisting of some fifteen generators, and is tied in with the Shawinigan Water and Power Company's 60-kv. system at Hemmings Falls about 50 miles from Shawinigan Falls, through a 15,000-kv.a. tie bank.

The load supplied on the interconnection is made up principally of lighting, industrial and miscellaneous loads in the metropolitan and rural areas, while a substantial portion of the Shawinigan Water and Power Company's load consists of grinder motors and large induction motors in the paper mills. In addition, there is a considerable number of resistance type loads, such as carbide and carborundum furnaces and electric steam generators. This latter group have a comparatively low speed characteristic in that they are not materially affected by frequency changes. They also have a comparatively low variation characteristic as distinct from loads having high variation characteristics, such as electric steel furnaces or large electric railway loads.

The monthly load factor of the Shawinigan Water and Power Company's *prime load only* is of the order of 75 per cent, while daily load factors of the *total load* often exceed 90 per cent. On several of the paper mills, automatic load control is used, so that daily load factors of the order of 98 per cent are often attained.

The result of having such high load factors and low variation characteristics is that normally there are no excessive load changes. There are, of course, the week-end periods when the paper mills are starting up or shutting down, and the normal load changes in the morning, noon hour and evening, due to the large Montreal load with a daily load factor of 65 to 70 per cent, but the times when these occur are known to the operating staff, and can be taken care of as routine matters.

As to control, it has been customary for the Shawinigan Water and Power Company to regulate frequency and time, the other companies operating their power stations so as to regulate load at the interconnected points. The Shawinigan Water and Power Company's system operator at Shawinigan is in control of the frequency and time regulation, the hand method of regulation being used. He designates the station to be responsible for frequency regulation, and changes the point of designation from time to

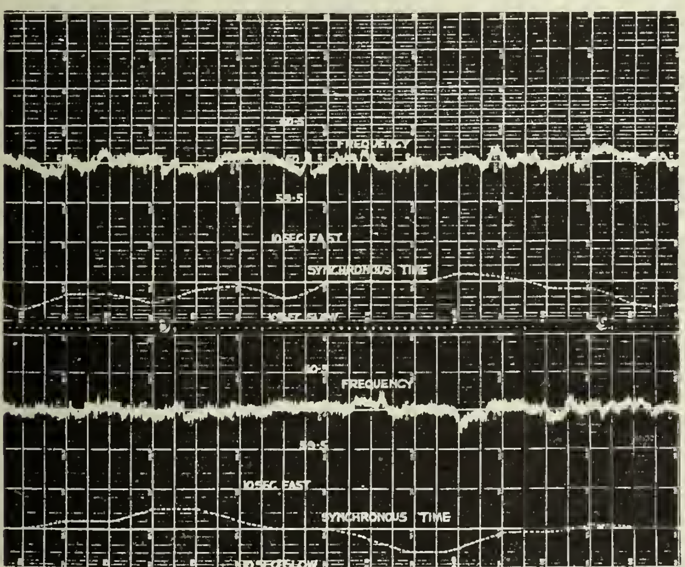


Fig. 13—Typical Frequency and Synchronous Time Regulation.

time, as may be required, for river flow regulation or for other purposes. With this method of regulation, normal frequency deviations are kept to the order of a maximum daily figure of ± .25 cycles.

A typical frequency record is given in Fig. 13, showing the actual variation in frequency and the deviation of synchronous time from normal (manual control).

While the various companies do not sell time, nevertheless, use is made of type "A" and "B" Warren master clocks as a guide to the regulation of frequency, with the result that synchronous time is available to the various customers with a maximum monthly error of ± 15 seconds. During the months of January and February, the average of the maximum daily departures of synchronous time from normal was 7.4 seconds fast and 7.6 seconds slow, which it is believed is quite satisfactory to the average clock user.


Fig. 14—High Sensitivity Frequency Meter.

As far as the Shawinigan Water and Power Company is concerned, their engineers have followed the progress of improved frequency control very closely during the past few years with considerable interest. In 1932, this company installed at LaGabelle station a modern type of automatic frequency and load-controlling apparatus for experimental purposes. This experimental work was temporarily dropped for various reasons, but it is anticipated that in the near future more conclusive tests will be made. In addition, this company is equipping additional power stations with a most modern type of frequency meter (see Fig. 14). As time goes on, it is hoped to still further improve the system frequency and time regulation at a comparatively small expense. This will be done mainly to give the best possible service to those customers who require close speed regulation in their manufacturing processes, and from the power company's standpoint, closer frequency regulation will facilitate the ability to transfer load between units, stations and systems.

To sum up, it may be said that under existing conditions the present degree of frequency regulation on this interconnected network is satisfactory to the various types of connected customers, and complaints, on this account, are very rare.

While the question of providing extremely accurate frequency and time regulation in this area may not be acute at the moment, future growth and additional interconnection will probably demand it. When the problem does become a major one, the use of some form of automatic control will no doubt be necessary, and the problem must become a common one to all interconnected companies, each sharing in the advantages and responsibilities.

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## Service Problems on the Power System

*E. W. Knapp, A.M.E.I.C.*

Service problems on a power system are many and varied, and a consideration of service enters into practically every phase of system operation. This paper will, in general, deal with the service reliability of various units of the Shawinigan Water and Power Company high voltage system, including brief references to special problems.

In order to study, analyze and extend service improvements, it is essential to keep accurate and complete records of operating and service conditions. It is good practice to obtain a field report giving a complete story for every trouble on the power system. These reports are forwarded to the head office, where the data are transcribed on forms suitable for study. Each operation is then studied and analyzed, and the results compiled for ready reference. Executive and department heads are then informed of general service conditions by means of weekly, monthly and yearly reports, and special reports are made up as required, concerning special problems. In this manner, responsible parties are kept fully advised as to service conditions on the power system.

One effective method of obtaining data quickly and accurately is by means of oscillograph tests. A few years ago, power company engineers were reluctant to submit power systems to the uncertain shocks and possible hazards of the staged test. To-day staged tests are quite common, and in many cases are part of the regular routine when placing new stations or systems into service. This policy, combined with careful checking of circuits, instruments and equipment, has been found a great help in preventing faulty installations and subsequent service interruptions.

Solidly grounded and isolated neutral systems each have certain advantages and disadvantages from a service standpoint. The solidly grounded neutral system automatically provides plenty of current to actuate protection relays during faults from one conductor to ground (usually known as Lg faults), and no serious overpotential to ground takes place on the sound phases. Ground faults, however, create a more serious disturbance on this system than corresponding faults on the isolated neutral system. The inability to operate open delta when one transformer of a bank is out of service may, at times, prove a disadvantage on this type of system. One problem on the isolated neutral system is to effectively and selectively clear Lg faults before cross-shorts occur. On some systems, the overpotential to ground on the sound phases during Lg faults becomes a service hazard, and it is imperative that this form of fault be isolated as quickly as possible.

One scheme of clearing Lg faults on the isolated neutral system consisted in automatically closing a sound phase to ground on the occurrence of an Lg fault, thus producing a single phase short-circuit through ground. This provided ground fault current to actuate the relays. Unfortunately, however, there was considerable delay in clearing Lg faults, and an overpotential to ground was left on the two sound phases for 1.5 seconds or more for each Lg fault on the system. This often resulted in cross-shorts, sometimes between widely separated parts of the system. This was a serious situation, not only from the power company standpoint, but also as regards adjacent communication circuits.

The next step consisted in reconnecting a 33,000-kv.a. transformer bank, normally operating delta/delta, on one of the larger 60-kv. systems, to delta/star, and solidly grounding the neutral point. This arrangement was successful in providing an effective means of clearing Lg faults, keeping overpotential on the sound phases to a nominal value, and eliminating cross-shorts. The experience with this installation seemed to indicate that a smaller grounding bank might be used as a grounding medium with success.

Finally, the large transformer bank was returned to normal service, and replaced with a small bank located at the same station. Two other 60-kv. systems were likewise provided with small grounding banks. In each case the grounding bank served the dual purpose of supplying load and acting as a grounding medium.

During the year 1933, a large number of Lg faults were cleared successfully by the action of the various grounding mediums. A small grounding bank for high voltage isolated neutral systems would appear to be a satisfactory medium for clearing Lg faults. The size of bank required will depend to some extent upon the system insulation, generator capacity and type of relay protection on each individual system.

The importance of an adequate relay protection cannot be overestimated. It would be impossible to maintain a satisfactory service to load centres, with present-day network and interconnected systems, without an effective and selective protection. In general, quick clearance of faults is important in reducing power arc damage, the chances of oil fires and system instability. Selective clearance of faulted circuits, however, is equally as important as quick clearance, from a service standpoint.

Considerable progress has been made in the protection art during the past few years. The relay organization of the Shawinigan Water and Power Company consists of sections to deal with engineering, experimental testing of instruments and circuits, secondary checks of installations, maintenance of equipment, primary testing on the power circuits, and analysis of all relay operations. This policy has resulted in a steady improvement in the relay situation. Table I indicates the general trend during the past three years, and in addition to showing progress, reveals that there is still room for further improvements.

Table I

Action of High Voltage Line Protection Equipment 1931-1933

| Year | Lines Effectively Cleared | Lines Failed to Clear Properly | Lines Cleared Non-Selective During Faults |
|---|---|---|---|
| 1931 | 81 per cent | 7.3 per cent | 11.7 per cent |
| 1932 | 85.5 per cent | 3.7 per cent | 10.8 per cent |
| 1933 | 92.0 per cent | 2.3 per cent | 5.7 per cent |

The above tabulation covers a total of 40 high voltage lines with a mileage in excess of 1,500 miles.

From a service standpoint, generator breakdowns are not a serious problem. A faulted generator can usually be cleared from the power system with nothing more than a momentary disturbance, and possibly a period of lowered frequency and voltage. Moreover, generator breakdowns are relatively infrequent, representing only about 12 per cent of station equipment breakdowns. There are far more transformers than generators on the power system, and transformer breakdowns are somewhat more frequent. However, if high voltage bushing failures are excluded, transformer troubles are only slightly more frequent than generator troubles. A transformer breakdown may create the more serious service condition, however, depending upon the location of the transformer, and facilities for resuming service and making repairs.

High voltage bushings are a potential cause of service interruptions. There are a great number of these on a power system, and it is, therefore, essential that this form of insulation be as free from breakdown as possible. This is particularly true in view of the large proportion that are located within the zone of high voltage bus protections where a fault may result in a total shutdown to the station concerned.

Table II will serve to illustrate the general situation with regard to frequency of station equipment breakdowns. This record is for the year 1933, and covers all high voltage stations on the system. There is considerable variation from year to year, but the record shown is fairly representative of existing conditions. There was a total of eighty failures at sixty-nine stations during 1933. In view of the large amount of equipment at these stations, this figure does not appear to be unduly high. The tabulation does indicate, however, where weaknesses exist, with possibility of improvement in certain sections.

Table II

Station Equipment Breakdowns (1933)

| High voltage bushings | Number | Per cent |
|---|---|---|
| Oil circuit breaker bushings | 8 | 10 |
| Power transformer bushings | 20 | 25 |
| Potential transformer bushings | 2 | 2.5 |
| Entrance, roof, wall and floor bushings | 19 | 23.5 |
| Total bushings | 49 | 61 |
| Other equipment | | |
| Generator breakdowns | 10 | 12 |
| Power transformer breakdowns | 12 | 15 |
| Bus and switch insulators | 2 | 2.5 |
| Low voltage cable breakdowns | 2 | 2.5 |
| Miscellaneous breakdowns | 5 | 7.0 |
| Total equipment | 31 | 39 |
| Grand total | 80 | 100 |
| Total high voltage stations involved in breakdown | 32 | 46 |
| Total high voltage stations not involved in breakdown | 37 | 54 |
| Total high voltage stations concerned | 69 | 100 |

Table III shows an interesting example of service conditions on two wood pole lines, as construction and operating conditions were changed. These lines are of 5-foot triangular construction, 60-kv. pin type insulators, and no overhead ground wires. Originally the pins and crossarms were wood, and about 85 per cent of the poles were provided with vertical ground wires. Some years ago it was found that the older insulators were not standing up very well, and it was decided to gradually replace existing insulators by some of improved design. Wood pins and crossarms were also deteriorating, and these were to be gradually replaced in steel.

Table III

Troubles on Two 60-Kv. Pin Type Wood Pole Lines

| Condition | 1927 | 1928 | 1929 | 1930 | 1931 | 1932 | 1933 |
|---|---|---|---|---|---|---|---|
| | Per cent | Per cent | Per cent | Per cent | Per cent | Per cent | Per cent |
| Wood pins and cross-arms | 48 | 30 | 19 | 10 | 4 | 0 | 0 |
| Steel pins and cross-arms | 52 | 70 | 81 | 90 | 96 | 100 | 100 |
| Improved type insulators | 28 | 56 | 72 | 76 | 79 | 80 | 81 |
| Gaps in pole down leads | 15 | 15 | 15 | 15 | 65 | 65 | 95 |
| Number of | | | | | | | |
| Lightning outages | 72 | 50 | 160 | 150 | 67 | 72 | 72 |
| Line material breakdowns | 100 | 205 | 145 | 100 | 67 | 22 | 11 |
| Cross-shorts | 135 | 170 | 320 | 55 | 0 | 0 | 0 |

1—The tabulation shows service conditions on the lines as construction and operating conditions changed.

2—All service percentages are based on the seven year average.

3—This system operated isolated neutral until March 1930, and since then, solidly grounded star.

From 1927 to 1930 line outages due to lightning, line material and cross-shorts showed a decided tendency to increase. This was apparently due to changing pins and crossarms from wood to steel. In 1930 these two lines were cut over to a separate system, and operated solidly grounded star. This immediately reduced line outages due to line material failures and eliminated cross-shorts, but did not appear to make the lines less susceptible to lightning flashover. During 1931 the vertical ground wires on one line were provided with 20-foot gaps, thus taking advantage of this section of the wood pole to increase the line insulation. This appeared to reduce insulator outages still further, and also reduced lightning outages. By 1933, practically all vertical ground wires had been provided with gaps, and wood pins and crossarms had been entirely replaced by steel.

Based on the seven year average, lightning outages in 1933 were down to 72 per cent, although that was a very bad lightning year. Line material outages were down to 11 per cent, and cross-shorts were down to zero, although in 1929, cross-shorts had reached 35 per cent of the total line troubles. This seems to indicate that the recent policies are having a beneficial effect.

Table IV shows 60-cycle high voltage line troubles per 100 miles of line for the past five years. Lightning outages have varied considerably from year to year, and it is difficult to indicate any definite trend towards fewer flashovers. A careful survey of troubles on individual lines does reveal, however, that considerable progress has been made towards making these lines less susceptible to lightning flashovers. Wind, snow and sleet troubles have become less frequent due partially to careful checking of conductor sags and better maintenance, etc. Line material, cross-shorts, unknown and miscellaneous outages have each shown rather a remarkable reduction during the five-year period. The table shows that line outages in 1933, due to these four causes, were only 7.5 per cent of the 1929 figures. During the same period, the total line outages per 100 miles of line were reduced from 42 to 15.5, or 37 per cent of the 1929 figure.

Table IV

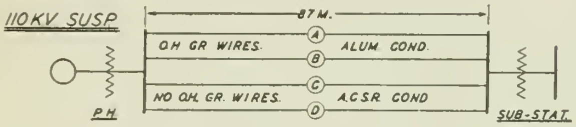
60-Cycle High Voltage Line Troubles Per 100 Miles of Line

| Cause of Line Trouble | Year Miles Lines | 1929 1046 28 | 1930 1380 34 | 1931 1491 39 | 1932 1508 40 | 1933 1508 40 | Ave. 1386 37 |
|---|---|---|---|---|---|---|---|
| Lightning | | 13.5 | 9.9 | 10.0 | 7.6 | 11.5 | 10.3 |
| Wind, snow and sleet | | 3.5 | 4.0 | 2.2 | 0.8 | 1.9 | 2.4 |
| Line material | | 6.0 | 2.9 | 1.9 | 1.3 | 0.7 | 2.3 |
| Cross-shorts | | 10.0 | 2.5 | 1.3 | 0.5 | 0.2 | 2.4 |
| Unknown | | 3.5 | 1.9 | 1.1 | 1.1 | 0.5 | 1.6 |
| Miscellaneous | | 5.2 | 1.8 | 2.5 | 1.0 | 0.4 | 2.0 |
| Total per 100 miles of line | | 42.0 | 23.0 | 20.0 | 12.4 | 15.5 | 21.0 |

In reviewing the situation with regard to improvement in line service, it is obvious that this improvement has been due to a number of causes. Improved maintenance, improved line insulation, more effective relay protection, better grounding mediums, and using part of the wood to increase line insulation, have all contributed to the general service improvement.

Figure 15 refers to four 110-kv. lines of two double circuit tower lines on the same right-of-way. These lines are each 87 miles in length. Lines *A* and *B* have two overhead ground wires, but there are no overhead ground wires on lines *C* and *D*.

The following records of lightning outages on these lines cover a twelve-year period:




| | | | | |
|---|---|---|---|---|
| Single line lightning shorts, line $A$ | 12 | = | 12.8% | |
| Single line lightning shorts, line $B$ | 7 | = | 7.5% | |
| Single line lightning shorts, line $C$ | 7 | = | 7.5% | |
| Single line lightning shorts, line $D$ | 68 | = | 72.2% | 65% |
| Total | 94 | = | 100 % | |
| Double line lightning shorts, line $A$/$B$ | 18 | = | 35 % | |
| Double line lightning shorts, line $C$/$D$ | 33 | = | 65 % | |
| Total | 51 | = | 100 % | 35% |
| Grand total | 145 | | | 100% |

$A$ and $B$ lines $\frac{\text{Double line shorts}}{\text{Total shorts on } A \text{ and } B} = \frac{18}{37} = 49\%$

$C$ and $D$ lines $\frac{\text{Double line shorts}}{\text{Total shorts on } C \text{ and } D} = \frac{33}{108} = 30\%$

Fig. 15.

From the above it will be noted that line $D$, farthest from the overhead ground wires, had far more lightning outages than the other lines. This seems to indicate that overhead ground wires do have a shielding effect, and tend to reduce lightning flashovers. The greatest ratio of double to single line faults occurred on $A$ and $B$ lines, but double and single line faults were much more frequent on lines $C$ and $D$.

Figure 16 shows a curve of service interruptions to representative customers of a large load centre since 1921. During the thirteen-year period, several changes took place with regard to the system set up. The system has been operating at 60-kv. during the period, but is largely insulated for 110-kv. operation.

From 1921 to 1924 the system was supplied with power over two radial lines approximately 30 miles in length. The outages per customer averaged 12.5 per year. During

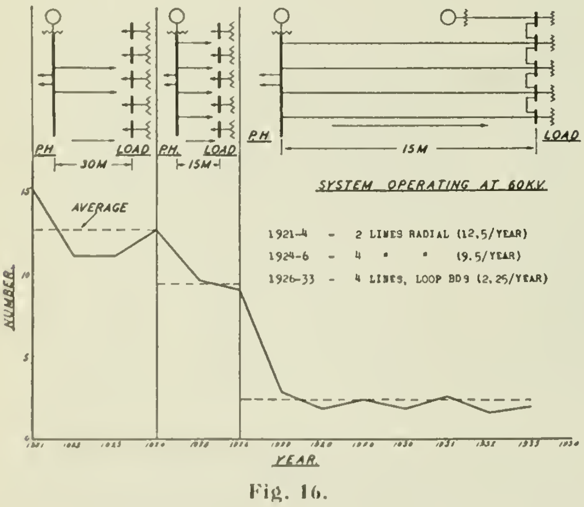



Fig. 16.

1924 a new power house was placed in service, and for the next two years, the system had four radial lines approximately 15 miles in length. During this period, the outages per customer averaged 9.5 per year, only a slight improvement over the previous period. During 1926, the various tie lines at the load centre were connected together to form a loop bus system. This arrangement immediately resulted in a reduction in customer interruptions to an average of 2.25 per year. There are other factors that have contributed to the improvement of service to the load centre, but undoubtedly the loop bus system has played an important part in this improvement.

Figure 17 indicates service conditions to a load centre supplied with power over four parallel lines, each 87 miles in length. There are two double circuit steel towers on the same right-of-way. The line insulators are 7 disc suspension, and the system is operating at 110 kv. The system is capable of supplying upwards of 200,000 kv.a to the receiving stations.

The curves are primarily for the purpose of showing the inherent service to be expected from a system of this nature. Stations and lines have each contributed to interruptions to the load centre during the past twelve years. It is interesting to note the gradual improvement in service for the first six years. From 1928 to 1933 there was an average of two interruptions per year, 1.3 due to lines and 0.7 due to stations. The curves would appear to indicate that this is inherently the average number of interruptions per year which may be expected from this system.

In many cases the customer can do much to make mill loads less susceptible to interruptions during momentary voltage and frequency variations on the power system. In many of the paper mills, a partial drop of mill load is almost as serious a condition as a total interruption. A recent survey of a number of large paper mills indicated that cases of dropping a considerable block of load, due to momentary disturbances on the power system, were more

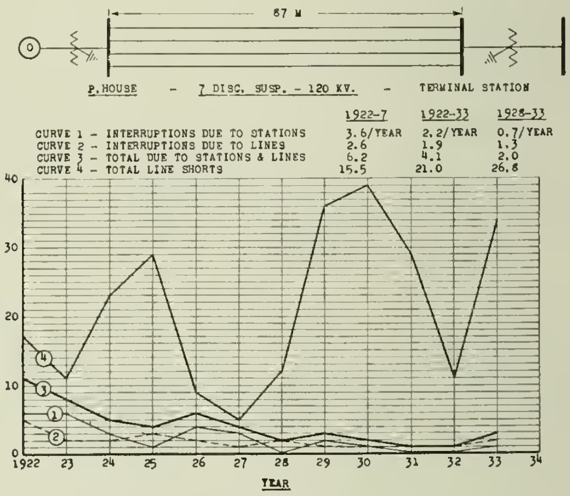



Fig. 17.

frequent than total interruptions, and the actual loss of production was greater due to this cause. In many cases these partial interruptions were due to instantaneous undervoltage releases on induction motors. It is important that mill equipment be as free as possible from interruption during momentary disturbances on the power system; otherwise, loss of production may occur which could be avoided.

In conclusion, it should be noted that the field of service improvement has by no means been exhausted. Many things can be done by both the power company and the customer to reduce service interruptions. Improved service is a matter of correlating engineering knowledge and experience, relative costs and available funds. Improved insulation and line construction, lightning protection, multi-lines, quick and effective clearing of faults, instantaneous reclosing of faulted circuits and customer equipment less susceptible to interruption during momentary disturbances, are all factors which will, in the future, tend to insure improved service to load centres. In order to insure proper co-ordination of the above factors, a careful analysis of service conditions is essential, combined with co-operation of power customers.

# Contribution of the Aeroplane to Canadian Industrial Development

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**Paper presented before the Montreal Branch of The Engineering Institute of Canada on March 1st, 1934, and later before the Halifax, Saint John, Moncton, Peterborough and Toronto Branches.**

**SUMMARY.—The author gives an outline of the manner in which aerial transportation has developed under Canadian conditions, and discusses such activities as forest protection, communication with remote districts and mapping of areas previously unsurveyed.**

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When, twenty-five years ago, mechanical flight in heavier-than-air machines first was achieved, it is likely that in the minds of those interested, the field of utility to which the aeroplane appeared peculiarly adapted was as an aid to observation, and particularly, observation for military purposes. Its use as a speedy vehicle of transportation was not at first realized, as the first aeroplanes were comparatively slow.

In 1913 a fast scout type aeroplane was produced which had the then remarkable top speed of 92 miles per hour. This factor of "speed" was a welcome addition in its military application to observation duties.

During the war period 1914-1918 aeroplanes were flown by men drawn from every branch of industry, so, with cessation of hostilities instinctively many of these men thought of the application of this new machine to the solution of the various problems with which they had been confronted in commercial life.

The advantages of aerial observation to the work of the surveyor, the forester and mining engineer, were at once apparent, and it was natural that the use of the aeroplane in Canada should be directed to problems where observation from the ground was restricted or where territory was inaccessible. So it was that from 1919 to 1923 flying was used almost entirely for inspection and observation in the heavily timbered areas of the eastern provinces. Transportation work for personnel and supplies was a secondary development and undertaken only when surface facilities were lacking or natural obstacles had to be overcome.

Quoting from the Dominion Government Report on Civil Aviation for 1924,—"It was therefore decided to concentrate on the development, in the first place, of those services for which there was an immediate need; in forestry and aerial surveying; in transportation to the remoter parts of the country; and leave for the time being, the development of air routes to countries where the natural conditions were easier, the population and traffic denser, and conditions altogether more favourable for experimental work."

This statement will suffice to determine the period with which it is proposed to deal in this paper, when considering the contribution of the aeroplane to industrial development. It will be noted that the period of general application of aerial activity to industry is less than ten years.

The aeroplane as a tool is yet a novelty. Definite types have been evolved to suit military requirements but most of the aircraft employed on commercial work are of the general purpose type. It follows that until types are evolved for particular kinds of work, maximum applicability and efficiency are not possible.

The operations which the aeroplane has been called on to perform may be divided into two classes:—(1) Those which are made possible only by the use of the aeroplane such as aerial sketching and photography, dusting and aerial prospecting. (2) Those in which it has entered into direct competition with existing methods of transportation.

No attempt will be made here to deal with operations which have not been conducted on a commercial scale. This is the broad interpretation of what is a direct contribution to industrial development.

## Forestry

### *Aerial Sketching*

The pioneer application of aircraft to industry in Canada was in connection with timber cruising, aerial sketching, and forest fire detection and suppression. Commencing with a series of experiments in the Saint Maurice valley in the summer of 1919, each subsequent year has seen a steadily increasing use of aircraft for these purposes, by the Dominion authorities, by the provincial governments, and by the great wood using industries, who in some cases established their own patrols and in others employed commercial firms to carry out the necessary flying.

To bring before the public the need of sane forest utilization, it is necessary to show how much raw material is available, also the annual growth and consumption.

A forest inventory is the first requirement and it follows that an aerial forest sketch map, quickly produced at low cost, is a primary need.

Such sketching is done by a specially trained forester during flights, and the detail is inserted on the best available map of the district, enlarged to convenient scale.

These sketch maps have proved of value for the following uses: Exploring the timber resources of unknown districts, mapping boundaries of recently burnt areas, checking up on areas cruised in previous years, to provide maps for forest protection purposes, as preliminary to a ground reconnaissance or forest survey, to check up cut-over areas. There are variations in the intensity of surveys of different localities.

(1) General or preliminary reconnaissance: This is the quickest, cheapest and least detailed. No detail of waterways or types is attempted, but only general classification of areas—whether burned over, timbered, or muskeg,—and of the merchantable types of softwood, hardwood and mixed.

(2) Aerial reconnaissance: This provides greater detail such as the main waterways, and drivable streams, the larger lakes and general forest types.

(3) Aerial forest survey: On this type detail is intensified. All drivable waterways and forest types are shown in detail comparable to that obtained by forest survey on the ground.

Up to the present time about 250,000 square miles have been sketched. This does not include territory that has been photographed for detailed maps. Both vertical and oblique photographs of forest types have been used, Canadian Airways alone having photographed 40,000 square miles. If the photographs are for forest estimating and logging purposes, those taken in the spring, fall or winter, are more satisfactory than those obtained in summer.

*Forest Fire Patrol*

Aircraft have been and are at present regularly employed on forest patrol throughout the heavily wooded portions of the Dominion. They may co-operate with ground organization, or act as independent patrol units.

Until the advent of the aeroplane in this phase of aerial activity, observation of the areas under supervision was confined to the efforts of lookouts posted on towers erected at strategic points across the country. Under ideal conditions these towers were in telephonic or radio communication with the base or central control station, but in the majority of cases they were entirely isolated, and the messages had to be forwarded on foot or by canoe.

Under this system, it was very difficult to locate a fire accurately, and after detection and location of the fire, the transportation of fire fighting equipment and personnel was extremely tedious and often the efforts of the fire fighters, through delay in commencing operations, were abortive.

It will be realized that a fire must of necessity have attained considerable proportions before the smoke can be seen from a distant lookout and it cannot be stressed sufficiently that all success in fire fighting is dependent on one factor—speedy attack.

Aerial transport alone can provide this. Independent of all land conditions and dependent only on the lakes and waterways with which the forest areas are interspersed, the aeroplane has proved the most efficient tool with which to meet the exigencies of the fire fighting service.

By a systematic series of aerial patrols at definite intervals—preferably, at least, every day in times of extreme hazard—fires may be discovered and accurately located at their inception.

Aircraft are used on:

1. Fire detection patrols.
2. Flights to report on fires under suppression and to keep deputies informed as to progress, disposition of crews and equipment.
3. Transportation of rangers, equipment and food supplies.

The work is carried out under the direction of the chief forest ranger, who issues instructions for each flight, and reports are made direct to him. Orders may call for a definite patrol of a certain area or line. In the case of a new fire being detected, the pilot will usually be instructed to fly to the nearest rangers' camp, collect such men and equipment as are considered necessary to fight the fire, and place them at the nearest possible point of attack. Once the pilot knows his area, the detection and suppression of any fire within a radius of fifty miles may be a matter of only two or three hours, provided that the fire is caught in its incipient stage.

The machines used on forest patrol should be able to take-off from small lakes with an "operating" load including pilot and kit, and "payload" of two rangers with their kit, tent, blankets, emergency rations, fire pump, hose, gasoline for pump engine, shovels, axes, jacks, etc.

The following is a typical report filed by a pilot when engaged on forest patrol.

"The machine was at Fort Francis from August 5th to September 15th except for three days at Sioux Lookout—thirty-seven calendar days, seven days rain, one day fog, twenty-nine flying days. During this time 124 passengers and 34,860 pounds of freight were carried, 198 flights were made—a distance of 11,650 miles, in all 149 hours and 22 minutes were flown (400 miles per flying day)."

This report also included details of landings at thirty-nine different points with special mention of hazards and general flying conditions.

It has been authoritatively stated that one single forest fire in the Fort Francis area cost the provincial government $70,000 to extinguish. For more than thirty days, two hundred and forty-nine men, two hundred tons of equipment, numerous planes and a chain of wireless sets were used. It is unfortunate that the credit side of this statement can only be hypothetical, but some idea of what it might be may be formed from the following illustrations.

A valuable stand of timber in a remote area was threatened by several fires. By means of aircraft, the fire fighting crews were rushed to the job and the fires put out. Experienced timber cruisers then estimated the value of the limits which, but for the aerial service rendered, undoubtedly would have been destroyed. This estimated value exceeded the total cost of the aerial forest patrol in this area for the entire season.

*Dusting*

Millions of cords of fir and spruce have been destroyed by the ravages of the spruce budworm, a caterpillar that feeds on the foliage of these trees with the result that the trees are killed.

Experiments were carried out in eastern Canada in 1927 to determine whether dusting of afflicted areas would destroy the budworm or even check the development of outbreaks and in 1930 dusting of forest areas was carried out on a commercial scale in areas adjacent to the city of Vancouver.

An attack of "hemlock loopers" threatened to destroy the forest growth in the Seymour creek area. Stanley Park, noted for its natural beauty and magnificent stands of timber, was also seriously defoliated. It was decided, therefore, to dust both of the afflicted areas with a calcium arsenate mixture. For this purpose three flying boats were employed. The areas had been plotted in strips and each pilot carried a plan.

The operation over the Stanley Park area—850 acres—was carried out early in the morning when there was little

**Fig. 1—Dusting, Seymour Creek Area.**

or no wind and took four and three-quarter hours. Seven and a half tons of calcium arsenate were loaded into the flying boats from a scow anchored in the harbour and distributed over the area.

Advantage was taken of previous experience in the use and distribution of this dust to incorporate certain improvements to the twin pack-saddle hoppers used on the flying boats and each hopper of four hundred pounds capacity had its own discharge directed below the bottom planes—

port and starboard respectively. The throats of the orifices were designed to allow a discharge of six hundred pounds in one and a half minutes. This ensured the specified amount of dust per acre being deposited on the trees.

In order to avoid packing and the necessary construction of an agitator in the discharge opening a tilting floor was arranged on the slope of the hopper. As the dust commenced to flow heavy springs raised the floor, so that as the quantity and weight in the hopper decreased the slope of the floor increased. In this way a constant flow was obtained to the hopper opening, which in turn led into the side of a venturi throat which discharged to the rear.

Later in the day the paths in the park were covered with a layer of loopers one to two inches thick. Examination of the area a week later proved that infestation had been entirely destroyed and two weeks after the operation the trees were once more assuming a green appearance.

Dusting of Seymour creek watershed commenced about a week after the Stanley Park operation. The area which was to be dusted, some 800 acres, lies about seven miles inland from salt water and it was necessary to climb 2,000 feet before discharging the dust.

The amount of dust discharged was approximately the same as in the previous operation, seven and a half tons, but the time taken was longer owing to the distance which had to be covered when travelling to and from the loading barge.

As it was not possible to maintain good formation, tactics were changed so that each aircraft dusted a certain predetermined area. About two weeks later it was apparent that this infestation had also been thoroughly eradicated.

Mr. G. R. Hopping, assistant forest entomologist, Department of Agriculture, who was in charge of the operations described, states that when an infestation of defoliating insects is controlled by dusting there is no assurance that another infestation will not occur within a few years. However, it is unlikely that this will occur until the infestations (e.g. hemlock looper) rise again over the entire region. In other words, there are series of years when factors (mainly climatic, or meteorological) are favourable for the rise of epidemics and in between there are


**Fig. 2—Trapper Shipping Winter Outfit of Dogs and Supplies.**

years when these factors cease to be favourable and the epidemics decline.

Following the dusting of the areas of Stanley Park and Seymour creek, the former in particular, was in better shape from the standpoint of defoliating insects and general tree health than for many years. The maintenance of green healthy trees bordering the line of the big conduit on Seymour creek (water reservoir) undoubtedly prevented the development of a serious fire hazard.

### Fur Trade

Today the old fur trading post, as such, only exists in the four western provinces, north of latitude 55 N. In Ontario and Quebec the territory north of the Canadian National Railway is dotted with trading posts. It is in these territories that the aeroplane has proved of most benefit to the fur trade.

The value of ranch bred pelts now represents about 26 per cent of the total raw fur production of Canada,

**Fig. 3—White Fox Skins Flown from Coppermine to Edmonton.**

valued during the past few years at approximately $12,500,000. With such an increase of ranch bred pelts, the trapper is faced with ever-increasing competition. His handicaps are, distance from rail head to trapping ground, with consequent loss of time and heavy expenditure for travelling, also if water transport be used possible loss or damage in transport. Lastly the trapper, even though he be familiar with prices by means of his radio, is unable to reach the market quickly and avail himself of favourable prices for disposal of his catch.

Like other riches of our Dominion the most valuable furs lie farthest from civilization. And so trappers have for years made their way to the Upper Thelon river, 150 miles east from Fort Reliance.

Heretofore, the trapper reached his trap-line in this region by an arduous water route, via Artillery lake and the maze of shallow streams on the water-shed to the east. His winter's outfit, including his five or six dogs, weighed a full fifteen hundred pounds. All had to be relayed, bit by bit, over more than thirty long hard portages. In order to have time remaining to secure supplies of caribou meat from the migrating herds before they passed on to the south, it was necessary to reach the trapping grounds by September 1st, and to accomplish this meant setting out from Reliance on July 1st. Then followed two months of the most exacting toil to cover but one hundred and fifty miles air-line distance.

The long months of winter trapping over, the very short "open water" season made a return to Reliance by canoe impossible, without the loss of a year's trapping as the price of each trip. So, late in April, camp was broken, and the season's fur catch hauled to the nearest trading post by dog team. By this method the trapper might spend six weeks of his year on the fringe of civilization before being forced to return to his work once more. Further, each year's trapping meant the loss of the good canoe by which he had made his incoming trip.

The late summer of 1930 saw two enterprising trappers on their way to their winter homes at Eileen lake in the first practical application of air freighting to the trapping industry.

In the autumn of 1931, four separate "outfits" went by air from Reliance to the head of the North Thelon river, where a much-desired but hitherto-unattainable trapping area lay. In 1932 trappers flew not only from the Reliance base, but also from the Lake Athabasca side of the watershed, and in 1933 were met, on their outward journey, by aircraft which flew them with their furs through to the railhead. Lowered flying costs have lessened expense to the trapper, and today he may be flown to his trap-line in one of the most obscure parts of the north and back again for less than the actual cash outlay necessary for the purchase of a canoe, outboard engine and fuel.

The fur trading companies, too, have realized the advantages of air transportation and ship furs in bulk from the trading posts to railhead. In northern Quebec furs are shipped by air from the posts at Mistassini, Chibougamau and Waswanapi to Oskelaneo or Senneterre on the Canadian National Railway. From north shore points they are shipped to Quebec. From the posts lying on the eastern shore of the Hudson Bay, Great Whale, Port Harrison and Povungnituk, bales of fur are transported to Moosonee.

Throughout northern Manitoba and in the territory adjacent to the Hudson Bay west coast, shipments are made to Sioux Lookout, The Pas and Winnipeg. From the far north, Coppermine river, Thelon river and the eastern slopes of the Rockies, the aeroplanes fly with their cargoes of pelts to railhead at McMurray or even to Edmonton.

The value of these shipments, which may range from 60 pounds to 1,500 pounds in weight, is difficult to ascertain. A small shipment of marten may be worth $36,000 or a load of 1,000 pounds may be valued at $20,000. There is a steady flow of fur traffic southward all the time, and as mining requirements provide only one way cargoes the contribution of the fur trade towards providing return cargoes cannot fail to have its effect in bringing about lower transportation charges.

Fig. 4 Seiner with Nets out in Prohibited Area off B.C. Coast.

It was estimated that during the 1932-1933 season these shipments exceeded 400 bales of raw fur. In 1929 these 400 bales would have been worth fully $1,500,000.

Fisheries

The production of the British Columbia fisheries in 1932 had a value of nearly $10,000,000 of which salmon contributed seven and a half million. This represents the value of fish marketed.

The aerial fishery patrol, which was instituted in 1923, is designed to assist in the conservation of salmon and to safeguard against the wholesale cleaning out of "schools" and heavy runs of fish in confined areas. Previous to the institution of the aerial patrol illegal fishing was common along the British Columbia coast. The deeply indented and irregular coast line favoured the "seiners" while the inspector's boat gave ample warning of its approach.

The purpose of the patrol embraces three main functions:

(1) Detecting violations in respect of fishing within boundary limits, or within specified distance from mouths of streams.
    Fishing within closed season (Friday 6 p.m. to Sunday 6 p.m.).
    Use of excessively long nets and carrying of extra web—the limit being 1,200 feet of web.

(2) Transportation of fishery officers, supervisors, inspectors, overseers and patrol men.

(3) Inspection of spawning areas—streams and lakes. (These streams may connect a chain of lakes and must be cleared to allow salmon to run. Many of the lakes are practically inaccessible except by air.)

The patrol commences during the latter part of June and continues until October 31st.

Detection is the chief function of seaplanes employed by the Fishery Department, and the advantage of aircraft over motor-boats for this purpose is apparent when inlets, sometimes not more than 10 miles apart, necessitate a water route of between 60 to 80 miles. This mobility of aircraft, combined with their ability to glide silently from high altitudes to a distant point, has made the fishermen distinctly careful and in the heavy fishing districts like Swanson Bay and the Charlotte Islands, it is now not unusual to go through a whole season without observing any violations whatsoever.

Usually after the pressure of heavy fishing begins to slacken off, the fishery officers find time to visit streams and lakes to see whether the salmon have actually spawned and if the spawn is in good condition.

In June and July, 1931, over forty-four thousand pounds of fresh fish were carried by air from Frobisher lake to Cheecham, Alta., on the Northern Alberta Railway. The fish was packed in ice for the 90-mile journey. This was one of the first applications of air transport to the freighting of fish in bulk. During February, March and April, 1933, aeroplanes were employed in northern Manitoba to carry fresh fish from Moose, William and Burntwood lakes to Cormorant lake on the Hudson Bay Railway. The fishing on the northern Manitoba lakes is done in winter time and the catch must not be frozen before reaching market. Snow was so deep that trucks or teams could not cope with the work, so aeroplanes with heated cabins were employed and nearly eighty thousand pounds of fish were carried an average distance of 40 miles. Figures for the winter 1933-1934 are not yet available, but there has been already a notable increase in the use of aeroplanes for the transport of fish from our northern lakes to railroad.

Aerial Survey and Mapping

Perhaps one of the most valuable branches of endeavour in which the aeroplane has been engaged is that of aerial survey. The oblique system of aerial photography was inaugurated and developed in Canada and this system has proved extremely satisfactory for the heavily-timbered areas of the provinces and the mining areas of the north.

Vertical photography has been developed to a high state of efficiency and has supplanted the oblique system of aerial survey wherever detail and accuracy, on a reasonably large scale, are required. This work can be and is being extended to municipal and private enterprise, thereby solving many civic and industrial problems at a reasonable cost.

Also, by means of the stereoscope certain areas can be mapped in relief so that every projection or apparent projection and its elevation can be readily discerned.

Aerial mosaics of any area can be completed in weeks. Large scale mosaics of city properties can be produced on which taxable detail shows up clearly. Property boundaries may be superimposed directly on this photograph so that every feature inside a boundary line can be recorded. Again the photographs composing a mosaic can be used in the field as plane table sheets.


**Fig. 5—Freight Awaiting Air Transportation between Norman and Old Fort Franklin.**

Stereoscopic study also gives the engineer full reconnaissance information in regard to filling and grading.

Aerial survey is particularly applicable to planning and zoning. All conditions effecting municipal improvement and civic problems are seen in photographic detail. By use of transparent colours on map copies, the zones are not only established, but even the non-technical citizen can readily read what lies within these zones and why changes are advocated. When the engineer is presenting recommendations to a non-technical board or committee, he is assisted greatly by being able to demonstrate his plans on readily understandable photographs. Many engineers now attach air photographs to their reports and recommendations, thereby saving many words of explanation and economizing the time of those attending the meeting.

Aerial maps, reduced to a convenient and economic scale, are often used to show the advantages of manufacturing sites. An air map, showing clearly the whole city with the available sites for factories blocked off, affords the prospect a splendid opportunity to choose his location in relation to distribution facilities which also are apparent. These aerial maps are usually supplemented by close-up oblique photographs.

The well-informed civil engineer has come to recognize the aerial survey as the most speedy and also one of the most reliable solutions to many a topographical engineering problem. New applications of it to industrial projects are discovered each year.

It is steadily gaining favour as a time and money saver, and it is extremely probable that ultimately, with the resumption of public works on a more extended scale, its application will be extended to all large developments where survey is involved.

### Mining

In 1924 the first air route for the regular conveyance of passengers, mails and freight was undertaken to serve the new gold field at Rouyn. Aerial transportation was applied later to the requirements of western mining at Red lake, Ont., in 1926 and these services are still in operation. In the years that followed air transport contributed to the primary development of mining territory in the following areas: northern Quebec, Ontario, northern Manitoba, northern British Columbia and finally Great Bear lake, N.W.T.

The extensive prospecting operations carried out in northern Canada during the past six years were made possible only by the use of aircraft, and the districts examined, the discoveries made, and the development accomplished by the aid of the aeroplane have been in territory that otherwise would not have received attention for at least another ten years.

Unfortunately, it is not possible to segregate the figures relating to work accomplished at this stage from those relating to subsequent performance. (See Tables I to IV.)

Some mining areas that became productive previous to 1929 were fortunate enough to obtain railroad and highway facilities, but other mines have had to carry on with water transport and air services. The Red lake and central Manitoba areas still rely on this combination and as lakes are frozen over for about seven months of the year air transport is relied on to provide the year round mail service.

Water routes have been improved and are used for heavy machinery and supplies that will keep over the winter, but for passengers, mail, fresh meat and vegetables, emergency requirements and transport of bullion, the aeroplane holds its own.

For a time it appeared that the sphere of utility for airçraft would slowly recede as the frontiers were thrust back, but with continued improvement in design and operation of aircraft, and with steadily increasing return loads, it appears probable that the aeroplane will continue to occupy a permanent position in the transportation schemes of these and other remote mining areas. Railways may be desired but the initial cost may be prohibitive. It is interesting to note the trend of development of transportation facilities at Great Bear lake, where the open water season is shorter even than in Ontario. With the water power available and with the Norman oil wells as an accessible source of fuel supply, it may be that only concentrates will be shipped out and this can be done by air as the relative cost of air transport to value of cargo transported is low. Notwithstanding the fact that development in this area is of such recent date and that the nearest railway is nearly 1,000 miles distant, a photographic mosaic covering 150 square miles in the vicinity of Echo bay was prepared and has been available by mining engineers for the past two years.

**Fig. 6—Break-up, Levine Point, Great Bear Lake.**

The appended tables show what has been achieved by one air transport company alone, in the following areas: Flin Flon and Sherridon, Central Manitoba, Red Lake, and Great Bear. The contribution of the aeroplane is increasing yearly as may be gauged from the fact that whereas all freight and express carried by Canadian Airways in 1931 amounted to 764,449 pounds, the total had more than trebled in 1933 amounting to 2,522,233 pounds, exclusive of 328,618 pounds of mail.

The following tables refer to work accomplished by this company alone.

TABLE I

MANITOBA

| | Flin Flon | | Sherridon (Sherritt-Gordon) |
|---|---|---|---|
| Population | | | |
| 1927 | Scattered-prospectors and early development | | Scattered—prospectors |
| 1931 (census) | 2,046 | | 2,263 |
| 1933 | 4,500 est'd | | |
| | School district most rapid growth in Manitoba—Est'd 1932 fall term—350 pupils. | | |
| Air Services | | | |
| Commenced: | August 1927 | | August 1927 |
| Discontinued: | June 1930 | | June 1930 |
| | Reason: Railway completed to both plants. | | |
| Air Transport Statistics | | | |
| 1927, 1928, 1929, 1930 | Total accomplishment in area till service discontinued. | | |
| | Mail (pounds) | Passengers | Express and Baggage (pounds) |
| | 50,053 | 4,232 | 740,593 |

TABLE II

MANITOBA

Central Manitoba Aera
(Lac du Bonnet Base)

Population
1927 Scattered—prospectors etc.
1931 (census) 546

Air Services
Commenced June 1, 1927
Still in operation
Mail not carried Summer 1931 and 1932.

| Air Transport Statistics | Mail (pounds) | Passengers | Express (pounds) |
|---|---|---|---|
| May 1927 to August 1929 | 50,986 | 1,768 | 220,108 |
| 1930 | 30,439 | 213 | 11,847 |
| 1933 | 41,361 | 1,266 | 281,394 |
| Total | 122,786 | 3,247 | 513,349 |

TABLE III

ONTARIO

Red Lake area
(Sioux Lookout Base)

Population
1927 Scattered
1931 (census) 600 Very definite increase in two years since census

Air Services
Commenced Christmas Day 1926
Still in operation.

| Air Transport Statistics | Mail (pounds) | Passengers | Express (pounds) |
|---|---|---|---|
| 1927, 1928, 1929 | 212,979 | 8,598 | 1,763,400 |
| 1930 | 33,527 | 1,387 | 264,976 |
| 1931 | 36,552 | 940 | 373,582 |
| 1932 | 47,170 | 1,006 | 432,995 |
| 1933 | 53,285 | 1,222 | 741,229 |
| Total | 383,513 | 13,153 | 3,576,182 |

TABLE IV

GREAT BEAR LAKE

North West Territories

Population
1929 Only a few traders and prospectors.
1933 Summer season, approximately 400.

Air Service Commenced
Mackenzie River — Summer 1929
Great Bear Lake { March 1930; First load prospectors' supplies.

**Fig. 7—Hospital Patient being Flown from Godbout to Quebec.**

| Air Transport Statistics Mackenzie River Area | Mail (pounds) | Passengers | Express (pounds) |
|---|---|---|---|
| 1930 | .... | 938 | 68,932 |
| 1931 | 42,829 | 961 | 138,626 |
| 1932 | 71,342 | 1,405 | 408,561 |
| 1933 | 53,842 | 882 | 403,756 |
| Totals | 168,013 | 4,186 | 1,019,875 |
| Great Bear traffic only | | | |
| 1931 | .... | 145 | 10,520 |
| 1932 | 1,592 | 256 | 104,167 |
| 1933 | 5,292 | 339 | 169,325 |
| Totals | 6,884 | 740 | 284,012 |

This picture would be incomplete if mention were not made of the contribution of the aeroplane to industrial life as regards health, bodily and mental recreation and the maintenance of adequate standards of living.

Obviously, it would be impossible to arrange for doctors, nurses, or hospital facilities at all northern communities, but in emergency, if aeroplanes are available, air transport is at once employed. In twelve months Canadian Airways' planes made over eighty humanitarian flights.

Federal officials, judges, police officers travel by air. This method of travel combined with the instantaneous communication offered by radio, has revolutionized the control exercised over these vast northern territories.

The fathers of the church and sisters of the religious orders are regular travellers on the 'planes that operate on schedule from McMurray to the Arctic ocean.

Bishop J. D. Anderson, of Moosonee, travelled nearly 1,000 miles throughout his diocese last summer in one week. During the coming summer, 1934, Right Rev. A. L. Fleming, Bishop of the Arctic, hopes to call at every mission, except four, in his diocese, which has a territorial area of 2,250,000 square miles, and extends from Ungava in the east, to Alaska in the west.

It is not too much to say that the possibility of journeys of this kind has made a complete change in the conditions of life in the more remote and previously inaccessible regions of the Dominion.

# The Reflecting Telescope for The David Dunlap Observatory

*by R. K. Young, Ph. D.*[1]

## DISCUSSION

Professor L. M. Arkley, m.e.i.c.[2]

Professor Arkley enquired how the measurements of the mirror surface were obtained to the required limits of accuracy, which approached 1/1,000,000 of an inch.

R. K. Young, Ph.D.[3]

Dr. Young replied that this was done by optical measurement. A parallel beam of light was directed on to the mirror, and the eye placed at the focus of the reflection. Then a razor was moved across the beam at the focus. If the surface was perfect it would blink all the light out from the eye; otherwise shadows would gather over the faulty part, due to the "hills and depressions."

Geo. E. Newill, m.e.i.c.,[4]

Mr. Newill enquired of what material the polishing tool was made, what kind of polish was used, and what was the life of the coating.

R. K. Young, Ph.D.

The author in reply stated that for the rough grinder cast iron was used; for the fine grinder, glass; and for the polish, cast iron covered with a compound of beeswax and rouge, which was allowed to set for some time on the mirror before polishing began. The life of the coatings depended upon the situation; when the mirror was near a city, it required resilvering three or four times a year; but if located in a desert, the coating would last for about a year. Lacquers were now being successfully used on mirrors as was also an aluminum coating.

A. W. Whitaker, Jr., a.m.e.i.c.[5]

Mr. Whitaker wished to know the reflecting power of the silver coating and if the mirror was repolished when resilvered.

R. K. Young, Ph.D.

Dr. Young observed that in the blue green region, from 90 per cent to 95 per cent of the light was reflected. Below that region only about 65 per cent of the light was reflected. With the aluminum coating there was about 75 per cent of the light reflected, but this was constant over most of the wavelengths, and so was more effective than the silver coating. The mirror was not mechanically repolished after it had been resilvered, only rubbed.

Brig.-General C. H. Mitchell, c.b., c.m.g., c.e., d.Eng., m.e.i.c.[6]

General Mitchell requested information on the operation and maintenance of the equipment, and also on temperature effects and the precautions taken in this respect.

R. K. Young, Ph.D.

The author replied that a trained mechanician was needed, but operators should have a slight knowledge of the operating equipment in order to prevent foolish blunders. All the electrical equipment was interlocking, however, and so protected from damage should an operator make a mistake.

With regard to the temperature, while the instrument was surrounded by a heating case, to keep the temperature range within the limits of from 1/100 degree to 1/10 degree, the larger mirror was uncontrolled. The only precautions which could be taken with it were to see that the design of the building was such that proper ventilation ensured that there was no difference between the inside temperature and the surrounding outside temperature, and further to wrap the mirror during the day and thus try and keep it as nearly as possible equal to the temperature of the following night. However, great caution must be used in doing this, due to moisture and various other atmospheric conditions.

J. A. Pearce[7]

Mr. Pearce stated that the new 74-inch reflector was similar to the 73-inch reflector of the Dominion Astrophysical Observatory, Victoria, B.C. It differed from the 73-inch only in minor details, some of which might be regarded as improvements over an instrument which had been designed nearly 20 years ago. The more important of these differences were:

1. A lighter observing platform to reach the principal focus.
2. The method of attaching the tube to the declination axis, to minimize the flow of heat from the more massive parts of the telescope to the mirror cell, which resulted in a temperature gradient across the mirror, producing astigmatism.
3. The motor to focus the secondary mirror, instead of a hand wheel was a difference, rather than an improvement, as the latter method had been quite satisfactory.
4. The iris diaphragm replaced a shutter. The shutter consisted of 12 sector-shaped steel leaves attached at their bases to 12 short shafts connected together by universal joints and a worm wheel rotated by a worm and shaft geared to a worm wheel attached at the lower side of the mirror cell. The hand wheel quickly raised or lowered the leaves simultaneously. When closed the leaves stood at an elevation of 30 degrees forming an arch and giving perfect protection to the mirror.
5. The clock controlled drive, favoured by the Grubb Parsons Company and adopted for the 74-inch telescope would ensure that the telescope was driven at accurate sidereal time. The 73-inch reflector was driven by the ordinary governor but so perfectly did it work that the need for a controlling device had never been felt. Indeed, for spectrographic work, for which the Victoria telescope was designed, it was desirable to have the stellar image drift along the slit of the spectrograph. For photographic work, however, the clock control drive was greatly to be preferred.

The very efficient performance of the 73-inch Victoria telescope during the 15 years, 8 months of its life had proved that the general design left little to be desired. More than 21,800 stellar photographs (spectrograms) had been secured in the 19,100 working hours, an average of 7 plates per night having been obtained. During the past 10 years the telescope had been almost exclusively employed in the investigation of stars fainter than the 6th magnitude, i.e., stars fainter than could be seen with the naked eye. The telescope might be easily handled by one observer, the average time consumed in changing from star to star and rotating the dome between photographs was only 4 minutes. With the engineer assisting the astronomer, this lost observing time was reduced to 2½ minutes. The ease of handling the 45 ton telescope (movable parts) was remarkable evidence of the perfection of mechanical design and workmanship.

It might confidently be anticipated that the Dunlap telescope would duplicate the performance of the Victoria telescope and before many months would be engaged in important astrophysical investigations and researches. Much credit was due to Professors Chant and Young for the construction and successful completion of this splendid instrument and the establishment of an excellent observatory.

(1) Paper presented before the Annual General Professional Meeting of The Engineering Institute of Canada, and published in the February, 1934, issue of The Journal.

(2) Professor of Mechanical Engineering, Queen's University, Kingston, Ont.

(3) Department of Astronomy, University of Toronto, Toronto, Ont.

(4) Consulting engineer, Montreal.

(5) Works superintendent, Aluminum Company of Canada, Ltd., Arvida, Que.

(6) Dean of the Faculty of Applied Science, University of Toronto, Toronto, Ont.

(7) Dominion Astrophysical Observatory, Department of the Interior, Victoria, B.C.

THE
# ENGINEERING JOURNAL
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## Aptitude and Professional Success

The qualifications for success in life are not usually thought of as a suitable subject for laboratory investigation, but of recent years psychologists have begun to direct their inquiries along this line. It is not without interest to inquire, for example, what are the personal characteristics that make for success in engineering work, and what is their relative importance. How can their existence in a given individual be ascertained, and, if he does not possess them, how far is it possible to develop any of them by early training and professional education.

It is comparatively easy to determine in the laboratory the capabilities of a material or the suitability of a machine for its work, but can similar methods be applied to the estimation of personality? The problem of selecting a suitable man for a given position has to be faced by individual employers, as well as by large corporations and governments. Some form of inquiry or examination has to be adopted, and such investigations take the most varied forms, depending on the point of view of the authority employing them. For instance, in selecting youngsters as cadets for the Royal Navy, if stories are to be believed, far less emphasis has been placed on book learning than on quickness, intelligence and powers of observation. When one embryo naval cadet was asked by the examining officer, "How did you get here this morning from the hotel at which you were staying?" he replied, "In a cab, Sir." "What was the number of the cab?" "Number 41868, Sir." "Good," said the officer who had asked the question. Another member of the board asked the presiding examiner, "How do we know that he gave the right number?", and the reply was, "I don't care a hang whether it was the right number or not. He answered quickly and smartly, and that is what we want."

The satisfactory results presumably obtained by such methods in this particular case would hardly commend them to people who base their opinion of a candidate's fitness upon his ability to make high marks on a carefully set written examination, the method of selection adopted in many branches of the public service in England. The world-wide reputation of the British Civil Service rests largely on the character of its higher officials, who are selected by open competitive examination. Over a period of years this procedure has resulted in the appointment of officers who reach an extremely high average of administrative ability, as exemplified by their work in such branches as the Colonial Service and the Civil Service of India. The examinations, however, are not of a technical or specialized character, but cover a wide range of cultural subjects and contain questions which can only be answered successfully by men of exceptional capacity and wide general reading. Thus it is interesting to note that these appointments leading to high administrative positions depend on the study of subjects largely unconnected with the ultimate life work of the candidates, and that the examinations test general ability rather than special knowledge.

As a contrast to the method of selection by competitive examination, psychologists are now urging the value of vocational analysis as a preliminary to vocational training.

It is evident that in approaching this subject there are two features to be considered, namely, the suitability of any given individual for a given calling, and then, the kind of training which he should afterwards receive to develop the special aptitudes which he possesses.

Some interesting general results of such analyses, as applied to engineering work, have been published recently,* and are based on studies carried out at one of the leading engineering schools in the United States. As a result of the psychological examination of a large number of business executives, engineers, scientists, doctors and lawyers, the broad fact emerged that the subjects of the investigation could be classed in two groups, having respectively the objective and subjective type of personality. These types are not sharply divided, because individuals range over the entire length of the scale from the extremely objective to the extremely subjective. The objective person is naturally interested in matters external to his own mind. He is a group worker and rejoices in contact with others. One hundred successful salesmen averaged "extremely objective," while one hundred business executives were distinctly "less objective." Subjective persons, on the other hand, tend rather to be absorbed in their own intellectual activities. The designing engineer, the successful research worker or inventor, are examples of this type. From the observations made it is apparently very unusual for a markedly subjective person to become more objective in outlook, or vice versa. In other words, this characteristic seems part of one's personality and is little affected by training or environment.

Apart from classification according to this important mental attitude, evidence was secured of the existence of a considerable number of other qualifications each having a more or less decisive influence on a man's fitness for engineering work. One of the chief of these is the gift of visualizing three-dimensional structure, which is indispensable for success in engineering, architecture and surgery. Curiously, women, as a group, have been found markedly inferior to men in this respect. Then there is creative imagination, which enables the possessor to develop new methods or contrivances for engineering work. We are not told whether, as a compensation, women excel in this. Next in importance is the faculty of inductive reasoning, which was found difficult to evaluate. It is the kind of power possessed, for instance, by an automobile trouble

*C. W. Squier, "Measuring Our Capabilities," *Mechanical Engineering*, October, 1933.

man, who takes a car out on the road or examines it in the shop and finds the cause of its failure or defective performance. This is probably the same characteristic as that of the successful diagnostician in medicine. It is used in gathering results and drawing conclusions from the data obtained, and is quite distinct from the ability to break down a problem into its components, which is so necessary for analytical work; it is synthetic, rather than analytic.

Among aptitudes considered of lesser importance in engineering work we find manual dexterity, visual memory and tonal memory—the powers of remembering things seen and heard. In the psychological work referred to studies have also been made of what is termed "accounting aptitude." This is the power of handling clerical details rapidly and accurately, and is a characteristic possessed by successful bankers, accountants, bookkeepers, stenographers and private secretaries. Accounting aptitude is apparently an inherent quality, perhaps inherited, certainly fixed in early youth, and as far as can be seen but little affected by environment and experience.

It will be noted that in the estimate of these aptitudes the value of memory is not strongly emphasized. It was found, however, that there was one very important feature depending on memory, which was possessed by all the persons studied who scored highly in the psychological tests. Practically all of the successful people examined had a large English vocabulary, and it seemed evident that this characteristic, more than any other which could be measured, separated the successful man from the unsuccessful. It does not distinguish one type of worker from another, and is possessed equally by the extremely objective and the extremely subjective types. A large vocabulary is, however, an acquired characteristic. It is within the reach of anyone willing to work sufficiently hard, although there were indications that those whose predominating characteristic was "engineering aptitude," namely, the gift for visualizing three dimensional structure, found it more difficult to obtain an extensive vocabulary than was the case with the average person, this deficiency being due possibly, to the lack of stress laid on English in the average American engineering school.

In regard to the nine or ten aptitudes or characteristics which were the subjects of study, it was noted that successful executives obtained high scores in a wide range of different tests. It seems, therefore, that range of aptitudes, rather than a high rating in any one aptitude, is characteristic of the type of man who becomes successful in administrative work.

In general, it was found that about one person in four scored "A" in one aptitude, while only one in sixteen excelled in two, and only one in sixty-four in three. Taking seven of the characteristics most easily measured, it appeared that only one person in about sixteen thousand would reach the upper twenty-five per cent of the list, whereas one in about one hundred and twenty-five was able to score above the average.

The results of inquiries like these are useful as a guide for the individual who desires to choose the life work for which he is best qualified. They will no doubt be studied by those in charge of the selection of personnel for large industrial and engineering organizations. It seems doubtful, however, whether they can be applied to any great extent by the individual employer in his task of interviewing applicants and using his own common sense and knowledge of human nature in appraising their character and personality.

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## Western Professional Meeting of The Engineering Institute of Canada July 11th to 14th, 1934

**VANCOUVER, B.C., where The Engineering Institute of Canada will hold a joint meeting with the members of the American Society of Civil Engineers.**

**An ideal place to visit this summer. Why not plan to include the convention in your holiday trip?**

*(Details of the programme appeared in the May issue of The Journal.)*

# OBITUARIES

## Bertram Scott Ashley, A.M.E.I.C.

Deep regret is expressed in recording the death in an aeroplane accident in December, 1933, of Bertram Scott Ashley, A.M.E.I.C. The wreck of Mr. Ashley's plane has now been found, and hope for his safety has reluctantly been abandoned.

Mr. Ashley was born in Leitholm, Scotland, on October 27th, 1889, and he received his early education in that country.

He was one of the best known mining engineers and prospectors in Ontario and Quebec. For many years he was with the O'Brien Company at their properties in Cobalt and Gowganda, and later he became associated with the Victoria Syndicate of the Mond Nickel Company. Mr. Ashley also acted as Canadian representative for various British mining firms. He was, perhaps, best known for his discovery of the gold mine in the Matachewan area which bears his name. In 1928 Mr. Ashley became manager of the Telluride Gold Mines Limited, at Englehart, Ontario, and in recent years he had devoted his attention almost entirely to prospecting, and it was only natural that, with his war experience as a pilot, he should have turned to the aeroplane as an aid in carrying on this work.

Mr. Ashley joined The Institute as an Associate Member on May 26th, 1920.

## William John Cunningham, A.M.E.I.C.

Deep regret will be felt at the announcement of the untimely death at Edmonton, Alta., on May 13th, 1934, of William John Cunningham, A.M.E.I.C.

Mr. Cunningham was born at Altrincham, England, on August 29th, 1886, and received his early education at the Altrincham Technical School. Later on he attended the College of Technology affiliated with the University of Manchester, and graduated from that institution.

During the years 1901-1907 Mr. Cunningham was apprentice and assistant engineer with the Altrincham Electric Supply Company, and, coming to Canada in 1907, was engaged on fitting and erecting in the electrical assembly shops of Allis-Chalmers Bullock Limited at Montreal for six months. In 1908 he entered the service of the city of Calgary as electrician and assistant chief engineer on power house and sub-stations, and in 1912 was appointed assistant superintendent. In 1915 Mr. Cunningham went overseas for the department of munitions. He first represented the firm of Vickers Limited, and for four months was with H.M.S. *Valiant*. He was then appointed to the Royal Arsenal at Woolwich, and remained there as inspector and on fitting naval and field guns until 1918. After the war, Mr. Cunningham returned to Calgary and resumed his former position. In 1919 he was appointed superintendent of the Edmonton power plant, and in 1925 he was named in addition, head of the street railway department of the city, and in the succeeding years Mr. Cunningham had much to do with the development and expansion of both utilities.

Mr. Cunningham became an Associate Member of The Institute on June 7th, 1924, and was an active member of the Edmonton Branch, having served on the executive committee on several occasions, and at the time of his death was convenor of the Branch committee on Engineering Education.

All members are again reminded that papers entered in competition for the Past-Presidents' Prize must be received previous to June 30th, 1934, by the General Secretary of The Institute.

Papers for the Students' and Juniors' Prizes must be received by the Branch Secretaries previous to June 30th, 1934.

# PERSONALS

Dr. A. Surveyer, M.E.I.C., consulting engineer, Montreal, has accepted the appointment as seventh member of the Advisory Finance Board of the City of Montreal. Dr. Surveyer has specialized in semi-financial and technical investigations and in these fields his work has been highly successful.

Dr. Surveyer graduated from Laval University with the degree of B.A. in 1898 and from the Ecole Polytechnique with the degree of B.A.Sc. and C.E. in 1902. The following year was spent taking a post-graduate course at the Ecole Speciale d'Industrie et des Mines du Hainaut, at Mons, Belgium. Dr. Surveyer commenced his professional career with the Public Works Department of Canada in 1904, and remained with the Department until 1911 when he entered private practice in Montreal. In August of the same year he was appointed by the Federal government a member of the St. Lawrence River Commission to judge difficulties arising between the hydro-electric companies and the ship-owning companies. In 1912 he reported to the Federal government on the effect of the Chicago Drainage Canal diversion on the harbours of the St. Lawrence river and the Great Lakes. He was later associated in making a joint report on the opportunity of the government guaranteeing the bonds of the Montreal Tunnel Company and the Montreal Central Terminal Company. During his career Dr. Surveyer has been employed in a consulting capacity by all the important cities in the province of Quebec as well as the Department of Public Works, Canada, the Department of Lands and Forests, Quebec, and the Quebec Streams Commission.

Dr. A. SURVEYER, M.E.I.C.

Dr. Surveyer takes an active interest in educational matters, and has rendered voluntary service for a number of years on the Research Council of Canada. He is a member of the Corporation of Professional Engineers of Quebec, the Institution of Civil Engineers, and the Société des Ingénieurs Civils de France.

Dr. Surveyer joined The Institute (then the Canadian Society of Civil Engineers) as a Student on March 16th, 1899, became an Associate Member on October 24th, 1907, and a full Member on June 22nd, 1912, and has always taken a keen interest in its affairs, having been a member of many important committees, including not only the standing committees of Council, but special committees dealing with the welfare of The Institute. He was elected to Council in 1915, on which he served continuously until the end of 1921. He was then elected vice-president, and filled that office for more than two years. He became President in 1924 on the death of W. J. Francis, and served until the end of 1925.

R. G. Bangs, A.M.E.I.C., formerly assistant engineer on the Welland Canal at St. Catharines, Ont., is now attached to the Transportation and Public Utilities Branch, Bureau of Statistics, Department of Trade and Commerce, Ottawa, Ont.

Kenneth Moodie, M.E.I.C., has entered the service of the Government of British Columbia as combustion engineer in the Department of Public Works, and is located at Vancouver, B.C.

P. A. Beique, A.M.E.I.C., consulting engineer, Montreal, has been appointed vice-president of the Montreal Tramways Commission. Mr. Beique has been a member of the Tramways Commission since 1926, and has for a number of years been prominent in engineering circles.

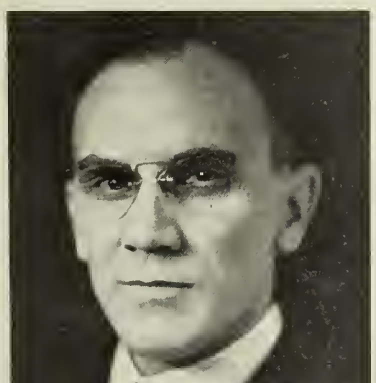
Norman G. McDonald, A.M.E.I.C., has been admitted to partnership in the firm of Gore, Nasmith and Storrie, consulting engineers, Toronto. Mr. McDonald, who graduated from the University of Toronto in 1918 with the degree of B.A.Sc., has been connected with his firm for the last twelve years.

J. L. Wickwire, Jr.E.I.C., is now division engineer with the Nova Scotia Department of Highways, and is located at Middleton, N.S. Mr. Wickwire, who graduated from McGill University with the degree of B.Sc. in 1924, was for a time with C. D. Howe and Company at Port Arthur, Ont.

H. A. Thompson, A.M.E.I.C., is now connected with the E. B. Eddy Company at Hull, Que. Mr. Thompson, who graduated from the University of Saskatchewan in 1927 with the degree of B.Sc., was at one time construction engineer with Morrow and Beatty Ltd., at Fitzroy Harbour, Ont., and in 1932 was on the staff of the Abitibi Power and Paper Company Limited at Smooth Rock Falls, Ont.

James F. MacLaren, A.M.E.I.C., has been admitted to partnership in the firm of Gore, Nasmith and Storrie, consulting engineers, Toronto. Mr. MacLaren, who has been associated with that firm for the past seven years, was at one time superintendent of construction with the Water Supply Section, Department of Works, Toronto, and later was connected with John Inglis Company Limited, Toronto.

John G. Hall, M.E.I.C., formerly vice-president and general manager of the Combustion Engineering Corporation Limited, Montreal, has been appointed general manager and director of the same company. Following



JOHN G. HALL, M.E.I.C.

graduation from McGill University in 1921 with the degree of B.Sc., Mr. Hall was engineer and assistant superintendent of the Back River Power Company until 1924, when he joined the staff of the Combustion Engineering Corporation as manager of the Winnipeg office which position he held until 1927 when he was transferred to Montreal to take over the appointment which he has held up to the present time. Mr. Hall is a member of the Associations of Professional Engineers of Quebec and Manitoba.

W. I. Bishop, M.E.I.C., president and managing director of W. I. Bishop Limited, construction engineers, Montreal, has been appointed a member of the Montreal Tramways Commission. Mr. Bishop is also president and managing director of the Raymond Concrete Pile Company Limited, president and managing director of Ambursen Hydraulic Company, vice-president of the Pacific Construction Company, vice-president of the Pacific Dredging Company.

Philip N. Libby, A.M.E.I.C., is on the staff of the engineering department of the Tennessee Eastman Corporation, and is located at Kingsport, Tenn. Mr. Libby was at one time chief draughtsman with the Riordon Pulp Corporation at Temiskaming, Que., and later was with the Canadian International Paper Company in the same capacity and as assistant to the construction manager. In 1930 he was superintendent of construction for Atwood Limited at Temiskaming, Que., and in 1931 was with the E. B. Eddy Company Limited at Hull, Que. Mr. Libby is a graduate of the University of Maine of the year 1917.

L. H. D. Sutherland, M.E.I.C., has recently incorporated the Sutherland Construction Company, Montreal, to engage in general contracting and engineering. Mr. Sutherland graduated from McGill University in 1909 with the degree of B.Sc., and following graduation was until 1911 with the Canadian Pacific Railway Company as inspector on caisson foundations for an addition to Windsor Station and clerk on construction of additions to several hotels. In 1911 he joined the staff of E. G. M. Cape and Company, and has continued this connection up to the present time, with the exception of the period 1915-1918 when Mr. Sutherland was overseas with the Canadian Engineers and Canadian Railway Troops.

H. Ross MacKenzie, A.M.E.I.C., who was recently elected president of the Association of Professional Engineers of the Province of Saskatchewan, is chief engineer in the Saskatchewan Department of Highways. He graduated from the University of Toronto in 1913 with the degree of B.A.Sc. Following graduation Mr. MacKenzie was appointed inspector with the Saskatchewan Board of Highway Commissioners and in 1917 was promoted to the position of field engineer in the Department of Highways. In 1929 he received the appointment which he now holds. Mr. MacKenzie takes an active interest in the affairs of The Institute, having represented the Saskatchewan Branch on the Council in 1926, 1927 and 1928, and was chairman of the Branch in 1929. In 1919 he represented the Saskatchewan Branch of The Institute at a conference held in Montreal for the purpose of preparing a draft of a model bill providing for the incorporation of provincial associations of professional engineers. In 1929 he was chairman of the Northwest International Highway Association.

E. Winslow-Spragge, A.M.E.I.C., was recently appointed first vice-president of the Canadian Ingersoll-Rand Company Limited. Following graduation from McGill University in 1908, Mr. Winslow-Spragge was for a year at Sault Ste. Marie and Fort William, Ont., with Robert W. Hunt and Company. He then joined the staff of the Canadian Ingersoll-Rand Company at Toronto, and shortly after that was transferred to northern Ontario in charge of the Cobalt office. In 1911 he was transferred to the Montreal office. During the war, Mr. Winslow-Spragge was engaged on the development of munitions manufacture in Canada, and subsequently became chief inspector and manager of the munitions department of his company. Following the armistice, he was appointed general sales manager, and in 1925 he became assistant general manager, in which capacity he has continued until the present. Mr. Winslow-Spragge is a member of the Canadian Institute of Mining and Metallurgy, and was recently elected to the executive council of the Montreal Branch of the Canadian Manufacturers Association.

T. W. Toovey, A.M.E.I.C., formerly chemical engineer with the B.C. Pulp and Paper Company Limited, Port Alice, B.C., has accepted a position with Dr. L. Rys, Harmanec, near Banske Bystrice, Czechoslovakia, in an advisory capacity. Mr. Toovey received his early education at the Royal Grammar School at Newcastle, England, and attended the Rutherford and Armstrong Colleges in the years 1914-1920. From 1914 to 1917 he was an apprentice in the chemical and metallurgical laboratories of Messrs. Sir W. G. Armstrong Whitworth and Company at Newcastle-on-Tyne. Coming to Canada, Mr. Toovey was from 1923 to 1928 in the Research Department of the Canadian International Pulp and Paper Company Ltd., at Hawkesbury, Ont.

C. E. Hogarth, A.M.E.I.C., has recently acquired an interest in the firm of J. D. Armstrong Construction Company Limited, sewer and excavating contractors, Hamilton, and has joined the staff as engineer. Following graduation from the School of Practical Science, University of Toronto, in 1915, with the degree of B.A.Sc., Mr. Hogarth was overseas until 1919 as a lieutenant with the Canadian Engineers. From April until October 1919 he was field engineer on the Welland Ship Canal, and later until July 1920 was field engineer and general foreman with the Austin Company at Cleveland, Ohio. In 1920 Mr. Hogarth was engaged with the Foundation Company of N.Y. as field engineer and in 1921-1925 he was sales engineer with the Refinite Company of Canada, and the Canadian International Filter Company at Toronto. In 1926 Mr. Hogarth was acting assistant superintendent on power house construction for the Detroit Edison Company at Detroit, Mich., and subsequently until 1931 he was engineering assistant with the Michigan Bell Telephone Company at Detroit. In 1931 Mr. Hogarth returned to this country as engineer with Christman-Burke Limited, Toronto.

## ELECTIONS AND TRANSFERS

At the meeting of Council held on April 24th, 1934, the following elections and transfers were effected:

### *Members*

COLLITT, Bernard, F.I.C., metallurgist, Jenkins Bros. Ltd. Montreal, Que.

GERMAN, Alan Macdonnell, B.A.Sc., (Univ. of Toronto), asst. mgr. and gen. supt., Canadian Dredging Co. Ltd., Toronto, Ont.

### *Associate Members*

HOLMAN, Clive Whelpton, (Assoc. Member, Inst. M.E.), teacher of mech'l. drawing, Technical and Commercial High School, Sault Ste Marie, Ont.

MATTSON, Ragnar John, C.E., (Royal Coll. of Engrg., Stockholm), engr., Foundation Company of Canada Ltd., Montreal, Que.

McARA, Peter Graham, B.Sc., (Univ. of Sask), asst. supt., water works dept., City of Regina, Sask.

McDERMID, George, B.Sc., (Univ. of Man.), acting asst. engr., way and structure dept., Winnipeg Electric Company, Winnipeg, Man.

McMILLAN, James, B.Sc., (Univ. of Alta.), purchasing agent, Calgary Power Co. Ltd., Calgary, Alta.

MORGAN, Philip Harold, constrn. supt., Beauharnois Construction Company, Beauharnois, Que.

PEELE, Percy Frederick, B.A.Sc., (Univ. of B.C.), sales engr., Canadian General Electric Co., Calgary, Alta.

TUCKER, Edward Francis, B.S., (Chem.), and Chem. Engr., (Clarkson College of Technology), vice-president and manager, Canadian Stebbins Engrg. and Mfg. Co. Ltd., and secretary and technical director, Stebbins Engrg. and Mfg. Co., Montreal, Que.

### *Juniors*

DuCHENE, Andrew Hubert, B.Sc., (Univ. of N.B.), asst. foreman on tests, Canadian General Electric Co., Peterborough, Ont.

EVANS, Owen Allen, B.Sc., (Queen's Univ.), assayer for the Algoma Central Railway, Sault Ste Marie, Ont.

FULLER, Allan Frederick Samuel, B.Sc., (Univ. of Sask.), 2345 Smith St., Regina, Sask.

LAMOUREUX, Marcel, B.Eng., (McGill Univ.), junior engr., Lake St. Louis Bridge Corporation, St. Guillaume, Que.

### *Transferred from the class of Junior to that of Associate Member*

LEITCH, Hugh James, B.Sc., (McGill Univ.), mgr., warehouse dept., Dominion Bridge Co. Ltd., Montreal, Que.

MacKINNON, William Duncan, B.Sc., (Queen's Univ.), supt. of board mill and steam plant, Donnacona Paper Co. Ltd., Donnacona, Que.

MOON, George Douglas, B.A.Sc., (Univ. of Toronto), dist. engr., Bell Telephone Company of Canada, Quebec, Que.

### *Transferred from the class of Student to that of Associate Member*

ADAMS, George Ronald, B.Sc., (Queen's Univ.), road engr., Veraguas Mines Ltd., Colon, Republic of Panama.

KENT, George Edward, B.Sc., (N.S. Tech. Coll.), asst. to refinery supt., plant No. 2, Imperial Oil Refineries, Ltd., Sarnia, Ont.

NICKERSON, Allan Douglas, B.Sc., (N.S. Tech. Coll.), transmission engr., Maritime Telegraph and Telephone Co. Ltd., Halifax, N.S.

WILFORD, John Richard, (Univ. of Toronto), asst. mgr. and secretary, F. R. Wilford & Co. Ltd., Lindsay, Ont.

### *Transferred from the class of Student to that of Junior*

CHISHOLM, Donald Alexander, B.Sc., (N.S. Tech. Coll.), miner, McIntyre Porcupine Mines, Schumacher, Ont.

CLIMO, Percy Lloyd, B.Sc., (Queen's Univ.), P.O. Box 215, Cobourg, Ont.

MADELEY, W. Arthur, B.A.Sc., (Univ. of B.C.), 4359 West 11th Ave., Vancouver, B.C.

MELLOR, John Harold, B.Sc., (McGill Univ.), field engr., mill constrn., Canadian Copper Refiners, Montreal East, Que.

PEFFERS, William Oswald, Capt., R.C.C.S., B.Sc., (Univ. of Alta.), District Signal Officer, Mil. Dist. No. 3, Kingston, Ont.

TAYLOR, William Russell Coates, B.Sc., (Univ. of Man.), operator, Moose Lake Power Plant, Atikokan, Ont.

### *Students Admitted*

ARTHEY, George Clayton, (Queen's Univ.), 206 Florence St., Ottawa, Ont.

BUBBIS, Nathan S., (Univ. of Man.), 406 Andrews St., Winnipeg, Man.

CLARKE, Bruce Porteous, (McGill Univ.), Lennoxville, Que.

COLPITTS, Henry Gardner Moore, (Univ. of N.B.), P.O. Box 344, Sussex, N.B.

CROSS, Douglas Henry, (McGill Univ.), 3581 University St., Montreal, Que.

DAVENPORT, Ralph Frederick, (Univ. of N.B.), 716 Charlotte St., Fredericton, N.B.

DeBLOIS, Howard Crawford, (R.M.C.), Ile Bizard, Que.

DUNLOP, Duthie MacIntosh, B.Sc., (Univ. of Man.), 128 Arlington St., Winnipeg, Man.

DYER, Edmund Gerald, B.Sc., (N.S.T.C.), 16 Merkle St., Halifax, N.S.

FRASER, Allan Donald William, (McGill Univ.), 1239 Van Horne Ave., Outremont, Que.

FRENCH, Philip Bemis, (McGill Univ.), 456 Pine Ave. West, Montreal, Que.

GOODSPEED, Herbert Newcombe, (Univ. of N.B.), 745 George St., Fredericton, N.B.

GORMAN, David Donald, B.Sc., (Univ. of N.B.), 188 O'Dell Ave., Fredericton, N.B.

HANKIN, Edmund Alfred, (McGill Univ.), 648 Murray Hill, Westmount, Que.

HARRISON, Ronald Dex, (McGill Univ.), 4902 Grosvenor Ave., Montreal, Que.

HURTUBISE, Jacques Edouard, (Ecole Polytechnique), 1430 St. Denis St., Montreal, Que.

LAPLANTE, Joseph Hormisdas Arthur, B.A.Sc., C.E., (Ecole Polytechnique), 2009 Marie Anne St., Montreal, Que.

LEVINTON, Zusse, B.Sc., (Univ. of Sask.), Ridgedale, Sask.

MacPHERSON, John Miles, B.Sc., (Univ. of N.B.), North Devon, N.B.

MICHAUD, Joseph Sylvia Andre, (Ecole Polytechnique), 3582 St. Famille St., Montreal, Que.

McMATH, Andrew Allan Brown, (McGill Univ.), 129 Edison Ave., St. Lambert, Que.

PAQUET, Jean M., (Ecole Polytechnique), 62 de Salaberry, Quebec, Que.

ROSS, Oakland Kenneth, (McGill Univ.), 1627 Selkirk Ave., Montreal, Que.

SAWLE, Ross Tregerthen, (Queen's Univ.), 23 Fraser St., Welland, Ont.

STEVENSON, Charles Lester, (Univ. of N.B.), c/o J. H. Stevenson, Esq., Bank of Nova Scotia, Saint John, N.B.

STURDEE, Charles Parker, (McGill Univ.), 3454 Peel St., Montreal, Que.

TANNENBAUM, Joseph, (McGill Univ.), 5344 Jeanne Mance St., Montreal, Que.

At the meeting of Council held on May 18th, 1934, the following elections and transfers were effected:

*Associate Member*

MAUDE, John Henry, (Assoc., Coll. of Technology, Manchester, Eng.), mech'l. engr., Dominion Bridge Company, Lachine, Que.

*Affiliates*

ALEXANDER, Stanley George, (Chicago Tech. School), chief operating engr., steam power plants, Canadian General Electric Co., Peterborough, Ont.

ROBERTS, Everett H., Director of Forests, Dept. of Natural Resources, Prov. of Sask., Regina, Sask.

WHITE, Robert John, (St. Francis Xavier Coll.), foreman, Project No. 123, Fredericton, N.B.

*Transferred from the class of Junior to that of Associate Member*

McCRONE, Donald Gordon, B.A.Sc., (Univ. of Toronto), chemist, The E. B. Eddy Co. Ltd., Hull, Que.

SAUVAGE, Robert, B.A.Sc., C.E., (Ecole Polytech.), bridge designing senior engr., Dept. of Public Works, Quebec, Que.

WILLIAMS, Edward Clifford, (Final Pass Cert. in Elec. Engrg., City and Guilds of London Institute), industrial heating specialist, Canadian General Electric Co. Ltd., Toronto, Ont.

*Transferred from the class of Student to that of Associate Member*

DECHMAN, Walter Fairchild, B.Sc., (N.S. Tech. Coll.), 19½ South St., Halifax, N.S.

FULTON, Fraser F., B.Sc., (McGill Univ.), 452 Stanstead Road, Town of Mount Royal, Que.

McCORMICK, Archibald Thomas, B.Sc., (Univ. of Man.), special products engr., Northern Electric Co. Ltd., Winnipeg, Man.

WOOD, Robert, B.Sc., (McGill Univ.), executive assistant, Quebec Power Company, Quebec, Que.

*Transferred from the class of Student to that of Junior*

AITKENS, John Currey, B.Sc., (Univ. of Man.), inspecting engr., Project No. 51, Hudson, Ont.

BUNTING, William Lloyd, B.Sc., (Univ. of Man.), supt. of public utilities, Flin Flon, Man.

FRANKLIN, Robert Lawrence, Lieut., R.C.O.C., B.Sc., (Queen's Univ.), Military College of Science, Woolwich, England.

HARDY, Robert McDonald, B.Sc., (Univ. of Man.), M.Sc., (McGill Univ.), lecturer, dept. of civil engrg., University of Alberta, Edmonton, Alta.

STEWART, John R., B.Sc., (McGill Univ.), service engr., Canadian Liquid Air Co. Ltd., Montreal, Que.

*Students Admitted*

BURKE, John Abel, B.Sc., (Univ. of Alta.), 628-15th St. South, Lethbridge, Alta.

CROWE, Frederick Ernest, B.Sc., (Univ. of N.B.), Jeffry, N.B.

DAVIDSON, George Ross, (R.M.C.), Kingston, Ont.

FAURE, Marcel A., (Ecole Polytech.), 32 Elmwood Ave., Outremont, Que.

KAUTH, Carl Gladstone, (Queen's Univ.), Gowanstown, Ont.

KINGSTON, Edgar Lloyd, (McGill Univ.), P.O. Box 149, Prescott, Ont.

LUPTON, Mac Joseph, B.Sc., (Univ. of Man.), 308 Niagara St., Winnipeg, Man.

MANZER, Ronald Wendell, B.Sc., (Univ. of N.B.), South Devon, N.B.

MITCHELL, William Reg., B.Sc., (Univ. of Man.), 344 Overdale St., Deer Lodge, Winnipeg, Man..

PEPALL, James Edward, (R.M.C.), 124 Heath St. W., Toronto, Ont.

PISTREICH, Archie Loebel, (McGill Univ.), 5638 Waverley Ave., Montreal, Que.

SWARTZ, Joseph Norman, (McGill Univ.), 1401 Ford St., Fort William, Ont.

VERGE, Gerard Arthur, (Leaving Cert., St. Patrick's High School, Quebec), 109 Murray Ave., Quebec, Que.

## Dominion Government Relief Camps and Unemployment

Permission has kindly been granted by The Hon. W. A. Gordon, Minister of Labour, to publish the following letter which he addressed to the President of The Institute, commenting on the assistance which The Institute has been privileged to give in connection with the Department of National Defence Relief Camps.

Ottawa, February 26th, 1934

Dear Sir:—

I have before me a report of the Committee on Unemployment organized by The Engineering Institute of Canada, which has been forwarded to me by General McNaughton, Chief of General Staff, Department of National Defence. In forwarding this report General McNaughton indicates to what a great degree your Institute has been co-operating with his Department in their efforts to handle the problem of the relief camps set up under the National Defence Department.

I have no doubt that the success which has marked the General's efforts and those of his staff in meeting this very difficult situation has, in a very great measure, been made possible by the loyal and effective service which has been rendered by the highly trained and experienced men which your Institute has supplied.

It has, however, been a worth-while undertaking and your Institute will, I am sure, draw much satisfaction, and justly so, from the knowledge that they have played a really important part in our combined effort. I desire to express to yourself and to your Institute my sincere appreciation of the very valuable co-operation which you have given the Government in this matter.

Yours faithfully,
(Sgd.) W. A. Gordon,
Minister of Labour.

The President,
The Engineering Institute of Canada,
Montreal, P.Q.

# RECENT ADDITIONS TO THE LIBRARY

### Proceedings, Transactions, etc.

American Society of Civil Engineers: Transactions 1933, Vol. 98.
University of Toronto: Transactions and Year Book 1934.

### Reports, etc.

*Air Ministry, Aeronautical Research Committee, Great Britain:*
Reports and memoranda:
No. 1569—The N.P.L. Open Jet Wind Tunnel.
No. 1568—Calculation of Critical Reversal Speeds of Wings.
No. 1565—Elastic Instability of a Thin Curved Panel.
No. 1562—Torsiograph Investigations on a Radial Engine with and without a Spring Hub with some Reference to Damping.
No. 1572—An improved Multitude Tilting Manometer.
No. 1564—Further Experiments on a Model Fairey 111F Seaplane.

*American Society of Civil Engineers:*
Year Book 1934.

*American Institute of Consulting Engineers Inc.:*
Year Book 1934.

*University of Toronto, Faculty of Applied Science and Engineering:*
Calendar, 1934-1935.

*Harbour of Montreal:*
Annual Report 1933.

*Quebec Harbour Commissioners:*
Report 1933.

*Vancouver Harbour Commissioners:*
Report 1933.

*American Institute of Mining and Metallurgical Engineers Inc.:*
Directory Section 1934.

*Ontario, Department of Mines:*
Forty-second Annual Report 1933, vol. XLII, Parts 4, 5 and 6.

*Canada, Department of Labour:*
Labour Legislation in Canada, 1933.

*Canada, Mines Branch, Department of Mines:*
The Canadian Mineral Industry in 1933.

*Canada, Geodetic Survey:*
Publication No. 48, Altitudes in Saskatchewan North of Latitude 51° 30′, by R. H. Montgomery.

# BOOK REVIEWS

## Treatise on Geodesy

*By Captain P. Tardi, with preface by General G. Perrier. Gauthier-Villars, Editors, Paris. Paper binding, 7 by 10 inches; 732 pages; illustrated, Vol. 1, 80 francs; Vol. 2, 70 francs.*

This treatise is an extensive review of the various phases of geodesy considered as the science dealing with the accurate measurement of areas of such size that the curvature of the earth must be taken into consideration. In this respect, it is of particular value to the experienced geodesist and engineer, and to others for the purpose of scientific reference.

The subjects have been treated under five main divisions:—

(1) General Principles of Geodesy;
(2) Mathematics of Geodesy and Triangulation;
(3) Geodetic Astronomy of Position;
(4) Dynamical Geodesy;
(5) The Figure of the Earth.

The first division is an historical summary of geodetic operations, for which the material was largely gathered from special monographs. In the second division, invar apparatus for base line measurement has been brought to the front in keeping with its increasing use in modern practice. The calculation of triangles and geographical co-ordinates is treated with special care. In his treatment of the representation of the terrestrial ellipsoid on a plane, the author has been inspired by the most recent researches of Roussilhe and Laborde. The adjustment of first order triangulation is outlined for the usual method of directions, and also for the more recent method of variation of co-ordinates, both geographical and rectangular. A feature of the chapter on secondary triangulation is a graphical method of adjustment.

In Volume II, the determination of time and the difference of longitude is the subject of a thorough analysis, justified by the importance which the question has commanded during the last twenty years, due to the more general use of impersonal micrometer meridian instruments and to radio time signals.

In the chapter on Latitude and Azimuth, there are set forth, apart from the recognized methods of meridian and circum-meridian observations, those of Littrow for observations on circum-polar stars and of Struve for stars in the prime vertical.

With regard to the simultaneous determination of local time and latitude, the chapters on the general method or perpendiculars of altitude and the prism astrolabe, consider a means of determination, unknown some thirty years ago, which is of great service at the present time.

In the section on Dynamic Geodesy and the Figure of the Earth, the most advanced theories in modern higher geodesy are presented in a brief and methodical form. Detailed descriptions of the gravity apparatus of Holweck-Lejay and of Venig Meinesz are given. These instruments are innovations of extreme importance, opening, as they do, new horizons to geodesy. Finally, the consideration of the results obtained through triangulation and gravity measurements, the explanation of the Isostatic Theory, by Pratt's method and also by Airy's, the newer method of areas in determining the elements of the terrestrial ellipsoid, are fully treated, and the volume closes with a chapter on the rigidity of the terrestrial globe, containing the most essential ideas on ocean tides, periodic deviation from the vertical, and variations of latitude and tides on the earth's crust.

The volumes are well printed, amply illustrated, and the whole constitutes a record of the science brought up to date. Although the text is in French, the investigator is relieved of the difficulty of reading either in German or French, through various volumes and authors, the many subjects succinctly dealt with by Captain Tardi in two volumes.

## The Young Man in Business

*By Howard Lee Davis, Director of Tech. Emp. and Training, N.Y. Tel. Co., published by John Wiley & Sons Inc. Price $2.00.*

As stated in the preface, this book is for all men and women now in business as well as for those about to seek their first position. With this in view, an effort has been made to take the viewpoint of the young man, and various phases of possible business activity are covered in the twelve chapters. The intention throughout is to help the reader to determine the line of action best suited to himself.

The author points out the importance of fundamental knowledge and the ability to think gained through study, these being indispensable for success. A man should, in fact, acquire early and then keep up throughout the whole of his career the habit of reading and studying.

Mr. Davis considers that in general the attitude of the young man in search of a job is too casual; he should have a definite plan in view, and as far as circumstances permit, should select his own work along the lines for which his aptitudes are the strongest. He would do well to remember that all vocations offer an opportunity for success.

The possible lines of thought of the interviewer and the applicant are also well discussed and methods of approach suggested.

The chapter on "Why Save from the Start" brings out the results of failure to save and the many advantages to be gained and opportunities that may be accepted if some funds are available to the young business man.

The possible behaviour of a man towards his work and his supervisor are considered, and later the seventh chapter on "The Preparation for Responsibility" states that the most important part of his work is when he is fitting himself for the future he desires and for which he has formulated his plans.

For this purpose the author recommends adequate preparation, driving force, attention to detail in both tangible and intangible work, and patience.

The rather unimpressive title of "Educate the Boss" heads a chapter which contains the procedure suggested when placing a plan before a superior for acceptance. Careful and thoughtful study from all viewpoints before presentation is advocated, and in some cases gradual attempts at approval, particularly where any radical change is proposed.

The section devoted to the writing of letters and reports is excellent, but somewhat brief. The factor which most frequently impedes the young man is the inability to express himself adequately in writing, to collect and arrange his thoughts, to give expression verbally. The suggestions made are very much to the point.

The last two chapters are on supervision and leadership, and the factors that are influential in securing promotion and in helping a man to be successful in supervisory work. The duties of a supervisor are outlined and a number of examples are given to illustrate the main points presented. The chapter closes with an outline of the four main functions of supervision.

The purchase of this book by any young business man is recommended as there will be very few who cannot acquire some useful knowledge from Mr. Davis' remarks.

## C.E.S.A. Specifications

The Canadian Engineering Standards Association announces the publication of three more approval specifications under Part II of the Canadian Electrical Code. These constitute specification No. 5, "Construction and Test of Service Entrance and Branch Circuit-Breakers," No. 11, "Construction and Test of Fractional Horsepower Motors," and No. 12, "Construction and Test of Electric Portable Lighting Devices."

These specifications outline conditions which must be met to secure approval for the sale in Canada of these types of electric equipment, and it is suggested that manufacturers secure copies from the C.E.S.A. at Ottawa, so that they may be properly informed. These specifications can be obtained at 25 cents per copy, on application to the Secretary, Room 3064, Research building, Ottawa.

## Erratum

The review of "Arc Welded Steel Frame Structures" by Gilbert D. Fish, which appeared on page 242 of the May, 1934, issue of The Journal, was prepared by H. M. Lyster, A.M.E.I.C., general manager, Dominion Welding Engineering Company, Limited, and not by C. M. Goodrich, M.E.I.C., as was stated when publishing the review.

# BULLETINS

*Tube Couplings*—The Parker Appliance Company, Cleveland, Ohio, has issued Bulletin No. 35, a 36-page booklet containing particulars of tube couplings of the threadless flaired tube type for industrial and domestic plumbing. The booklet also contains a resume of the company's products with specifications and uses.

*Double Reduction Worm Units*—An 8-page folder received from the Hamilton Gear and Machine Company, Toronto, Ontario, contains details of specifications and materials of construction together with motor and load rates of the type D-W small double reduction worm units. A table of the various ratios which can be obtained and the dimensions of the units which are made in seven sizes are included.

*Motor Compressor*—A 4-page leaflet received from Canadian Ingersoll-Rand Company Limited deals with a two-stage air-cooled compressor unit with built in motor, which it is claimed has a number of advantages over the usual unit. It is manufactured in a number of sizes and ratings.

*Surface Condensers*—The Worthington Pump and Machinery Corporation, Harrison, N.J., have issued a 4-page folder giving details regarding the folded tube layer type surface condensers. These are of welded steel shell design, and are manufactured in a number of different sizes.

*Refrigeration Compressors*—A 6-page folder received from the Worthington Pump and Machinery Corporation, Harrison, N.J., gives particulars regarding the horizontal duplex type single-stage and two-stage refrigeration compressors. These are belt-driven and direct-connected to a synchronous motor, and are fitted with feather valves. They are manufactured in seven sizes.

*Soot Blowers*—The Diamond Power Specialty Corporation, Detroit, Mich., has issued a 4-page folder giving a short comparison of three types of soot blowers.

## Corrected Acknowledgment

In our issue for April, 1934, the photographs Figs. 1 and 2 appearing with Dr. D. F. Kidd's article "Mineralization in the Great Bear Lake District" were acknowledged incorrectly. The credit line "By courtesy of the R.C.A.F." should have appeared under each of these reproductions.

## File of The Journal Available

A member of The Institute is willing to donate to any institution or person desiring it a complete file of The Engineering Journal, with the exception of the year 1922, which could be supplied by Headquarters. These copies are stripped of the advertising pages, but are in good condition. Enquiries regarding this matter should be addressed to Headquarters, 2050 Mansfield Street, Montreal.

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*Foster Wheeler Limited*, Montreal, has secured from the Riley Corporation of Worcester, Mass., the exclusive right to manufacture and sell Riley fuel burning apparatus for use in the Dominion of Canada. The Riley Engineering and Supply Co. Ltd., of Toronto, is discontinuing the manufacture and sale of power plant equipment.

This firm has also taken over exclusive rights for the sale and manufacture of the Ruths Steam Storage Systems in Canada.

## The Effect of Construction on General Prosperity

We are permitted to publish the following figures which illustrate the widespread influence of expenditure on a typical construction job, in giving employment in a great variety of different lines of manufacturing and transportation. It will be seen that the effect of such an undertaking in reviving business is felt by a large number of people who are only indirectly connected with the construction industry itself.

The example taken is the new addition to the rayon plant of Courtaulds (Canada) Limited, recently constructed at Cornwall, Ontario, by the Foundation Company of Canada Limited who were the general contractors.

The officers of that company desired to obtain figures showing the value of construction work in material and in labour, both direct and indirect, and they accordingly requested their subcontractors to supply the following information, stating that the intention of the survey was to show that construction work actually had a more widespread effect than is generally supposed:

(*a*) Number of man hours entering into the manufacture of your materials—Canadian.

(*b*) Number of man hours assembling in your shop.

(*c*) Number of man hours in the installation on the job including handling to and from cars or trucks.

(*d*) Number of ton miles handled: divided into rail, boat and truck.

The contract was commenced in October, 1933, and the plant was scheduled to be manufacturing silk by May 7th, 1934. The additions consisted of the following buildings which were steel frame, with brick walls, concrete footings and floor slabs, and precast Haydite roofs.

Mill—507 feet by 135 feet by two storeys.

Storage and shipping building—100 feet by 150 feet by two storeys.

$CS_2$ building—40 feet by 75 feet.

New office building—60 feet by 80 feet.

Addition to churn and mixer building—75 feet by 35 feet by four storeys.

Addition to soda settling building—20 feet by 75 feet.

Addition to pump house—30 feet by 25 feet.

New fume stack—200 feet high.

Underground traffic tunnels connecting new buildings with former buildings.

| | | |
|---|---|---|
| Total cost of new addition including machinery...... | | $2,500,000 |
| Expended on Canadian machinery.................. | | 750,000 |
| Expended on British machinery of a kind not made in Canada.......................................... | | 750,000 |
| Number of man hours in direct labour on the work: | | |
| By general contractor................ | 950,233 | |
| By subcontractors................... | 124,536 | |
| Total.......................... | 1,074,769 | |

From the replies received it was found that indirect labour would run into very large figures and further that it would be impossible to obtain the information from the different manufacturers without putting a large staff on securing the data. However, enough work was done to discover that *more than two million hours of labour* had been provided indirectly throughout Canada in mines, quarries, refineries, transportation systems, manufacturing plants and harbours from British Columbia to Nova Scotia.

As an illustration of the impetus given to business by this one contract the following quantities will be of interest:

37,500 tons of construction material were incorporated in the work.

Over 2,000 tons of common brick were shipped from Delson, Quebec, to the work.

1,200 tons of structural steel were shipped to Lachine, Quebec, from Europe and the United States, fabricated, shipped to the work and erected.

Over 1,000 tons of Haydite partition blocks were made in Montreal from aggregate shipped from Cooksville, Ontario, then shipped to the work.

745 tons of precast Haydite roof slabs were cast in Cooksville, Ontario and shipped to the work

430 tons of asphalt was shipped from Montreal.

200 tons of lead, mined and refined in British Columbia, was consumed in the work.

142 tons of corkboard were shipped from Spain through the harbour at Saint John, N.B.

6,852,181 ton miles of freight was hauled by rail to the work.

90,990 ton miles of freight was hauled on the highways to the work.

3,138 tons of freight was shipped by boat and handled through the different harbours of Canada.

17,725 hours of work was given to farmers' teams.

It is exceedingly difficult to visualize the hours of indirect labour given through the acquiring, manufacture and transportation of the above quantities but possibly an example will be of assistance.

The Otis Fensom Elevator Company of Hamilton, Ontario, supplied equipment consisting of machinery weighing 7½ tons. This was shipped by truck from Hamilton, the transportation amounting to 3,150 ton miles, approximately 1,580 man hours were required for manufacture and 945 hours for installation at the job. However, the company stated that these figures did not include the labour expended by the vendor in the production of the following materials purchased and used by the manufacturer: Rails, pig iron, coke, wiring, conductor cables, conduits and fittings, wire ropes, sheet and structural steel, steel bar stock, bronze, lumber, lead, copper, tin, bolts, screws, nuts, paint, carbons, springs, forgings, controller slates, mica, asbestos, babbit, solder, oils, greases, nails, cotton, friction and rubber tape.

# BRANCH NEWS

## Halifax Branch

*R. R. Murray, A.M.E.I.C., Secretary-Treasurer.*
*C. Scrymgeour, A.M.E.I.C., Branch News Editor.*

Departing from the customary monthly supper meeting, the Halifax Branch of The Engineering Institute of Canada accepted the invitation of its chairman, R. L. Dunsmore, A.M.E.I.C., superintendent of the Imperial Oil Refinery at Dartmouth, N.S., to visit and inspect the large Imperial Oil refining plant on Friday, April 27th, 1934.

That much interest and importance was attached to the proposed inspection of an oil refining plant was evidenced by the large percentage of local members who made up a group totalling sixty-five, and which were augmented by an additional ten members connected with the refinery, these latter assisting in the tour of inspection by acting as guides.

The Branch members met at the Halifax wharf of the Imperial Oil Limited at 2.30 p.m. and were conveyed across the harbour by the Imperial lighter, the *Novalite*, being met at the refinery docks by the superintendent and members of the engineering staff. Before inspecting the plant, the visitors were given two short talks on refinery engineering and refinery processing by Charles Scrymgeour, A.M.E.I.C., plant engineer, and R. L. Dunsmore, A.M.E.I.C., refinery superintendent—the first of these talks outlining the principal problems affecting the construction and maintenance of the plant units, and the latter, a graphic description of the processing of petroleum oils.

Although only two hours were available for a tour of the plant, a complete cycle of all the refining operations, the mechanical shops and the steam and electric power plants was possible, at the conclusion of which The Institute members were taken to the plant town site of Imperoyal where, much to the appreciation of the visitors, light refreshments were served at the club house.

A vote of thanks and expression of appreciation to Mr. Dunsmore and the Imperial Oil Limited, moved by H. S. Johnston, M.E.I.C., concluded a very interesting and instructive meeting, and the members again boarding the *Novalite*, were conveyed back to the city.

## London Branch

*H. A. McKay, A.M.E.I.C., Secretary-Treasurer.*
*Jno. R. Rostron, A.M.E.I.C., Branch News Editor.*

Somewhat of an innovation was adopted for the regular April meeting, as a speaker was not available. At the kind invitation of E. V. Buchanan, M.E.I.C., the meeting, limited to corporate and affiliate members, was held at his residence. About sixteen members were present and J A. Vance, A.M.E.I.C., Branch councillor, gave a report on the activities of the plenary meetings of Council at Headquarters. A discussion then followed on the constitution of The Institute. It had been felt for sometime that it was desirable to hold a conference on the standing of the professional engineer at the present day both with regard to The Institute and the Provincial Associations. This was taken full advantage of and several suggestions were made which may be brought forward later.

Following the discussion, refreshments, provided by our host, were much enjoyed and the balance of the evening was spent at cards or in social intercourse.

The evening concluded with a hearty vote of thanks to our host, Mr. Buchanan, proposed by the chairman, Frank Ball, A.M.E.I.C., and which was unanimously carried.

## Moncton Branch

*V. C. Blackett, A.M.E.I.C., Secretary-Treasurer.*
*(Reported by T. H. Dickson, A.M.E.I.C.)*

The regular meeting of the Moncton Branch was held in the City Hall on Tuesday, April 17th, 1934, the speaker being H. E. Bigelow, Ph.D., F.R.S.C., Professor of Chemistry, Mount Allison University. The subject of the address was "Chemistry in Industry," which contained a vast amount of useful information concerning the manufacture of many chemical products which are much better known than is their process of manufacture.

### Chemistry in Industry

In his opening remarks, Dr. Bigelow commented on the scarcity of Canadian books on chemical subjects and cited this as the principal reason for the unfamiliarity of Canadians with what has been done in industrial chemistry in Canada.

In illustrating the importance of the chemical industry, Dr. Bigelow stated that the mineral production of Canada for 1929 amounted to $310,000,000. The capital invested in plant $867,000,000 and the products of the industry were valued at $140,000,000 and since 1929 there have been numerous expansions but later figures are not yet available.

As Canadian Industries Limited manufacture a very wide range of chemical products, most of the address concerned the various interests of this company which originated with the Hamilton Powder Works about 1870 and was founded by Mr. Brainerd. Canadian Industries is associated with British Industries Limited, and also with the E. I. DuPont de Nemours and Co. Inc., for the interchange of patented processes.

They have plants in various parts of Canada generally located at points where the required raw materials can be obtained in abundance.

Some plants deal with wood, not as timber, but in the pulp or cellulose state.

Air is a raw material from which is extracted nitrogen and oxygen both of which have many uses.

Sulphur dioxide is obtained as a waste product from various smelters and converted into valuable fertilizers.

Salt is another common raw material which can be used as one of the materials to produce numerous chemical products. The speaker mentioned in passing, the very extensive salt beds near Moncton which will no doubt be the location of a chemical industry sometime in the future. Sandwich, Ontario, also has large supplies.

From water the cheapest and most common raw material is obtained, hydrogen and oxygen. Gun-cotton, an explosive, is obtained by treating cellulose with nitric acid, and about one-half of the nitric acid used is made from nitrogen obtained from the air.

Nitroglycerine is made by treating glycerine with nitric acid, the glycerine being obtained from fats. Cordite is manufactured by dissolving nitroglycerine in nitro-cellulose and dynamite is nitroglycerine diluted with an earth or powder to make it stable.

Gun-cotton mixed with camphor and pressed to a particular shape and heated to a set temperature forms cellulose which is marketed under various trade names, that used by Canadian Industries being Pyralin.

At Sandwich, Ontario, water is pumped into a salt bed 1,600 feet under ground, this dissolves the salt which is then pumped to the surface and evaporated. This salt solution can also be electrolized to produce hydrogen gas, chlorine gas and lye.

Cellulose treated with sodium hydroxide makes a parchment paper, but if carbon disulphide is added, a thick viscous liquid results. If this is passed through orifices and run into a solution viscose silk results.

Courtaulds at Cornwall manufacture another type of artificial silk from cellulose and acetic acid which is called celanese, the highest grade of artificial silk.

Dr. Bigelow's address showed how closely the various industries and products are allied and the many uses to which the products can be put.

In closing, he stated that most of the fundamental substances used in chemistry are found in Canada and that the development of chemical industries in Canada is just beginning and rapid development should take place in the future.

Professor H. W. McKiel, M.E.I.C., made a few remarks in connection with the address, stressing the importance of the chemist in the present scheme of industry.

H. B. Titus, A.M.E.I.C., a former student of Dr. Bigelow's, moved a hearty vote of thanks, which was seconded by G. E. Smith, A.M.E.I.C.

## Niagara Peninsula Branch

*P. A. Dewey, A.M.E.I.C., Secretary-Treasurer.*

A dinner meeting was held on April 11th, 1934, at the Lincoln hotel, St. Catharines. Forty members were in attendance, including H. B. Stuart, A.M.E.I.C., chairman of the Hamilton Branch, and A. Love, A.M.E.I.C., the Secretary-Treasurer.

Chairman W. R. Manock, A.M.E.I.C., introduced the speaker, Mr. F. A. Nagler, chief engineer of the Canadian Allis-Chalmers, Limited, and took occasion to felicitate the Branch upon the honour lately bestowed by The Institute to several of the members, namely: A. J. Grant, M.E.I.C., as recipient of the Sir John Kennedy Medal, E. G. Cameron, A.M.E.I.C., as the new Vice-President for Ontario, W. Jackson, M.E.I.C., as Branch Councillor and Mr. C. G. Cline, A.M.E.I.C., for having received honourable mention in the Past-Presidents' prize competition.

Mr. Nagler is a believer in full size tests wherever possible, and he spoke with the authority of an engineer who had made many of the standard tests on materials only to see some of them fail when subjected to actual working conditions with no acceptable theory to account for such failure.

Tension, elongation and hardness tests are valuable up to a certain point, but they do not always tell the whole story, said Mr. Nagler, and in machines which are subjected to shock, high speeds and reversals the story is particularly inadequate.

Wood, bakelite, aluminum are typical of materials which are forcing their way into the steel field by reason of their strength per pound of weight in cross sectional area.

Cavitation of ship propellers and pitting of water wheel runners are common defects about which there is not complete agreement among research engineers. In answer to questions, Mr. Nagler went into this point more fully and explained that Allis-Chalmers had built a large scale testing plant for the observation of pitting under heads as great as 100 feet. Observations had indicated that pitting was purely a mechanical function and was due to the sudden collapse of nucleii in the small vortexes which are formed at certain speeds and are set up primarily by surface irregularities. For that reason a polished surface is more desirable at all points where a vortex may form than a hard skin which may be rough. Even polished glass will pit, however, and the action may be observed 2 or 3 inches back of the normal surface. Mr. Nagler stated that these actions and effects had been photographed and reproduced under slow motion so that there was very little doubt about the cause.

Some examples of the forward march in welding as applied to pipes, boilers, cylinders and spheres were followed by a moving picture reel showing some of the beautiful scenery in northern British Columbia where Mr. Nagler had hunted big game with a bow and arrow. The picture illustrated a material that was nearly perfect for the duties which it had to perform; namely the Oregon Yew, which went into making the bows. This wood will test to 30,000 pounds per square inch in tension and is five times as strong as steel, per pound of section. The arrows can be driven some 300 yards and will go through the larger game animals such as bear and moose.

### Electoral Meeting

The electoral meeting for the year was held at Erie Downs Golf Club on May 9th, 1934, with sixteen members and their friends as the guests of chairman W. A. Manock, A.M.E.I.C.

This meeting, which seems to have developed into an annual institution, is looked forward to by all the members of the executive as an opportunity for meeting the new officials and extending the courtesies to those who have served so faithfully in the past. At it the ballots are checked, counted and reported by the scrutineers and the personnel of the new executive is made known for the first time. They then hold a short session to appoint their chairman, vice-chairman and secretary-treasurer for the coming year.

The old executive, which carries on until the end of May, then discusses the final arrangements for the annual meeting, and an adjournment is made about 2.30 p.m. for a game of golf.

## Ottawa Branch

*F. C. C. Lynch, A.M.E.I.C., Secretary-Treasurer.*

At a noon luncheon of the Ottawa Branch at the Chateau Laurier on March 22nd, 1934, W. P. Dobson, M.E.I.C., of Toronto gave an address upon "The Hydro Electric Power Commission Laboratories." Mr. Dobson is in charge of the Testing and Research Department and the Electrical Inspection Department of the Ontario Hydro Electric Power Commission.

Alan K. Hay, A.M.E.I.C., chairman of the local Branch, presided and in addition head table guests included: Group Captain E. W. Stedman, M.E.I.C., J. T. Johnston, M.E.I.C., Commander C. P. Edwards, A.M.E.I.C., A. B. Lambe, A.M.E.I.C., Dr. Frank Allan, Dr. R. W. Boyle, M.E.I.C., B. Stuart McKenzie, M.E.I.C., J. H. Ralph, John Murphy, M.E.I.C., and H. E. M. Kensit, M.E.I.C.

### Ontario Hydro Electric Laboratories

The first work of the laboratories, stated Mr. Dobson, was the testing of meters. Shortly thereafter lamps were tested, the laboratories acting as a sort of central purchasing bureau responsible for a very large amount of testing of lamps for different municipalities.

The laboratories then extended their operations so that now the testing work covers practically every field, its purposes briefly being two-fold: first, to obtain good quality products used in the Commission's equipment, and second, to maintain this good quality.

Mr. Dobson then, by way of example, traced the course of various items of equipment throughout their period of test, the first item considered being the prime mover of a power unit. Other items touched upon were, in turn, electric generators, concrete structures, rubber gloves, safety belts, transformer oil, wood poles, paints, insulating oil, lamps, transmission lines, cable conductors, and so on.

With regard to large generators, the actual tests are usually made in the field after the generators are completed. This is a work of some magnitude often requiring many weeks.

The immense amount of concrete entering into the field structures of the Commission has resulted in new scientific methods for studying the properties of concrete, ways of mixing, and so on.

After construction, the concrete structures are carefully examined every two years by laboratory experts. Sometimes, as a result of these examinations, extensive repairs are made. At the same time, valuable knowledge is accumulated regarding the behaviour of concrete structures under varying conditions.

Considering the question of research, the speaker stated that problems of a more or less scientific nature are constantly arising in the design, construction and operation of the system. A research committee has recently been formed, with suitable subcommittees, to look after problems relating thereto, to discover research talent, to receive suggestions from the staff and to undertake the development of equipment in a more systematic way than in the past. Some problems had been suggested to the National Research Council at Ottawa to whom the speaker paid a high tribute for their work "in producing results in pure and applied science of immense value to utilities."

The investment in the laboratories is less than one-tenth of one per cent of the investment of the Commission. The operating expense is much less, so that as a result the burden on the cost of power is really negligible.

In speaking about the "approval laboratory," one of the laboratories of the Commission, Mr. Dobson stated that it was begun nearly twenty years ago as a result of Ontario legislation aimed at maintaining the safety of electrical equipment. There has since been a gradual evolutionary development so that there is now a Canadian Electrical Code which was issued in 1927 by the Canadian Engineering Standards Association, and is effective in all the provinces of the Dominion. Inspection and approval is carried out under this Code, and the products of some 1,500 manufacturers are on the approved list.

### Canada at the World's Fair

How the Canadian exhibit at the recent Century of Progress exhibition at Chicago drew two and a half million visitors, the interest displayed in the exhibit by the American tourist and business man, and the efficient manner of supplying information to all who asked for it, were a few of the points brought out in an outstanding noon-luncheon address at the Chateau Laurier on April 20th, 1934, before the Ottawa Branch of The Engineering Institute of Canada. C. W. Wright, Honorary President of the Northern Ontario Boards of Trade, who had been appointed to the Dominion government staff for the course of the exhibition, was the speaker.

The Canadian exhibit, jointly sponsored by the Dominion government, the Canadian National Railways, and the Canadian Pacific Railway, portrayed a cross-section of the natural resources of Canada and included the largest map of the Dominion ever prepared. This map measured 130 feet in length by 30 feet in width, was electrically illuminated and was designed and assembled under the direction of F. P. Cosgrove, of the Department of Trade and Commerce, who also had charge of the exhibit.

Canada's participation in the Century of Progress exhibition, in addition to the interest aroused and the information given out at the exhibition itself, also resulted in some seventy-one hundred detailed requests for information which were referred to Ottawa and answered by the various government departments concerned. One noteworthy feature was the fact that twenty-five hundred school teachers asked for literature to aid in the teaching of geography.

Alan K. Hay, A.M.E.I.C., chairman of the local Branch of The Engineering Institute of Canada, presided, and other head table guests included: Dr. Charles Camsell, M.E.I.C., Watson Stellar, Capt. T. Magladery, C. A. Bowman, A.M.E.I.C., Group Captain E. W. Steadman, M.E.I.C., J. G. Parmalee, L. L. Bolton, M.E.I.C., J. B. Harkin, John Murphy, M.E.I.C., Noulan Cauchon, A.M.E.I.C., F. C. C. Lynch, A.M.E.I.C., and C. McL. Pitts, A.M.E.I.C.

## Quebec Branch

*Jules Joyal, A.M.E.I.C., Secretary-Treasurer.*

### Visite du Président

A un lunch qui eut lieu au Château Frontenac le 6 avril 1934, la Section de Québec avait comme invité d'honneur Monsieur F. P. Shearwood, M.E.I.C., Ingénieur en Chef de la Dominion Bridge Company of Montreal et Président de l'Institut des Ingénieurs du Canada pour l'année 1934.

Le lunch était sous la présidence de Monsieur Hector Cimon, M.E.I.C., qui, en termes très élogieux, présenta Monsieur Shearwood à l'assistance.

Le Président de l'Institut se leva au milieu des applaudissements et fit une brève causerie traitant plus particulièrement des différents problèmes auxquels l'Institut doit faire face. Monsieur Shearwood a d'abord déclaré que l'Institut avait fait beaucoup pour le développement de la science au Canada et que le public lui en doit une reconnaissance de tous les instants; cette organisation étend ses ramifications dans toutes les parties du pays et elle se doit de continuer l'œuvre qu'elle a commencée.

Monsieur Shearwood passa en revue diverses questions importantes concernant l'Institut et insista sur la nécessité pour chacun de ses membres d'exprimer leur opinion sur les amendements proposés et ce en exerçant leur droit de vote.

Monsieur A. R. Decary, M.E.I.C., Président-Honoraire à vie de la Section de Québec et ancien Président de l'Institut remercia Monsieur Shearwood puis Monsieur E. A. Evans, M.E.I.C., l'un des fondateurs de notre association et le doyen de la Section de Québec dit aussi quelques mots.

### Difficulties Met With in the Operation of a Hydro-Electric Power System

Summary of a paper delivered by E. Gray-Donald, A.M.E.I.C., superintendent, Power Division, Quebec Power Company, at a meeting of the Quebec Branch held at Palais Montcalm on February 12th, 1934.

It seems to be a very common idea that once a hydro-electric plant, with its transmission lines, substations and distribution lines, is built all that is left to do is to sit back and enjoy life.

A power system, such as that of the Quebec Power Company, is generally roughly divided into three broad divisions: generation, transmission and distribution.

The whole spirit of a hydro-electric generating plant is the river; things happen to rivers: they are flooded at certain times and at others nearly dried up. The ratio of maximum to minimum flow, which is about 2 to 1 for the St. Lawrence river, is about 125 to 1 for the rivers on the north shore near Quebec.

The minimum flow of a river can be increased by regulating works, such as dams.

Frazil ice, blockage of racks by logs, stumps and trash brought down by the river offer difficulties often met with.

Inside the power house an eternal vigilance is required. Temperature of thrust bearings must be watched carefully and all sorts of electrical troubles may occur.

The chief trouble with transmission lines is lightning. On long spans vibration often damages conductors at the support. Insulators are damaged by stones or more frequently rifle bullets. Other causes of trouble are ice, birds, cats, squirrels and sometimes human beings.

Underground transmission and submarine cables are another cause for worry.

Only mechanical damage has been spoken of, but there is also the ever-present danger of electrical breakdown.

Substations may be large or consist only of one bank of transformers. In a fair-size substation there are transformers, switches, bus bars, cables, voltage regulators, motor generator sets, constant current transformers and rectifiers, and a host of other things, then there is all the control and protective equipment.

The ordinary transformer is a fairly simple piece of apparatus to operate, yet it is surprising what can go wrong.

Outdoor switchgear must be carefully maintained so that they will at all times operate freely, these require a great deal of attention and all their mechanism must be watched constantly. Rotating equipment is the cause of endless worry.

The nerves of a substation lie in the control or protective equipment. Nowadays nearly everything is done from the control room.

To the uninitiated a distribution system is merely an unsightly jumble of poles and wires spread over the beautiful streets of our fair cities.

The proper design of a distribution system for a city like Quebec required a lot of technical knowledge and a great deal of thought. Loads increase and decrease; part of the population moves to new residential districts, their old quarter is built up with shops and the old shopping district becomes devoted to manufacturing. This shift of population is continuous and the distribution system is constantly changing to meet new conditions.

Trees are a cause of trouble for the distribution system and another is complaints of low voltage.

## Saint John Branch

*S. Hogg, A.M.E.I.C., Secretary-Treasurer.*
*C. M. Hare, S.E.I.C., Branch News Editor.*

### Operation of a Lobnitz Rock Breaker

C. S. MacLean, A.M.E.I.C., of this Branch, was the speaker at the monthly meeting held in the Admiral Beatty hotel on March 27th, 1934.

The subject chosen for the address was "The Operation of a Lobnitz Rock Breaker."

The speaker opened his remarks by describing in detail and showing slides of the apparatus operating from the scow "Glenbuckie" which has been at work in the main channel of the Saint John Harbour during the past two years.

The apparatus was developed by Lobnitz and Company Ltd., of Renfrew, Scotland. It consists essentially of a heavy chisel that is lifted and dropped on the rock, chopping pieces off the face of the cut, as you might cut pieces from the end of a board with a carpenter's chisel. The chisel of the "Glenbuckie" is a steel cylinder twenty-seven feet long by twenty-two and a half inches diameter and weighing fifteen long tons. It has an alloy steel point with a shank fitting into a hole in the end of the body. The point is renewed when worn. The chisel works in a tube of heavy plate lined with a wooden bushing that serves to guide and restrain it, and through which a descending chisel expels the water with some force to wash away the broken rock at the spot being worked. The apparatus is mounted on a steel hull one hundred and sixty feet long by forty-five feet beam.

The speaker went on to describe the deck machinery, especially a rather unusual clutch on the main winch which operates the chisel. Steam is furnished by a Scotch marine boiler to the main winch, the manoeuvring winch, a winch to handle the tube, and auxiliary apparatus. In operation three blows per minute may be struck, the chisel being hoisted and dropped fourteen feet each time.

The types of rock encountered were next described. At one place rock was so hard that the chisel point had to be replaced every three days.

It is necessary to know the height of the tides at all times when working. The speaker described the complex analysis required, and presented some original thoughts on the causes of currents and undertow in the harbour.

At the conclusion of the address a vote of thanks was moved and seconded and tendered to the speaker by the chairman.

## Toronto Branch

*W. S. Wilson, A.M.E.I.C., Secretary-Treasurer.*
*O. Holden, A.M.E.I.C., Branch News Editor.*

The regular meeting of the Toronto Branch was held on Friday, April 13th, 1934, in the Debates room, Hart House, with Lieut.-Col. R. E. Smythe, A.M.E.I.C., occupying the chair.

Several distinguished visitors were present, including Mr. W. A. Curtis, president of the Toronto Flying Club; Mr. L. C. L. Murray, manager of de Havilland Aircraft; Mr. W. Alan Scott of Canadian Airways and Mr. P. W. Reynolds, M.E.I.C., of the Shell Oil Company.

The speaker of the evening was Mr. William B. Burchall, advertising publicity manager, Canadian Airways, Limited, whose subject was "The Contribution of the Aeroplane to Canadian Industrial Development."

Mr. Burchall said that the use of the aeroplane for non-competitive activities, such as aerial photography and surveying, commenced immediately after the war. Its use in general transportation commenced about ten years ago, the first regular service in Canada being instituted at Haileybury in 1924.

In Canada air transportation has not yet proved a serious competitor to the railroads, but has been a beneficial auxiliary. As 75 per cent of the country is not served by road or rail, the aeroplane is proving an admirable instrument in opening up rich but inaccessible districts.

The aeroplanes most commonly used in commercial pursuits are of the general service type adaptable to a wide variety of loads. For instance, the Canadian Airways have a freighter which has such excellent aeronautical characteristics that it can carry a pay load of three tons a distance of 100 miles at a fuel cost of $10.00, or 3⅓ cents per ton mile.

As used in forestry the aeroplane has been found invaluable in timber cruising. About 250,000 square miles of timber land have already been sketched from the air, and about 40,000 photographed. Aerial photographs show very clearly the type and density of growth and the cut areas.

In combating insect pests, "dusting" from the air allows great areas to be treated in a short time, and is very cheap and effective.

The trapper is taking to the air and the aeroplane is now used by the Pacific Coast fishery patrols to replace the fast motor boat which was at a disadvantage in law enforcement due to the indented and tortuous nature of the coast line.

Aerial photographs have proved useful in city and harbour planning, and make useful progress records and attractive illustrations for advertisements. Accurate contour maps may be plotted from them, and they often remove the necessity for expensive surveys.

It is in the mining industry that the aeroplane has found its greatest field of endeavour and the freight and passenger traffic in connection with this industry has risen to large proportions.

In answer to a query, the speaker gave some statistics regarding risk attending travel by air, notable figures being that the Canadian Airways passenger fatality rate to the end of 1932 was one per 1,231,887 miles, and that the last 8,500,000 miles of daylight service had been flown without a single fatality.

The lecture was illustrated by many slides, which served to drive home the point that aerial photographs are useful and interesting.

A vote of thanks was moved by W. G. Chace, M.E.I.C., and seconded by Mr. Reynolds.

The meeting was brought to a close by Mr. Curtis, with an appeal to members of The Institute to aid in the effort to procure for the city of Toronto an adequate municipal airport. He pointed out that, as Toronto is at present the financial centre of the Ontario mining industry, which makes great use of aerial transport, the lack of aerial facilities is likely to prove costly. The city needs a port for transfer from planes equipped with wheels to those equipped with skis or floats, such as are used exclusively for northern travel.

## Vancouver Branch

*A. I. E. Gordon, Jr.E.I.C., Secretary-Treasurer.*

### The Preservation of Timber

An open meeting of the Vancouver Branch, held on Monday, March 12th, 1934, at 8.15 p.m., in the auditorium of the Medical-Dental building, was addressed by H. N. MacPherson, A.M.E.I.C., on "The Preservation of Timber." The address was illustrated with motion pictures showing every phase of the wood preserving industry. The speaker dealt principally with the creosoting of fir on the Pacific coast and stressed the importance of framing timber structures before treatment in order that the protective coating may remain intact during and after construction. The chairman, P. H. Buchan, A.M.E.I.C., introduced Mr. MacPherson, and following a long and interesting discussion, E. C. Thrupp, A.M.E.I.C., moved a vote of thanks.

Before adjournment, P. L. Pratley, M.E.I.C., on a visit from the east, spoke briefly on the Annual General Meeting.

### The Scientific Side of Flight

The April meeting of the Branch was held on the evening of Thursday, the 12th, in the Medical-Dental auditorium. The speaker was Mr. R. Rolleston West of the Department of Mechanical Engineering of the University of British Columbia, who chose as his subject "The Scientific Side of Flight," and dealt in some detail with the special problems presented in aeroplane design and model and full scale tests of new types.

### Canadian Automobile Industry

In co-operation with the Victoria Branch, the Vancouver Branch of The Institute was fortunate in securing a very interesting motion picture entitled "From the Ground Up" from the Motion Picture Bureau of the Dominion government. This dealt with the Canadian automobile industry and was shown at a meeting held in the auditorium of the Medical-Dental building on the evening of Thursday, May 10th, 1934. The film showed many interesting close-ups of the modern machinery used in Canadian plants, as well as many processes in subsidiary industries. Emphasis was laid on the fact that automobiles are one of Canada's leading exports and nearly two hundred thousand Canadians are dependent directly or indirectly on the industry for employment.

A request that the film be held over for exhibition in Vancouver schools was received by the Branch.

## Victoria Branch

*I. C. Barltrop, A.M.E.I.C., Secretary-Treasurer.*
*Kenneth Reid, Jr.E.I.C., Branch News Editor.*

On Wednesday evening, April 25th, 1934, the Victoria Branch entertained about eighty of its members and friends in the K. of C. hall, when motion pictures were shown depicting the manufacture of automobiles in Canada. The films were obtained through the courtesy of the Dominion Government, Department of Trade and Commerce. In the absence of the Branch chairman, J. N. Anderson, A.M.E.I.C., presided. Invitations were sent to members of the local automotive trade and to the students of Victoria College, which is affiliated with the University of British Columbia.

Aerial views of the automobile manufacturing plants in Canada were shown. These plants occupy over 300,000 acres of ground, in value $98,000,000 in plant investment, employ 16,000 direct employees in normal times, and average an output of over 385,000 cars per year. They absorb raw products taken from over six hundred sources of supply.

The various steps in the manufacture of automobile steel, through furnaces, rolling mills, foundries, etc., were shown, and also the manufacture of machined parts such as blocks, gears, pistons, shafts, etc.

The film then continued to show the manufacture and assembly of many separate articles all of which are combined to make up the finished car. From these smaller units the picture transferred to the manufacture of rubber and rubber products.

After the completion of the chassis assembly, the picture again transferred to the building of the automobile body, both wooden and all-steel. This was followed by the painting of the assembled body. The upholstery for the body and its manufacture in the textile mills of Canada were next shown.

This was followed by the manufacture of storage batteries and finally the assembly of the body to the finished chassis.

Canada is the second largest exporter of automobiles in the world. The packing and shipping departments of the automobile factories were also visited, showing the crating and shipping facilities.

A film of this nature clearly shows the vast number of industries that become related in the manufacture of a single car.

## Winnipeg Branch

*E. W. M. James, A.M.E.I.C., Secretary-Treasurer.*
*E. V. Caton, M.E.I.C., Branch News Editor.*

A meeting of the Winnipeg Branch of The Engineering Institute of Canada was held in the University building, Broadway, Thursday evening, April 5th, 1934, Major A. J. Taunton, A.M.E.I.C., in the chair. After the general business was completed, the meeting was handed over to the junior engineers, their chairman, Mr. Stevens, presiding.

Three papers were presented by the junior engineers, as follows:

"The Beauharnois Project"—Mr. E. A. Grasby.
"Aerial Navigation" —Mr. Walter M. Murray, S.E.I.C.
"Public Works Projects" —Mr. Wallace Walkey.

### The Beauharnois Project

Mr. Grasby dealt with the general engineering features of the Beauharnois project, paying particular attention to certain engineering problems and describing methods which had been used to overcome the difficulties. He gave a very interesting summary of the main constructional features, and his detailed explanation of certain of the methods of construction was of great interest.

### Aerial Navigation

Mr. Murray gave a paper on "Aerial Navigation" and dealt very completely with the methods and instruments used. The interest of the meeting in this paper was indicated by the suggestion that sometime during the coming year he be asked to give a paper to The Engineering Institute on this subject.

### Public Works Projects

Mr. Walkey then presented a paper on "Public Works Projects." He pointed out that among the junior engineers were a large number of men who at present were unemployed and these men had taken on themselves the job of listing all proposed public works which had been suggested by various bodies to relieve the present unemployment situation. He stressed the fact that practically no work had been done towards a proper consideration of the economics and engineering features of any of these schemes; that there was an entire absence of plans and designs, and even if the money were found tomorrow it would be several months before it was possible for any construction work to be gone ahead with owing to the absence of such plans and designs. This being so, the junior engineers had decided to look carefully into all the various plans suggested, both from the engineering and economic view points, to make approximate preliminary designs and estimate of the cost, and now asked the assistance and co-operation of the members of The Engineering Institute and Professional Association in the work. It was stated that office accommodation had already been provided for this work by the senior organizations.

An active discussion followed, during which many members of the senior organizations promised their full support, and congratulated the junior engineers on their public spirited action in this matter.

At the close of the meeting, T. C. Main, A.M.E.I.C., moved a resolution, which was unanimously adopted:

"That a suitable petition be forwarded to both the Dominion and provincial governments, urging them to give serious consideration to the time and effort required for technical investigation to the end that as little delay as possible will result in commencing construction in any public works programme after its authorization."

# EMPLOYMENT SERVICE BUREAU

**The Service is operated for the benefit of members of The Engineering Institute of Canada, and for industrial and other organizations employing technically trained men—without charge to either party.**

*All correspondence should be addressed to*

**The Employment Service Bureau, The Engineering Institute of Canada**
**2050 Mansfield Street, Montreal**

## Situation Vacant

PATENT ATTORNEY'S OFFICE. Opening for a young and ambitious man with technical training, where immediate salary is not important. Excellent future prospects. Apply to Box 1031-V.

## Situations Wanted

MECHANICAL ENGINEER, Canadian, with technical training and executive experience in both Canadian and American industries, particularly plant layout, equipment, planning and production control methods, is open for employment with company desirous of improving manufacturing methods, lowering costs and preparing for business expansion. Apply to Box No. 35-W.

MECHANICAL ENGINEER, A.M.E.I.C. Married. Experience in machine shops, erection and maintenance of industrial plant mechanical and structural design. Reads German, French, Dutch and Spanish. Seeks any suitable position. Apply to Box No. 84-W.

INDUSTRIAL ENGINEER, B.Sc., McGill Univ. Age 29. Married. Mechanical and electrical engineering experience with four large Canadian companies; including supervision of manufacture of various products, reduction of manufacturing costs, factory planning and investigation of piece work systems. Available on short notice. Apply to Box No. 132-W.

PURCHASING ENGINEER, graduate mechanical engineer, Canadian, married, 34 years of age, with 13 years' experience in the industrial field, including design, construction and operation, 8 years of which had to do with the development of specifications and ordering of equipment and materials for plant extensions and maintenance; one year engaged on sale of surplus construction equipment. Full details upon request. Apply to Box No. 161-W.

CIVIL ENGINEER, age 44, open for employment anywhere, experience covers about 20 years' active work, including 7 years on municipal engineering, 2 years as Town Manager, 3 years on railway construction, 3 years on the staff of a provincial highway department, 2 years as contractor's superintendent on pavement construction. Apply to Box No. 216 W.

REINFORCED CONCRETE ENGINEER, B.Sc., P.E.Q., eight years experience in construction design of industrial buildings, office buildings, apartment houses, etc. Age 30. Married. Apply to Box No. 257 W.

ELECTRICAL ENGINEER, B.Sc., '28, Canadian. Age 25. Experience includes two summers with power company; thirteen months test course with C.G.E. Co; telephone engineering, and the past thirty months with a large power company in operation and maintenance engineering. Location immaterial and available immediately. Apply to Box No. 266-W.

MECHANICAL ENGINEER, age 28, nine years all round experience, Grad. Inst. of Mech. Engs. England, S.E.I.C. Technical and practical training with first class English firm of general engineers; shop, foundry and drawing office experience in steam and Diesel engines, asphalt, concrete machinery, boilers, power plants, road rollers, etc. Experience in heating and ventilation design and equipment; 18 months designing draughtsman with Montreal consulting engineers. 2½ years sales experience, steam and hot water heating systems, power plant equipment, machinery, oil-burning apparatus. Canadian 4th class Marine Engineers Certificate; C.N.S. experience. Available at short notice. Apply to Box No. 270-W.

DESIGNING DRAUGHTSMAN, experience in layout of steam power house equipment and piping. Wide experience in mechanical drive and details of machinery, gearing, and hoists. Accustomed to layout of small mill buildings of steel and timber, structural design and details. Good references. Present location Montreal. Apply to Box No. 329-W.

PLANE-TABLE TOPOGRAPHER, B.Sc., in C.E. Thoroughly experienced in modern field mapping methods including ground control for aerial surveys. Fast and efficient in surveys for construction, hydro-electric and geological investigations. Apply to Box No. 431-W.

ELECTRICAL ENGINEER, B.Sc., A.M.E.I.C., Am.A.I.E.E., age 30, single. Eight years experience H.E. and steam power plants, substations, etc., shop layouts, steel and concrete design. Location immaterial. Available immediately. Apply to Box No. 435-W.

CIVIL ENGINEER, B.A.Sc., and C.E., A.M.E.I.C., age 30, married. Experience over the last ten years covers construction on hydro-electric and railway work as instrumentman and resident engineer. Also office work on teaching and design, investigations and hydraulic works, reinforced concrete, bridge foundations and caissons. Location immaterial. Available at once. Apply to Box No. 447-W.

SALES ENGINEER, M.A.Sc. Univ. of Toronto, wishes to represent firm selling building products or other engineering commodities, as their representative in Western Canada. Located in Winnipeg. Apply to Box No. 467-W.

## Situations Wanted

CIVIL ENGINEER, B.Sc., A.M.E.I.C., with six years experience in paper mill and hydro-electric work, desires position in western Canada. Capable of handling reinforced concrete and steel design, paper mill equipment and piping layout, estimates, field surveys, or acting as resident engineer on construction. Now on west coast and available at once. Apply to Box No. 482-W.

MECHANICAL ENGINEER, B.Sc. Age 28, married. Four and a half years on industrial plant maintenance and construction, including shop production work and pulp and paper mill control. Also two and a half years on structural steel and reinforced concrete design. Available at once. Apply to Box No. 521-W.

CIVIL ENGINEER, Canadian, married, twenty-five years' technical and executive experience, specialized knowledge of industrial housing problems and the administration of industrial towns, also town planning and municipal engineering, desires new connection. Available on reasonable notice. Personal interview sought. Apply to Box No. 544-W.

ELECTRICAL AND MECHANICAL ENGINEER, B.Sc., A.M.E.I.C. Experience includes C.G.E. Students' Test Course and six years in engineering dept. of same company on design of electrical equipment. Four summers as instrumentman on surveying and highway construction. Several years experience in accounting previous to attending university. Desires position with industrial concern where the combination of technical and business experience will be of value. Apply to Box No. 564-W.

### Employment Situation Slightly Improved

During recent months a definite upswing has occurred in the employment of engineers in the following lines: chemical, metallurgical, mining and mechanical, with a very slight improvement in civil in some parts of the country.

Since the first of the year it has been possible to remove eighty-one names from our roll of unemployed as having obtained either temporary or permanent positions.

This is decidedly encouraging but it is still far from satisfactory and is likely to remain so until some more definite improvement in employment is registered for engineers in the civil and electrical fields and for recent graduates.

CIVIL ENGINEER, age 25, single, graduate. Creditable record on responsible hydro and railroad work in both Eastern and Western Canada. Apply to Box No. 567-W.

MECHANICAL ENGINEER, A.M.E.I.C., with twenty years experience on mechanical and structural design, desires connection. Available at once. Apply to Box No. 571-W.

MECHANICAL ENGINEER, B.A.Sc., '30, desires position to gain experience, and which offers opportunity for advancement. Experience in pulp and paper mill and one year in mechanical department of large electrical company. Location immaterial. Available immediately. Apply to Box No. 577-W.

DOMINION LAND SURVEYOR, and graduate engineer with extensive experience on legal, topographic and plane-table surveys and field and office use of aerophotographs, desires employment either in Canada or abroad. Available at once. Apply to Box No. 589-W.

MECHANICAL ENGINEER, Canadian, technically trained; eighteen years experience as foreman, superintendent and engineer in manufacturing, repair work of all kinds, maintenance and special machinery building. Location immaterial. Available at once. Apply to Box No. 601-W.

CHEMICAL ENGINEER, S.E.I.C., B.Sc., University of Alberta, '30. Age 31. Single. Six seasons' practical laboratory experience, three as chief chemist and three as assistant chemist in cement plant; one year's p.g. work in physical chemistry; three years' experience teaching. Desires position in any industry with chemical control. Available immediately. Apply to Box No. 609-W.

DESIGNING ENGINEER AND ESTIMATOR, grad. Univ. of Toronto in C.E., A.M.E.I.C., twenty years experience in structural steel, construction and municipal work. Available at once. Apply to Box No. 613-W.

## Situations Wanted

CIVIL ENGINEER, A.M.E.I.C., R.P.E., Ontario; three years construction engineer on industrial plants; fourteen years in charge of construction of hydraulic power developments, tower lines, sub-stations, etc.; four years as executive in charge of construction and development of harbours, including railways, docks, warehouses, hydraulic dredging, land reclamation, etc. Apply to Box No. 647-W.

ELECTRICAL ENGINEER, B.Sc. in E.E. (Univ. of Man., '30). Age 25. Two year Can. Westinghouse Apprentice Course. Depts.—Switchboard assembly, general draughting office, switchboard engineering, test office. One year's experience since then designing and rewinding small motors and transformers. Location immaterial. Apply to Box No. 651-W.

MECHANICAL ENGINEER, A.M.E.I.C., Canadian, technically trained; six years drawing office. Office experience, including general design and plant layout. Also two years general shop work, including machine, pattern and foundry experience, desires position with industrial firm in capacity of production engineer or estimator. Available on short notice. Apply to Box No. 676-W.

DIESEL ENGINEER. Erection and industrial engineer, A.M.E.I.C., technically trained mechanical engineer with English and Canadian experience in erection and operation of steam and Diesel equipment in power house and mines, pumping, rock drilling, air compressors. Experienced in industrial and steel works operations including rolling mills, quarries, sales. Open for position on maintenance, operation or sales engineer. Location immaterial. Apply to Box No. 682-W.

MECHANICAL AND STRUCTURAL ENGINEER. Six years experience with prominent manufacturer, designing, heating and power boilers, boiler installations, coal and ash handling equipment. Good practical knowledge of steel plate work welding. Also wide experience in designing, estimating and detailing structural steel for buildings and bridges. Good education. Have held position of responsibility. Above can be verified by best of references. Available at once. Apply to Box No. 692-W.

ELECTRICAL AND CIVIL ENGINEER, B.Sc., Elec., 29, B.Sc., Civil '33. Age 27. Jr.E.I.C. Undergraduate experience in surveying and concrete foundations; also four months with Canadian General Electric Co. Thirty-three months in engineering office of a large electrical manufacturing company since graduation. Good experience in layouts, switching diagrams, specifications and pricing. Best of references. Available immediately. Apply to Box No. 693-W.

MECHANICAL ENGINEER, B.Sc., '27, Jr.E.I.C. Four years maintenance of high speed Diesel engines units, 200 to 1,300 h.p. Also maintenance of D.C. and A.C. electrical systems and machinery. Draughting experience. Westinghouse apprenticeship course. Practical mechanical and electrical engineer with a special study of high speed Diesel engine design, application and operation. Location in western or eastern Canada immaterial. Apply to Box No. 703-W.

COMBUSTION ENGINEER, R.P.E., Manitoba, A.M.E.I.C. Wide experience with all classes of fuels. Expert designer and draughtsman on modern steam power plants. Experienced in publicity work. Well known throughout the west. Location, Winnipeg or the west. Available at once. Apply to Box No. 713-W.

ELECTRICAL ENGINEER, B.Sc., University of N.B., '31. Experience includes three months field work with Saint John Harbour Reconstruction. Apply to Box No. 722-W.

MECHANICAL ENGINEER, age 41, married. Eleven years designing experience with project of outstanding magnitude. Machinery layouts, checking, estimating and inspecting. Twelve years previous engineering, including draughting, machine shop and two years chemical laboratory. Highest references. Apply to Box No. 723-W.

CIVIL ENGINEER, B.Sc. (Alta. '31), S.E.I.C. Experience includes three seasons in charge of survey party. Transitman on railway maintenance, and concrete bridge designing. Nature of work and location immaterial. Apply to Box No. 724-W.

YOUNG CIVIL ENGINEER, B.Sc. (Univ. of N.B. '31), with experience as rodman and checker on railroad construction, is open for a position. Apply to Box No. 728-W.

DESIGNING ENGINEER, M.Sc. (McGill Univ.), D.L.S., A.M.E.I.C., P.E.Q. Experience in design and construction of water power plants, transmission lines, field investigations of storage, hydraulic calculations and reports. Also paper mill construction, railways, highways, and in design and construction of bridges and buildings. Available at once. Apply to Box No. 729-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.Sc., Univ. of B.C. '30. Single, age 24. Sixteen months with the Allis-Chalmers Mfg. Co. as student engineer. Experience includes foundry production, erection and operation of steam turbines, erection of hydraulic machinery, and testing texropes and centrifugal pumps. Location immaterial. Available at once. Apply to Box No. 735-W.

CIVIL ENGINEER, M.Sc., A.M.E.I.C., R.P.E. (Ont.), ten years experience in municipal and highway engineering Read, write and talk French. Married. Served in France. Will go anywhere at any time. Experienced journalist. Apply to Box No. 737-W.

## Situations Wanted

RADIO AND ELECTRICAL ENGINEER, B.Sc. '31, S.E.I.C. Age 27. Experience in installation of power and lighting equipment. Temporary operator in radio station; studio experience with part time announcing. Two summers in switchboard and installation department of telephone company, eight months on extensive survey layouts. Interested in sales work of electrical or radio equipment. Available on short notice. Location immaterial. Apply to Box No. 740-W.

CIVIL ENGINEER, graduate '29. Married. One year building construction, one year hydro-electric construction in South America, fourteen months resident engineer on road construction. Working knowledge of Spanish. Apply to Box No. 744-W.

SALES ENGINEER, B.Sc., McGill, 1923. A.M.E.I.C. Age 33. Married. Extensive experience in building construction. Thoroughly familiar with steel building products; last five years in charge of structural and reinforcing steel sales for company in New York state. Available at once. Located in Canada. Apply to Box No 749-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. Queen's Univ. '29. Age 25. Married. Three years experience as construction supt. and estimator for contracting firm. Experience includes general building, bridges, sewer work, concrete, boiler settings, sand blasting of bridges and spray painting. Available at once. Apply to Box No. 776-W.

CIVIL ENGINEER, B.Sc., '25, Jr.E.I.C., P.E.Q., married. Desires position, preferably with construction firm. Experience includes railway, monument and mill building construction. Available immediately. Apply to Box No. 780-W.

DRAUGHTSMAN, experience in civil engineering, forestry engineering, land surveying and house construction. Good references. Apply to Box No. 781-W.

ELECTRICAL AND SALES ENGINEER, S.E.I.C., grad. '28. Experience includes one year test course, one year switchboard design and two years switchboard and switching equipment sales with large electrical manufacturing company. Three summers Pilot Officer with R.C.A.F. Available at once. Apply to Box No. 788-W.

ELECTRICAL ENGINEER. Specializing in power and illumination reports, estimates, appraisals, contracts and rates, plans and specifications for buildings. Available on interesting terms. Apply to Box No. 795-W.

MECHANICAL AND INDUSTRIAL ENGINEER, S.E.I.C., B.Sc. in Mech., (Queen's, '32) and M.Eng. in Indust., (McGill, '34). Age 25. Single. Forty months as moulder's helper, machinist, etc. in foundries, machine shops, and on hydro-electric construction. Now completing two-year Rockefeller Foundation Fellowship at McGill. Good references. Available on short notice. Apply to Box No. 797-W.

CIVIL ENGINEER, S.E.I.C., graduate '30, age 23, single. Experience includes mining surveys, assistant on highway location and construction, and assistant on large construction work. Steel and concrete layout and design. Apply to Box No. 809-W.

CIVIL ENGINEER, college graduate, age 27, single. Experience includes surveying, draughting concrete construction and design, street paving both asphalt and concrete. Available at once; will consider anything and go anywhere. Apply to Box No. 816-W.

CIVIL ENGINEER, B.E. (Sask. Univ. '32), S.E.I.C. Single. Experience in city street improvement; sewer and water extensions. Good draughtsman. References. Available at once. Location immaterial. Apply to Box No. 818-W.

CIVIL ENGINEER, B.Sc., A.M.E.I.C., with fifteen years experience mostly in pulp and paper mill work, reinforced concrete and structural steel design, field surveys, layout of mechanical equipment, piping. Available at once. Apply to Box No. 825-W.

ELECTRICAL ENGINEER, S.E.I.C., grad. '29, age 24, married; experience includes one year Students Test Course, sixteen months in distribution transformer design and eight months as assistant foreman in charge of industrial control and switchgear tests. Location immaterial. Available at once. Apply to Box No. 828-W.

CIVIL ENGINEER, B.A.Sc., D.L.S., O.L.S., A.M.E.I.C., age 46, married. Twelve years experience in charge of legal field surveys. Owns own surveying equipment. Eight years on technical, administrative, and editorial office work. Experienced in writing. Desires position on survey work, assisting in or in charge of preparation of house organ, on staff of technical or semi-technical magazine, or on publicity, editorial or administrative office work. Available at once. Will consider any salary, and any location. Apply to Box No. 831-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. '32 (Univ. of N.B.). Age 25. married. Two years experience in power line construction and maintenance; one year of highway construction; one summer surveying for power plant site, location and spur railway line construction. Available at once. Location immaterial. Apply to Box No. 840-W.

CIVIL ENGINEER, B.Sc. '15, A.M.E.I.C., married, extensive experience in responsible position on railway construction, also highways, bridges and water supplies. Position desired as engineer or superintendent. Available at once. Apply to Box No. 841-W.

CIVIL ENGINEER, B.Sc. (Alta. '31), S.E.I.C., age 24. Experience, three summers on railroad maintenance, and seven months on highway location as instrumentman. Willing to do anything, anywhere, but would prefer connection with designing or construction firm on structural works. Available immediately. Apply to Box No. 846-W.

## Situations Wanted

MECHANICAL ENGINEER, Jr.E.I.C., technical graduate, bilingual, age 30. Two years as designing heating draughtsman with one of the largest firms of its kind on this continent handling heating materials; three years designing draughtsman in consulting engineers' office, mechanical equipment of buildings, heating, ventilation, sanitation, power plant equipment, writing of specifications, etc. Present location Montreal. Available at once. Apply to Box No. 850-W.

BRIDGE AND STRUCTURAL ENGINEER, A.M.E.I.C., McGill. Twenty-five years' experience on bridge and structural staffs. Until recently employed. Familiar with all late designs, construction, and practices in all Canadian fabricating plants. Desirous of employment in any responsible position, sales, fabrication or construction. Apply to Box No. 851-W.

STRUCTURAL ENGINEER, B.A.Sc., A.M.E.I.C. Twenty-two years experience in design of bridges and all types of buildings in structural steel and reinforced concrete. Three years experience in railway construction and land surveying. Apply to Box No. 856-W.

MECHANICAL ENGINEER, B.Sc. '32, S.E.I.C. Good draughtsman. Undergraduate experience:—One year moulding shop practice; two years pipe fitting and sheet metal work; one year draughting and tracing on paper mill layout; six months machine shop practice; and eight months fuel investigation and power heating plant testing. Desires position offering experience in steam power plants or heating and ventilating design. Will go anywhere. Apply to Box No. 858-W.

MECHANICAL ENGINEER, age 31, graduate Sheffield (England) 1921; apprenticeship with firm manufacturing steam turbine generators and auxiliaries and subsequent experience in design, erection, operation and inspection of same. Marine experience B.O.T. certificate thoroughly conversant with Canadian plants and equipment. Available on short notice. Any location. Box No. 860-W.

CHEMICAL ENGINEER, B.Sc. (McGill '21), A.M.E.I.C., age 36, married; three years since graduation with pulp and paper mills; eight years in shops, estimating and sales divisions of well-known gas engineering and construction companies in the United States. Excellent references. Available on short notice. Apply to Box No. 866-W.

CONSTRUCTION ENGINEER (Toronto Univ. of '07). Experience includes hydro-electric, municipal and railroad work. Available immediately. Location immaterial. Apply to Box No. 886-W.

ELECTRICAL ENGINEER, graduate 1929, S.E.I.C. Single. Experience includes two years with electrical manufacturing concern and one on highway construction work. Available at once. Will go anywhere. Apply to Box No. 887-W.

CIVIL ENGINEER, B.Sc., Montreal 1930, age 26, single, French and English, desires position technical or non-technical in engineering, industrial or commercial fields, sales or promotion work. Experience includes three years in municipal engineering on paving, sewage, waterworks, filter plant equipment, layout of buildings, etc. Available immediately. Apply to Box No. 891-W.

ELECTRICAL ENGINEER, grad. Univ. of N.B. '31. Experienced in surveying and draughting, requires position. Available at once. Will go anywhere. Apply to Box No. 893-W.

CIVIL ENGINEER, B.A.Sc., Jr.E.I.C., age 29, single. Experience includes two years in pulp mill as draughtsman and designer on additions, maintenance and plant layout. Three and a half years in the Toronto Buildings Department checking steel, reinforced concrete, and architectural plans. Available at once. Location immaterial. At present in Toronto. Apply to Box No. 899-W.

DESIGNING ENGINEER, A.M.E.I.C. Permanent and executive position preferred but not essential. Fifteen years experience in designing power plants, engine and fan rooms, kitchens and laundries. Thoroughly familiar with plumbing and ventilating work, pneumatic tubes, and refrigeration, also heating, electrical work, and specifications. Apply to Box No. 913-W.

CIVIL ENGINEER, B.Sc., '25, McGill Univ., Jr.E.I.C., P.E.Q., age 32, married. Experience as rodman and instrumentman on track maintenance. Seven and one-half years with Canadian paper company, as assistant office engineer handling all classes of engineering problems in connection with woods operations, i.e., road buildings, piers, booms, timber bridges, depots, dams, etc. Apply to Box No. 933-W.

ELECTRICAL ENGINEER, Dipl. of Eng., B.Sc. (Dalhousie Univ.), S.B. and S.M. in E.E. (Mass. Inst. of Tech.), Canadian. Married. Seven and a half years' experience in design, construction and operation of hydro, steam and industrial plants. For past sixteen months field office electrical engineer on 510,000 h.p. hydro-electric project. Available at once. Apply to Box No. 936-W.

CIVIL ENGINEER, B.Sc., O.P.E. Experience includes several years on municipal work-design and construction of sewers, steel and concrete bridges, watermains and pavements. Available at once. Apply to Box No. 950-W.

CIVIL ENGINEER, B.Sc. (Univ. of Sask. '33), S.E.I.C., age 28, single. Experience in testing hydro-electric equipment, draughting, surveying, city street, improvements, technical photography. Available at once. Location immaterial. Apply to Box No. 986-W.

ELECTRICAL ENGINEER, S.E.I.C., B.Sc., (N.S. Tech. Coll., '33), desires work. Experience in transmission line construction. Location or class of work immaterial. Apply to Box No. 1010-W.

## Situations Wanted

ENGINEER SUPERINTENDENT, age 44. Engineering and business training, executive ability, tactful, energetic. Had charge of several large projects. Intimate knowledge of costs and prices, reports and estimates. Available immediately. Any location. Apply to Box No. 1021-W.

CIVIL ENGINEER, B.Sc. (Queen's 14), A.M.E.I.C., Dominion Land Surveyor, 5 months' special course at the University of London, England, in municipal hygiene and reinforced concrete construction. Experience covers legal and topographic surveys, plane tabling and stadia surveying, railway and highway construction, drainage and excavation work. Available at once. Apply Box No. 1035-W.

ELECTRICAL ENGINEER AND GEOPHYSICIST. Age 36. Married. Seven years experience in geophysical exploration using seismic, magnetic and electrical methods. Two years experience with the Western Electric Company of Chicago, working on equipment and magnetic materials research. Experienced in radio and telephone work, also specializing in precise electrical measurements, resistance determinations, ground potentials and similar problems of ground current distribution. Apply to Box No. 1063-W.

ELECTRICAL ENGINEER, B.A.Sc. Univ. Toronto '28. Experience includes Can. Gen. Elec. Co. Test Course. Also more than two years in the engineering dept. of the same company. Available on short notice. Preferred location central or eastern Canada. Apply to Box No. 1075-W.

ELECTRICAL ENGINEER, B.Sc. Married. Eight years electrical experience, including operation, maintenance and construction work, electrical design work on large power development, mechanical ability, experienced photographer, employed in electrical capacity at present. Available on reasonable notice. Apply to Box No. 1076-W.

GRADUATE IN MECHANICAL ENGINEERING, 1927, desires opportunity in Diesel engine field, preferably in design and development work. Skilled draughtsman and clever in design. Familiar with basic theories of the Diesel engine and in touch with recent developments and applications. Anxious to obtain a foothold with up-to-date company. No objection to shopwork or other duties as a start but would prefer shopwork and assembly if possible. Apply to Box No. 1081-W.

CIVIL ENGINEER, age 27, graduate 1930, single. Experience includes detailing, designing and estimating structural steel, plate work and pressure vessels; also hydrographic surveying. Available at once. Apply to Box No. 1111-W.

ELECTRICAL ENGINEER, B.Sc., in E.E. (Univ. of N.B. '34), S.E.I.C. Experience in bridge and road construction and auto repairing, desires position in industrial or power plant. Any locality. References on request. Apply to Box No. 1114-W.

CIVIL ENGINEER, B.Sc. Sask. '30. S.E.I.C. Age 24 years. Experience in municipal engineering, including sewer and water construction, sidewalk construction, paving, storm sewer design, draughting, precise levelling, and reinforced concrete bridge construction. Unmarried. Available at once. Will go anywhere. Apply to Box No. 1115-W.

ELECTRICAL ENGINEER, B.Sc.E.E. (Univ. of N.B. '31). C.G.E. Test Course included industrial control, induction motors and transformers; the transformer test included desk work for two months on computing losses, efficiencies, etc. Available at once. Apply to Box No. 1119-W.

MECHANICAL ENGINEER, B.A.Sc. (Univ. of B.C.), M.S. (Univ. of Pittsburgh). Canadian. Age 26. Single. One year graduate student course, W.E. and M. Co., East Pittsburgh. Three and a half years engineering research in mechanics with the same company. Location immaterial. Available at once. Apply to Box No. 1123-W.

GEODETIC AND TOPOGRAPHICAL ENGINEER, D.L.S., M.E.I.C. Experience in all kinds of geodetic and topographical surveys, especially photo-topography, well versed in all kinds of air photo surveys; Canadian and U.S. patent method of determining position and elevations of points from air photographs. Available at once anywhere in Canada or the United States. Apply to Box No. 1127-W.

PETROLEUM CHEMIST, B.Sc. in Chem. Eng. Age 25, Single. One and a half years experience as assistant chemist. Capable of taking charge in small refinery. Wishes position anywhere in Canada. Apply to Box No. 1130-W.

ELECTRICAL ENGINEER B.Sc., Queen's '33. Single, age 23. Anxious to gain experience. Present experience installing small private hydro-electric plant. Location immaterial. Available at once. Apply to Box No. 1137-W.

CIVIL ENGINEER, A.M.E.I.C., with over twenty years experience in field and office on construction, maintenance, surveying, location, etc., desires position preferably of a permanent nature. At present near Montreal, but willing to locate anywhere. Apply to Box No. 1168-W.

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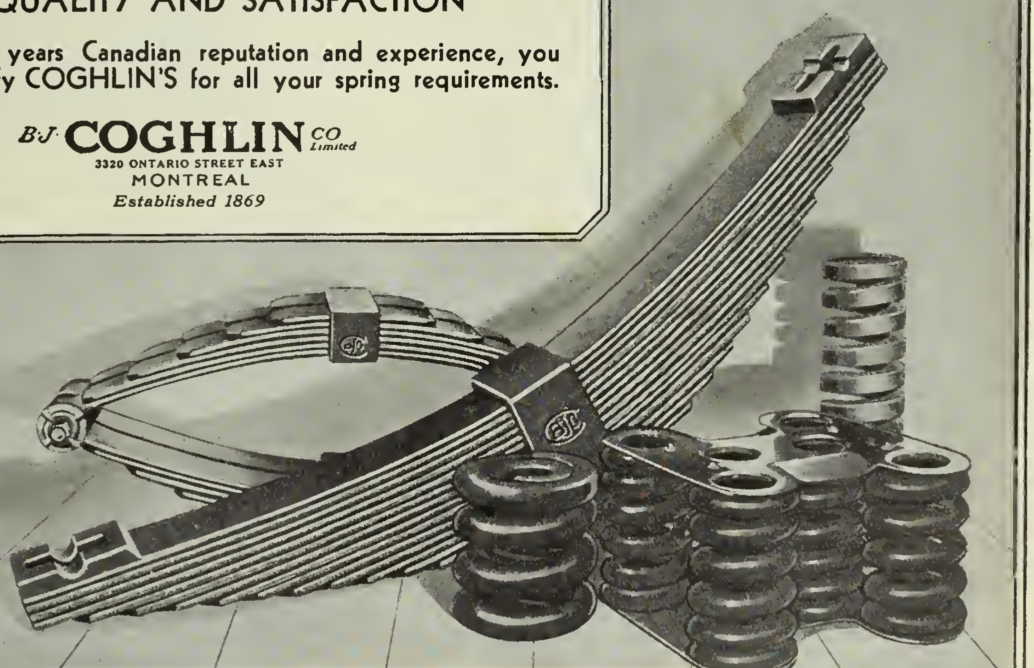

Agents: Harvard Turnbull & Co., Toronto
Filer Smith Machinery Co., Ltd., Winnipeg   Gordon & Belyea, Ltd., Vancouver

# Purchasers' Classified Directory

*A Selected List of Equipment, Apparatus and Supplies*

For Alphabetical List of Advertisers see page 22.

A

**Acids:**
Canadian Industries Limited.
**Aerial Survey:**
Canadian Airways Ltd.
**Ammeters and Voltmeters:**
Bepco Canada Ltd.
Crompton Parkinson (Canada) Ltd.
**Angles, Steel:**
Bethlehem Steel Export Corp.
**Ash Handling Equipment:**
Babcock-Wilcox & Goldie McCulloch Ltd.
Combustion Engineering Corp. Ltd.
**Asphalt:**
Barrett Co. Ltd.
**Axles, Steel, Forged:**
Dominion Foundries & Steel Ltd.
Dominion Steel & Coal Corpn. Ltd.

B

**Ball Mills:**
Dominion Engineering Works Limited.
Wm. Kennedy & Sons Ltd.
Foster Wheeler Ltd.
Wm. Hamilton Div. Canadian Vickers Ltd.
**Balls, Steel and Bronze:**
Can. S.K.F. Co. Ltd.
Wm. Kennedy & Sons Ltd.
**Barking Drums:**
Canadian Ingersoll-Rand Company, Limited.
**Bars, Steel and Iron:**
Bethlehem Steel Export Corp.
Dominion Foundries & Steel Ltd.
Dominion Steel & Coal Corpn. Ltd.
**Bearings, Ball and Roller:**
Can. S.K.F. Co. Ltd.
**Billets, Blooms, Slabs:**
Bethlehem Steel Export Corp.
Dominion Foundries & Steel Ltd.
**Bins:**
Canada Cement Co. Ltd.
**Blasting Materials:**
Canadian Industries Limited.
**Blowers, Centrifugal:**
Can. Ingersoll-Rand Co. Ltd.
B. F. Sturtevant Co. of Can. Ltd.
**Blue Print Machinery:**
Montreal Blue Print Co.
**Boilers:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Canadian Vickers Ltd.
Combustion Engineering Corp. Ltd.
Foster Wheeler Limited.
E. Leonard & Sons Ltd.
Vulcan Iron Wks. Ltd.
**Boilers, Electric:**
Can. General Electric Co. Ltd.
Dominion Engineering Works Limited.
Northern Electric Co. Ltd.
**Boilers, Portable:**
Foster Wheeler Ltd.
E. Leonard & Sons Ltd.
**Boxes, Cable Junction:**
Northern Electric Co. Ltd.
**Braces, Cross Arm, Steel, Plain or Galvanized:**
Northern Electric Co. Ltd.
**Brackets, Ball Bearing:**
Can. S.K.F. Co. Ltd.
**Brakes, Air:**
Can. General Elec. Co. Ltd.
**Brakes, Magnetic Clutch:**
Northern Electric Co. Ltd.
**Bridge-Meggers:**
Northern Electric Co. Ltd.
**Bridges:**
Canada Cement Co. Ltd.
Canadian Vickers Ltd.
Dominion Bridge Co. Ltd.
**Bucket Elevators:**
Jeffrey Mfg. Co. Ltd.
**Buildings, Steel:**
Dominion Bridge Co. Ltd.

C

**Cables, Copper and Galvanized:**
Northern Electric Co. Ltd.
**Cables, Electric, Bare and Insulated:**
Can. Westinghouse Co. Ltd.
Can. General Electric Co. Ltd.
Northern Electric Co. Ltd.
**Caissons, Barges:**
Dominion Bridge Co. Ltd.
**Cameras:**
Associated Screen News Ltd.
**Capacitors:**
Bepco Canada Ltd.
Can. Westinghouse Co. Ltd.
Lancashire Dynamo & Crypto Co. of Can. Ltd.
**Castings, Brass:**
The Superheater Co. Ltd.
**Castings, Iron:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Dominion Engineering Works.
Foster Wheeler Ltd.
Wm. Kennedy & Sons Ltd.
E. Leonard & Sons Ltd.
The Superheater Co. Ltd.
Vulcan Iron Wks. Ltd.
**Castings, Alloy Steel:**
Dominion Foundries & Steel Ltd.
**Castings, Steel:**
Dominion Foundries & Steel Ltd
Wm. Kennedy & Sons Ltd.
Vulcan Iron Wks. Ltd.
**Catenary Materials:**
Can. Ohio Brass Co. Ltd.
**Cement Manufacturers:**
Canada Cement Co. Ltd.
**Chains, Silent and Roller:**
Hamilton Gear & Machine Co.
Jeffrey Mfg. Co Ltd
**Channels:**
Bethlehem Steel Export Corp.
**Chemicals:**
Canadian Industries Limited.
**Chemists:**
Milton Hersey Co. Ltd.
Roast Laboratories Reg'd.
**Chippers, Pneumatic:**
Canadian Ingersoll-Rand Company, Limited.
**Choke Coils:**
Ferranti Electric Co.
**Circuit Breakers:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.
**Clarifiers, Filter:**
Bepco Canada Ltd.
Crompton Parkinson (Canada) Ltd.
**Clutches, Ball Bearing Friction:**
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**Clutches, Magnetic**
Northern Electric Co. Ltd.
**Coal Handling Equipment:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Combustion Engineering Corp. Ltd.
**Combustion Control Equipment:**
Bailey Meter Co. Ltd.
**Compressors, Air and Gas:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Canadian Ingersoll-Rand Company, Limited.
**Concrete:**
Canada Cement Co. Ltd.
**Condensers, Steam:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Canadian Ingersoll-Rand Company, Limited.
Foster Wheeler Limited.
**Condensers, Synchronous and Static:**
Bepco Canada Ltd.
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Crompton Parkinson (Canada) Ltd.
Harland Eng. Co. of Can. Ltd.
Lancashire Dynamo & Crypto Co. of Can. Ltd.
Northern Electric Co. Ltd.
Bruce Peebles (Canada) Ltd.
**Conditioning Systems, Air:**
B. F. Sturtevant Co. of Can. Ltd.
**Conduit:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co Ltd.
**Conduit, Underground Fibre, and Underfloor Duct:**
Northern Electric Co. Ltd.
**Controllers, Electric:**
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Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.
**Couplings:**
Dart Union Co. Ltd.
Dresser Mfg. Co. Ltd.
**Couplings, Flexible:**
Dominion Engineering Works Limited.
Dresser Mfg. Co. Ltd.
**Couplings, Flexible:**
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Hamilton Gear & Machine Co.
Wm. Kennedy & Sons Ltd.
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Dominion Hoist & Shovel Co. Ltd.
**Cranes, Shovel, Gasoline Crawler, Pillar:**
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Dominion Hoist & Shovel Co. Ltd.
**Crowbars:**
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**Crushers, Coal and Stone:**
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Jeffrey Mfg. Co. Ltd.
Wm. Kennedy & Sons Ltd.

D

**Dimmers:**
Northern Electric Co. Ltd.
**Disposal Plants, Sewage:**
W. J. Westaway Co. Ltd.
**Ditchers:**
Dominion Hoist & Shovel Co. Ltd.
**Drills, Pneumatic:**
Canadian Ingersoll-Rand Company, Limited.
**Dynamite:**
Canadian Industries Limited.

E

**Economizers, Fuel:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Combustion Engineering Corp. Ltd.
Foster Wheeler Limited.
B. F. Sturtevant Co. of Can. Ltd.
**Elbows:**
Dart Union Co. Ltd.
**Electric Blasting Caps:**
Canadian Industries Limited.
**Electric Railway Car Couplers:**
Can. Ohio Brass Co. Ltd.
**Electrical Repair Work:**
Montreal Armature Works.
**Electrical Supplies:**
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Can. Ohio Brass Co Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.
**Electrification Materials, Steam Road:**
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**Engines, Diesel and Semi-Diesel:**
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Canadian Ingersoll-Rand Company, Limited.
**Engines, Steam:**
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Canadian Vickers Ltd.
Harland Eng. Co. of Can. Ltd.
E. Leonard & Sons Ltd.
**Evaporators:**
Foster Wheeler Limited.
**Expansion Joints:**
Foster Wheeler Limited.
**Explosives:**
Canadian Industries Limited.

F

**Feed Water Heaters, Locomotive:**
The Superheater Co. Ltd.
**Filtration Plants, Water:**
W. J. Westaway Co. Ltd.
**Finishes:**
Canadian Industries Limited.
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Northern Electric Co. Ltd.
**Floodlights:**
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Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.
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Jenkins Bros. Ltd.
**Floors:**
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**Forcite:**
Canadian Industries Limited
**Forgings:**
Bethlehem Steel Export Corp.
Dominion Steel & Coal Corpn. Ltd
**Foundations:**
Canada Cement Co. Ltd.

G

**Gaskets, Asbestos, Fibrous, Metallic, Rubber:**
The Garlock Packing Co. of Can. Ltd.
**Gasoline Recovery Systems:**
Foster Wheeler Limited.
**Gates, Hydraulic Regulating:**
Canadian Vickers Ltd.
Dominion Bridge Co. Ltd.
**Gauges, Draft:**
Bailey Meter Co. Ltd.
**Gear Reductions:**
Hamilton Gear & Machine Co.
**Gears:**
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Dominion Engineering Works Limited.
Hamilton Gear & Machine Co.
Wm. Kennedy & Sons Ltd.
**Generators:**
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Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Crompton Parkinson (Canada) Ltd.
Harland Eng. Co. of Can. Ltd.
Lancashire Dynamo & Crypto Co. of Can. Ltd.
Northern Electric Co. Ltd.
Bruce Peebles (Canada) Ltd.
**Governors, Pump:**
Bailey Meter Co. Ltd.
**Governors, Turbine:**
Dominion Engineering Works Limited.
**Gratings, M. & M. Safety:**
Dominion Bridge Co. Ltd.

H

**Hangers, Ball and Roller Bearing:**
Can. S.K.F. Co. Ltd.
**Headlights, Electric Railway:**
Can. General Elec. Co. Ltd.
Can. Ohio Brass Co. Ltd.
Can. Westinghouse Co. Ltd.
**Heat Exchange Equipment:**
Foster Wheeler Limited.
**Heating Systems:**
C. A. Dunham Co. Ltd.
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Canadian Ingersoll-Rand Company, Limited.
Dominion Hoist & Shovel Co. Ltd.
Wm. Hamilton Div. Canadian Vickers Ltd.
**Humidifying Equipment:**
W. J. Westaway Co. Ltd.

I

**Incinerators:**
Canada Cement Co. Ltd.
**Indicator Posts:**
Jenkins Bros. Ltd.
**Industrial Electric Control:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.
**Injectors, Locomotive, Exhaust Steam:**
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**Inspection of Materials:**
J. T. Donald & Co. Ltd.
Milton Hersey Co. Ltd.
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Bepco Canada Ltd.
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Crompton Parkinson (Canada) Ltd.
Ferranti Electric Ltd.
Moloney Electric Co. of Canada, Ltd.
Northern Electric Co. Ltd.
**Insulating Materials:**
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**Insulators, Porcelain:**
Can. Ohio Brass Co. Ltd.
Northern Electric Co. Ltd.
**Intercoolers:**
Foster Wheeler Limited.

J

**Journal Bearings and Boxes, Railway:**
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L

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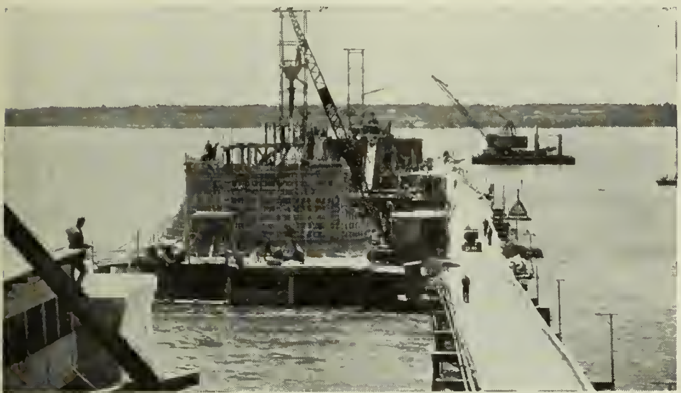

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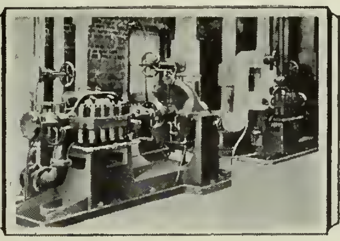

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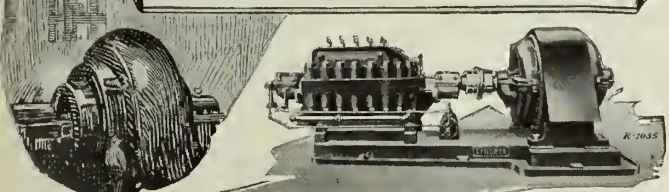

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**Lightning Arresters:**
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- Can. Westinghouse Co. Ltd.
- Ferranti Electric Ltd.
- Northern Electric Co. Ltd.

**Line Materials:**
- Can. Ohio Brass Co. Ltd.
- Northern Electric Co. Ltd.

**Locomotives, Electric:**
- Can. General Elec. Co. Ltd.
- Can. Westinghouse Co. Ltd.

### M

**Machinery, Hydraulic:**
- Dominion Engineering Works Limited.

**Machinery, Metal and Wood-Working:**
- Dominion Engineering Works Limited.

**Magnetic Separators:**
- Northern Electric Co. Ltd

**Material Handling Equipment:**
- Jeffrey Mfg. Co. Ltd.

**Metallurgists:**
- Roast Laboratories Reg'd.

**Meters, Boiler, and Coal:**
- Bailey Meter Co. Ltd.

**Meters, Electric:**
- Can. General Elec. Co. Ltd.
- Can. Westinghouse Co. Ltd.
- Ferranti Electric Ltd.
- Northern Electric Co. Ltd.

**Meters, Flow:**
- Bailey Meter Co. Ltd.
- Neptune-National Meters Ltd.

**Meters, Liquid (Hot or Cold):**
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- Neptune-National Meters Ltd.

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**Mining Machinery:**
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- Canadian Vickers Ltd.
- Dominion Engineering Works Limited.

**Motion Pictures:**
- Associated Screen News Ltd

**Motors, Electric:**
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- The Can. Fairbanks-Morse Co. Ltd.
- Can. General Elec. Co. Ltd.
- Can. Westinghouse Co. Ltd.
- Crompton Parkinson (Canada) Ltd.
- Harland Eng. Co. of Can. Ltd.
- Lancashire Dynamo & Crypto Co. of Can. Ltd.
- Northern Electric Co. Ltd.
- Bruce Peebles (Canada) Ltd.

**Moulded Goods, Rubber and Asbestos:**
- The Garlock Packing Co. of Can. Ltd.

### O

**Oil Burning Equipment:**
- Bethlehem Steel Export Corp.

**Oil Refining Equipment:**
- Foster Wheeler Limited.

**Ornamental Iron:**
- Vulcan Iron Wks. Ltd.

### P

**Packings, Asbestos, Cotton and Flax, Metal, Rubber:**
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**Paving Materials:**
- Barrett Co. Ltd.

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**Pinions:**
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- Canadian Wood Pipe & Tanks Ltd.

**Pipe Coils:**
- The Superheater Co. Ltd.

**Pipe Couplings and Nipples:**
- Dart Union Co. Ltd.

**Plates, Steel:**
- Bethlehem Steel Export Corp
- Dominion Foundries & Steel Ltd.

**Pneumatic Tools:**
- Canadian Ingersoll-Rand Company Ltd.

**Pole Line Hardware:**
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- Northern Electric Co. Ltd.

**Polishes:**
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**Powder, Black and Sporting:**
- Canadian Industries Limited.

**Power Switchboards:**
- Bepco Canada Ltd.
- Can. General Elec. Co. Ltd.
- Can. Westinghouse Co. Ltd.
- Crompton Parkinson (Canada) Ltd.
- Harland Eng. Co. of Can. Ltd.
- Northern Electric Co. Ltd.

**Preheaters, Air:**
- Babcock-Wilcox & Goldie-McCulloch Ltd.
- Combustion Engineering Corp.
- Foster Wheeler Limited.

**Projectors:**
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**Pulleys:**
- Plessisville Foundry.

**Pulleys, Ball Bearings, Loose:**
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**Pulp and Paper Mill Machinery:**
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- Canadian Ingersoll-Rand Company, Limited
- Can. Westinghouse Co. Ltd
- Dominion Engineering Works Limited.
- Wm. Hamilton Div. Canadian Vickers Ltd.
- Harland Eng. Co. of Can. Ltd.

**Pulverized Fuel Systems:**
- Babcock-Wilcox & Goldie-McCulloch Ltd.
- Bethlehem Steel Export Corpn.
- Combustion Engineering Corp. Ltd.
- Foster Wheeler Limited.
- Wm. Kennedy & Sons Ltd.

**Pump Valves, Rubber:**
- The Garlock Packing Co. of Can. Ltd.

**Pumps:**
- Babcock-Wilcox & Goldie-McCulloch Ltd.
- Canadian Ingersoll-Rand Company, Limited.
- Foster Wheeler Limited.
- Wm. Hamilton Div. Canadian Vickers Ltd.
- Harland Eng. Co. of Can. Ltd.

**Purifiers, Water:**
- W. J. Westaway Co. Ltd

### R

**Radiator Air Vents and Traps:**
- Jenkins Bros. Ltd.

**Radiator Valves:**
- Can. Ohio Brass Co. Ltd.
- Jenkins Bros. Ltd.

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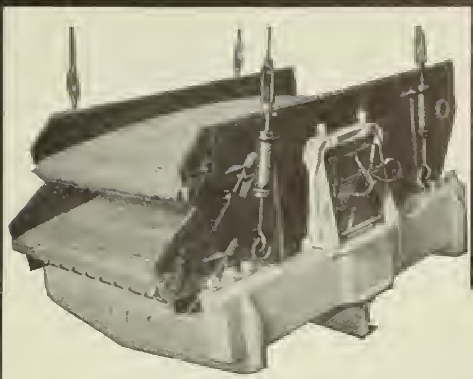

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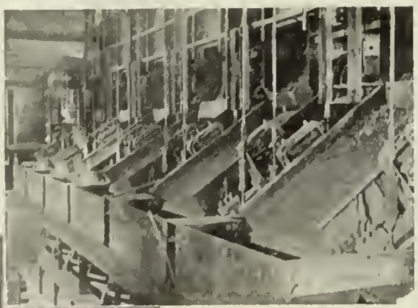
*A double deck vibrating screen (type FB-2) is shown above. A battery of single deck screens are shown at the right.*



*Left—a single deck Jeffrey-Traylor Screen with roll feed.*

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*Jeffrey-Traylor also makes electric vibrating Conveyors, Feeders, Dryers and Coolers. Send for data.*

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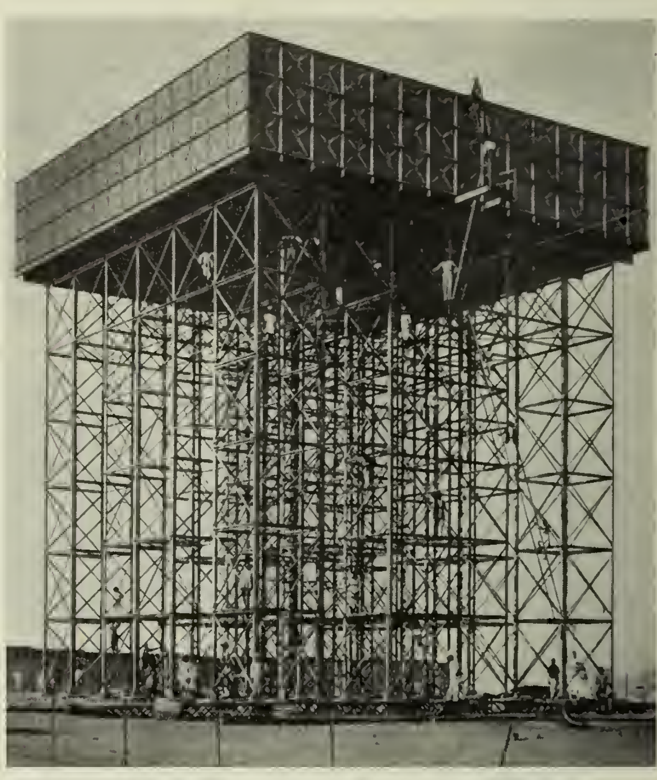

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# THE ENGINEERING JOURNAL

VOL. XVII
No. 7

JULY
1934

## *In this issue*



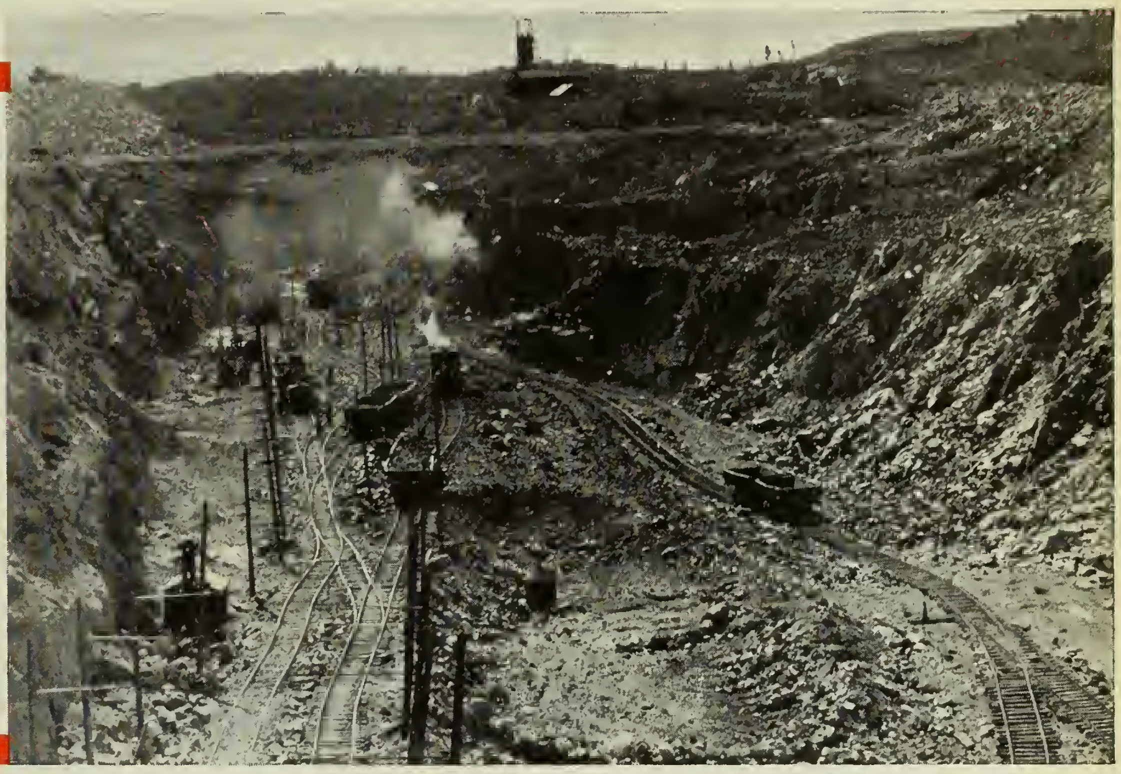
PUBLISHED MONTHLY BY

THE ENGINEERING INSTITUTE *of* CANADA

# The Romance of Mining in Canada

In the early days of locating his claim the mining prospector suffered untold hardships. To-day the prospector goes out equipped to meet practically all emergencies.

## COPPER PRODUCTION IN 1932 WAS 247,679,070 POUNDS



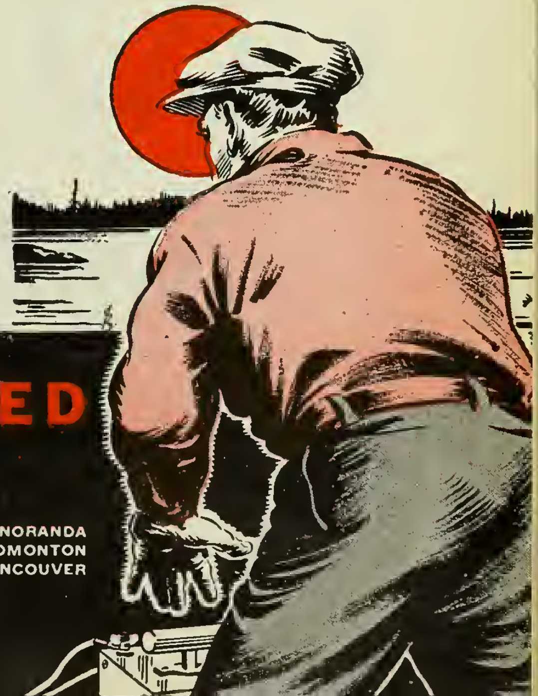
*The Flin Flon Mine*

ALTHOUGH Louis XIV granted a concession to Nicholas Denys to mine copper on Cape Breton Island in the year 1654, over 250 years elapsed before refined copper was produced commercially in quantity—by the Consolidated Mining & Smelting Company, at Trail, B.C. Copper mining is still one of the most important divisions of the mining industry in this Province.

Another of the earlier important copper mines in Canada was the Eustis property in the township of Ascot, Que., where over sixty years ago copper matte was produced. The Eustis mines are still producing both copper and iron sulphide concentrates.

Much development has been carried on in the last ten years in the Flin Flon district of Manitoba, on the Saskatchewan boundary. The Flin Flon mine, which is operated by the Hudson Bay Mining and Smelting Company, produced 31,068,556 pounds of copper in 1931. In the production of copper—as in all other Canadian mining projects—C-I-L Explosives have played an important part in speeding production and lowering labor costs.

ET142



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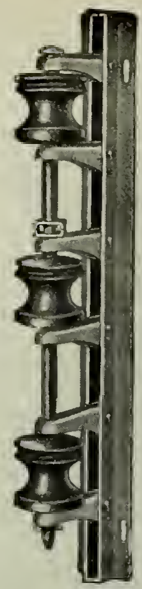
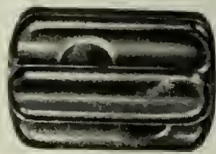
Slater Double Thimbleye Anchor Rods (Patented)


Slater Vertical Wireholders


Slater Secondary Racks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Slater MaxAmp. Connectors (Patented)


GUY AND GROUND WIRE
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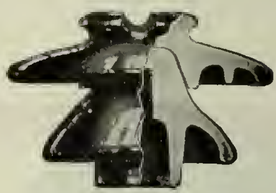
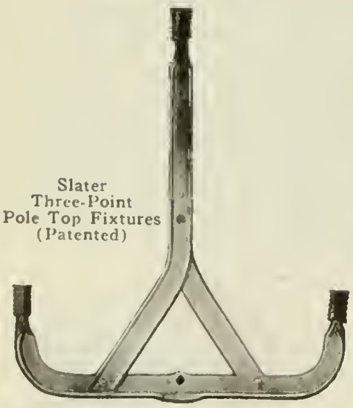
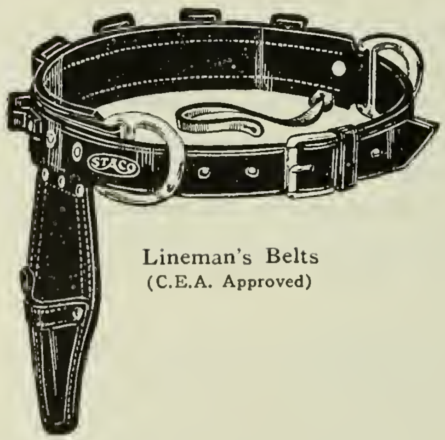
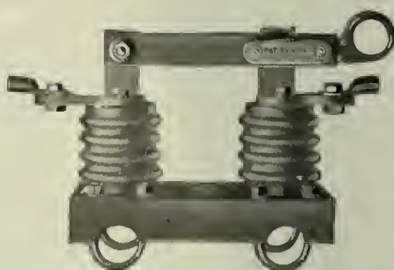

Pin Insulators


Slater Three-Point Pole Top Fixtures (Patented)



Lineman's Belts (C.E.A. Approved)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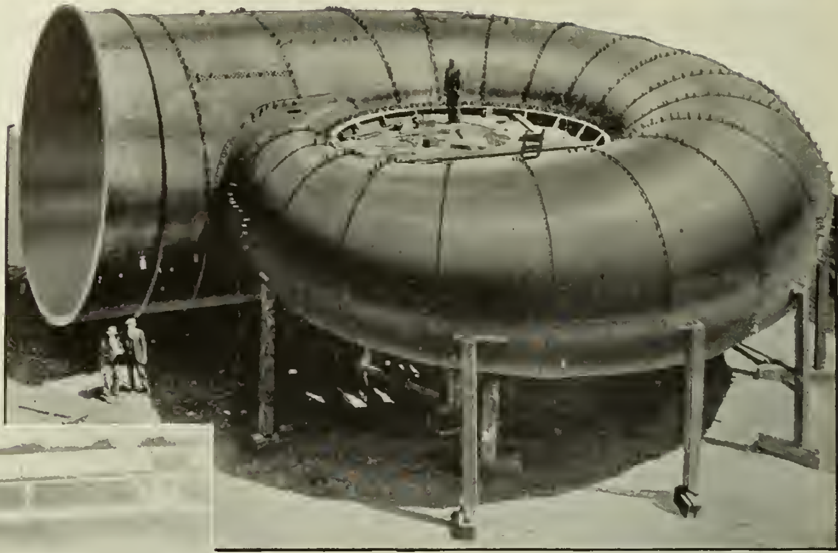
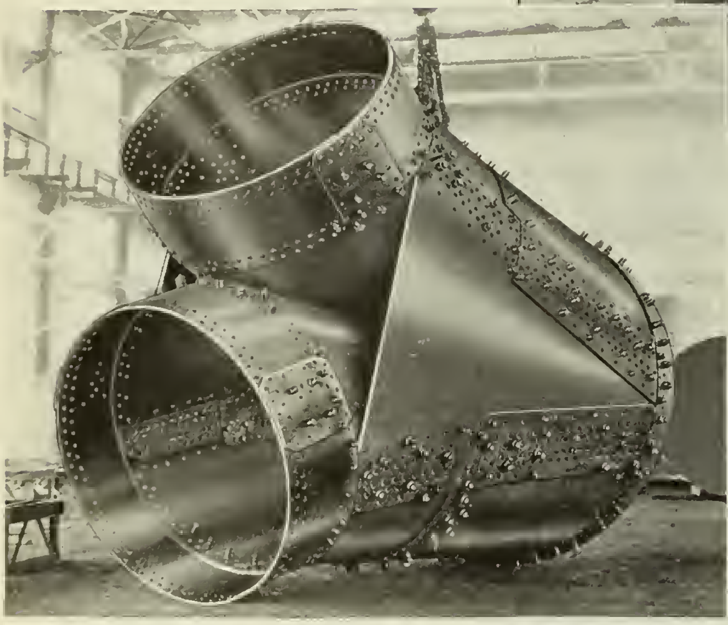
# TANK WORK



Volute Casing, Intake Diameter 23 3"



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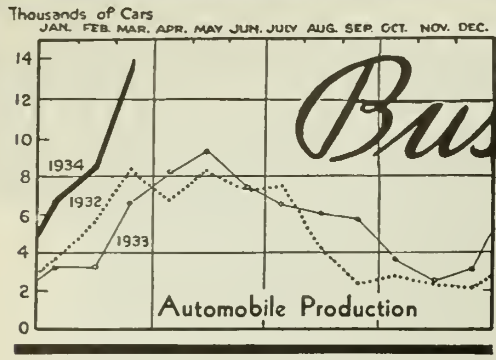


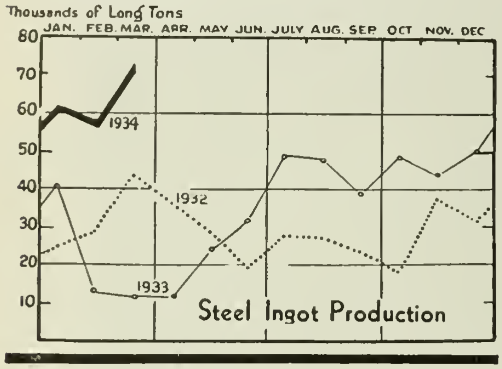


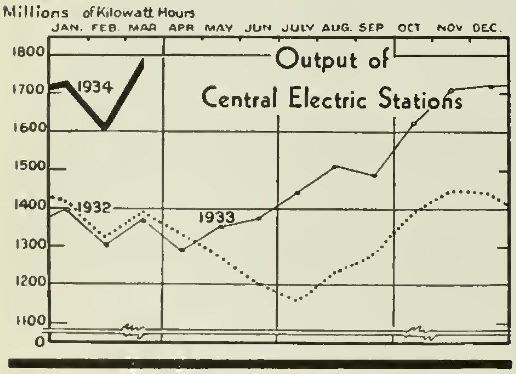


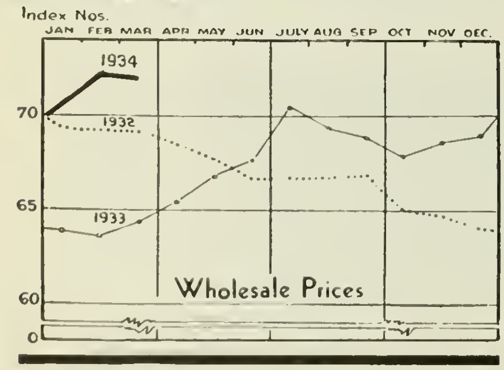


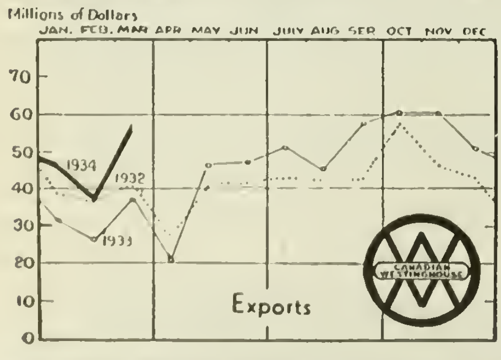


Charts courtesy The Financial Post

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**July 1934** **Volume XVII, No. 7**

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# Town Planning Aspects of Vancouver and Fraser River Harbours

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**Paper to be presented at the Western Professional Meeting of The Engineering Institute of Canada, to be held in Vancouver, B.C. on July 11th to 14th, 1934.**

**SUMMARY.—The present developments in the three divisions of Vancouver Harbour and in the Fraser River are described with reference to such matters as administration, zoning, railway and road transportation, industrial and residental areas and harbour facilities. The problems involved in possible future developments are indicated.**

While we are inclined to view town planning as of greatest importance in zoning, in streets and transit problems, and in parks, civic art and other recreational problems, its application to harbour development is somewhat less definite. In the major seaports of the world, of which Vancouver is one, the harbour is in most cases the greatest single asset of the community. It is usually of much greater than local importance and in many cases is of outstanding national importance. The latter is especially true of Vancouver and the Fraser river harbours, which with Prince Rupert constitute the only outlets for Canada on the Pacific ocean. The actual movement of goods and commodities which pass through these ports comprises over 70 per cent of the total movement, the balance being of local origin or for local consignment. As a part of the town plan for a seaport, there is a rightful demand that future development of the waterfront facilities should recognize proper access for the free movement of freight and passengers to and from the harbour by highway and railway with a minimum of impediment on such movements. The plan should further recognize the need for adequate railway facilities, which include berthside and depressed tracks on pier or wharf, adjacent storage and switching trackage and car storage yards of ample holding capacity within economical proximity to the points of transfer from rail to water, and vice versa. There should be suitable interchange arrangements where two or more railways operate within the terminal area, and if possible a unified control for the operation of the waterfront or terminal railway. The plan should provide for the systematic development of the waterfront with proper lines of demarcation between deep sea, coastwise, industrial, and recreational waterfront facilities. Waterfront roadways should be provided which allow direct connection between various portions of the harbour front and which enable city fire, police, ambulance, and other services to operate with greatest despatch.

To properly understand the town plan as applicable to Vancouver and Fraser river harbours, it is necessary to have a brief description of the natural characteristics of those ports and their method of government and public control.

### Vancouver Harbour

Vancouver harbour comprises all tidal waters east of the line joining Point Grey and Point Atkinson. It is divided into three parts, the outer harbour and False creek, the central harbour lying between First and Second Narrows, and the inner harbour, lying above the Second Narrows. (See Fig. 1.) The total area of the harbour is 48 square miles, and the shoreline has a length of 98 miles. In general, the outer harbour with its beaches and homesite properties along the waterfront has been set aside as a recreational area, and confined to bathing, boating and sea-planing. False creek has been reserved for waterfront development to accompany heavy industrial operations. The central harbour water frontage with the exception of Coal harbour, has all been zoned for heavy industrial development, and there are located thereon, deep sea piers and wharves, coastwise piers and wharves, grain jetties, lumber assembly wharves, oil wharves, ferry terminals and ship repair plants in the form of drydock and marine ways. Coal harbour accommodates light industries in its outer reach, while at the Stanley Park end are located the Vancouver Rowing Club and the winter quarters of the Royal Vancouver Yacht Club. The inner and upper harbour is set aside in part to industrial development, principally on Port Moody Arm, while the North Arm is largely recreational, being used to a large extent for summer homes.

Let us now examine in some detail the regulations which are already in effect and the programme of future use and development of the various areas.

### Outer Harbour

The outer harbour which includes the mouth of False creek contemplates ultimately no industrial development west of Burrard street bridge. There are to-day some nonconforming uses on the north side of the mouth of the creek, but these will eventually be eliminated. Picture then Greater Vancouver's Marine Drive and beaches. Commencing at the westerly point of Point Grey, or even at South Granville street, and the north arm of the Fraser river, one may travel overlooking the ocean, and for the greater part almost along its shore, for a distance of thirty miles past Spanish Banks, Jericho and Kitsilano beaches, across Burrard bridge, westerly along First, Second and Third beaches, around Stanley Park, across the proposed First Narrows bridge at Prospect Point, thence along the north shore to Horseshoe bay and beyond. Further, it is likely that in a few years a marine driveway will extend northward along the east side of Howe Sound to Squamish and Garibaldi Park. Plans have already been completed and estimates compiled, and a public sentiment created to a considerable degree for this project. The beaches of the outer harbour are one of the community's greatest assets for the health and contentment of its citizens.

### False Creek

False creek as noted is zoned for heavy industrial development, and has already progressed to a considerable degree in this direction. Its industries include sawmills and other woodworking plants, bridge and structural steel assembly plants, manufactories heavy and light, fueling terminals, gas plants, marine ways and many smaller concerns. This waterway is the back door to the central business district and to the adjoining residential areas south and east of its shores. Once a shallow arm of the sea extending almost three miles easterly from English bay and connected at high tide with the central harbour, it is now a waterway carrying a dredged depth of twenty feet at low water for a distance of two miles or more. The malodorous tide flats have disappeared, wharves have appeared on the north and south shores, and extensive railway yards have been built at the easterly end of this waterway to accommodate the Canadian National and Great Northern Railways, occupying over five hundred acres and having an ultimate capacity of over twelve thousand cars. From time to time a suggestion has been put forward that False creek be reclaimed and filled with suitable material as far west as Granville street, the principal argument put forward being, that this would solve the transportation problem across False creek. Such a scheme would eliminate bridges, but not viaducts and grade separations, and it would destroy the enormously valuable water transport connection to the so called "back door" of the city.

The final development of False creek is not yet at hand but the accompanying plan (Fig. 2) prepared by the Town Planning Commission indicates what is anticipated as its ultimate development.

### Central Harbour

The central harbour of Burrard Inlet is the most important of the various subdivisions of Vancouver harbour. Here deep sea ships load and discharge cargoes of many varieties. Deep sea and coastwise passengers arrive and depart at and from its piers and wharves; it holds the romance of this ocean port. The south shore is already developed to about seventy per cent of its available shoreline. The nature of this development has already been


Fig. 1—General Plan of Greater Vancouver.

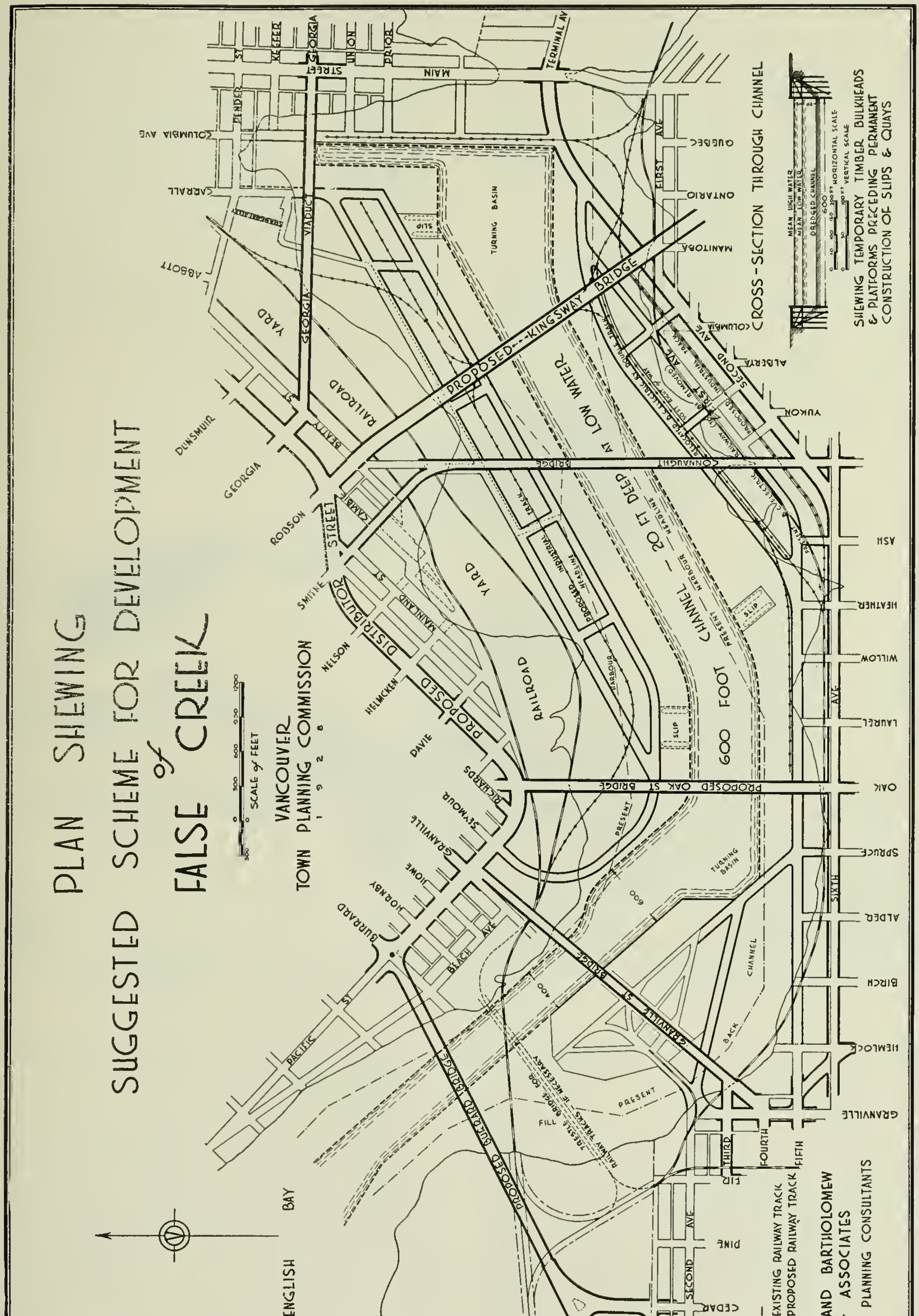


Fig. 2—False Creek Development.

referred to. Much of the development work is of a permanent nature, and several of the deep sea piers are of the finest in existence. The future planning of the south shore calls for an increase in capacity of railway trackage, particularly holding or storage yards, improved access to False creek railway yards (the C.P.R. tunnel being one of the recommendations already put into effect), extension of the waterfront roadway system, and a much improved system of fire mains, fire hydrants, and fire station as a headquarters for fire boats. Railway operating problems on the south shore are as yet quite complex and the maximum efficiency at the minimum of cost will be accomplished only when placed under one control for all local services in the form of a terminal or belt line railway.

The north shore of the central harbour is as yet almost virgin territory so far as any permanent development is concerned. It has in many respects far greater possibilities for development than has the south shore. These possibilities are shown by the plan. (Fig. 3.) Permanent construction has a wider field at lessened cost as compared with the south shore. Foundation and dredging problems are simpler. Railway connections are less difficult. Storage space for trackage is more commodious and adjoining industrial property is of much greater area. While the centre of population is now and will always be on the south shore, there can be no doubt that the north shore will in due time carry on at least half of the port's deep sea business. For this reason it is quite important to the citizens of Greater Vancouver that the town plan of the north shore of the harbour shall provide for the best possible use of its entire shore line when developed to ultimate capacity. Better transportation connections will then be required between north and south shores, for the north shore municipalities will in the course of time develop greatly, and many of their people will reside on the southern slopes of the mountains.

### Inner Harbour

The inner harbour of Vancouver comprises two distinct bodies of water, the Port Moody arm, seven miles in length, being a direct extension of the central harbour, while from this body of water the north arm of Burrard Inlet extends in a north westerly direction about twelve miles. The Port Moody arm is all zoned for heavy industrial development, but with the exception of the extreme upper end which has a shore line of two miles or more, the shores are fairly precipitous and the waterfront development is expensive. The principal expense involved in the development of this waterfront lies not so much in the construction of wharfage as in the excessive cost of reclaiming the shore by virtue of the heavy filling required. For the foregoing reason it is unlikely that the inner harbour industrial section will be extensively developed for a great many years. The Fraser river offers equally accessible waterfrontage with a much lower cost of construction, and of a type which would serve a similar class of business. The north arm of Burrard Inlet, while not definitely zoned as to use, possesses a shoreline which is of little or no industrial value. Its use is almost entirely given up to summer homes of people living in the Greater Vancouver area. The only exceptions to this use are two rock quarries and the Buntzen Lake power plant of the British Columbia Electric Railway Company.

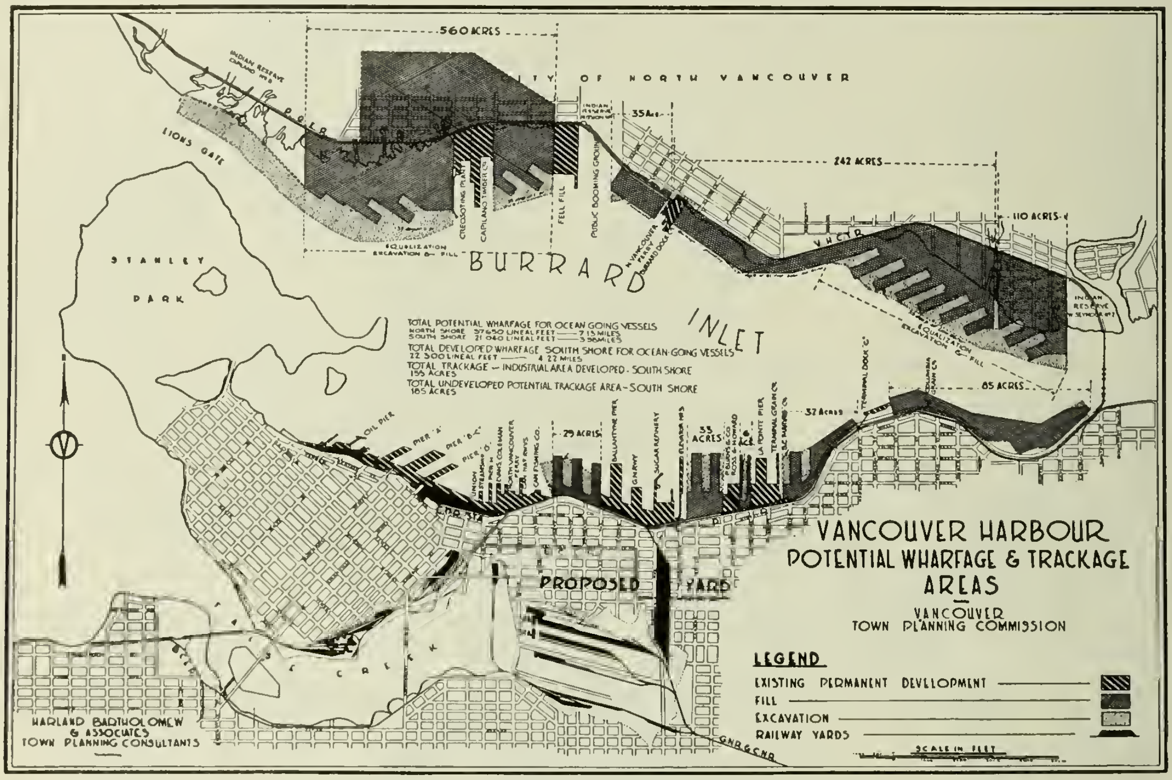


Fig. 3—Central Harbour, Vancouver.

### Improvements Projected and in Hand

While no general plan has been developed to cover the final picture of harbour development, there have been prepared detailed plans covering certain sections of the waterfront and of additional transportation facilities. (Fig. 4.) Many improvements have already been effected, the principal of which has been the betterments to navigation, which, due to heavy tidal currents, have constituted a serious problem. The First Narrows entrance to the inner harbour has over a period of years been widened from 700 to 1,200 feet and the tidal current reduced from six to four knots. Further widening to 1,500 feet is now planned, although it will undoubtedly require a great many years to effect, since coupled with this widening is the demand for increased depth. Some improvement has been effected at the Second Narrows but much remains to be done in

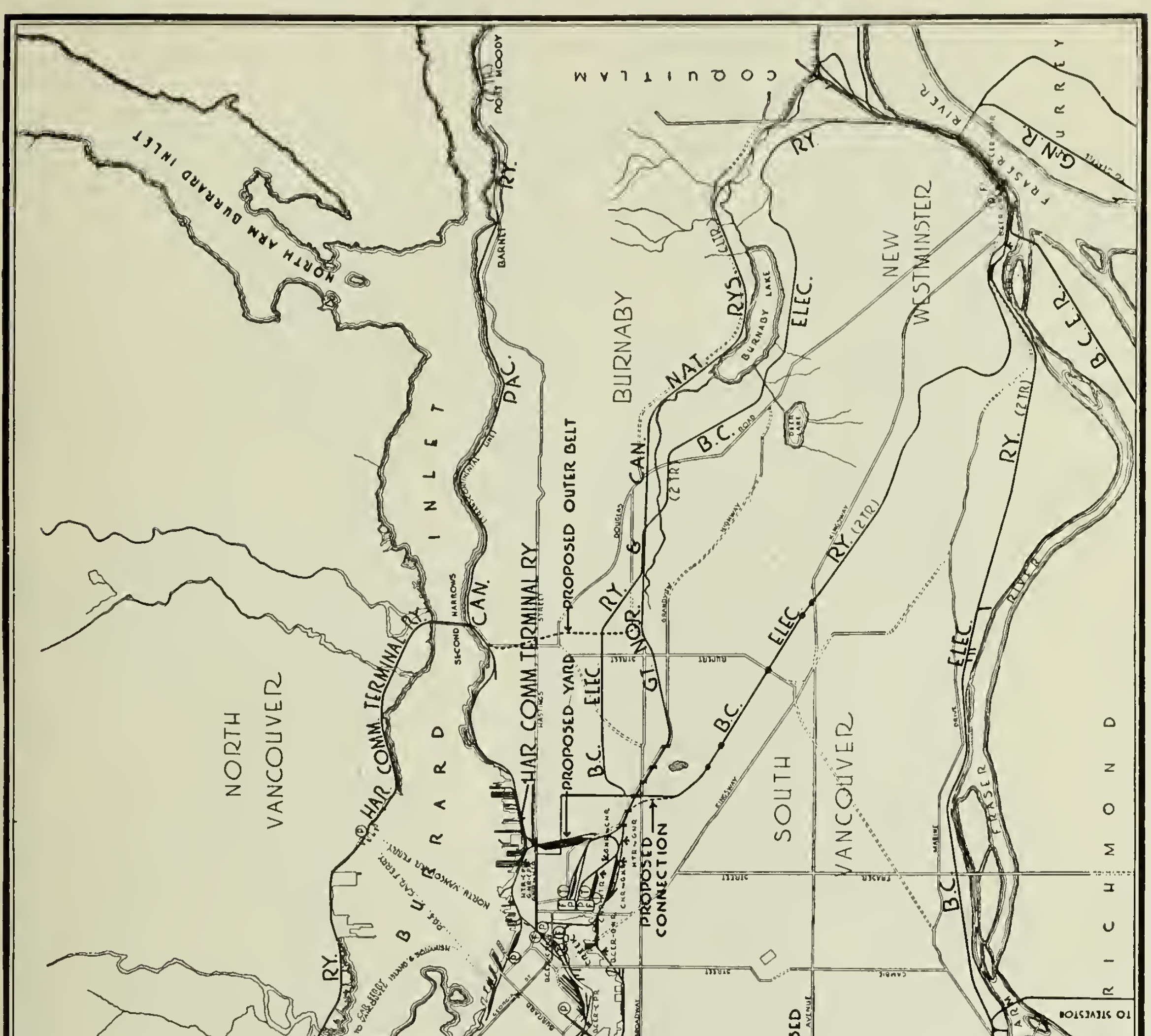


Fig. 4—Railroads and Harbour Plan.

widening and reducing the very heavy tidal current at this point. The Second Narrows bridge has been recently reconstructed, and for a period of at least twenty years, will have to answer the demand of rail transportation to the north shore. It is contemplated that eventually permanent improvement at the Second Narrows will be effected in the form of a lock or locks, possibly, but not definitely accompanied by a dam which would make the inner harbour a fresh water one. This subject has so many angles that it could only be dealt with in a separate paper. The False creek channel has been deepened to 20 feet at low water and has now a minimum width of 300 feet. Further improvements already referred to are contemplated in the extension of the shore line and further widening of the dredged channel.

Due to growth of population on the north shore, further transportation facilities will be required in the near future, and the project is well advanced for a high level bridge crossing at Prospect Point, the entrance to the inner harbour.

Plans for increased railway facilities within the Vancouver terminal and for additional waterfront roads are well advanced and some of the work which this scheme embraces has been placed under way. A waterfront roadway outside the railway tracks is planned extending from Lapointe pier to Port Moody. This embraces a very large programme of reclamation and filling; approximately 15 per cent of this work has been completed in the inner harbour and more is in progress. Provision is now made in all waterfront leases for the setting aside of a 90-foot strip to permit the continuation of this work in the future. The scheme also includes a belt line or terminal railway for the entire waterfront with the exception of the heavily developed portion of the inner harbour from Lapointe pier westerly to Coal harbour. Additional railway facilities have been planned and recently two new storage yards have been constructed, one known as the Glen Drive yard at the head of False creek, and the second the Harbour Commissioners' Hastings mill yard. The construction of these yards has considerably simplified the movement of traffic from Canadian National and Great Northern Railways to the waterfront of the central harbour. A large section of terminal railway, about four miles in length, including a 2,000-foot subway under the Esplanade and a very heavy grading operation at Moodyville, has in recent years been constructed on the north shore of the central harbour. The terminal railway, it should be explained, is owned and operated by the Vancouver Harbour Commissioners, a body appointed by, and representing the Federal government interest in the port. This body has full control and administration of all port business and is represented on the Vancouver Town Planning Commission.

Many minor and some quite interesting development projects of Vancouver harbour have been planned, but space does not permit a description of their details.

### Fraser River Harbours

The control and administration of the development of the Lower Fraser river is at the present time vested in two Harbour Commissions representing the Federal interests therein. The New Westminster Harbour Commissioners control and govern the main river from its mouth to Douglas island at present head of deep sea navigation, a distance of 25 miles. The north arm of the Fraser is controlled and governed by the North Fraser Harbour Commissioners. For the purposes of this paper, however, it is proposed to disregard the artificial division which has been set up in the control of these waters and to deal with them jointly in the matter of their use and service to the Dominion and more particularly to those areas which they serve. The main channel of the Fraser river is available for deep sea shipping, and now permits the operation of ships which draw not more than 26 feet of water when loaded. There is considerable difficulty in maintaining an adequate depth of water at the mouth of the main river, due to the silting often found in the deltas of such streams. This difficulty, however, is gradually being overcome by the construction of training walls and jetties to confine the water to a definite channel. Approximately 40 per cent. of the programme of work contemplated has been carried out at an expense of three million dollars. The principal development of the river to date has taken place in the vicinity of New Westminster, where ocean wharves have been constructed, providing berthage for fourteen deep sea ships at one time. No passenger business is at present transacted in the harbour of New Westminster but a growing freight traffic is well established. The Fraser river harbours do a very large part of the lumbering business of the province, and in the year 1929 reached a peak of five hundred and twenty million feet, of which approximately two hundred and fifty million was exported by water. The total cut represented approximately 30 per cent of the lumber manufactured by the entire province.

### New Westminster Harbour

The main channel of the Fraser river from Douglas island to the sea provides for almost continuous industrial development on both banks, although in most cases a certain amount of dredging is required, which fortunately can be utilized in the preparation of the site on the inshore side. The saw mill industry is particularly well accommodated on the main channel of the river, its only drawback being the movement of logs to the mill site during the freshet season, when the current is so heavy as to make towing upstream almost impracticable. The policy of the Dominion government with respect to industrial development has been generous, and in almost all cases, the dredged material is made available for the on-shore site at a nominal cost to the new industry. Dredging improvements are carried out entirely by the hydraulic method, two large dredges being used for this purpose, one of the usual hydraulic type pumping continuously through a pipe line to the shore or the land, the other the carrier type which picks up its own load of dredged material in the stream and pumps it out either on the shore or in deep water outside the mouth of the river.

The problem of road and rail access to various water frontages of the Lower Fraser is simple compared with Vancouver harbour. Railway service is already available to the entire frontage on both banks of the Fraser river with the exception of a ten-mile strip on the south shore from a point opposite Annacis island to the sea. With the exception of the city of New Westminster, no definite plan has as yet been adopted with respect to waterfront roads, but it is anticipated that these will follow and parallel the existing railway lines. In the city of New Westminster itself a waterfront road known as Front street has been developed in rear of the waterfront wharves and adjoining railway trackage. This is a wide thoroughfare, and will adequately care for future requirements. Railway trackage adjoining the river is ample and convenient and the cost comparatively light. As yet no definite step has been taken towards serving the waterfront by a terminal railway system, although it has been before the Harbour Commissioners for their consideration, and inter-switching arrangements between the various operating railways have been modified and improved from time to time at a gradual decrease in cost. Four railways at the present time serve various sections of the waterfront of the harbour of New Westminster, namely the Canadian National Railways, Great Northern Railway Company, Canadian Pacific Railway and the British Columbia Electric Railway Company.

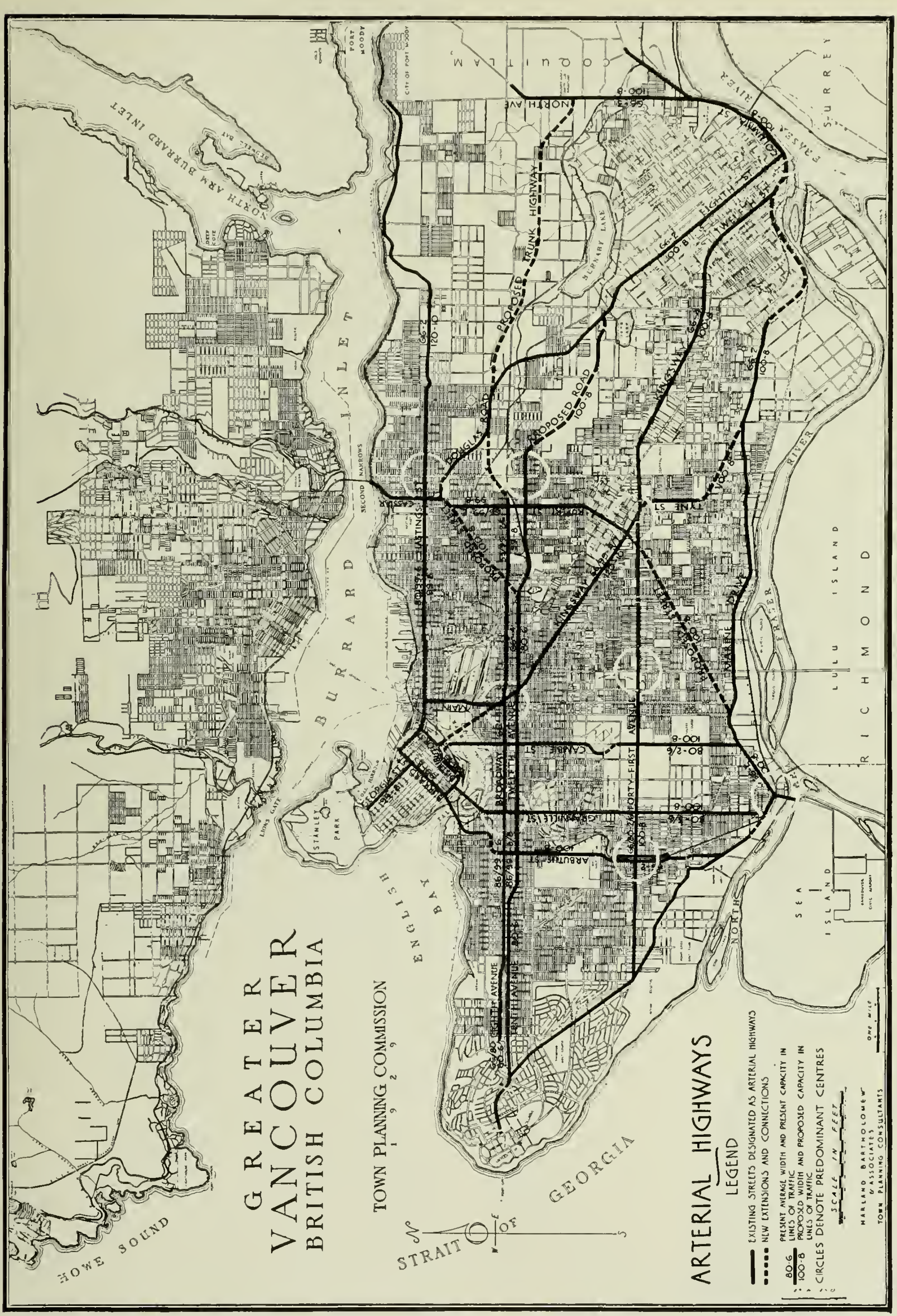


Fig. 5—Arterial Highways.

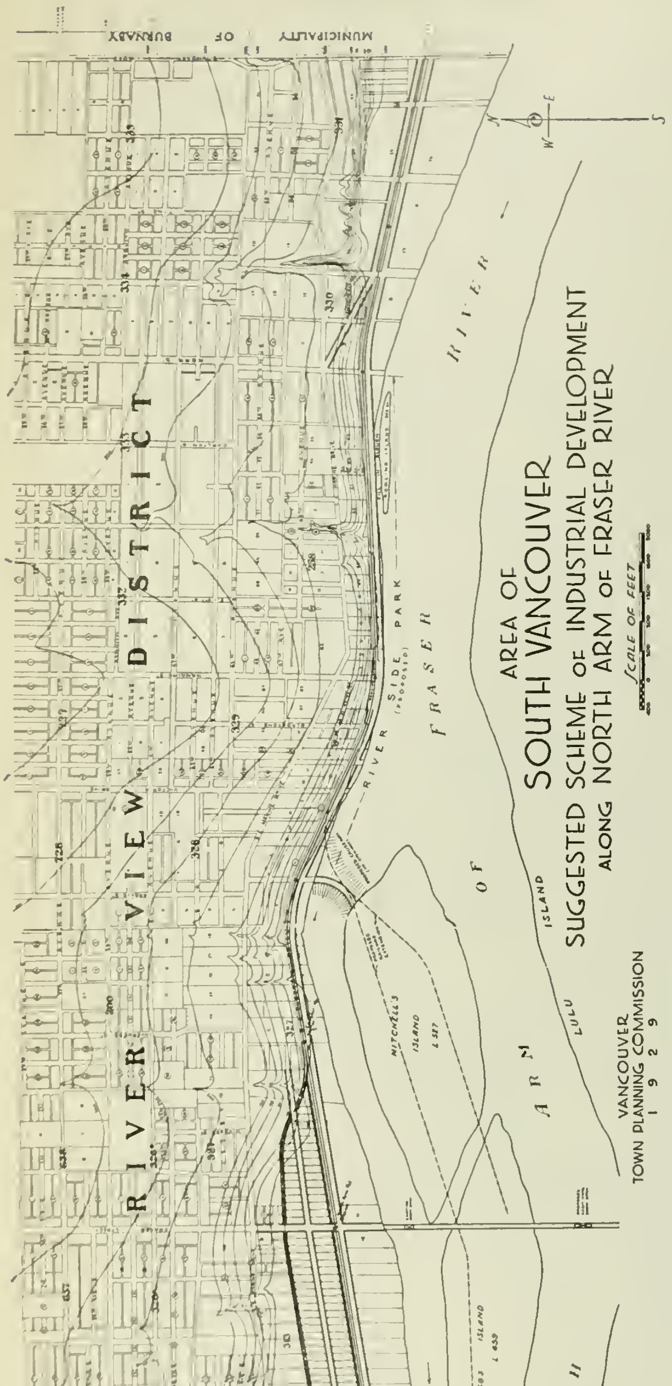


Fig. 6—South Vancouver Shore Development.

The largest single development on the river operating an export business is the Pacific Coast Terminals. This company operates four terminals in the city limits of New Westminster and provides for seven deep sea berths. The railway handling at its main No. 1 terminal is carried out by its own motive power, the company operating two locomotives for its own use.

A recent development of the port has been the construction of a grain elevator on the south shore opposite New Westminster by the New Westminster Harbour Commissioners. This elevator is leased to one of the larger private companies, and for the first time during the past season an appreciable amount of grain has been handled. The total shipment this year will amount to approximately three million bushels.

Transportation across New Westminster harbour is at the present time adequate so far as railway service is concerned, but quite inadequate for vehicular traffic. A large ferry is operated on the lower river between Ladner and Woodward's Landing, accommodating motor vehicular traffic and passengers. The New Westminster bridge is a combined railway and highway bridge, but the highway portion is unsuitable for present day traffic, due both to the narrowness of the thoroughfare and the fact that it was originally designed for much lighter motor truck loading than now exists. Two proposals are before the Harbour Commissioners for improvements, namely highway bridges at Ladner and at New Westminster. Charters have been granted by the province to private bridge companies for these two sites and there is every reason to believe that one, if not both of these structures will be built in the near future. The improvement which would follow would undoubtedly stimulate industrial development in the port of New Westminster.

Actual and proposed arterial highways are shown in Fig. 5.

The government of the harbour of New Westminster is similar to that of the port of Vancouver with the exception that the city of New Westminster nominates one of the three commissioners and in addition the Act provides that the net revenue of the port shall become the property of the city of New Westminster from time to time when such revenue is not needed for development plans of the immediate future.

In general it may be assumed, and the policy of the commissioners is directed accordingly, that the port of New Westminster will secure the bulk of those industries requiring substantial amounts of waterfrontage with considerable rear area for their operations and extension. Cheapness in the question of sites, in their development cost and in maintenance indicate strongly that this type of development will ensue. There is no teredo or other marine borer action on the Lower Fraser river, and in consequence it is unnecessary to use treated material for the foundation of waterfront structures there.

### Future Development

To date there is only one large project and definitely planned development which has been stated and planned by the Port Authority. This is the construction of a land locked deep sea harbour in the Annacis channel. It is proposed to close the upper end of that channel by means of a dam and causeway, and deepen and widen the channel for its entire length. This development will provide approximately three and one half miles of deep sea waterfrontage on the two banks of the deep sea channel so formed. Ample room exists in rear of the channel on both banks for a very valuable development of this section of the harbour.

### North Fraser Harbour

The North Fraser harbour limits extend from the Lulu island bridge at the upper end of Lulu island to the straits of Georgia. The actual shore line of this body of water lies in four separate municipalities, namely New Westminster, Burnaby, Vancouver and Richmond. It accordingly becomes difficult to deal with this development in the same comprehensive way as in Vancouver. So far, the on-shore planning has been confined almost entirely to the area bounded by the city of Vancouver. Of this area the westerly portion from the foot of Angus drive to the sea has been zoned as residential and recreational, while the balance, easterly to the city boundary with Burnaby, has been zoned for industrial use. There is one exception to the above, namely, a park area has been set out for approximately 6,000 feet of frontage immediately east of Mitchell island, which it is proposed to denote as "Riverside Park." (See Fig. 6.)

The general use of the north arm so far as the city of Vancouver and Burnaby are concerned, is not dissimilar to that of False creek. It now serves and will in future serve to a greater extent the local needs of the community living on the south slope of Vancouver and Burnaby. There is considerable sawmill development and in the neighbourhood of Eburne there is an industrial section which embraces several types of industry. The channel is used entirely for shallow draught shipping, its depth at the present time being maintained as 15 feet at low water. The final plan proposes 20 feet at low water, which will then accommodate coastwise shipping. The movement of logs to lumber mills on the main river from points on Vancouver island and the northern coast is confined almost entirely to this channel and the Harbour Commissioners have provided certain booming and mooring grounds to assist in the log movement.

As on the main channel of the river, a training wall has been constructed at the mouth of this channel, which, when completed, will confine the flow of the water to a comparatively narrow area between this training wall and the shore line of the Point Grey section of the city of Vancouver. Approximately $900,000 has been spent on this improvement work to date, and its completion will involve an additional expenditure of approximately the same amount. It will have to be accompanied by a considerable programme of dredging in the same area. The general problem of dredging, however, is less onerous than in the main river, due to the fact that a comparatively small amount of silt laden water passes through this channel during freshets. Consideration has been given to the construction of a lock at the point where the north arm leaves the main river. Such an arrangement would entirely eliminate silting and would assist in the maintenance of depth in the main river by virtue of the fact that a greater amount of water would then pass through the main channel. While it is quite possible that this scheme may eventually materialize, the expense is considerable and certainly is not warranted at the present time.

The government of North Fraser harbour is by Commission, organized similarly to that of Vancouver, but due to the fact that very little revenue is received in its operation, no general plan of development has so far been prepared. Pier headlines have been established throughout its length on both sides of the river and as development gradually takes place, the channel becomes better defined and consequently maintains its dredged depth more satisfactorily.

Railway connections to the north arm are fairly complete, there being in existence continuous service to both sides of the channel from New Westminster to Eburne. It is probable that in due course additional railway service may be extended to Sea island, but this appears to be well in the future. Roadway access to the waterfront is well developed on Lulu island and in the Vancouver area but considerable remains to be done in the area covered by the municipality of Burnaby.

A modern airport known as the Vancouver Airport and Seaplane Harbour has been established and at a cost of $300,000, partially constructed, on the south arm of the North Fraser harbour. The site when completely developed will comprise six hundred acres of flying field and five thousand feet of seaplane waterfrontage, the width of the seaplane harbour being sixteen hundred feet. The site in question was recommended by the Vancouver Town Planning Commission.

In the matter of government, it seems to be generally conceded that with the three distinct corporations administering the port business of the harbours of Vancouver, New Westminster, and the North Fraser, control is excessive. Undoubtedly two corporations would be sufficient for all purposes and in the course of time it is probable that the joint interests of all three bodies will become so intermingled as to make advisable the setting up of one port authority in the entire area. Due to differences in the form of administration and to local prejudices, the time is not yet opportune for such a proposal but a better understanding of these differences is gradually ironing out much of the prejudice. It is but one more example in Canada of the high cost of too much government.

# The Automotive Diesel Engine

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SUMMARY.—The paper outlines the early development of the Diesel engine and discusses its characteristics as regards the methods of injecting the fuel into the cylinder and the process of combustion as influenced by the type of injection and the design of the cylinder head. A number of points in design and construction require attention when applying the Diesel engine to automotive work. These are mentioned and data given as to the performance and economy which may be expected.

### Historical

While Dr. Rudolf Diesel, the inventor of the engine so universally named after him, undoubtedly had in mind the possibility of his engine being used in road vehicles, he unfortunately did not live to see the real fulfilment of this objective. For many years after its conception the development of the Diesel engine was slow, but finally the transition from the heavy slow moving type of engine to the high speed automotive engine came about very quickly when the magnitude of the development is taken into consideration.

Although the original patent specification was published in the year 1892 it was not until five years later that the first Diesel engine was put into commercial operation. This was at the works of the M.A.N. company at Augsburg in Germany. Great interest was taken in this engine and it was generally acclaimed as being the most efficient form of heat engine known; a condition which still holds good.

During the next fourteen or fifteen years the development of the use of the Diesel engine was naturally slow,—there were many obstacles to be overcome, not only with regard to the design and manufacture of the engine itself but also with regard to its public acceptance. Fear of the shortage or high price of suitable fuels was raised, possibly by competitors, and the inventor was himself largely responsible for proving the tremendous variety of fuels which could be successfully employed in this type of engine. However, at this time land installations were becoming quite common in all countries of the world and in the year 1911 there were probably as many as three hundred vessels in service with Diesel motors for propulsion purposes, the largest of which, however, would not exceed 1,000 h.p. in output.

During the next fifteen years or so, up to, say 1926 and 1927, the development was more rapid, not only with regard to its use but also with regard to size. Land installations had multiplied all the world over, numbers of manufacturers were building the engine, and in many countries the Diesel engine had become as familiar as the older reciprocating steam engine. At sea, however, a very striking advance had been made; not only were there as many motorships being built as steam ships, but the available horse power per engine had been increased to 15,000 in actual service and 20,000 designed.

Throughout this period, however, the heavy weight, large bulk and slow speed of the Diesel engine made its use in the automotive field out of the question. Up to the year 1925 weights were at least 200 pounds per horse power, while many types of engine exceeded this figure. Nevertheless attention was being paid to the possibility of the engine being built in a much lighter form and with higher speeds suitable for use in vehicles. In the year 1909 Dr. Diesel built a 30-h.p. four cylinder reversible engine, which ran at the very high speed (for that time) of 600 r.p.m., to which he referred as being "for an automobile engine for heavy loads or marine work."

By 1927, however, considerable advance had been made, especially in Germany, and engines of 50 brake horse power, weighing about 1,500 pounds and turning at speeds up to 1,000 r.p.m. were in actual use. At the same time the development of the high speed Diesel particularly for marine service was also taking place, and in 1929 and 1930 engines with specific weights reduced to 30 pounds per horse power were quite common.

It might be said that in 1927, commercially the automotive Diesel was almost unknown, by 1930 it was recognized as a real possibility and by 1933 there were at least thirty manufacturers producing automotive Diesels with weights as low as 10 pounds per horse power, speeds as high as 4,000 r.p.m. (more generally, of course, at much lower speeds) and in sizes from about 40 h.p. up to say 150 h.p.

The history of the development would be incomplete without at least a reference to the fact that some few years ago the Diesel also became available for use in the aeroplane, having its weight reduced to as low as 2¼ pounds per horse power, a truly remarkable achievement.

### Stages of Mechanical Development

There has been a certain amount of controversy regarding the real origin of the type of engine which has become universally known as "Diesel," owing to differences of opinion regarding the responsibility for the invention of some of the finer points. However, as far as the "man on the street" is concerned he has been satisfied to apply the name to almost every type of internal combustion engine using oils heavier than gasoline provided compression ignition either wholly or in part, was used.

Diesel's patent specification is a lengthy one covering every feature of a "process for producing motive work from the combustion of fuel." After drawing attention to the faulty process in previous use and describing in detail the working of his engine, either with a pulverized solid fuel or with a liquid fuel, he claimed as his invention an engine in which high compression created a sufficiently high temperature to ignite the fuel without other means, and in which combustion took place on a constant pressure cycle.

During the course of the years both these features have gone through many changes and variations. For example, for a long period, and indeed up until quite recently, many engines were built which did not have a sufficiently high compression to give compression ignition in its entirety but relied on some form of additional heat being supplied to aid ignition. The term "Semi-Diesel" was applied to these engines. The extra heat required was obtained in many ways, such as hot tubes, hot bulbs, uncooled portions of the cylinder heads, electric igniters and so forth, the chief advantage of this form of engine being the use of lower compression ratios which facilitated manufacturing and at the same time gave a somewhat more silent running engine. However, it had the disadvantage of not obtaining the highest possible efficiency. In recent years the Semi-Diesel has been almost entirely eliminated and practically all forms of the modern engine are "Full Diesel."

Similarly the constant pressure cycle has not been adhered to. Many engines have used a constant volume cycle, and many are designed to operate on a combination of constant pressure and constant volume cycles. However, the actual internal cycle has not been considered of sufficient importance to warrant special reference in the designation of the engine. The automotive Diesel of today almost entirely operates on a combined cycle and indeed may change its cycle during its operation to meet different conditions.

While the question of whether an engine operates on a two-cycle or four-cycle principle has nothing to do with the Diesel principle, which is equally applicable to either type of engine, nevertheless there developed in the world of Diesel engine users and builders a "battle of the cycles." In the automotive field, however, the two-cycle engine is almost non-existent (with the exception of the Junkers opposed piston type engine which is two-cycle in principle) so it is unnecessary to enter into this controversy in discussing the automotive engine.

Another phase of the mechanical development has been the use of compressed air in conjunction with fuel injection giving rise to the terms "blast air" and "air injection." Dr. Diesel makes reference in his specification to the use of air at a higher pressure than the compression pressure but apparently it is not cited as one of the essential features of his invention. Nevertheless for many years air injection came to be looked upon as one of the essential features of the engine, and as very high pressures, up to 3,000 pounds per square inch and more, were required, this was a feature which led to a great deal of mechanical trouble. Diesel engines thus came to be divided into two classifications, "air-injection" and "solid injection." The latter has been steadily gaining ground and in the case of the automotive engine is universal.

Up to the time of the introduction of the automotive Diesel, therefore, there were alternative combustion systems available described as Diesel and Semi-Diesel, and at the same time there were available two- and four-cycle engines and also air injection and solid injection engines. In the case of the automotive engine it is fortunate that these controversial features have all been settled, as the Diesel, four-cycle, solid injection engine is the only type being used. However, there must be controversy, and at the present time it is broadly over the general merits of the two main types of combustion systems used, namely direct injection versus pre-chamber, the latter system having in turn a number of variations.

During the various stages of mechanical development considerable departure was made from the ideas originally contained in the Diesel patent, and many arguments were raised against the continued use of the name Diesel as applied to engines which were characteristically different and in the marine world the name has been more or less dropped and the term "motorship" generally adopted. Similarly in the automotive field in Great Britain the term "oil engine" has been universally adopted. In the United States the name Diesel has been retained and in Canada both forms of nomenclature are used. The use of the name Diesel leads to a certain amount of confusion especially to the lay mind, nevertheless the term "oil engine" is far from being a correct description of the characteristics of the engine.

### Characteristics of the Diesel Engine

In their mechanical construction the majority of automotive Diesels follow conventional designs, quite similar to gasoline engine practice. This is a very fortunate circumstance for the development of the engine because only a few of the larger users could possibly develop especially trained personnel. In the great majority of cases the automotive Diesel has to be operated and maintained by a personnel which has been brought up on gasoline engines. The inherent parts of the engine such as the crankshaft, connecting rod, pistons, valve gear and valves are essentially the same as in gasoline engine practice but are designed to take care of higher working stresses and higher compressions. It is of interest to note, however, that the automotive Diesel has not come into existence as a development of the gasoline engine but rather as a development of the heavier types of Diesel, which accounts for the fact that very few gasoline engine manufacturers had very much success in their first attempts to produce a Diesel. The Diesel engine, and especially the automotive type, is far from being an easy engine to build, a fact which was fully appreciated by the inventor, as in a preface to "Diesel Engines" by Chalkley, written in 1911, he states "The Diesel motor must be constructed with extreme care and the best materials employed in order that it may properly fulfil all its capabilities; only the best and most completely equipped works can build it . . . The Diesel motor is therefore not a cheap engine, and I would add a warning that the attempt should never be made to try to build it cheaply, by unfinished workmanship, particularly for export."

The fundamental difference between the Diesel and gasoline motor comes about entirely through the fact that compression ignition is utilized in the former, and all other differences are subsidiary to, and resultant from this particular feature. The use of compression ignition leads to the impossibility of compressing, on the up stroke of the piston, a combustible mixture, otherwise pre-ignition would take place. In the gasoline engine a charge of air and fuel, well mixed by the carburation process, is drawn into each cylinder and compressed to a point where the resultant temperature is not high enough to cause ignition of the mixture, and then ignited at the required instant by means of an electric spark. This necessity of avoiding pre-ignition places a definite limit on the highest useful compression ratio which varies with the type of engine and particularly with the type of fuel. For example, with low grade gasolines, the ratio will be as low as 4½ to 1, while with high grade ethyl and aviation gasolines it may be as high as 7 to 1. In the case of the Diesel engine compression ratios of at least 13 to 1 and as high as 19 to 1 are in use, with the consequent necessity of only admitting fuel at the instant when it is proper for combustion to take place, namely near the top dead centre.

The problem which therefore had to be solved, was that of measuring out very accurately minute quantities of fuel oil, forcing it into the combustion chamber against a fairly high pressure and at the correct instant and for the correct length of time, disintegrating it into still smaller droplets and finally distributing these droplets uniformly throughout the combustion chamber. Furthermore the whole performance must be repeated with great regularity and frequency. Actually in an average size Diesel engine the amount of fuel to be injected for each combustion stroke may be as little as a cubic millimeter, the length of the injection period may only be 1/150 or 1/200 of a second and occurring perhaps twenty times every second.

The actual process of fuel combustion is different in the two types of engine. In the case of the gasoline engine the combustion chamber is to all intents and purposes completely filled with a combustible mixture of air and gasoline vapour at a pressure of about 100 pounds per square inch, when a spark is applied creating a flame which gradually spreads throughout the chamber burning up all the oil. The term "gradually" is of course relative, but is very important. It is only by insuring the gradual propagation of the flame throughout the chamber that a smooth running engine will be obtained. From the instant when the spark is applied there is a definite delay period before the flame spreads and causes an increase in pressure. This delay period varies with different fuels but in any one engine is fairly constant in point of time regardless of the speed of the engine, which leads to the necessity of varying the time of ignition with the speed of the engine in order that the end of the delay period may approximately coincide with top dead centre, otherwise there will be a knock if ignition is too early or a loss of efficiency if it is too late. Care has to be taken, however, that the rate of pressure rise in the combustion chamber after the delay period is kept below a critical figure otherwise detonation will take place giving rise to a knock. In other words if the rate of propagation of the flame is too great, the pressure on the unburned portion of the fuel mixture rises so rapidly that the resulting heat cannot be dissipated fast enough with the result that this unburned portion of the fuel ignites spontaneously, that is to say, explodes or detonates, causing an objectionable knock.

Briefly, therefore, combustion in the gasoline engine may be described as taking place in two distinct periods, first the delay period during which the nucleus of a flame is being formed without any particularly noticeable pressure rise, and secondly, the period when the flame spreads throughout the combustion space causing a definite rise in pressure.

In the case of the Diesel engine, however, the process is essentially different owing to the fact that the fuel itself is only gradually admitted during the combustion period. What actually occurs is that at the correct instant, which in practice is from 10 to 20 degrees before top dead centre, fuel injection commences, but as in the case of the gasoline engine there is a certain delay period before the commencement of the real pressure rise. This period is also fairly constant in time for a given fuel, leading to the necessity of varying with the speed of the engine the time at which ignition commences. During this period some of the very finest particles of the injected oil are ignited by the hot air, forming the nucleus of the flame in very much the same way as in the gasoline engine, but from this point on the flame has to be fed with additional fuel instead of being allowed to spread through the fuel that is already present. It naturally follows that since the fuel is being injected at one point, either the products of combustion must be removed from the vicinity of the injector and replaced by fresh air supplies, or else the fuel itself must be injected through the burning area to the fresh air beyond, which leads to the necessity of providing a very definite turbulence or commingling of the air and fuel if complete combustion of the maximum amount of fuel is to take place. In a gasoline engine turbulence is necessary but a sufficient amount is created by the compression normally provided; in the case of the Diesel, however, this is not nearly sufficient and a much greater stirring up of the air and fuel and indeed a controlled stirring up is absolutely necessary. There are many methods of obtaining this turbulence, and what happens during the combustion period in any particular engine depends entirely on the method adopted. For example, the oil injected during the latter part of the injection period may be shot right past the flame, ignited as it passes, and completing its burning in the more distant parts of the chamber, thus giving rise to a condition somewhat similar to the spreading of the flame in the gasoline engine. On the other hand the flame may be kept more or less stationary and adjacent to the injection nozzle with provision for bringing up fresh supplies of air continually displacing the products of combustion.

At this point reference might be made to the difference in pressure conditions. In the gasoline engine, the pressure at the end of the compression stroke may be about 100 pounds per square inch and the pressure rises to say 250 pounds per square inch. Maximum pressure naturally has to be obtained within a few degrees of top dead centre but it is at least possible to spread this rise over 8 or 10 degrees of crank angle hence avoiding too rapid a pressure rise which would cause a knock. In the case of the Diesel, however, much higher pressures are involved, and within a comparatively small crank angle it is now necessary to reach a maximum pressure of six or seven hundred pounds per square inch making it very difficult to avoid some knock, which has been one of the characteristics of the Diesel engine. It has been possible, however, to build automotive Diesel engines in which the transition from one stage to another is so smoothly made that the characteristic knock largely disappears especially at high speeds.

The use of heavier oils than gasoline comes about as the result of the compression ignition system, because far more efficient combustion takes place at the higher pressures. It is a characteristic therefore of the Diesel engine, that not only does it burn its fuel far more efficiently than a gasoline engine, but at the same time it has the capability of burning low grade fuels which naturally cost very much less than the highly refined gasolines. It is quite possible to burn some of the heavier oils in a low compression engine with the carburation system, but the efficiency is low, added to which is the difficulty of obtaining reliable ignition under all circumstances. Conversely gasoline can be burned in a compression ignition engine with high efficiency, but the engine would have to be designed for use with gasoline for which commercially of course, there is no justification. If gasoline is burned in a Diesel engine designed to operate on a heavier oil, the combustion characteristics will be different with the result that a smooth running engine would no longer be the case and it would only be a matter of time before mechanical troubles might ensue.

Another characteristic of the Diesel which is essentially different from the gasoline engine is the lower mean working temperature, which also comes about as the result of the compression ignition system. While the temperature at the end of the compression stroke is very much higher in the

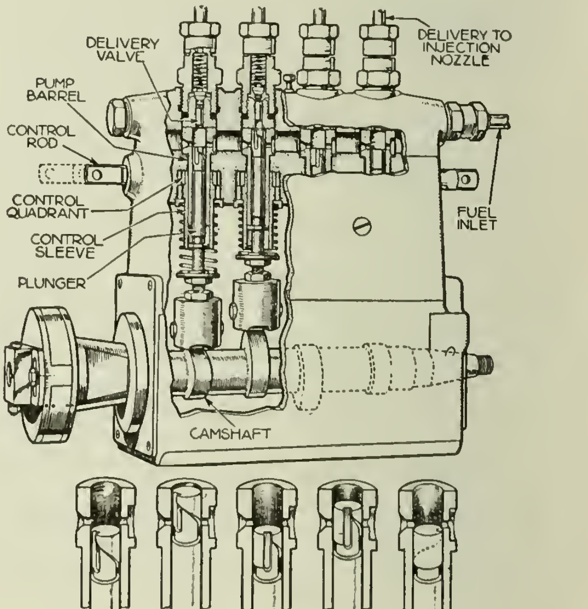


Fig. 1—The Bosch Pump.

Diesel, the temperature at the end of the pressure period or at the beginning of the working stroke is very much lower owing to the smaller quantity of fuel more efficiently burned. The exhaust gases are also discharged at a very much lower temperature, and losses to cooling water and by radiation are lowered, all contributing to the higher overall efficiency of the engine.

It will be clear that the designer and builder of an automotive Diesel engine had a number of problems to solve, which may be broadly summed up as follows:—First of all he had to devise a method of measuring and pumping at high pressure very small quantities of fuel with very accurate timing and with great frequency, and at the same time to provide for considerable flexibility owing to the necessary speed and load variations. Secondly, he had to provide a means of injecting the fuel into the cylinder head. Thirdly, he had to provide for the dissemination of the fuel throughout the combustion chamber, under widely varying conditions of load and speed in the same engine. While solving his problems he had also to take care that his final product had all the good points of the gasoline engine such as flexibility, speed range, smoothness, clean exhaust and silence. Needless to say success did not always crown his efforts, nevertheless taking into consideration the nature of the problems to be solved, he has been remarkably successful.

## Mechanical Features

*Fuel Pumps.*

There are naturally a large variety of fuel pumps in service today and indeed a variety of systems. The system which is almost universally used, however, is that in which there is an individual fuel pump for each cylinder of the engine. In this system the fuel pump itself performs the functions of timing, measuring and delivering thus avoiding the necessity of timing valves at the injectors themselves, which are used in some of the other systems. Pressure has to be provided to at least 1,000 pounds per square inch in many engines, to 2,000 pounds in most direct injection engines, and in some rare cases to 10,000 pounds per square inch. Furthermore the amount of fuel to be measured out must be variable under the control of the governor or accelerator pedal, and the timing of the commencement of injection must also be varied in accordance with the speed of the engine.

Obviously the manufacture of such a pump is a highly specialized proceeding and it is not surprising that many Diesel engine manufacturers have found it preferable to purchase this part of the equipment from the Bosch company, who originally became famous as manufacturers of magnetos for gasoline engines. While the Bosch pump is in more extensive use than any other type, a study of all the various means of obtaining the same end is of interest to the mechanically minded. There are constant stroke and variable stroke pumps, there are single plunger and double plunger pumps and many other combinations.

The Bosch pump, which is illustrated in Fig. 1, has all the simplicity of the constant stroke single plunger type, with an ingenious arrangement whereby the effect of a variable stroke is obtained. A special camshaft is usually provided driven at one-half engine speed, and a cam is set for each cylinder. A series of plungers are mounted over the cams in units of one, two, three or four to a set. Every plunger has a roller at the lower end which is kept in contact with the cam by means of a heavy spring, so that as long as the engine is turning the plunger is moving up and down with a constant stroke. The plunger, however, is free to turn on its vertical axis under the control of a geared quadrant which meshes with a horizontally sliding rack which in turn is under the control of the governor or accelerator pedal. The upper end of the plunger, which is a close sliding fit in its barrel, is cut away helically for a portion of its periphery below the top, leaving an irregular annular passage of varying depth. By turning the plunger by the above mentioned quadrant, the period for which the inlet ports are closed can be varied, being proportional to the depth of the annular passage below the top of the plunger; thus the discharge of the pump can be controlled by the pedal or by the governor from nothing to the maximum.

The necessary variation of the time of injection is obtained by rotating the camshaft in relationship to the crankshaft—a simple mechanical problem carried out in various ways.

*Injectors or Sprayers.*

As in the case of the fuel pump there are many types of injector in use, but in the main they may be divided into two classes, namely high and low pressure. The former are essential for use in direct injection engines and the latter may be used in conjunction with other forms of combustion system, such as the pre-chamber design, to which reference will be made in due course.

The purpose of the sprayer is to break up the fuel stream into fine particles and to distribute the particles throughout the combustion chamber. It is necessary that this should be done without any "dribble" and with a clean cut-off at the end of the injection period. The majority of sprayers have some form of spring loaded valve which is raised as soon as the pressure developed in the feed line by the pump reaches a pre-determined amount. The oil is then forced through the nozzle by the pump. The nozzle itself varies in different designs. For example in the case of a direct injection engine, it usually contains a number of very small orifices set radially. For engines where a high degree of turbulence is provided, it is not necessary to break up the fuel so minutely and so nozzles of the Pintle type or with a single jet are utilized. It will readily be seen, however, that any study of sprayers is contingent upon the design of combustion chamber with which it is to be used.

*Combustion Chambers.*

As previously explained the combined design of combustion chamber and sprayer must be such as to permit the complete burning of the maximum amount of fuel if the highest efficiency is to be obtained. The large variety of designs in general use can be broken down into four groups, each of which has its own characteristics, its own advantages and disadvantages, and its own adherents.

There are probably more engines in use with direct injection systems than with any of the other types, so this system will be described first. A general type is illustrated in Fig. 2A. In a direct injection engine, the combustion chamber is simply the space between the top of the piston, which may be slightly dished, and the flat under side of the cylinder head. As only a limited degree of turbulence is possible with this design, it becomes necessary that high injection pressures and very fine sprayer nozzle orifices must be used, in order to atomize the oil into the smallest possible particles and at the same time project these particles to the farthest limits of the combustion chamber. One manufacturer very simply solves the problem of creating such turbulence as is necessary with this system by shielding one side of the inlet valve, with the result that the incoming air on the suction stroke, enters the cylinder tangentially setting up a swirl which is maintained during the compression stroke, with the final result that the oil is injected into a revolving mass of air.

In another design the sprayer is set tangentially so that the action of the spray is to set up a swirl within the combustion chamber.

A second system, illustrated in Fig. 2B, is a modification of direct injection utilizing a separate chamber formed in the cylinder head, into which the oil is injected. This chamber is usually in the form of a sphere directly open to the main body of the cylinder. The effect during operation is that on the compression stroke air is forced into the sphere with a definite rotary motion and fuel is then injected into this highly turbulent mass. In this way the necessity of fine atomization is avoided, and as the maximum travel required within the combustion chamber is very much less than in the case of the direct injection engine a very much lower pressure of injection can be used. The process of combustion is started with the finer particles of oil, and the expansion resulting therefrom working its way out into the main cylinder space results in so much turbulence that the larger particles of oil are burned up in due course.

The third system, illustrated in Fig. 2C, is the pre-chamber proper, which is not very extensively used in

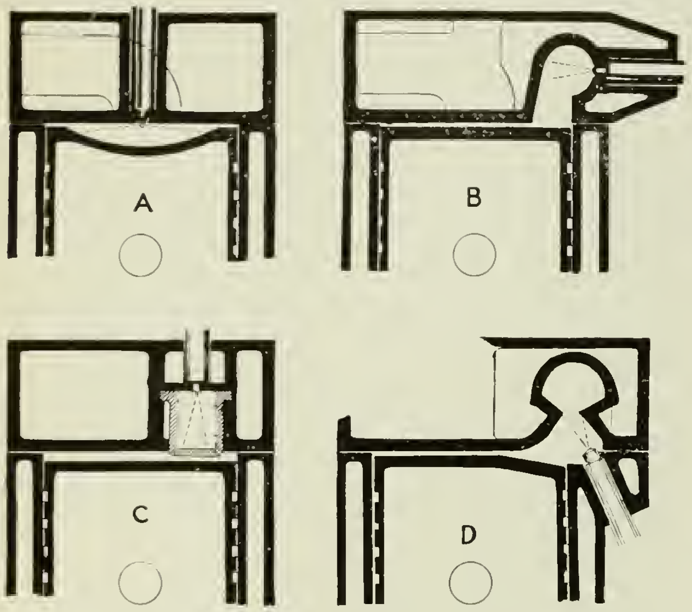


Fig. 2—Types of Combustion Chambers.

automotive engines, but nevertheless has its adherents in some of its forms. In this design the fuel is injected into a chamber formed in the cylinder head, which is only connected with the cylinder proper by comparatively small orifices. The action is somewhat as follows:—During the latter part of the compression stroke air rushes through the small orifices at considerable pressure and velocity, thereby setting up a high degree of turbulence in the chamber. Oil is then injected, and again it is not necessary to have fine atomization or high spray velocity hence a low pressure single spray orifice can be used. As the finer particles of oil burn in the chamber a considerable pressure is built up therein, finally rushing through the small orifices, carrying the heavier particles along with it into the cylinder proper where combustion is finally completed. The high velocity obtained through the orifices sets up a high turbulence in the cylinder thereby enabling combustion of the larger particles of oil to take place.

In the fourth system, illustrated in Fig. 2D, an expansion chamber is provided either in the cylinder head or in the top of the piston, with a somewhat constricted entrance. The amount of the constriction varies in different designs. The sprayer is so located that oil is injected against the narrow part of the opening into the chamber and not directly into the chamber. During the compression stroke considerable turbulence is set up owing to the passage of air into the chamber. When injection commences, combustion starts around the mouth of the chamber and partly within as well, with the result that the air in the chamber expands, rushes out against the oncoming stream of oil, carrying it into the body of the cylinder, in this way setting up high turbulence.

In giving consideration to the relative merits of the different systems, the problem has to be viewed from two different angles, namely manufacturing and operating. From the manufacturing point of view the direct injection system has the disadvantage of requiring high pressure injection, and very efficient sprayers, but also has the advantage of a very simple design of cylinder head and piston. The various chamber designs have the disadvantage of requiring complicated cylinder heads, but the advantage of lower injection pressures and less efficient sprayers. There would also appear to be some substantiation of the suggestion that the chamber systems are to a large extent the outcome of the air-injection school of thought and the direct injection follows the line of solid-injection practice. Adherents of air-injection were of the opinion that complete combustion could only be obtained with the aid of air-injection, which not only helped in the atomization of the fuel but also created added turbulence. Adherents of solid injection systems have always maintained that complete combustion could be obtained without the added complication of air-injection.

From the operating point of view, the advantage is entirely with the direct injection engine, because it has a materially lower fuel consumption, lower compression ratio, and readily starts from "all cold" without the aid of electric igniters, which are necessary adjuncts to the starting up of most types of pre-chamber engine. The running is smoother and absolutely clear exhaust is obtained with direct injection engines.

In the final analysis therefore, it would appear that the advantages are very much in favour of the direct injection engine, once the manufacturing difficulties have been solved. As far as the operator is concerned high injection pressures are no objection.

*Starting Methods.*

One other feature in which the Diesel is characteristically different from the gasoline engine is in the starting process. When electric starting is used, as it generally is, the only difference is that a starting motor and battery of much larger capacity must be used in order to overcome the high compression. It is necessary, however, to provide for hand starting, because batteries and electric starters have been known to fail. With the high compression pertaining to the Diesel engine it is obviously out of the question to expect any average individual to pull the engine over the compression stroke. Means are therefore usually provided whereby compression may be entirely relieved by holding either the exhaust or the inlet valves off their seats under the control of the operator. Under this condition he is then able to spin the engine by means of a crank handle to a reasonable speed in say three or four revolutions, he then releases the compression relief control and there will be sufficient energy in the flywheel to carry the engine over a compression stroke with the result that firing is commenced and the engine is running. In effect this is easier than cranking a gasoline engine and furthermore has the advantage that the danger of a back-fire is eliminated. It is also noteworthy, that from the moment of the first firing stroke the engine is ready to take up full load without the necessity of warming up or adjustments of fuel-air ratios so commonly necessary with the gasoline engine when it is cold.

*Auxiliary Equipment.*

There is only one item of auxiliary equipment which has to be treated differently in a Diesel engine and that arises owing to the fact that there is no appreciable drop in pressure in the inlet manifold, in other words there is no vacuum system available for operating the fuel system, windshield wiper, booster brakes or other auxiliaries. This feature is readily taken care of, however, by driving a small exhauster from a suitable part of the engine.

Water circulating pumps, fans, charging dynamos, fuel supply and so forth all follow gasoline practice with small variations. Somewhat less radiation is needed, less water circulation and very frequently a fan can be entirely dispensed with. Other variations from gasoline engine practice are more or less straightforward ones created by heavier stresses and so forth to which further reference will not be made.

### Application of the Automotive Diesel

As far as the general principles of the Diesel engine are concerned there is no reason why it should not be used in every type of road vehicle, whether it be a pleasure car, bus, truck or "steam roller." At the present time, however, it is not being produced in small enough sizes to make its use possible in smaller passenger cars, nor even in the small trucks. It has on the other hand been used quite successfully in larger types of pleasure car, in racing cars, and literally in thousands of buses and trucks in all parts of the world, operating under all kinds of conditions. Its use is really determined by economic conditions rather than by mechanical considerations.

In comparing Diesel engines and gasoline engines as prime movers, it will be found that they have somewhat different characteristics as far as their application is concerned, but comparatively little difference when it comes to operating characteristics. In general the Diesel engine is liable to be longer, wider, higher and heavier than its gasoline counterpart. These features are generally taken care of quite easily, especially in designing a new vehicle, and the fact that in the early days of the development practically every Diesel vehicle put into operation was converted from a gasoline driven vehicle is an indication that there are no insuperable obstacles to be overcome.

The point of real divergence comes about through the Diesel being run at maximum speeds considerably less

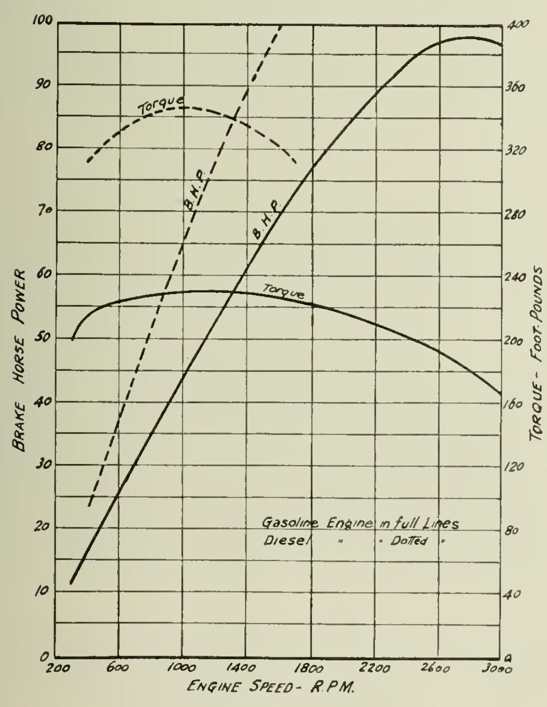


**Fig. 3.**

than the maximum speed of the gasoline engine. Commercially Diesels are usually limited to about 2,000 r.p.m., while gasoline engines are run at speeds of 3,000 r.p.m. and over. The reasons for this speed difference have nothing to do with the compression ignition system as Diesel engines are actually run at speeds of 4,000 r.p.m., but the lower speed ordinarily obtaining is probably the result of mechanical considerations combined with manufacturer's policy. Mechanically the difficulty of running at high speed comes about through the high stresses set up in rapidly moving and fairly heavy parts. It would also seem probable that the Diesel engine manufacturer has been in a position to dictate to the user to a greater extent than in the case of the gasoline engine manufacturers. The life of an engine is to a great extent proportional to its speed, and therefore the high speeds of the gasoline engines reduce their effective life, on the other hand being a cheap engine this is not a serious matter and indeed the

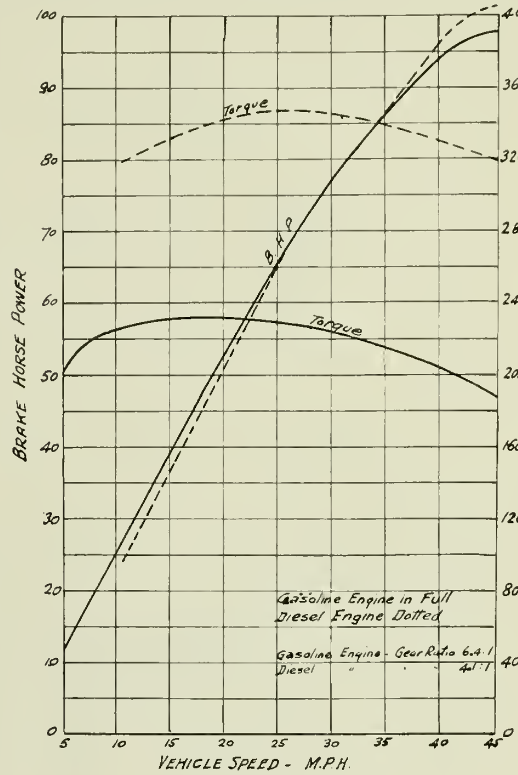


**Fig. 4.**

demand of the market has generally been for higher speeds even at the expense of more frequent replacements. On the other hand the Diesel is an expensive engine and it must have a long life if it is to be economically worth while.

In any event the user of the engine is not so much interested in the rotative speed of the engine as he is in the speed of the vehicle and he demands just as much speed with the Diesel as with the gasoline engine and he can get it, but different mechanical arrangement especially with regard to gear ratios becomes involved. The rear axles must both turn at the same speed and therefore a very much lower rear axle ratio is required in the case of the Diesel engine. If a high road speed is required such as 60 miles per hour, this ratio may become lower than commercially practicable or than commercially available and in that event a gear box with an "overdrive" or an auxiliary gear box may be employed, in either case the effect is to step up the speed of the propellor shaft as compared with the engine speed. On the other hand if low speeds especially for heavy trucking are satisfactory a standard rear axle ratio can be made use of.

If a vehicle is to be driven with a certain load, at a certain speed with certain road conditions, it will take so much horse power (data are sadly missing as to how much) and the amount will be just the same whether a high speed gasoline engine or a low speed Diesel engine is to be used. (See Figs. 3 and 4.) The Diesel engine with its low speed develops a higher torque than the gasoline engine, but as tractive effort is a function of torque multiplied by the overall gear ratio the final result in terms of tractive effort is the same in either case for a given horse power. Figure 5 indicates the tractive effort obtainable at various gear ratios with a typical gasoline and Diesel engine. There is however a feature which is quite different and that is in regard to the stresses which will be set up in the transmission. For example, a 100 b.h.p. Diesel engine will develop a torque of 350 foot-pounds as compared with 250 foot-pounds for the corresponding higher speed gasoline engine, with the result that the Diesel must have a gear box

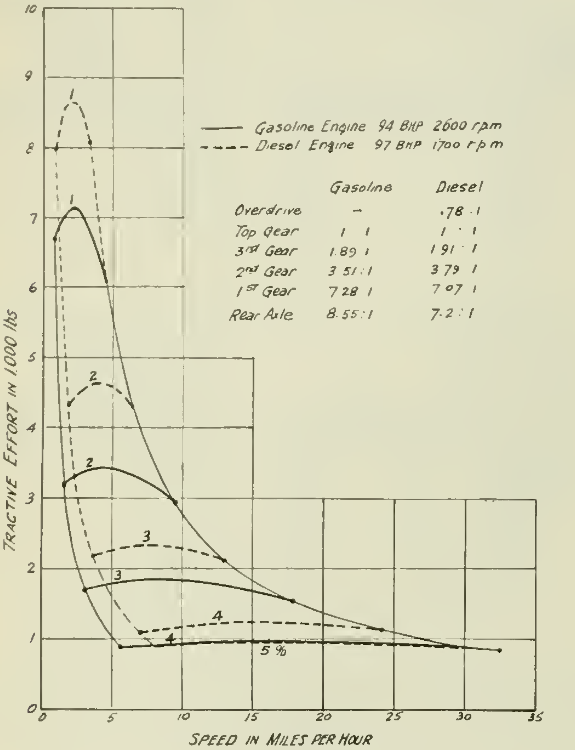


**Fig. 5.**

capable of withstanding the higher torque. Similarly the propellor shaft must also be stronger unless an overdrive gear box is used, in which case there may be little difference in the torque.

As far as operating results are concerned there is no very marked difference (except of course in cost) between the Diesel and the gasoline engine, but nevertheless the driver of the Diesel vehicle will notice some features which are not quite the same. First of all, when he goes to start up, even if the engine is quite cold, he gets the benefit of full power immediately, he does not have to nurse the engine until warm, or make carburetor adjustments. Secondly, the accelerator pedal usually operates through a governor, so that while the gasoline accelerator has the function of controlling the amount of fuel supplied to the engine, the pedal on the Diesel actually controls the speed of the engine, with the result that generally there is considerably less foot work—not a very important feature, but nevertheless of interest as being characteristically different. Thirdly, gear ratios are different on account of the slow engine speed of the Diesel and generally the effect is such that the Diesel appears to pull very much better at slow speeds than the gasoline engine, actually resulting in less gear changing.

With regard to the question of reliability this naturally varies with different makes of engine in both fields. But broadly speaking everything is in favour of the Diesel. Troubles in the gasoline engine frequently develop in some part of the ignition system or in the carburetor. These features are eliminated in the Diesel and their part taken by the fuel pumps and sprayers. There has now been sufficient experience gained to warrant the statement that these elements give less trouble than the corresponding elements in the gasoline engine. A little dirt in gasoline seriously interferes with the operation of the carburetor and reacts on the operation of every cylinder in the engine. Dirt in fuel oil is likely to choke a sprayer, wholly or in part, but this will cause a loss of power in one cylinder only. The probability of impairing the efficiency of all the sprayers is very remote unless there has been the grossest of carelessness in handling the fuel. Furthermore with the high pressures involved there is always the possibility that a choked sprayer will clear itself before very long. However, if this does not happen the changing of a sprayer takes very little longer than changing a spark plug.

There is nothing in the Diesel to cause mechanical breakdowns to be any more frequent than with gasoline engines, and indeed the lower mean temperatures should have the result of eliminating some of the causes of such troubles. When Diesels first appeared in the automotive field it was only natural that they should not be quite as reliable as the gasoline engine with its years of development and experience back of it, but today there is no question but that it is mechanically as reliable as the gasoline engine and even more so when all factors are taken into consideration.

A discussion of the characteristics of fuel and of lubricating oils is a subject unto itself, and as there are commercially available any number of oils for both purposes which are quite satisfactory, there is no necessity of entering into such a discussion. Different fuels naturally have quite a different reaction in the combustion process, and hence the actual running of the engine. Generally speaking however, the distillates of petroleum are the most satisfactory; care has to be taken however, that a clean oil is obtained. Similarly, with regard to lubricating oil, the automotive Diesel requires a high quality oil of the correct viscosity for the type of lubrication involved.

### Economics

The comparative economics of Diesel and gasoline engines only will be dealt with, and not the broader subject of the economics of motor vehicle operation, except in so far as the use of Diesel engines has effect thereon.

The fundamental reason for the existence of the automotive engine of the Diesel type is that of its inherent economical operation, and its natural field is therefore almost entirely limited to vehicles which are directly used for money making purposes or where the cost of operation, such as in municipal services, is a serious item. While the day may come when the oil engine is extensively, if not entirely, used in all vehicles the possibility is not in sight at the present time and therefore discussion may be limited to operations such as heavy duty or long distance trucking, bus and coach services, or municipal services of various kinds.

The first reason for the economy obtainable is the low fuel consumption of the Diesel owing to the high efficiency obtained with compression ignition. Test bed consumptions of gasoline engines give about 0.75 pounds per b.h.p. hour, while the corresponding figure for the Diesel is only about 0.40 pounds per b.h.p. hour. In actual road service, however, experience shows that under parallel conditions the fuel consumption of the Diesel may safely be taken as being one-half that of the gasoline engine, while if a comparison is made between the best of Diesels and an inefficient gasoline engine the ratio will become as low as one-third.

The second reason for economy is the lower cost of the fuel used, and in the case the actual amount is liable to be somewhat problematical owing to the influence of outside factors. The cost of gasoline varies considerably with different grades, and with different marketing conditions, fuel oil of a suitable nature, however, usually varies between a minimum of 8 cents per gallon and a maximum of 12 cents. There are of course exceptional cases, but a figure of 10 cents per gallon is reasonable for most economic studies. There is however, the possibility of a "gasoline" tax being applied to fuel oil when it is used for motor vehicles. However, under present day conditions, the differential between gasoline and oil could hardly be less than 8 cents per gallon and might be as much as 20 cents. In other words fuel oil may cost from ⅔ to ⅓ of the cost of gasoline. Hence the fuel expense ratio, combining the lower consumption with the lower cost may vary from at least ⅓ to a possible $^1/_9$. In a number of instances in actual service a saving of 80 per cent in the fuel cost has been reported.

It is interesting to note that the same question is raised today, as when the Diesel first made its appearance—"What about the supplies and price of suitable oils?"—coupled with the suggestion that when Diesels become universal the demand for oil will cause the price differential to be reduced or eliminated. However, certain common sense features cannot be overlooked, namely: (*a*) suitable Diesel fuel oil is cheaper to produce than gasoline, especially the high grade gasoline required for modern engines; (*b*) a wide range of oils can be utilized; (*c*)the same oil as is used in domestic oil burners is suitable so the price may well have to be kept low in order to compete in this field with coal; (*d*) suitable oils are being distilled from coal giving a new and independent source of supply; (*e*) the use of Diesel engines in vehicles cannot possibly approach the universal within a great many years, and the proportion of oil required for Diesel vehicles will be small in relation to total gasoline consumption. It would therefore appear that within the normal life of any engine which is being put into service today there is no reason to assume that there will not be a substantial differential in favour of Diesel oil.

While the principal economy obtained from the Diesel is from the low fuel consumption as outlined above, experience shows that there are other economies. Consumption of lubricating oil is an item of some importance. During the early days of the automotive Diesel it was apt to consume more lubricating oil than the comparable gasoline engine in similar service. Experience, however, has enabled this condition to be rectified and there are Diesel engines in operation today consistently giving lubricating oil consumptions of 1,500 miles to the gallon even under such difficult conditions as city bus service. Under similar conditions the gasoline engine consumes at least five times as much oil. This is the result of the lower mean working temperatures of the Diesel, its lower speed, and the reduction of dilution effects.

Maintenance costs are definitely less with the Diesel. This can be traced to the high quality of materials which have of necessity to be used, low working temperatures, and low speed. One operator of a large fleet has stated that he only finds it necessary to dock his Diesel vehicles every 10,000 miles for valve grinding, carbon removal and so forth, as against 5,000 miles for similar operations with gasoline vehicles in similar service.

In order to indicate what may be expected from the operation of a Diesel vehicle, the following table gives some general figures, based on the use of a heavy duty vehicle with an engine of about 100 brake horse power capacity, either gasoline or Diesel. Two different values are given for the cost of fuel oil due to the possibility of considerable variation existing in practice.

| | Gasoline | Diesel | |
|---|---|---|---|
| Price of fuel.................cents per gallon | 25 | 10 | 16 |
| Fuel consumption............miles per gallon | 5 | 12 | 12 |
| Lubricating oil consumption...miles per gallon | 250 | 1,500 | 1,500 |
| Cost of fuel per mile..................cents | 5.0 | 0.83 | 1.33 |
| Cost per mile, fuel and lubricating oil....cents | 5.3 | 0.88 | 1.38 |
| Cost of running 10,000 miles..............$ | 530 | 88 | 138 |
| Cost of running 50,000 miles..............$ | 2,650 | 440 | 690 |
| Cost of running 200,000 miles..............$ | 10,600 | 1,760 | 2,760 |
| Total saving on basis of 200,000 miles representing the approximate life of either engine..............................$ | — | 8,840 | 7,840 |

The question may naturally be raised as to whether there are some compensating items of increased cost, or serious mechanical or operating disadvantages to offset the tremendous advantage of economy of operation. Outside of the possibility of higher taxation the answer is definitely in the negative.

There is, however, one offsetting feature and that is the higher initial cost of the Diesel. Diesel engines have been produced cheaply, and a Diesel engine might be obtained at a price that would compare favourably with the cost of a gasoline engine of the best quality, but with the cheap Diesel the full advantages of economy of operation and maintenance are not obtained. The advantages of economy which have been referred to above are such as will be obtained with the use of a high class carefully built Diesel engine, which naturally costs more to produce than a gasoline engine. Before the final economic answer can be obtained provision has to made for the writing off of this additional cost; however, the foregoing table of savings indicates that at the end of what may be looked upon as the ordinary economic life of an engine the savings are sufficient to offset any possible excess cost of the Diesel. In fact the operator of a heavy duty vehicle, or coach, where a Diesel engine of 100-h.p. is customarily used will be from four to five thousand dollars in pocket when the time comes to discard his engine.

# The Tidal Phenomenon

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SUMMARY.—Describing briefly the various factors which influence the rise and fall of the ocean tides, the author gives examples of the complicated tidal phenomena occurring on the Atlantic coast of Canada. He also indicates some of the ways in which tidal currents affect the work of the harbour engineer in providing safe conditions for navigation.

Rise and fall of tide are recorded on the Great Lakes, but for the unbroken and easily distinguishable evidence of this phenomenon we must turn to the great oceans of the world.

Two theories are advanced to account for tidal action:—

(*a*) the Newtonian, or statical theory, and

(*b*) the Laplace, or dynamical theory.

Newton explained the phenomenon by reason of the differential attraction exerted by the moon and the sun on the earth's centre and on the water at its surface, the moon's influence predominating in the ratio of 5 to 2 on account of its greater proximity to the earth. Laplace considered the fact of the earth's rotation, and made the movement of the water a resultant of this and lunar attraction.

The fact that the higher tides are an invariable accompaniment of times of new and full moon shows that lunar influence is concerned in their production. This deduction is confirmed by the further fact that the times of high and low water occur about fifty minutes later every day, which coincides with the average period taken by the moon to pass the same meridian on succeeding days.

Generally, two high and two low tides occur in each period of twenty-four hours and fifty minutes, that is, high water to low water is about six hours and twelve minutes, and so on.

The tidal range in mid-ocean is estimated by various authorities at from 2 feet to 4 feet, increasing as it approaches the coasts, where local influences act on the progress of the wave so that the tidal conditions, both as to time and height, vary in relatively short distances.

This variation is especially evident along the coast of the British Isles. The single tidal wave from the Atlantic is divided off the southwest coast of Ireland and at Land's End into three portions: the main wave continues its course along the west coast of Ireland, while two branches diverge into the Irish Sea and into the English Channel respectively.

After performing their several circuits of Great Britain and Ireland, the waves meet at the north producing great variations in the rise of tide, from a range of almost zero at a point on the east coast of Ireland to about 30 feet on the Lancashire coast. The ocean wave passing west of Ireland and being least obstructed passes south into the Irish Sea and also into the North Sea, meeting the two north-bound waves with a variety of conditions.

It is presumed that each tidal wave originates in the southern oceans and proceeds northward. The wave appears to travel upwards of 500 miles per hour in ocean depths of 4,000 fathoms or over; at about 400 miles per hour in the north Atlantic Ocean where depths are generally less than 2,500 fathoms; at about 60 miles per hour in depths of 50 fathoms, and only 15 miles per hour in depths of 5 fathoms. Thus the tide which originates in the southern ocean does not reach the eastern coast of Canada the same day, but actually takes thirty-six hours or three complete tidal periods. It is for this reason, therefore, that the highest spring tides do not occur on the east coast of Canada, at the time of new or full moon, but actually thirty-six hours later.

We are, of course, more concerned with the tidal movement in its relation to the shore line and it is here that the tidal phenomenon develops its most interesting features. On the shore of the ocean the water level does not remain stationary, as it appears to on the shores of lakes. It gradually rises till it reaches its highest point, termed high water, and then it falls till it reaches its lowest point, which is termed low water. The difference in level is called the range of tide, and this movement goes on continually. As the tide moves vertically on the shore, the water flows into the bays, river estuaries, etc. on the rising tide and outwards on the falling tide. The inflow is called the flood and the outflow the ebb.

The higher tides with the greater range are termed spring tides and those with the lower range, neap tides. Not that the high tides occur in the spring, but rather that they spring upwards to a greater height.

Every movement of the sun and moon has an influence on the tide. The period from new moon to new moon is the synodic month and is about twenty-nine and a half days. The point on the moon's orbit which is nearest the earth is perigee and the point where it is farthest is apogee. The period of rotation from perigee to perigee is called the anomalistic month. Its length is slightly over twenty-seven and a half days.

While every movement of the sun and moon has its effect on the tide, in different parts of the world some one movement of the moon has a dominating effect, and the others become secondary. These variations in cause and effect have evolved three distinct types of tides:—

(*a*) The synodic, in which the leading variation in the range of the tide takes place twice a month, the range being greater at new and full moon, and less at the moon's quarters.

(*b*) The anomalistic, in which the greatest variation in the range accords with the moon's distance, and takes place once a month.

(*c*) The declinational, in which the changes due to the moon's declination (which makes the two tides of the day unequal in range) are so large and obvious that all other features of the tide are obscured.

While one of these variations is dominant in the several types of tides, the others are not entirely absent.

The synodic has fifty-seven tide intervals from new moon to new moon; the anomalistic fifty-three from perigee to perigee, and the declinational fifty-three from the moon's crossing of the equator to the next crossing in the same direction.

The synodic type of tide is predominant in the North Atlantic, on most of the coasts of Europe and North America. The anomalistic type is that found in the Bay of Fundy and Hudson Strait. The declinational type is found in the Pacific Ocean and to a marked degree in portions of the Gulf of St. Lawrence around the coast of Prince Edward Island and the north shore of New Brunswick.

When the moon is full or new, the line of its attraction coincides with the sun's attraction and the lunar and solar tides are added to one another by being super-imposed. It is then that we get spring tides. At the moon's quarters the tides are opposed and we get the neap tides.

It is known that the position of the sun in the heavens is north of the equator between March 21st and September 21st each year and south of the equator from September 21st to March 21st. The moon moves exactly in the same way except the period of time is less than a month instead of a year. The moon, therefore, has a north or south declination according to its position north or south of the celestial equator.

When the normal phases of the moon have the greatest influence on the tidal conditions, that tide is of the synodic type; when the moon's distance has the greatest influence the tides are of the anomalistic type, and when the moon's declination has the greatest influence the tides are of the declinational type.

There is a degree of uniformity in the tides of the synodic and anomalistic types, with two high and two low waters each twenty-five hours, but tides of the declinational type, while they do not entirely lose the effect of springs and neaps, show considerable inequality in the height of the two tides of the day when the moon is at a high angle of declination. This change in the height of the tide is termed "diurnal inequality," and when it does occur, there is also a pronounced inequality in the time interval between successive high waters. At this time there is usually only one high water each day, the second high water only approaching half tide level. Such a tide occurs at Victoria, B.C., and on the north shore of Prince Edward Island. When the moon is over the equator, however, the tidal action returns to normal and the two high and two low water periods occur as elsewhere.

The Dominion of Canada was very fortunate in having a scientist of the standing of Dr. W. Bell Dawson, M.E.I.C., F.R.S.C., as Superintendent of Tidal Surveys during the years of investigation and development. Primary tidal stations were established beginning in 1894 and secondary stations were established for short periods, so that today it is possible to predict the time and height of high and low water for almost any harbour on the Canadian seaboard, a condition which is absolutely necessary for the safe navigation of tidal harbours and their approaches.

It has been found that it takes eighteen years and eleven days for the sun, the moon, and the earth to occupy the same relative positions in the heavens. Consequently, tidal phenomena are reproduced under similar conditions at the end of successive periods of this duration, and the observation of the series of tides during one complete period will suffice to establish an accurate prediction for any future date of the interval studied.

Lord Kelvin invented an apparatus, which is now in the South Kensington Museum, for the mechanical prediction of tides. The National Physical Laboratory has since designed the "India Office Tide Predicting Machine," which can be used for predicting the tides, and preparing tide tables for any year, for any port for which the constants requisite for setting the machine have been determined by observation. The Dominion of Canada prepares tables of these predicted tides which are extremely accurate.

We may digress for a moment to get a picture of the approach of a tidal wave to the Atlantic coast of Canada. Figure 1 shows a portion of the coast at morning high water on October 23rd, 1934. The tide tables state that this tide arrives at Halifax at 7.58 a.m. Atlantic Standard time, at Saint John, N.B., at 11.45 a.m. and so on. If you study a chart of the Atlantic coast, you will find that the edge of the continent is really about 40 miles east of Sable island or 140 miles east of the main shore of Nova Scotia. Along this line we find that the ocean depth decreases rapidly from 1,000 fathoms to about 50 fathoms and, no doubt, the progress of the tidal wave is much impeded at this point and its velocity reduced considerably.

Co-tidal lines have been plotted on this map (Fig. 1) showing approximately the advance of high water level towards the coast at time intervals. You will note that the high water which reaches the continental bank east of Sable island at 6.00 a.m. requires two hours to reach Halifax; five hours and forty-five minutes to reach Saint John; twelve hours to reach the north shore of Prince Edward Island, and thirteen hours to reach Quebec. It must not be imagined that the water actually moves these distances, as the tidal wave is due to external forces, and

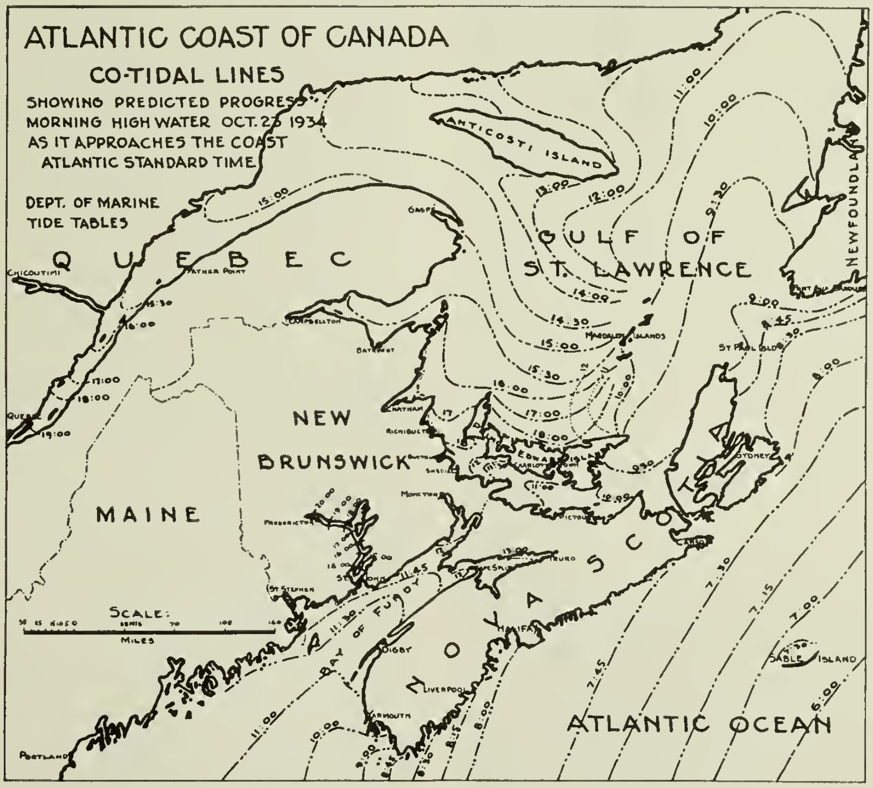


Fig. 1—Co-Tidal Lines, Atlantic Coast of Canada.

the water does not move horizontally except at a very slow rate and not always in the direction normal to the progressive time intervals.

There are three points on the map where the tidal waves, progressing from opposite directions, meet with varying effects. The first is at the northeast corner, where the tidal wave through the Strait of Belle Isle meets the wave progressing northward along the west coast of Newfoundland. The high waters of these two waves meet between Port Saunders, Newfoundland, and Bonne Esperance, P.Q., with no appreciable effect other than the normal high water condition.

The second is the wave from the Atlantic progressing north through the Strait of Canso, between Cape Breton Island and the mainland of Nova Scotia, meeting the wave which has passed around the north end of Cape Breton and southerly towards the east end of Prince Edward Island. In this case the times of high water are not simultaneous, the two tides are of different types, and the normal range is 4½ feet and 6 feet. The result is that a considerable tidal stream with a maximum velocity of 4 knots per hour flows through the strait. It has been possible to predict the change in direction of this current, which information materially assists navigation.

The third point of interest is the meeting of the two tidal waves in the Northumberland Strait west of Cape Tormentine. There appears to be a difference in time of about six hours with the result that the tide tables make the following explanation:—

"In the region at the western end of Northumberland Strait, when the declination of the moon is at all high, the tide shows a pronounced range once only in the day; but with a singular reversal of its features in a short distance.

"At Richibucto, it is the rise which is pronounced, and the other tides remain near the low-water level; while in Shediac Bay the fall is pronounced, with little variation from the high-water level on the other tides, whose range is not over 1½ feet. At Buctouche, which is midway between these localities, the limiting type of tide is reached. The tide remains for nearly half the day within about a foot of the same level, and drops once in the day to lower low water. It is only when the moon is quite near the equator that this is not the case. Thus at high water there is almost always a long stand, which continues from two hours to as much as eight hours. It is only at perigean springs, when the rise is greatest, that the high water is sharp and definite in time. The middle point of this long stand is within an hour or two at the same time of day, without the usual progression, for six to nine days altogether. The actual time falls between midnight and 7 a.m. in early summer (June and July) but towards the autumnal equinox, the mid-time of the long stand retrogrades into the previous day; and then remains during the autumn, between 4 and 9 p.m. as a rule. Because of the length of the stand at high water these hours may be depended on for practical purposes; except when its duration is shortened at perigean springs."

Attention may be drawn to two nationally known tidal features which are of particular interest:—The Reversing Falls at Saint John, and the Tidal Bore at Moncton, N.B.

Saint John Harbour is a river estuary. The St. John river, with its many branches, empties into the harbour through a narrow rocky gorge. Obstructions in the water area of the gorge form a dam which keeps the water level of the river above elevation 16.0 feet above low water or 2.0 feet above mean sea level, so that at low water spring tides there is a fall from the river level above the falls to harbour level below the falls of about sixteen feet.

When the tide rises to elevation 16.0 or about 16.5 above low water spring tide, a period of slack water occurs at the falls and for the following hour it is possible to navigate the passage with safety. The tide in the harbour continues to rise until a maximum height of 28.0 feet above low water spring tide, or 14.0 feet above mean sea level, is reached, during which time the harbour waters flow upriver through the gorge, giving a maximum fall towards the river of about nine feet.

The effect of the tidal flow into the river is to cause a tidal range of about 2¼ feet just above the falls and this tide continues up the river for about ninety miles until the next rapids section is reached.

This process continues with another slack water period on the falling tide and so on. During the freshet season in the river the slack water period occurs nearer the time of high water.

The city of Moncton is located on a bend in the Petitcodiac river which empties into the Bay of Fundy at its northeast end. The spring tide rise at the mouth of the river is about 44 feet. For some miles below Moncton the river is practically dry at low water so that the tidal wave travelling up the river is obstructed by the friction of the bottom and the wave changes to one of translation with the top of the wave travelling faster than the bottom. The bore is first noticeable about eight miles below Moncton and travelling at a speed of about 8 miles per hour passes Moncton with a height of about 3 to 4 feet. The bore arrives at Moncton about three hours and forty-five minutes after high water at Saint John. A bore is also noticeable in the Salmon river at Truro, N.S. and in the Shubenacadie river, N.S. as well as in the Amazon, Hooghly, Severn, Tigris and Euphrates, Seine and the Dordogne.

It has been a common question to ask "Why is it not possible to harness some of this tidal power and generate electric power?" It has been done, but not in Canada. However, extensive investigations have been made, especially on the shores of the Bay of Fundy. The most noteworthy, of course, is the Passamaquoddy Bay project which has been proposed by United States interests, as the waters are on the International boundary. This scheme involves interference with navigation and fishing rights of both countries and no development has yet taken place, pending legislative enactments.

Prior to this, proposals were made to develop tidal power at the mouth of the Petitcodiac river. Schemes have also been suggested to make some use of the Reversing Falls, and also the swift tidal stream which passes Cape Split at the entrance to the Minas Basin in Nova Scotia.

Tidal action plays a part in the design, construction, equipment, maintenance and operation of any harbour on the Atlantic coast.

It is natural that we should be more conversant with the details of piers, sheds, loading and unloading equipment of our harbours than of any other feature. It is not the design, construction and operation of these which give the harbour engineer his greatest engineering worries, but rather the maintenance of channel depths in the approaches and the protection of such approaches so that shipping may come and go without hindrance.

Years ago it was a common statement of those not directly connected with shipping to state that the approaches to the tidal harbours in the Bay of Fundy were navigated with danger, due to the considerable rise of tide and the prevalence of fogs. It is true that there are certain tidal streams in the Bay of Fundy as well as fog, which must be considered by all navigators, but it is also true that the investigations carried out by the Canadian government have been so thorough that today the navigator is provided with definite information as to the nature, extent and time of these currents, so that he meets them where they are expected and proceeds to his port of destination without

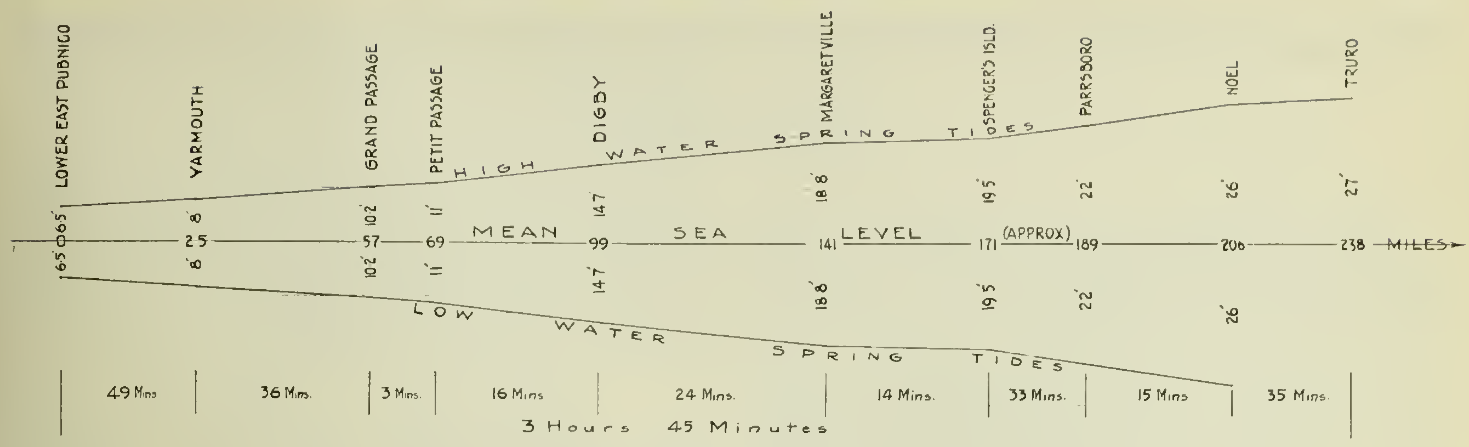


**Fig. 2—High and Low Water Along Nova Scotia Shore of the Bay of Fundy.**

delay. Radio equipment, of course, has largely removed the fog menace.

While the need for the construction of works to protect the harbour approaches from storm waves is not due to the rise and fall of the tide, the location and extent of these works in relation to the deep channel portion of the approach must be considered in their influence on the horizontal movement of the tidal currents.

The restriction of harbour entrances, either by parallel jetties or by converging breakwaters, naturally changes the normal movement of the waters in and out of those harbours. The flow of the water, either tide water alone or augmented by effluent river waters, has produced a balance in the formation of the underwater surface, and permanent change in that surface will not usually occur unless some artificial element is introduced.

All tidal harbours experience an inflow and outflow of water. Usually the inflow occurs during the rising or flood tide and the outflow during the falling or ebb tide. Where the harbour is a river estuary, as is often the case, the ebbing tidal waters are augmented by the fresh water from the river, usually giving a longer period of outflow than of inflow.

If the traffic of a natural harbour increases sufficiently to warrant improvements in landing facilities, depths at the piers, increased channel depths, and protection works, the experienced harbour engineer must closely examine the present conditions and study carefully the changed conditions which will exist if channels are deepened, entrances are narrowed, or the tidal capacity of the harbour is increased or decreased by the removal of old structures, by the deepening of berths and inner areas, or by the construction of additional piers, quay walls, etc.

It has been an axiom that, as far as possible, the tidal capacity of a harbour should not be decreased. If extra tidal capacity is provided, the incoming tide will attempt to fill up the added space and in doing so, the velocity of the flood stream is increased. The increase of the velocity naturally increases its carrying capacity for sand, gravel, etc., which covers the bottom.

The same is true of the ebb stream flowing outwards, with the result that a new balance is ultimately found and the depth of water in the entrance becomes stable after meeting the requirements of the increased tidal flow.

It can be readily seen that a change in the conditions of the tidal flow will occur if the entrance channel is enlarged or reduced, by the deepening of the channel, the increasing of its width, or the reduction of the width by the construction of works such as parallel piers or jetties, or converging breakwaters.

When such a channel is deepened, it must be realized that if the new depth cannot be maintained by the natural flow of the inward and outward tidal currents, expensive artificial means will have to be employed. If the entrance channel is restricted, the velocity of the current is increased, scour of the bottom occurs, with a natural increase in the depth of water. But as soon as the restrictions are passed the current is suddenly reduced and a bar is formed outside the piers with the material carried by the tidal stream, unless this reduced velocity occurs in an area where the coastal or littoral current is sufficiently strong to carry the transported materials beyond the areas required for safe navigation.

There is a fascination about tidal studies and a satisfaction in controlling the tide to provide improved conditions for the benefit of trade and navigation. The construction of piers, quay walls, wet docks, etc. in tidal harbours has been and is an expensive undertaking. It was the English practice, as seen at Liverpool and London, to accommodate ocean vessels in wet docks which are entered at high water through gates just as a vessel enters a lock in our Great Lakes canals. The loading and unloading proceeded at the walls of these wet docks with the vessels afloat.

The Canadian practice in the harbours of great tidal range, such as Saint John and Quebec, is to build quay walls and piers at which the vessel moves up and down with the tide with, usually, sufficient water at the pier at low water to float any ship which may call. This, of course, necessitated a great height of pier wall—in the case of Saint John about 70 feet—to provide 36 foot depth at low water spring tides.

The British practice required a less height of wall; it gave a stable height of vessel with relation to sheds, loading equipment, etc. as against the continual up or down movement of the vessel at the Canadian piers. It is significant, however, that in France there is a movement towards the increase of "tidal accommodation" as opposed to the use of wet docks. Major DuPlat Taylor recently stated that "twenty-five years ago it was thought that tidal berths were unsafe for ships and practically all the berthage was provided in impounding docks. In 1912 the river jetty at Tilbury was the first structure of any size on the Thames to provide tidal accommodation. It was 1,000 feet long of reinforced concrete on precast cylinders. All the new docks at Le Havre are tidal and the new deep water berths at Southampton are of this nature."

It is possible, therefore, that we have not lagged behind in the type of harbour facilities best suited for tidal harbours.

The author is indebted to the Department of Marine of Canada for the use of works on this subject by Dr. W. Bell Dawson, for the free use of their annual tide tables, and to Mr. H. W. Jones, M.E.I.C., of the Tidal Survey Branch, for advice on the movement of the tides in the Gulf of St. Lawrence.

# Stresses in Stiffened Circular Tubes under External Pressure

*Raymond D. Johnson*[1]

## DISCUSSION

H. C. Boardman[2]

The author has reached his conclusion in a manner savoring of legerdemain. Only by wizardry could he have made the mental journey from $\Delta$ to $\delta$ to $\delta'$ to $f'$ and $a$ by the path which he travelled. The writer confesses his inability to follow the trail exactly. In places he found the signs illusory if not false. The promise that "It will be shown that where the tube is not precisely round before external pressure is applied, the bending stresses are *directly* proportional to the initial amount of deviation from a true circle" is not and, of course, cannot be fulfilled since the bending moment obviously increases with the distortion, just as it does in the case of an initially curved column.

Equation (5) is a close approximation based on the assumption, contrary to fact, that the moments at the points of maximum deflection are equal. This case is covered in Section 59, pages 242, 243, and 244 of the first edition of "Applied Elasticity" by Timoshenko and Lessells. Equation (5) may be instructively written in the form, $M = pr\ (\Delta + \delta)/2$, where $\Delta/2$ is the initial, and $(\Delta + \delta)/2$ the final maximum radial departure from a truly circular form.

Equation (6) also appears to be an approximation derivable for the special cases of a variable external loading on a cross-section initially perfectly round, a quadrant of which is illustrated by Fig. 4. $P$ is any point on the quadrant arc, and $M_p$ the moment at $P$. Because of symmetry it is evident that the tangent lines at $A$ and $B$ do not rotate when the load is applied. This is expressed mathematically by the equation

$$\int_o^{\frac{\pi}{2}} M_p r\, d\theta = 0$$

$$\text{or } \int_o^{\frac{\pi}{2}} \left[ -M_A + wr^2\,(1 - \cos\theta) - \frac{1}{2}\, wr^2 (1 - \cos\theta)^2 \right] r\, d\theta = 0$$

$$\text{or } \int_o^{\frac{\pi}{2}} \left[ -M_A + \frac{1}{2}\, wr^2 \sin^2\theta \right] r\, d\theta = 0$$

whence $M_A = M_B = wr^2/4$ numerically. The shortening $\delta$ of the vertical diameter is

$$\frac{2}{EI_o} \int_o^{\frac{\pi}{2}} M_p r^2 \cos\theta\, d\theta,$$

whence $\delta = wr^4/6\, EI_o$. The ratio of $\delta$ to $M_A$ is $2\, r^2/3\, EI_o$. Therefore $\delta = 2\, r^2 M_A/3\, EI_o$ which is the author's equation (8). Obviously, the same moment and deflection would be obtained by assuming a uniform external pressure and, in addition, the vertical loading of Fig. 4. The moments are assumed to be unaffected by the deflection.

It, therefore, appears that the ratio of moment to deflection resulting from the special loading of Fig. 4 on an initially round ring with the effect of the deflection on the moment ignored, is assumed to be the same as the corresponding ratio for an initially deformed ring subjected to a uniform external pressure with the effect of the deflection on the moment included. Considering that $\Delta$ is small as compared to $r$, this assumption seems reasonably accurate but a rigorous proof is elusive, and desirable.

The point $C$ of Fig. 4 represents one corner of an inscribed square. Under the special loading there shown the change in length, $Z$, of one side of the square is

$$\frac{2}{EI_o} \int_o^{\frac{\pi}{4}} M_p \left( r \cos\theta - r \cos\frac{\pi}{4} \right) r\, d\theta,$$

whence $Z = 0.0589\ wr^4/EI_o = 0.3536\ \delta$, which agrees with equation (10).

Equations (5), (8) and (10), and the beam formulae, are the tools which the author ingeniously and almost mystically uses to evaluate $\delta$ and $\delta'$. He first assumes a ribbed tube out-of-round by an amount $\Delta$ for its entire length, then imagines a uniform external pressure $p$ applied, which lengthens the longest and shortens the shortest rib diameter an amount $\delta$, and causes the shell between adjacent ribs to act as four extraordinary beams, having neutral axes along the node lines where they join, and subjected to a complicated and intangible loading made up of four components, one of which is uniform and positive, one uniform and negative, one variable according to the deflection curve and positive, and one similarly variable and negative. These components are obtained from the expression

$$\int_o^l p'\,(\Delta' + y)\, dx,$$

using $8\ \delta'/15$ as the mean value of $y$. The justification for using $p'\,(\Delta' + y)$ as a beam load perpendicular to the plane of the nodes eludes the mind of the writer. To accept it requires an act of faith. Is $p\Delta'/2$ of equation (5) a *load* on the ring perpendicular to the node lines?

The peculiarly elusive nature of the author's analysis, which appears to be mathematically accurate, is due to the following facts:

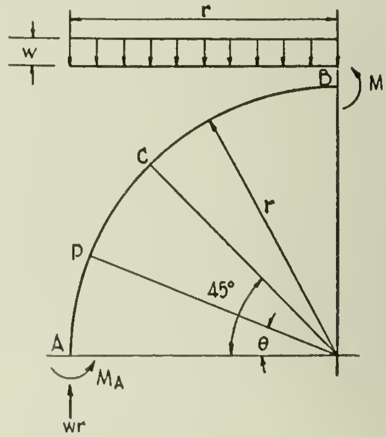


**Fig. 4.**

(*a*) The analysis assumes a constant ratio of maximum moment and maximum deformation in a ring, whether the peripheral edges be free from shearing stresses as in the case of equation (5), or subjected to shearing stresses as in the case of rings cut out by transverse planes between ribs.

(*b*) The beams are treated without reference to the *actual* loads upon them, which loads are the uniform external pressure, the end reactions at the junctions with the

[1] Paper presented at the General Professional Meeting of The Engineering Institute of Canada, Montreal, 1934, and published in the January, 1934, issue of The Journal.

[2] Chicago Bridge and Iron Works, Chicago, Ill.

ribs, and the forces on the node lines. The reader tries in vain to picture how $p'(\Delta' + y)$ is a beam load and, if so, in what direction it acts, and where it is applied. He can see that the summation of the $p'r(\Delta' + y)\,dx$ values over the length $l$ results in $M'$, or in other words, that the moments of which the plates are relieved because the rib is present are carried by the rib, but he cannot see $p'(\Delta' + y)$ as an actual physical load on the beam.

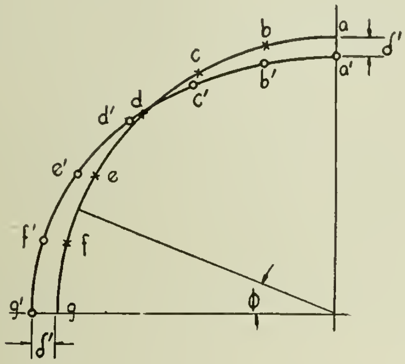


Fig. 5.

(*c*) The assumed beam action seems bizarre. The node lines of each beam are taken as the double neutral axis, requiring that the longitudinal stresses in the beam be either all compression or all tension; the node lines move farther apart or nearer together under the load, and deflect perpendicular to the node plane only 0.3536 as much as the corresponding point on the outermost fibre; yet the usual deflection formulae for beams are used and assumed to apply to the node lines.

The writer suggests the following method of approach to the general problem:

Figure 5 represents a quadrant of a circle with equally spaced points $a$, $b$, $c$, $d$, $e$, $f$ and $g$ marked thereon, and a quadrant of an ellipse having the same circumference as the circle, with equally spaced points $a'$, $b'$, $c'$, $d'$, $e'$, $f'$ and $g'$ marked thereon. By inspection, it is apparent that, if the circle quadrant deforms into the ellipse quadrant, it can do so only by a practically tangential movement of the node point $d$ and by entirely radial movements of the points $a$ and $g$. Point $d$ moves to $d'$, and points $a$ and $g$ move to $a'$ and $g'$, respectively.

These observations lead to the conclusion that, if the circle represents a rib and the ellipse represents the outline of the deformed tube midway between ribs, there must be shearing stresses, varying in intensity as a function of $\phi$, on every transverse section between the mid-section represented by the ellipse and the rib represented by the circle. In each quadrant of each transverse section the shear intensity must be a maximum near the point for which $\phi = 45°$, where the shear is nearly all tangential, and at points for which $\phi = 0°$ and $\phi = 90°$, the tangential shear must be zero, and the radial shear intensity small because $\delta'$ is small as compared to $\Delta$, and because the plates have slight bending strength in radial directions. It, therefore, seems reasonable to neglect the radial shears and assume that the tangential shear intensity varies as $\sin 2\phi$.

This reasoning applies also if the rib outline is an ellipse and the tube outlines on transverse sections between ribs are ellipses having eccentricities greater than the eccentricity of the rib ellipse. To facilitate the computations a circular initial shape for the ring and rib is assumed. Figure 6 represents a quadrant of a ring cut out by two transverse planes one inch apart; $P$ is any point on the arc; $s$ is the tangential shear per inch of arc, and $k$ is a constant to be evaluated so that $s = k \sin 2\phi$ and so that $M_A = M_B = pr(\Delta + \delta + y)/2$. The end axial force

$$V = H = kr\int_0^{\frac{\pi}{2}} \sin 2\phi \cos\theta \, d\theta = 2\,kr/3.$$

The moment at the point $P$ is

$$M_p = M_A - \frac{2}{3}kr(r - r\cos\theta) + kr\int_\phi^\theta \sin 2\phi\,[r - r\cos(\theta - \phi)]\,d\phi$$

$$= M_A - \frac{1}{3}kr^2\sin^2\theta.$$

Because of symmetry the tangents to the arc at $A$ and $B$ do not rotate when external pressure is applied to the ring.

Therefore $\int_0^{\frac{\pi}{2}} M_p\,ds = M_A\,r\int_0^{\frac{\pi}{2}} d\theta - \frac{1}{3}kr^3\int_0^{\frac{\pi}{2}} \sin^2\theta\,d\theta = 0$

whence $M_A = kr^2/6 = pr(\Delta + \delta + y)/2$, from which $k = 3p(\Delta + \delta + y)/r$ and $s = (3p/r)(\Delta + \delta + y)\sin^2\phi$.

Tangential shearing stresses distributed according to this equation, on an initially circular ring, would result in moments practically equal, at corresponding points, to those due to the uniform pressure $p$ on a ring initially out-of-round by the amount $\Delta + \delta + y$.

This demonstration makes it appear highly probable that there exist on transverse sections of a properly ribbed tube initially out of round substantially tangential shearing forces which relieve the tube plates of practically all girth moments, and transfer them to the ribs. Obviously this can be true only if the ribs are designed to resist these bending moments without undue distortion.

Since $M' = (f - pr/t)\,I/e$, equation (8) can be written in the form $\delta = \frac{2r^2}{3EI}\left[\frac{I}{e}(f - pr/t)\right]$ from which an approximate value of $\delta$ can be calculated. If $pr/t$ be omitted for safety and simplicity, the formula becomes $\delta = 2r^2f/3Ee$, and therefore $\Delta + \delta = \Delta' = \Delta + 2r^2f/3Ee$. The term $y$ is small compared with $\Delta$ and $\delta$; by neglecting it, and assuming that all bending moments are carried by the rib, $M' = prl\Delta/2 = [\Delta + 2r^2f/3Ee]\,prl/2$, which is suggested for use in place of equation (25).

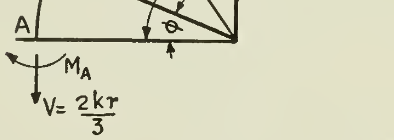


Fig. 6.

The corresponding maximum shear intensity between rib and shell is $3pl\Delta'/r = [\Delta + 2r^2f/3Ee]\,3pl/r$ per inch of arc.

The author condemns designs based on studies of "the elastic instability of perfectly circular tubes,"—perhaps rightly. Nevertheless Euler's column formula, though based on a study of the elastic instability of perfectly straight and homogeneous columns, has for years been very successfully used in designing columns which admittedly were not originally straight or homogeneous. Euler's formula gives the load under which a perfectly straight and homogeneous column may be expected to suddenly buckle. The factor of safety used with it allows for the unknown initial departures from perfection. The writer believes that the results of studies of "the elastic instability of perfectly circular tubes" can with equal success be applied to the design of tubes initially slightly out-of-round if the factor of safety be judiciously chosen. He has found the following line of reasoning very helpful, although not rigorously accurate.

Euler's formula for pin ends is:

$P = \frac{\pi^2 EI}{L^2}$, in which

$P$ = Total critical load on the column.
$E$ = Modulus of elasticity of steel.
$I$ = Least moment of inertia of column cross-section.
$L$ = Length of column.

A ring cut out of a tube by two transverse planes one inch apart may be considered to act under uniform external pressure, as four Euler columns, each a quadrant long.

Let:

$t$ = Tube plate thickness.
$p_o$ = Critical external pressure; that is, the pressure at which a tube initially perfectly round will probably buckle.
$r$ = Radius of tube.

Then, referring to Euler's formula above,

$$P = p_o r,\ L = \frac{\pi r}{2},\ L^2 = \frac{\pi^2 r^2}{4},\ \text{and}\ I = \frac{t^3}{12},$$

whence,

$$p_o r = \frac{\pi^2 E\left(\frac{t^3}{12}\right)}{\left(\frac{\pi^2 r^2}{4}\right)} = \frac{Et^3}{3R^2},\quad \text{or}\quad p_o = \frac{Et^3}{3\,r^3}$$

Let $p$ = The allowable working pressure, using a factor of safety of 4 with respect to the pressure. Then:

$$p = Et^3/12\,r^3 \ \text{or}\ t^3 = 12\,pr^3/E,\ \text{or}\ t^3 = pr^3/2{,}500{,}000$$

$$\text{or}\quad t = (r\sqrt{p})/136 \ \text{or}\ p = 2{,}500{,}000\ (t/r)^3,$$

which are convenient forms for practical use in designing long cylinders.

The result of this admittedly loose way of reasoning agrees exactly with the formula derived in Slocum and Hancock's "Text-Book on the Strength of Materials." Practically the same result is also obtained on pages 245, 246, 247, 248 and 249 of Timoshenko and Lessel's "Applied Elasticity," if the factor of safety be 3 instead of 4.

In the case of a ribbed tube, such as the internal riser of a surge tank, the formula corresponding to $t^3 = pr^3/2{,}500{,}000$ becomes $I = pr^3l/E$, in which $I$ and $l$ are the same as in the author's paper. This formula applied to the design problem chosen by the author gives:

$$I = \frac{(15)\ (60)^3\ (210)}{30{,}000{,}000} = 23.$$

If a factor of safety of 5, instead of 4, with reference to pressure were used, $I$ would come out about 30, which corresponds closely with the author's chosen value of 31.53.

Formulae based on elasticity stability hold only when the stresses do not exceed the elastic limit.

The author's practice of designing on the basis of stresses, rather than on the basis of elastic instability, deserves commendation, and his methods have proved their practical worth. Nevertheless, a reader of his paper wishes that his results could have been reached in a less devious and elusive manner, and harbours a suspicion that their successful use is due not so much to their exactness as to the remarkable strengthening effect of stiffening rings on thin walled steel tubes. Just as there are many structurally successful combinations of sizes, shapes and spacings for the supports of pipe lines and horizontal tanks, and for the stiffeners of web girders, so there are probably many structurally successful combinations of rib sizes, shapes, and spacings for thin walled tubes subjected to uniform external pressure. Wind girders for standpipes are astonishingly effective in preventing the collapse of the shells under irregular and fluctuating wind pressures.

If the author would present a rigorous stress analysis for an elliptical ribbed tube of considerable eccentricity and apply it to a slightly out-of-round tube as a limiting case, and if he would also present critical test data to support his design methods, he would be rendering an unquestioned great service to the engineering profession.

Professor Gilbert Cook[3]

An important subject has been dealt with, and one which has never yet been successfully treated by analytical methods. Indeed, the problem of stability of a perfectly cylindrical tube with end constraints has not been completely solved; and the added complication of irregularities in shape and thickness makes it still more intractable to mathematical analysis. The employment of coefficients in order to allow for imperfections of form is rational when such coefficients bear a definite relation to the type and magnitude of the imperfections; but, as a rule, they perform the functions of a factor of safety rather than as a reliable measure of the deficiency of strength.

The author is therefore to be congratulated on the courage he has displayed in his attempt to put the design of stiffened tubes, with known imperfections, upon a rational basis. He would have earned the gratitude of all who have worked on this subject if he had made his treatment more intelligible. An unnecessarily complicated notation has interfered considerably with the process of logical argument, and certain symbols have been employed for quantities whose existence is based upon assumptions which are not sufficiently justified or even clearly stated.

It is well known that a long tube would deform, by the application of external pressure, into the shape shown by Fig. 2. It will not be disputed that a stiffened tube, in which the ribs are comparatively weak will deform similarly, the rib partaking of the same type of deformation as the shell. The author gives the impression (in the paragraph in the middle of the second column, page 2), though it could not of course be his intention, that the tube is actually weakened when the rib is made so strong that deformation into an elliptical shape is prevented.

The essential feature of the author's method is the conception of a tube made up of four longitudinal beams, the stiffness of which resisted the deformation. The action of a stiffening rib on the stresses in the shell is, however, as the author recognized, much more complicated than this; and it requires more detailed consideration as to how far the assumption is permissible. The reactions at the rib will consist of shearing forces having components radially and tangentially, and of couples having components both in the radial and transverse planes, all these components varying from point to point round the rib. Which of these components will be predominant at any given point is not at once obvious, but it might safely be presumed that the actions in the shell will not be any simpler in character than the reactions at the rib. The author might elucidate a part of his argument which is particularly obscure, and which appears to be fundamental to his treatment. This refers to the matter between equa-

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tions (19) and (22) including Fig. 3, and especially the paragraph beginning with the statement "Inasmuch as these opposing forces do not support each other with the girth stiffness neglected, they must somehow be entirely counteracted by the beam loads." What does the author really mean by a "beam load"? The only load on an element of the shell is the external pressure; all the other actions on it are due to internal stresses. A little elaboration of Fig. 3, explaining the exact significance of the various arrows, would help towards making its meaning clear. As it stands, Fig. 3 would appear to suggest that the girth stress in the shell is compression at one point and tension at another.

While, therefore, the assiduity with which the author has pursued his investigation is greatly to be admired, it is a matter for regret that he has not made his argument sufficiently clear to call forth effective criticism. In view of the numerous assumptions made, the validity of his equations will in any case ultimately depend upon the extent to which they are found to agree with the results of actual tests.

S. Clifford Doughty[4]

The author's paper should be regarded more as a guide to design of large steel tubes than as a solution of a problem in stress mechanics; in the former respect it is eminently successful. It has, too, the backing of the author's long practical experience in construction of large tubes.

Technically, the treatment of the shell stresses as simulating those in conventional beams may be open to further development in the way of precise stress analysis, such as the statement of the shear deformations, and an adjustment of the moment of inertia of a beam to provide for fibre stresses not proportional to ordinates from the chord through the nodes, the effect of all of which, however, on the deflection of the beam is apparently well represented by the author's conception of the beam deflection as that of the node line. For though the stresses have not at present been solved by rigorous analysis, a small amount of calculation will serve to convince technicians that a different treatment of the longitudinal behaviour of the shell will have almost no effect on the moments and stresses in the ribs, none at all on the recommended spacing of ribs in equation (40) and only such effect on the shell stresses as to increase, rather than decrease, the small disparity between the calculated and experimental rupture pressures given in the tabulation by Mr. Laber, which has been brought to the writer's notice. Such larger disparity, of course, may be accounted for by slight imperfections in the single spans used in the experiments, where continuity of the beams is interrupted and the slope of the ends may not remain exactly zero, thus inducing a lower rupture pressure.

The remaining uncertainty of the exact value of $d$, although possibly trifling, is nevertheless likely to be of far more consequence than any further refinement of the stated shell behaviour. However, from the point of view of the science of elastic structures, known and unknown, it will be desirable to have in the future an exact analysis of the shell stresses, which may be of considerable importance in types of structures yet to be invented.

In any discussion of the validity of the present argument, it should be borne in mind that the prime consideration for engineers in designing tubes with angles, or other yielding rings, as stiffeners, is the exact evaluation of the rib stresses, along with a rule for rib spacing which will insure these always being greater than the shell stresses. This has been accomplished, to a degree of precision within known limits, where the recommended spacing of ribs is used and criticism of the shell stresses themselves is in this respect immaterial.

N. R. Gibson, M.E.I.C.[5]

The author's paper is the only complete analysis of the stresses in stiffened circular tubes under external pressure that has come to the attention of the writer, and he is to be complimented on having derived precise working equations covering this important and complex problem.

Upon receiving this paper, the writer, with the assistance of Mr. L. S. Bernstein and Mr. E. B. Strowger, undertook the task of checking the equations and reporting upon their usefulness in the field of practical designing. All the equations have been substantiated. This discussion would, therefore, be confined to comparing the results of using the author's exact method with the results of an approximate method as used by an experienced designing engineer.

For this comparison, three pipes have been selected having diameters of 8, 10 and 12 feet subjected to an

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Table II

Comparative Weights of Pipe and Stiffener

| | | | (1) Author's Formula | | | | | | (2) Approximate Method | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $f_s$ in Pipe Plate | Pipe Diameter | Thickness of Plate | Stiffener Angles | Stiffener Spacing | Weight of Stiffener | Weight of Stiffener per Linear Foot of Pipe | Weight of Pipe per Linear Foot | Total Weight per Linear Foot of Pipe | Stiffener Angles | Stiffener Spacing | Weight of Stiffener | Weight of Stiffener per Linear Foot of Pipe | Weight of Pipe per Linear Foot | Total Weight per Linear Foot of Pipe | Per Cent Weight 2/1 |
| 15,000 pounds per square inch | feet | inches | inches | inches | pounds | pounds | pounds | pounds | inches | inches | pounds | pounds | pounds | pounds | |
| | 8 | 3/8 | 5×5×3/8 | 196 | 327 | 20.0 | 386 | 406 | 5×5×3/8 | 102 | 327 | 38.5 | 386 | 425 | 104.7 |
| | 10 | 7/16 | 6×6×7/16 | 210 | 572 | 32.7 | 562 | 595 | 6×6×7/16 | 123 | 572 | 55.7 | 562 | 618 | 103.9 |
| | 12 | 1/2 | 8×6×7/16 | 256 | 809 | 38.0 | 772 | 810 | 8×6×1/2 | 144 | 920 | 76.7 | 772 | 849 | 104.7 |

Average 4.4 per cent.

external pressure of 15 pounds per square inch. The results using the two methods are shown in Table II. The saving in weight is about 5 per cent when the author's method is used. In addition to this saving in weight, there would be an additional saving in shop and field work due to the great stiffener spacing allowed, which might result in a total saving of as much as 10 per cent in the total cost of the pipe.

Based upon this investigation, it is evident that the use of the author's method results in a substantial gain in economy.

For the approximate design the following assumptions have been made:

(1) The pipe between the stiffeners was assumed to be divided into four beams, each of one-quarter circumference, and all of which carry the load to the stiffener section. The entire load was assumed to be carried to the stiffeners, i.e., the pipe walls carried no girth stresses.

(2) These beams were designed as continuous beams, taking a load equal to the resultant total pressure on the quarter circumference.

(3) The stiffener section was designed as a closed ring, taking direct and bending stresses due to the beam loads. A width of plate, equal to one-sixth the span, was assumed acting with the stiffener angle to make up the stiffener section.

(4) No allowance has been made for the strengthening effect of the adjacent quadrants upon each of the four beams. The allowable unit stress in bending of 15,000 pounds per square inch had been used, and the plane of bending has been taken through the centre of gravity rather than through the nodes.

As to assumption No. 1 where the entire load is considered as carried to the stiffeners, it has been shown in several works on elasticity* that a circular unstiffened tube with a small ratio of thickness to diameter tends to buckle under uniform external loads, the circumference breaking up into a varying number of even division, prior to failure, beginning with 4 where it is comparatively stable. The critical value of the pressure beyond which more than four divisions occur and where the tube becomes highly unstable is $p = \frac{3\,EI}{r^3} = \frac{Et^3}{4\,r^3}$. Using this formula it can be readily shown that the load carrying capacity of the plate as a tube is very nominal without stiffeners. Taking the author's example for a true circular section, the critical value of $p$ for a thickness of 7/16 of an inch and a radius of 60 inches is 2.93 pounds per square inch. This is less than 20 per cent of the load of 15 pounds per square inch which must be carried. Moreover, for an elliptical section with $\frac{\Delta}{r} = 0.01$ as the true original shape of pipe, the eccentricity sets up girth bending moments which cause further deflections, which would further limit the critical value of $p$.

As to the assumption No. 4 it is probable that an experienced designer in making a solution in the absence of Mr. Johnson's exact method would allow for the stiffening effect of the adjacent sections of the pipe by using a higher unit stress in the plate rather than shift the axis of the plate from its centre of gravity to a chord through the nodes. Even with this assumption and a unit stress as high as 20,000 pounds per square inch in the steel plate, there would still be a saving of approximately 4 per cent in weight and 7 per cent in cost, if the pipe were designed in accordance with the author's formulae.

*See "Applied Elasticity," by Timoshenko and Lessels.

Eugene E. Halmos[6]

This paper, while seemingly a formidable mathematical treatise, is of the greatest practical value to the profession. It places at the disposal of engineers formulae, sadly lacking heretofore, with the help of which they will be able rationally to solve problems now necessarily handled by the "common sense" or "rule of thumb" method.

The problems to which the subject matter of the paper is applicable are numerous and are frequently encountered in almost every field of engineering activity. It appears that there should have been a long standing and widespread demand for thorough knowledge of the stress conditions existing in circular pipes with both rigid and yielding stiffeners supporting external fluid pressure and it is truly remarkable that something new could be produced in this field of structural mechanics. Nevertheless, the writer believes that the formulae developed and published by Mr. Johnson are the first which make it possible to design such pipes, like any other structure, for definite stresses and with a known factor of safety.

The writer knows of three previous formulae dealing with the strength of pipes subjected to external fluid pressure:

(1) The Boussinesq* formula

$p = 3\,IE/r^3$ or, in the author's notation $p_o = Et^3/4r^3$. . .(a) giving the unit exterior fluid pressure, under which an unstiffened circular pipe of given material, radius and shell thickness will just fail.

(2) An equivalent formula, which includes the effect of Poisson's ratio, was derived by Bresse in 1829,

$$p_2 = \frac{Et^3}{r^3}\left(0.25 + 2.706\,\frac{r^4}{l^4}\right) \qquad \text{(b)}$$

This formula, derived by Forcheimer, was published by the writer himself.† It proposes to give the unit exterior fluid pressure, under which a pipe of given material, radius and shell thickness, of a length $l$ between, and simply supported by, rigid stiffeners, would just fail.

This formula was reached incidentally in a study of the strength against buckling of a pipe loaded in an axial direction. In its derivation no account was taken of the beam-strength of the shell quadrants and, therefore, the rupture pressure given by the formula is too low, or, conversely, the thickness of the shell for a given rupture pressure is too great, or the distance between stiffeners too small.

(3) A third formula,

$$p_k = \frac{2\,E}{(n^2-1)\left[1+\left(\frac{nl}{\pi a}\right)^2\right]^2}\cdot\frac{h}{a} + \frac{2\,Em^2}{3\,(m^2-1)}\left[n^2 - 1 + \frac{2\,n^2 - \frac{m+1}{m}}{1+\left(\frac{nl}{\pi a}\right)^2}\right]\cdot\frac{h^3}{a^3} \qquad \text{(c)}$$

where

$p_k$ = critical unit radial pressure on pipe shell
$l$ = length of pipe between bulkheads
$a$ = radius of pipe
$2\,h$ = thickness of pipe
$\frac{1}{m}$ = Poisson's ratio
$n$ = a positive whole number $\geq 2$, which makes $p_k$ a minimum. It should not be confused with the symbol $n$ in the author's notation.

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*Comptes Rendus 97 (1883), pages 844, 1131.

†Trans. A.S.C.E., Vol. 85, page 668. According to Engesser, "Centralbaatt der Bauverwaltung," Vol. 8, the coefficient of the second member in the bracket would become 13.5 for a shell fixed to the rigid stiffeners.

Values of $n$ for different ratios of radius to length and of shell thickness to radius, are given in the table below:—

| $\frac{100\,h}{a}$ | .2 | .4 | .6 | .8 | 1.0 | 1.2 | 1.4 | 1.6 |
|---|---|---|---|---|---|---|---|---|
| $\frac{a}{l} = 0$ | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| $\frac{a}{l} = 0.1$ | 4 | 3 | 3 | 3 | 2 | 2 | 2 | 2 |
| $\frac{a}{l} = 0.2$ | 5 | 4 | 4 | 4 | 3 | 3 | 3 | 3 |
| $\frac{a}{l} = 0.3$ | 6 | 5 | 5 | 4 | 4 | 4 | 4 | 4 |
| $\frac{a}{l} = 0.4$ | 7 | 6 | 5 | 5 | 5 | 4 | 4 | 4 |
| $\frac{a}{l} = 0.5$ | 8 | 6 | 6 | 5 | 5 | 5 | 5 | 4 |

Now $n$ represents the number of waves into which the pipe shell divides itself at the point of failure; and $2\,n$, therefore, is the number of nodes. The formula is not applicable for the cases when the computed critical load, $p_k$, would result in a direct compressive stress in the pipe shell, $p^k a/2\,h \geqq$ the elastic limit of the material. For steel, with $E = 30 \times 10^6$ pounds per square inch, and an elastic limit of 27,000 pounds per square inch, the values corresponding to this condition are those below and to the right of the heavy line in the table.

This formula was derived by R. von Mises* for the case of a pipe fixed at its ends to rigid bulkheads. The formula correctly expresses the amount of the external pressure under which such a pipe, of given material, radius, shell thickness and length will be at the point of failure. The results of a number of tests, made by loading pipes of various sizes to destruction, demonstrated a satisfactory agreement between the calculated and observed rupture pressures.

It will be noted that (leaving lateral deformation out of consideration) formulae (b) and (c) revert to formula (a) for $l = \infty$, which is the case of an unstiffened pipe. This same result is obtained from the author's formula (30).

As already pointed out, formulae (a), (b) and (c) are intended to give the unit radial, exterior pressures, under the action of which a perfectly circular pipe will fail. They do not give the critical pressure for tubes which are "out of round" nor any information on the unit stresses in the pipe shell and stiffeners when loads are applied which fall below the rupture loads or when stiffeners are used which are not perfectly rigid. Nevertheless, it is customary to use the formulae for design by arbitrarily choosing 1/3, 1/4 or 1/5 of the critical load as the permissible loading of the pipe, on the assumption that the factor of safety will increase in the inverse proportion. Such a procedure, of course, is not founded on facts and may lead to faulty or uneconomical design, or both. This uncertainty is eliminated by the use of the author's formulae which give practically correct results as to the magnitude of the actual stresses in the pipe shell and stiffeners for any assumed loading and deviation from the true circle in all cases when the design is such that these stresses are well within the elastic limit of the structural material as is usually required by the specifications.

*Zeitschrift des Vereines Deutscher Ingenieure, 1914.

The method followed by the author in deriving his formulae is original and nothing short of ingenious. He first describes the observed behaviour of a pipe under external load and states that, for proper design, the formation of only 2 complete waves (4 beams) in the shell should be considered.

A study of the table just given reveals the interesting fact that as the product of the shell thickness and length increases, the number of nodes decreases and approaches 4 so that $n = 2$. The decrease in the rigidity of the stiffeners evidently has the same effect as the increase in length. Also, the author's working formulae are predicated on a reasonable proportional rigidity of pipe shell and stiffeners which tends to increase the product $hl$ (or $tl$) and enhances the formation of a minimum number of nodes. If we now consider that, by hypothesis, the pipe is already slightly out of round, it becomes obvious that the assumption of 4 nodes by the author is warranted by theory as well as by practical experience, so long as the shell thickness is sufficient to permit the shell quadrants to maintain their integrity as beams acting between stiffeners.

The author takes no account of the effect of axial and shearing forces, and of Poisson's ratio on the deformation of the shell and rib and assumes that all deformation is due to bending moments only. The writer believes that these omissions are fully justified within the limits claimed for the application of the author's formulae. The studies made by Becker,* Matsumura and Mahabe† and Haigh‡ give sufficient evidence to show that, for practical purposes, the author's assumptions are permissible.

The author did not follow the method of analysis according to Love, Timoshenko and von Mises, nor that more recently developed by Bauersfeld and Dischinger; von Mises found the rigorous solution of the critical external pressure of a pipe with rigid ribs and Dischinger that of the stresses in a thin vault acting as a beam with rigid diaphragms at the point of support. The solution of these problems by means of the "membrane theory" led to extremely involved mathematics and the writer ventures the opinion that the attempt to solve the problem on hand in the same rigorous manner would meet with insurmountable analytical difficulties.

The author approaches his task by first evaluating the co-efficients which permit the expression of bending moments in terms of deflections and vice versa. Next, based on sound reasoning and by remarkable skill in mathematical treatment, he determines the portion of bending moment supported by the girth strength of the shell and that supported by the rib to which it is transmitted through beam action. Eliminating successively the unknown terms, he finally expresses these moments in known quantities, and, dividing by the proper section modulus, he arrived at the stresses sought.

In the course of the operations just described, the author makes two approximations, both of which are believed to be permissible.

The first, and more important, is that the author treats the beams as if they were able to deflect independently of each other. This, of course, cannot be so, because one beam deflects inward, the other outward, and they are joined at the nodes which are contained in the plane of the neutral axes of both beams. Therefore, in the vicinity of the nodal lines, there must be a region in the shell where an adjustment of these two tendencies must take place. The writer believes that this region is too narrow to affect materially the value of the moment of inertia of the beam

*University of Illinois Eng. Expt. Sta. Bull. 85.
†Memoirs Coll. of Eng. Kyoto Univ., 1915.
‡Proc. British Assn. 1919 and 1921.

cross-section. He bases his opinion, first, on the fact that the deflections should be very small with the working stresses assumed and the large section moduli of the shell quadrants and, therefore, the adjustment can take place in a short distance from the node especially when it is considered that the formulae are recommended only for thin shells having a thickness of 0.006 to 0.02 of the radius. Second, the author's formulae revert to the classical formula (a) for $l = \infty$; and, finally, a comparison of results obtained from formula (36) shows a reasonable agreement with those of formula (c) and with values furnished by tests.

The second approximation is, that the author used, for $I'$, the moment of inertia of a circular quadrant instead of the deformed one. The permissibility of this procedure seems obvious.

The consideration of imperfect construction is extremely important from a practical point of view. It is obvious that, even should the use of any of the formulae (a), (b) or (c), if the safety factor is selected high enough, result in a safe theoretical pipe, a comparatively small deviation from the circular shape in the actual pipe may reduce the margin of safety to zero. The great value of the author's paper is believed by the writer to lie in that it gives to the designer the means of fitting his design to practical tolerances.

Dr. T. H. Hogg, M.E.I.C.[7]

The author is to be complimented in having derived a workable formula, which is particularly useful in the determination of the maximum stress in the stiffening rib angles of a circular tube subject to uniform external pressure. He states that the same principles are also applicable to penstocks under partial vacuum, but presumably this would not apply to horizontal pipe lines or tunnels under external water pressure, except where the external pressure is of large magnitude compared with the diameter of the pipe.

Empirical formulae have been derived from tests to determine the allowable plate thickness for cylindrical furnaces. One of these is the Board of Trade formula

$$WP = \frac{99{,}000 \times t^2}{(L + 1)\, d}$$

where

$WP$ = working pressure in pounds per square inch,
$t$ = allowable thickness of plate in inches,
$L$ is the unsupported length of the tube in feet, and
$d$ is the diameter of the tube in inches.

In these tests, made on tubes up to 3 feet in diameter, the tube is probably completely restrained from distortion at the ends.

Mr. Johnson's study, however, covers the condition where the stiffening ribs are of less than infinite rigidity. Since the bending in circular pipes subject to external pressure is due to deformation in manufacture, the author's basis of assuming a reasonable limit of deformation to be specified and the design of the various members to meet this requirement, appears a most logical procedure. The tolerance recommended by the author appears a reasonable one, viz., a difference of one per cent between diameters in the same transverse plane.

The practical application of formula No. 40, as worked out in the numerical example given, is of great interest. The law of similitude mentioned is particularly useful, and should enable the preparation of tables or curves for given working pressures and plate thickness. A tabulation which has been worked out from Mr. Johnson's formula and the law of similitude is given below. The figures given are for a head of water of 40 feet on the rib, and a maximum stress in the rib of 15,000 pounds per square inch.

| Plate Thickness | Rib Angle | Rib Spacing | Diameter |
|---|---|---|---|
| inches | inches | inches | inches |
| ¼ | 3½ × 3½ × ¼ | 100 | 69 |
| 5/16 | 4 × 4 × 5/16 | 126 | 86 |
| ⅜ | 5 × 5 × ⅜ | 151 | 103 |
| 7/16 | 6 × 6 × 7/16 | 176 | 120 |

The rib angles have been assumed to have equal legs, and to be of the same thickness as the plate, which simplifies the determination of the maximum stress, and at the same time provides good structural design. Similar tables could be calculated for other heads.

The profession is indebted to Mr. Johnson for his many contributions on hydraulic subjects, particularly in connection with the design of Johnson valves, surge tanks (both simple and differential), and intakes. The writer was fortunate in having been associated with him in the early days at Niagara Falls on differential surge tank studies, on which subject he has given much extremely interesting and useful data. This work has now been supplemented by this present paper on the determination of stresses in the internal riser, which offers a rational solution to a heretofore uncertain feature of design.

Herbert J. Laber[8]

The author is to be complimented for his valuable contribution to a definite phase of engineering. Designers who have been confronted with the problem of properly stiffening a tube under external pressure will fully appreciate its merit.

When the engineer considers the great amount of uncertainty involved in using stability equations based on infinite stiffeners in such designs he comes to the conclusion that he never knew how much of a factor of safety there actually was, either on the load or stress. This paper, which is an expression in stress, now made it possible for the designer to compute with fair accuracy his margins of safety on stress and load.

The author's conception of a figure slightly out of round initially in the development of his theory deserves praise. Here, for the first time, is a stress equation based on a practical shape with which engineers have to deal. Theories based on perfectly circular tubes with infinite stiffeners are subject to criticism in that they involve theoretical rather than practical structures. The writer does not discredit earlier theories involving collapsing pressures but merely endeavours to point out the practicability of the author's paper.

Although the author professes little credence in his values of $p_c$ it is interesting to see just how these compare with some experiments, and those as computed from the collapsing pressure equation of R. von Mises*. The experiments listed are those of Fairbairn† and Bach‡, with all the values tabulated to conform to the author's nomenclature.

A résumé of the Fairbairn experiments indicates four of the author's values for critical pressure practically agreeing with the experiments, one value less, and the remaining three greater. A similar comparison of the Bach experiments shows two values less than the experimental and the remaining value greater by 6.5 per cent. It should be noted, however, that the collapsing pressure in each

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*Zeitschrift des Vereines Deutscher Ingenieure, 1914, page 750.
†Transactions of the Royal Society, London, 1858, page 389.
‡Zeitschrift des Vereines Deutscher Ingenieure, 1894, page 689.

Fairbairn Experiments

| $r$ | $a$ | $b$ | $p$ pounds per square inch (exp.) | $p_v$ pounds per square inch (Mises) | $p_c$ pounds per square inch (Johnson) | Number of Nodes |
|---|---|---|---|---|---|---|
| 3 | 19.66 | .0143 | 32 | 27.59 | 40 | 4 |
| 3 | 10.00 | .0143 | 65 | 71.75 | 68.70 | 6 |
| 3 | 10.00 | .0143 | 52 | 71.75 | 68.70 | 6 |
| 3 | 10.00 | .0143 | 48 | 71.75 | 68.70 | 6 |
| 4 | 7.5 | .01075 | 39 | 43.21 | 49.1 | 6 |
| 4 | 10.0 | .01075 | 31 | 32.56 | 32.5 | 6 |
| 5 | 10.0 | .0086 | 19 | 18.01 | 18.85 | 6 |
| 5 | 6.0 | .0086 | 33 | 32.13 | 28.65 | 8 |
| 6.1 | 9.59 | .00705 | 11 | 11.64 | 12.78 | 6 |
| 6.0 | 10.0 | .007166 | 12.5 | 11.43 | 12.5 | 6 |

Bach Experiments

| | | | | | | |
|---|---|---|---|---|---|---|
| 19.685 | 2.125 | .0162 | 360 | 455.6 | 353 | 10 |
| 19.685 | 3.96 | .0228 | 480 | 590.8 | 511 | 8 |
| 26.988 | 1.33 | .0093 | 135 | 187.7 | 121 | 14 |

case of the Bach experiments, according to Mises equation is greater than either the experimental or the author's value of $p_c$. In the Fairbairn experiments, however, the collapsing pressures according to Mises equation agree more closely at times with the tests than do those determined by the author's equation. Fairbairn covered no great range in his experiments but merely confined them to tests on tubes of small diameters. Because of this limitation it is possible that his specimens conformed more nearly with the rigid requirements demanded by the Mises equation and consequently the loads computed with the latter are more nearly an indicator of the collapsing pressures.

When the experiments of Bach are considered the results agree more with the author's theory. This probably can be partly accounted for by the larger diameter of tubes. Here a true circular form is more difficult to obtain and hence the premises are not strictly adaptable to the stability theory. When it is realized that the author's equation is an expression at the limit of a theory involving stress on a shape slightly out of round initially his value of $p_c$ is a better indicator of collapse when any eccentricity in shape is likely to be present. Fairbairn attributed some of the discrepancies in his experiments to the fact that some of his specimens were possibly out of round to a slight degree. Although the author's theory differs entirely with the thought involved in Mises derivation it is interesting to note that the same number of nodes are developed using the two equations for collapse.

The purpose of the foregoing comparison is not to prove the accuracy of the author's equation over others but merely to illustrate the possibilities of its usage.

Professor G. H. MacCullough[9]

The difficulty of the problem which Mr. Johnson has had the courage to attack in his paper is appreciated. Therefore it is not surprising that during a casual reading of this paper several queries arose in the mind of the present discussor. Perhaps a more detailed explanation of some of the assumptions would have cleared up some of the apparent difficulties. The following comments may be pertinent:—

1. Has the elastic stability of the pipe wall been considered?

2. The author assumes four kinds of loads. It is not clear how each arises. Are these loads forces or are some of them moments at various sections? Are they real or artificial loads?

3. If there are axial forces present as well as forces at right angles to the deflection curve, the statement of the first paragraph, page 3, concerning the sum of the individual deflections equaling the resultant deflection is questionable. For under these conditions, there is no linear proportionality between the magnitude of the compressive force and the deflection which it produces.

4. When dealing with plates, such as the wall of the pipe should not $\frac{E}{1-\mu^2}$ be used instead of $E$? $E$ is correct only for bending of ordinary beams. $\mu$ is Poisson's ratio.

Julian C. Smith, M.E.I.C.[10]

This paper seems to the writer to be an original and valuable contribution to the mathematical treatment of a difficult subject. The engineer who gets the usual amount of mathematics finds in books on mathematics or hydraulics a treatment of circular tubes, under external pressure, which shows only compressive stresses up to the point of failure. The tube, however, does not ordinarily fail in this way. Usually it begins to collapse from instability, and by the time the full strength of the material is reached the tube will have deformed to such an extent that it is useless for the purpose which it was to fulfil.

The introduction of stiffening rings changes this elementary conception of stress, by introducing longitudinal stresses arising from beam action. With truly circular tubes having truly circular stiffeners of infinite rigidity, the strength of the tubes is indeterminate, and is subject to slight variations in material, in thickness and in the method of attachment to the rings.

If the rings are not infinitely stiff, they will distort, and stresses will arise which, as the author points out, are complicated. His assumption of an initial departure from circular form is ingenious and original, and the concept of beam action is a reasonable simplification. On this basis, the argument proceeds mathematically until it is summarized in two equations with which a safe design can be made.

The author does not go into details as to many applications of his mathematical treatment of this problem. He has used it, as he states, in the design of the risers in the surge tanks, these risers under certain conditions being under external pressure. There are many other instances which would occur to an engineer in which this problem is of importance. Pipes laid under water, or under ground sufficiently soft to permit an assumption of uniform pressure: submarines and other structures of this shape are all problems of importance to engineers.

The mathematical development appears difficult because it is necessarily much condensed. Once the fundamentals are clearly seen, the rest of the subject follows from some very complicated substitutions which do not require any advanced mathematical theory, though one may admire the ingenuity exhibited in their treatment. The physical meaning of these substitutions, however, will probably be apparent only to a few.

The Institute is fortunate in the presentation of such a paper: one which will stimulate interest and thought on the part of our members in this method which gives a direct solution to a problem of frequent occurrence.

R. D. Johnson[11]

An insignificant error in the "Percentage Increases" listed in the table should be noted. These may be refined with sufficient accuracy by multiplying each of them by

(9) Professor of Engineering Mechanics, Worcester Polytechnic Institute, Worcester, Mass.

(10) President, Shawinigan Water and Power Company, Montreal.

(11) Hydraulic engineer, 67 Wall Street, New York, N.Y.

the quantity (1.21 — .01 $n$). This error is the result of a trifling misstatement of the general expression* for the moment of inertia of a segment of tube about its chord as an axis. If the discrepancy had remained undiscovered, no harm would have been done.

The author wishes to take this opportunity to express his appreciation of the interest shown in his monograph and to thank those who have participated in the discussion.

He expected his analysis would receive the benefit of criticism by two distinct classes of commentators, namely, expert technicians who would be inclined to discredit it and competent engineers who would be likely to endorse it. The prevalence of the former class on committees of the two great American engineering societies drove him abroad for enough understanding to gain acceptance of his paper for publication. The latter class have been able to follow his reasoning without assistance from him and he could but conclude that further elaboration is unnecessary. The approval of such men as Messrs. Smith, Gibson, Hogg and Halmos constitutes adequate confirmation. Mr. Macphail's effort at elucidation was effective enough to bring forth Dr. Gibson's concise statement that "All the equations have been substantiated" not only by himself but evidently also by Messrs. Strowger and Bernstein.

A careful reader will discover that the author accomplished, at any rate, what he set out to do when he arrived at the closely approximate equation (40) having shown that the value of $K$ is usually so small as to be negligible. Therefore, no matter how many technical faults may be found in the behaviour of shell stresses as set forth, the fact remains that engineers have received substantially if not precisely what they have long been seeking. That is all he tried to do and he is little interested in controversies over fine points which would doubtless ensue. The paper is more practical than academic.

Mr. Doughty's comments are clearly the result of much sound and careful thought. The precise extent to which the stated shell stresses and deflections depart from the truth must apparently remain in doubt pending further refinement. Meantime, the author retains his own faith in their reliability, sufficient at least for an accurate outcome of his purpose.

Mr. Boardman opened his discussion vigorously by repudiating the whole analysis, denying the basic consideration that bending stresses are directly proportional to $\Delta$. Defence against this and his other imputations, seem impossible without repetition of arguments.

Professor Cook might find Mr. Laber's comparisons satisfactory. They were largely new to the author and most gratifying. Necessity for improvement in the proposed method of design was not here indicated.

It was suspected that Professor MacCullough's casual reading accounted for the questions, which would doubtless later resolve themselves. It may be remarked, however, that "elastic stability" has been so well considered as to have been almost entirely discarded; that "four kinds of loads" have not been assumed but proved to be acting; that extraneous axial forces have been neglected as unimportant especially when shortening of the tube under load is permitted; that the use of Poisson's Ratio has not been considered necessary in the type of analysis submitted.

The author begs to be excused from trying further to justify his conclusions to experts whose methods, however laudable and generally superior to his own, have nevertheless been incompetent, thus far, to produce a design both economical and trustworthy for the particular case under consideration. It is assuming too much to suppose that he could be more convincing by striving to emulate them. He wishes to reiterate that no claim is made to a rigorous analytical perfection and some minor errors may be expected to become evident, as many discarded odds and ends, thought to be unimportant, may be woven into the theory by those who are clever enough. Engineers, however, are interested only in such criticism as would improve the practical formulae offered and the experts are invited to furnish something better than mere doubt.

* $I' = r^3 t\,(\theta - 3\sin\theta\cos\theta + 2\,\theta\cos^2\theta) + rt^3\,(\theta - (1/3)\sin\theta\cos\theta)/4$
where $\theta = \pi/n$

# Western Professional Meeting

The photographs appearing on the opposite page are those of a number of Institute members who are taking a prominent part in the Western Professional Meeting of The Institute which is to be held in conjunction with the Annual Convention of the American Society of Civil Engineers in Vancouver, on July 11th to 14th, 1934.

F. P. Shearwood, M.E.I.C., the President of The Institute, will welcome the delegates, and the President of the American Society of Civil Engineers, Harrison P. Eddy, M.E.I.C., will reply and deliver his annual address to the Society. E. A. Cleveland, M.E.I.C., is Chairman of the Joint Local Committee.

At the luncheon to be held the first day, P. H. Buchan, A.M.E.I.C., the Chairman of the Vancouver Branch of The Institute, will be in the chair, and the speaker will be A. S. Gentles, M.E.I.C., President of The Association of Professional Engineers of British Columbia.

At the technical sessions of The Institute, Patrick Philip, M.E.I.C., will speak on **Highways and Highway Transportation in British Columbia**, W. G. Swan, M.E.I.C., will present a paper entitled **Town Planning Aspects of Vancouver and Fraser River Harbours**, P. L. Pratley, M.E.I.C., will give a paper on **The Substructure of the Reconstructed Second Narrows Bridge**, and at a joint technical session J. C. MacDonald, M.E.I.C., will address the meeting on **The Canadian Aspects of the Columbia River Drainage Basin.**

# Prominent Speakers at the Western Professional Meeting of The Engineering Institute of Canada

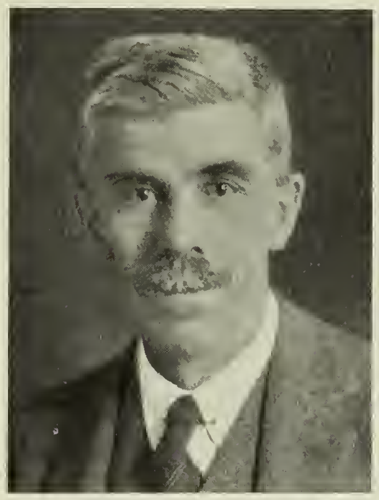
A. S. GENTLES, M.E.I.C.

HARRISON P. EDDY, M.E.I.C.
President, American Society of Civil Engineers.

E. A. CLEVELAND, M.E.I.C.

## Vancouver, B.C.
### July 11th to 14th, 1934

PATRICK PHILIP, M.E.I.C.



F. P. SHEARWOOD, M.E.I.C.
President, The Engineering Institute of Canada.

P. L. PRATLEY, M.E.I.C.

W. G. SWAN, M.E.I.C.

P. H. BUCHAN, A.M.E.I.C.
Chairman, Vancouver Branch, E.I.C.

J. C. MacDONALD, M.E.I.C.

THE
# ENGINEERING JOURNAL
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OF CANADA



VOLUME XVII JULY 1934 No. 7

## The Toronto Centenary

Canada is commemorating this year two events which stand out in the country's romantic history, and which are separated by an interval of three hundred years. In 1534 Jacques Cartier made his first voyage in search for a north-west passage to the east, landed at Gaspé, and sailed up the Gulf of St. Lawrence. In 1834 the City of Toronto was incorporated and the little settlement of York came into its own.

The French adventurers of the sixteenth and seventeenth centuries were well endowed with that spirit of enterprise which has resulted in the building of Canada as we know it today. Cartier himself ascended the St. Lawrence as far as the Lachine Rapids, and his voyages led the way for his successors, Champlain and his followers, whose work, more than seventy years later, ultimately resulted in the establishment of the French regime in Lower Canada. Some of the early French explorers were traders; some were churchmen; others, like LaSalle, were in the King's service. Many of our principal cities now stand on sites marked out by these men, and one of them is Toronto.

In 1720 a French trading post was established at a harbour on Lake Ontario, named by the Indians "Place of Meeting," and later a fort was built there to check the enterprise of the English, who were then active at Oswego across the lake. This fort, known as Fort Rouille, was abandoned after the termination of the French regime, but in 1794 its site was selected by Governor Simcoe as the seat of government of the new province of Upper Canada. It is interesting to note that one of the first ceremonies of the Toronto Centenary this year, held on May 24th, was an official reception of descendants of the Marquis de la Jonquière, who was Governor of New France at the time of the building of this fort, and the descendants of Major-General Simcoe. The town was named York, and the first Provincial Parliament met there in 1797.

At that time the backbone of the population of Ontario was composed of the Loyalists from the newly formed United States, who sought homes under the British flag, and who gave to Upper Canada its desire for tolerance and responsible government. The town saw something of the war of 1812, suffering severely at the hands of the American Generals Pike and Dearborn. At that time the population numbered only 456. When peace was restored the work of creating a capital for Upper Canada was resumed, and in 1834, by which time the population numbered 9,256, the Provincial Legislature incorporated the city under the original Indian name of its site, Toronto. The inhabitants lived mainly between York street and the Don, and several public buildings, such as the Parliament Buildings and Osgoode Hall, had already been erected, together with a residence for the Lieutenant-Governor. The principal power plant of the city at that time was a windmill near the mouth of the Don.

Following incorporation, the first years of the city's existence were somewhat troubled by political unrest, but after the union of Upper and Lower Canada in 1840 this condition terminated when much needed reforms were obtained during Lord Elgin's Governorship.

The railway era of the 50's gave great impetus to the growth of Toronto and it became a terminal and distributing point for the railways which began to cover the more thickly settled portions of the province. The first locomotive built in Canada was constructed in Toronto in 1853, and the first through train between Toronto and Montreal ran over the Grand Trunk Railway in October 1856. Since that time the growth of population has been rapid, being over 40,000 in 1864, passing the 100,000 mark in 1884, and reaching 600,000 in 1928.

With citizens mainly of British stock, Toronto has also become the home of many new Canadians from continental nationalities, a fact which gives a cosmopolitan tinge to its crowded streets. The striking view of Toronto's towering buildings, as seen from the harbour, is a visible sign of the city's importance as a commercial, industrial and financial centre, a status exemplified by banking statistics which showed bank clearings of over four billion dollars in 1932. Lying in the most highly industrialized area of Canada, the gross value of its manufactured products was over five hundred million dollars in 1930. Ever since the development of the Cobalt camp in 1907, Toronto has held a leading position in connection with the mining industry, and Ontario, with a mineral production of a hundred million dollars a year, looks to the city as the headquarters of that industry.

The city is justly proud of its harbour, that natural feature which adds so much to its amenities, and is of such importance as the only harbour of refuge on the north shore of Lake Ontario. Harbour development, particularly during the last decade, has been remarkable, and the Harbour Commissioners, while reclaiming nearly two thousand acres of land suitable for industrial areas, have provided wharfage and harbour terminals for the use of large steamers up to 25 feet draught, and have taken the opportunity of constructing a new thoroughfare along the entire waterfront of the city from east to west, leading from the industrial centres in the east to the Exhibition Grounds and the recreational and park areas at the west end. There are few cities whose waterfront development has been so well balanced, or where the various agencies of modern transportation have been so well co-ordinated in the interests of both commercial activity and the public welfare. The city administration in Toronto has always been progressive as regards public health and sanitation, and the cheap and plentiful supply of electrical power developed in Ontario by the Hydro-Electric Power Commission has enabled its citizens to take full advantage of the most modern aids to domestic life. In all of these projects the engineer has had a leading part, whether in construction, highway development, transportation, or in the civic services.

Today Toronto is an outstanding Canadian example of a great city which is not only a busy centre of commercial, industrial and educational activity, but is pre-eminently a city of homes. Its Centenary is being marked by a series of ceremonies which began on March 5th, the actual anniversary of the city's Charter, were followed on May 24th by a characteristic historic pageant, and which will be continued during the summer and fall. In carrying out all these events, and in reviving the memory of their historic past, Toronto citizens have the hearty goodwill of their fellow Canadians, from their own province, from the Maritimes, the Province of Quebec, the Prairies, and the Pacific Coast.

## Meeting of Council

A meeting of Council was held at Headquarters on Friday, June 15th, 1934, at eight o'clock p.m., with President F. P. Shearwood, M.E.I.C., in the chair, and ten other members of Council present. Mr. D. C. Tennant, M.E.I.C., chairman of The Institute's Committees on Membership and Unemployment, was also present by request.

Replies were received from several of the Ontario branches in regard to the point raised by Mr. H. D. Anger, Barrister, of Toronto, regarding the difficulty in cases where engineers perform work for municipalities in Ontario without engagement in the form prescribed by law. As a result, it was decided that the corporate members of The Institute in Ontario should be informed regarding the situation, and that a communication should also be addressed drawing the matter to the attention of the Association of Professional Engineers of Ontario.

A memorandum presented by Councillor C. M. Pitts, dated May 30th, 1934, with reference to the co-ordination of the engineering profession in Canada, received further consideration, and expressions of opinion were read from a number of members of Council regarding Mr. Pitts' plan. Past-President Lefebvre outlined the activities of The Institute in this direction, which had been commenced in 1925, explaining the reasons for the slow progress that had been made. He pointed out that the co-ordination of the Professional Associations themselves was now in the hands of a Committee of Eight, composed of representatives of the eight organizations concerned, and he believed that it would be undesirable at this time to complicate matters by the formation of an Institute committee. After further discussion it was resolved to give the matter further consideration in the fall.

Discussion took place regarding the subject for the Past-Presidents' Prize for the year 1934-1935, and it was unanimously decided to approve the subject recommended by the Lethbridge Branch, namely, "The Co-ordination of the Activities of the Various Engineering Organizations in Canada."

Mr. Tennant, chairman of The Institute's Membership and Unemployment Committees, attended by request, and reported regarding the recent activities of these committees. It was noted that the applications for admission showed some increase as compared with last year, but Mr. Tennant felt that there should be no relaxation of the efforts made by the various branches to induce qualified engineers to join The Institute. This could only be done if members in each branch took an active interest in the problem.

As regards unemployment, the committee's report indicated a distinct improvement as compared with last year, but it was realized that there was still much work to be done by the branch unemployment committees.

Following a letter from Mr. J. J. Traill, M.E.I.C., chairman of the Toronto Branch Annual Meeting Committee for 1935, it was decided that the Forty-Ninth Annual General and General Professional Meeting of The Institute should be held on Thursday and Friday, February 7th and 8th, 1935, at the Royal York Hotel, Toronto.

Nine resignations were accepted, a number of reinstatements were effected, one special case was dealt with, and one Life Membership was granted.

A number of applications for admission and for transfer were considered, and the following elections and transfers were effected:

| *Elections* | | *Transfers* | |
|---|---|---|---|
| Member | 1 | Member to Assoc. Member | 2 |
| Assoc. Members | 4 | Junior to Assoc. Member | 3 |
| Juniors | 4 | Student to Assoc. Member | 2 |
| Students admitted | 14 | | |

The Council rose at eleven forty p.m.

## Annual Meeting 1935

At the meeting of Council held on June 15th, 1934, the invitation of the Toronto Branch to hold the Forty- Ninth Annual General and General Professional Meeting of The Institute at Toronto on February 7th and 8th, 1935, was accepted with appreciation.

## The Past-Presidents' Prize 1934-35

Council has selected as the subject of the essays to be submitted for the competition for the prize year July 1st, 1934 to June 30th, 1935:—

### The Co-ordination of the Activities of the Various Engineering Organizations in Canada

The rules governing the award of this prize are as follows:—

The prize shall consist of a cash donation of the amount of one hundred dollars, or the winner may select books or instruments of no more than that value when suitably bound and printed, or engraved, as the case may be.

The prize shall be awarded for the best contribution submitted to the Council of The Institute by a member of The Institute of any grade on a subject to be selected and announced by the Council at the beginning of the prize year, which shall be July first to June thirtieth.

The papers entered for the competition shall be judged by a committee of five, to be called the Past-Presidents' Prize Committee, which shall be appointed by the Council as soon after the Annual Meeting of The Institute as practicable. Members and Honorary Members only shall be eligible to act on this committee.

It shall be within the discretion of the committee to refuse an award if they consider no paper of sufficient merit.

All papers eligible for the competition must be the bona fide work of the contributors and must not have been made public before submission to The Institute.

All papers to be entered for the competition must be received during the prize year by the General Secretary of The Institute, either direct from the author or through a local branch.

## ELECTIONS AND TRANSFERS

At the meeting of Council held on June 15th, 1934, the following elections and transfers were effected:

*Member*

STIRLING, John Bertram, B.Sc., (Queen's Univ.), partner in firm, E. G. M. Cape and Company, Montreal, Que.

*Associate Members*

BECK, Humphrey Campbell, (Fed. Polytechnic Inst., Zurich), engr. for Brown-Boveri & Company, (Home) Sandringham, Norfolk, England.

CORNER, Edward Ponsonby, (Glasgow Tech. Coll.), representative, Prov. of Quebec, Hamilton Gear and Machine Co., 1120 Castle Building, Montreal, Que.

GILBERT, Gordon Macdonald, B.Sc., (Univ. of Man.), acting engr. and supt., Vancouver and District Joint Sewerage and Drainage Board, Vancouver, B.C.

HANSEN, Darrel Adrian, B.Sc., (Univ. of Alta.), asst. to divn. engr., Northern Division, Calgary Power Company, Edmonton, Alta.

*Juniors*

GAUDEFROY, Henri, B.A.Sc., C.E., (Ecole Polytechnique, Montreal), 4590 Hutchison St., Montreal, Que.

GILCHRIST, John, B.Sc., (Univ. of N.B.), designer and dftsman., General Steel Wares, Montreal, Que.

STEPHENS, Donald McGregor, B.Sc., (Univ. of Man.), technical dftsman., surveys br., Dept. of Mines and Natural Resources, Winnipeg, Man.

TAYLOR, Andrew, B.Sc., (Univ. of Man.), technical dftsman., surveys br., Dept. of Mines and Natural Resources, Winnipeg, Man.

*Transferred from the Class of Associate Member to that of Member*

EVANS, Edwin Ronald, (Mt. Allison Univ.), civil and struct'l. engr., Lewisville, N.B.

GAHERTY, Geoffrey Abbott, B.E., (Dalhousie Univ.), President, Montreal Engineering Company, Ltd., and Calgary Power Company Ltd., 244 St. James St., Montreal, Que.

*Transferred from the class of Junior to that of Associate Member*

O'HALLORAN, James, B.Sc., (McGill Univ.), plant engr., Anglo-Canadian Pulp and Paper Mills, Ltd., Quebec, Que.

SEXTON, Jack Kenneth, B.Sc., (Univ. of Sask.), Calgary Power Company, Ltd., Seebe, Alta.

WAY, William Russell, B.Sc., (McGill Univ.), asst. supt. of operation, Shawinigan Water and Power Company, Montreal, Que.

*Transferred from the class of Student to that of Associate Member*

COWAN, Elijah, B.A.Sc., (Univ. of Toronto), control man, Lake St. John Paper and Power Company, Dolbeau, Que.

LORD, George Ross, B.A.Sc., (Univ. of Toronto), M.Sc., (Mass. Inst. Tech.), lecturer in mech'l. engrg., Univ. of Toronto, Toronto, Ont.

*Students Admitted*

AMAN, Thomas Freeman Stewart, (Queen's Univ.), 77 Highland Ave., Belleville, Ont.

BELLAMY, Keith Lacy, (Queen's Univ.), 2548 Taylor St., Niagara Falls, Ont.

BENTLEY, Kenneth Earl, B.Sc., (N.S. Tech. Coll.), Billtown, Kings Co., N.S.

DAVIS, Ralph Cargill, B.Sc., (Univ. of Alta), Etzikom, Alta.

DEMOCKO, Gerald George, (Queen's Univ.), Fort William, Ont.

ELLIOTT, John Courtenay, B.Sc., (Queen's Univ.), 335 James St., Ottawa, Ont.

ELLSWORTH, Arthur Crayton, (Queen's Univ.), R.R. No. 1, Ridgeway, Ont.

GAYFER, Edwin Ralph, B.Sc., (Univ. of Man.), 9917-108th St., Edmonton, Alta.

HAZELTON, William Beverley, B.Sc., (Univ. of N.B.), Beebe, Que.

McCANN, William Neil, B.Sc., (Univ. of Man.), 2517 Wallace St., Regina, Sask.

MONTGOMERY, James William, B.Sc., (Univ. of Alta.), Wetaskiwin, Alta.

TAPLEY, Donald Gordon, B.Sc., (N.S. Tech. Coll.), 65 Walnut St., Halifax, N.S.

WALLMAN, Clifford George, B.Sc., (Univ. of Man.), 322 Home St., Winnipeg, Man.

WILLIAMS, Leslie Chevers, B.Sc., (Queen's Univ.), 23 Ossington Ave., Ottawa, Ont.

## Result of May Examinations of The Institute

The report of the Board of Examiners presented at the meeting of Council held on May 18th, 1934, certified that S. G. Johre, London, Ont., having passed the examination of The Institute under Schedule C for admission to Associate Membership, has satisfied the examiners as regards his educational qualifications for that class of membership.

# OBITUARY

## William Gore, M.E.I.C.

Widespread regret will be felt at the death at Long Branch, Ontario, on June 7th, 1934, of William Gore, M.E.I.C.

Born at King's Lynn, England, on April 13th, 1871, Mr. Gore was apprenticed to Alfred Dodman, M.Inst.M.E., at Kings Lynn from 1888 to 1892, and in 1892-1893 he was assistant engineer on the design, construction and erection of steam engines, boilers, pumps and general mechanical constructional work. From 1893 until 1896 Mr. Gore attended the Central Technical College of the City and Guilds of London, receiving the diploma of Associateship (A.C.G.I.), the Whitworth Exhibition in 1894, and the Siemens Memorial Medal in 1895.

WILLIAM GORE, M.E.I.C.

From 1896 until 1897 he was chief draughtsman to the Fowler Waring Gables Company at North Woolwich, England, and later, until 1899, was assistant to George F. Deacon, consulting engineer, London, on design, construction, arbitration and parliamentary work in relation to engineering works of highest magnitude. From 1899 to 1912 Mr. Gore was chief assistant to Mr. Deacon and to Sir Alex. Binnie, Son and Deacon, his successors, being connected with, among others, the following works: London Water Supply, Welsh scheme; Liverpool Water Supply, Vyrnwy scheme; Ebbw Vale Water Supply; London Underground Railways; Petrograd Water and Sewerage; Athens water supply; Malta and Gozo sewerage; Sydney sewage outfall; Ravi crossing Bari Doab canal irrigation project. In 1912 Mr. Gore became consulting engineer to Ransome verMehr Machinery Company of London, England, to John verMehr Engineering Company, of Toronto, and was located at Toronto, Ontario. In 1919 Mr. Gore became a partner in the firm of Gore, Nasmith and Storrie, consulting engineers, Toronto, retaining the association until the time of his death. During his association with that firm his wide experience in water works and sewerage problems caused Mr. Gore to be regarded as an authority on sanitary engineering and questions of public health. He was engaged on the water supply projects for Toronto, Ottawa, Belleville, Windsor, St. Thomas, Hamilton and Calgary. Among the principal sewerage and sewage disposal plants on which he advised may be named those for North Toronto, Toronto, York Township and Kitchener.

Mr. Gore was a member of the Institution of Civil Engineers, and the Institution awarded the George Stephenson gold medal to him in 1907.

He joined The Institute as a Member on January 29th, 1918.

# PERSONALS

Chas. W. West, A.M.E.I.C., formerly division engineer, Welland Ship Canal, Department of Railways and Canals, at Thorold, Ont., has been appointed superintendent engineer.

B. W. Pitfield, S.E.I.C., graduate in civil engineering from the University of Alberta this year, has secured a position with Canadian Industries Limited, Montreal.

Charles E. Garnett, A.M.E.I.C., vice-president and chief engineer of Gorman's Limited, Edmonton, Alta., was recently elected vice-president of the Canadian Institute of Mining and Metallurgy.

H. B. Price, S.E.I.C., has joined the staff of the Canadian Fire Underwriters' Association, Montreal. He graduated from McGill University with the degree of B.Eng., in 1932.

Donald Rhodes, S.E.I.C., is now district engineer in the Sherbrooke district of the Bell Telephone Company of Canada. Mr. Rhodes graduated from McGill University in 1928.

L. E. Ennis, A.M.E.I.C., has been appointed district engineer in the Quebec district of the Bell Telephone Company of Canada, and is now located in Quebec, Que. Mr. Ennis was formerly toll pole and wire engineer, at Montreal.

Eric L. Hartley, S.E.I.C., is now civil engineer in the Farm Lands and Properties Department of James Richardson and Sons Limited, Winnipeg, Man. Mr. Hartley graduated from Queen's University in 1933 with the degree of B.Sc.

W. J. S. Dormer, A.M.E.I.C., formerly division toll plant engineer, Quebec district, Bell Telephone Company of Canada, Montreal, has been appointed district engineer in the Three Rivers and Montreal suburban districts, with headquarters in Montreal.

R. L. Strong, S.E.I.C., is in the Ballistics Department of Canadian Industries Limited, at Brownsburg, Que. Mr. Strong, who graduated from the University of Toronto in 1931 with the degree of B.A.Sc., was in 1932 research assistant at McGill University, Montreal.

W. D. Black, M.E.I.C., president of the Industrial Relations Committee of the Canadian Manufacturers Association, and vice-president of the Otis-Fensom Elevator Company Limited, Hamilton, has been appointed employers' delegate to the International Labour Conference in Geneva.

Graham Kearney, M.E.I.C., is with the firm of Sawford and Kearney, electrical and mechanical engineers, Vancouver, B.C. Mr. Kearney had been engaged in private practice in Montreal since 1932. He was at one time sales engineer with the Canadian General Electric Company, Limited, Montreal.

E. D. Gray-Donald, A.M.E.I.C., superintendent of the power division of the Quebec Power Company, has been awarded the degree of M.Sc. from Laval University, Quebec. Mr. Gray-Donald graduated from McGill University in electrical engineering in 1926, and has since been with the Shawinigan Water and Power Company and the Quebec Power Company.

J. R. Donald, M.E.I.C., is president, and H. W. B. Swabey, M.E.I.C., is secretary, of the newly-formed firm of Donald-Hunt Limited, inspecting engineers and metallurgists, Montreal.

Mr. Donald, who was managing-director of J. T. Donald and Company, Limited, Montreal, graduated from McGill University in 1913, following which he joined the Nichols Chemical Company, Limited, at Sulphide, Ontario. The next year he was engaged in general consulting with J. T. Donald and Company Limited. From 1916-1918 he was chief inspector of explosives, chemicals, for the Ministry of Munitions, Canada, and in 1919 he was appointed chemical engineer and chief chemist of the Canadian Packing Company Limited, Toronto, later rejoining J. T. Donald and Company Limited.

Mr. Swabey has been associated with J. T. Donald and Company Limited since 1926. He was supervising engineer on the construction of the Atlantic, Quebec and Western Railway; resident engineer, for a time, on the construction of the Quebec and Saguenay Railway, and served the Canadian Pacific Railway Company as resident engineer on the construction of the Campbellford-Lake Ontario and Western Railway. During the war, as chief inspector of steel, Mr. Swabey had charge of the inspection of all steel and forgings for shells manufactured in Canada for the British government.

E. M. VanKoughnut, Jr.E.I.C., is now connected with Messrs. Crane and Company, a firm of stockbrokers, Montreal. Mr. VanKoughnut, who graduated from the Royal Military College, Kingston, in 1922, was in 1923-1924 with the Steel Company of Canada. In 1926-1928 he was on the staff of the Shawinigan Engineering Company, and in 1928 he was with the Brazilian Traction Company at Toronto. In 1929 Mr. VanKoughnut was in Sao Paulo, Brazil, with the Sao Paulo Tramway, Light and Power Company Limited. Mr. VanKoughnut was subsequently with the late Frederick B. Brown, M.E.I.C., Montreal.

A. W. Sinnamon, M.E.I.C., formerly works manager of the Van Dorn Iron Works Company of Cleveland, Ohio, is now factory manager of The Geometric Stamping Company of the same city. Mr. Sinnamon was born in Ireland, and upon coming to Canada in 1901, was first employed in the mechanical department of the Dominion Iron and Steel Company Limited, at Sydney, N.S., following which he was appointed chief engineer of the Canada Foundry Company Limited at Toronto, Ont. In 1913 he was engaged in private practice in Ottawa, and was later, for six months, chief engineer of the Anniston Ordinance Company, Alabama, returning to Montreal to accept the position of mechanical superintendent of Armstrong-Whitworth and Company of Canada, Limited. From 1917 to 1918 Mr. Sinnamon was manager of the Joliette Steel Company, Joliette, Que., and subsequently was engaged in organizing the Terrebonne Electric Power and Steel Company to develop hydro-electric power at Terrebonne, Que. In 1919 he was appointed assistant chief engineer of the Algoma Steel Corporation Limited, at Sault Ste. Marie, Ont. In 1921 he was engaged in private practice, and in 1924 he became mechanical engineer of The Hubbell and Benes Company, Cleveland, Ohio. In 1927 Mr. Sinnamon took over the position from which he has recently resigned.

## Recent Graduates in Engineering

Congratulations are in order to the following Students of The Institute who have recently completed their course at the various universities:—

### McGill University

#### Honours, Medals and Prizes

Daignault, Lawrence George, Verdun, Que.—B.Eng., (Ci.); Honours in Civil Engineering; British Association Medal.

Mellor, Alfred Geoffrey, Westmount, Que.—B.Eng., (El.); Honours in Electrical Engineering; The Engineering Institute of Canada Prize.

Sarault, Gilles Edouard, Outremont, Que.—B.Eng., (El.); Honours in Electrical Engineering; Montreal Light, Heat & Power Consolidated Second Prize.

Swartz, Joseph Norman, Fort William, Ont.—B.Eng., (Chem.); Honours in Chemical Engineering; British Association Medal.

Young, Gilbert Maxwell, Montreal, Que.—B.Eng., (Mech.); Honours in Mechanical Engineering; British Association Medal; The Jenkins Brothers Limited Scholarship.

### Degree of Bachelor of Engineering

Bellew, Leo Thomas Frederick, B.Eng., (El.), Montreal, Que.
Benoit, André Persillier, B.Eng., (Ci.), Montreal, Que.
Brumell, Orby Richard, B.Eng., (Mech.), Buckingham, Que.
Butler, John Arthur Tweed, B.Eng., (Mech.), Montreal, Que.
Clarke, Bruce Porteous, B.Eng., (Mech.), Lennoxville, Que.
Cross, Douglas Henry, B.Eng., (Mech.), Sherbrooke, Que.
Fraser, Allan Donald William, B.Eng., (El.), Outremont, Que.
French, Philip Bemis, B.Eng., (Mech.), Montreal, Que.
Graham, Charles Allison, B.Eng., (Mech.), Chesterville, Ont.
Gregory, Jack Henry, B.Eng., (Mech.), Winnipeg, Man.
Hankin, Edmund Alfred, B.Eng., (Mech.), Westmount, Que.
Harrison, Ronald Dex, B.Eng., (Mech.), Montreal, Que.
Johnson, James Richard, B.Eng., (Mech.), Revelstoke, B.C.
Kerr, Robert Allen, B.Eng., (El.), Montreal, Que.
McCann, Edward Howard, B.Eng., (Mech.), Regina, Sask.
McMath, Andrew Allan Brown, B.Eng., (Mech.), St. Lambert, Que.
Mullen, Thomas James, B.Eng., (Mech.), Montreal, Que.
Nichols, Judson Timmis, B.Eng., (Mech.), Westmount, Que.
Phillips, Robert Weston, B.Eng., (Mech.), Chambly Canton, Que.
Pistreich, Archie Loebel, B.Eng., (El.), Montreal, Que.
Rogers, Carl Lemual, B.Eng., (El.), Moncton, N.B.
Ross, Oakland Kenneth, B.Eng., (Mech.), Montreal, Que.
Sturdee, Charles Parker, B.Eng., (Mech.), Vancouver, B.C.
Tannenbaum, Joseph, B.Eng., (Mech.), Montreal, Que.

### Master of Engineering

Jehu, Llewellyn, B.Sc., (McGill Univ. '30); M.Eng., (Ci.), Lachine, Que.
Richards, Victor Lloyd, B.Sc., (Queen's Univ. '32); M.Eng., (Mech.), St. Thomas, Ont.
Savage, Palmer Ernest, B.Sc., (McGill Univ. '31); M.Eng., (Ci.), Montreal West, Que.

## Queen's University

### Degree of Bachelor of Science (with honours)

Campbell, Fraser, B.Sc., (Ci.), Richmond, Que.
Hillier, Cecil Henry, B.Sc., (Mech.), Sarnia, Ont.
Sawle, Ross Tregerthen, B.Sc., (El.), Welland, Ont.

### Degree of Bachelor of Science

Arthey, George Clayton, B.Sc., (Mech.), Tweed, Ont.
Blaine, Donald Smith, B.Sc., (Ci.), Trenton, Ont.
Buell, Milton Allan, B.Sc., (Ci.), Kingston, Ont.
Elliott, John Courtney Lang, B.Sc., (Ci.), Ottawa, Ont.
Ingles, Charles Leycester, B.Sc., (Ci.), Toronto, Ont.
Kauth, Carl Gladstone, B.Sc., (El.), Gowanston, Ont.
Klotz, Carl Otto Paul, B.Sc., (Ci.), Westboro, Ont.

## Nova Scotia Technical College

### Honours, Medal and Prize

Woods, William Daniel, Halifax, N.S.—B.Sc., (Mech.); Honours in Mechanical Engineering; the Governor-General's Medal; Association of Professional Engineers of Nova Scotia Prize.

### Degree of Bachelor of Science (with honours)

Bentley, Kenneth Earle, B.Sc., (Ci.), Billtown, Kings Co., N.S.
Holder, Allan Scott, B.Sc., (Mech.), Truro, N.S.
Reinhardt, Gerard Victor, B.Sc., (Mech.), La Have, N.S.

### Degree of Bachelor of Science

Bacon, Charles Ives, B.Sc., (El.), North Tryon, P.E.I.
Colgan, Patrick Joseph, B.Sc., (El.), Halifax, N.S.
Corkum, Philip Byron, B.Sc., (El.), Halifax, N.S.
Granville, Francis Xavier, B.Sc., (Ci.), Halifax, N.S.
Hamilton, Cecil Roy, B.Sc., (El.), Weymouth, N.S.
McLeod, Wilson Churchilll, B.Sc., (Mech.), Caledonia, Queen's Co., N.S.
Matheson, Joseph Silver, B.Sc., (Mech.), Halifax, N.S.
Powell, Clarence Wilhelm, B.Sc., (El.), Halifax, N.S.
Tapley, Donald Gordon, B.Sc., (El.), Halifax, N.S.

## University of New Brunswick

### Honours and Medal

Crowe, Frederick Ernest, Jeffrey, Kings Co., N.B.—B.Sc., (El.); Honours in Electrical Engineering; Lieutenant-Governor's Bronze Medal

### Degree of Bachelor of Science

Gorman, David Donald, B.Sc., (Ci.), Fredericton, N.B.
Hazelton, William Beverley, B.Sc., (Ci.), Beebe, Que.
Manzer, Ronald Wendell Mowatt, B.Sc., (Ci.), South Devon, N.B.
Stevenson, Charles Lester, B.Sc., (Ci.), Saint John, N.B.
Walker, Alexander Harold, B.Sc., (Ci.), Montreal, Que.

## University of Manitoba

### Honours and Medal

Love, Edwin Reginald, Winnipeg, Man.—B.Sc., (El.); Honours in Electrical Engineering; The University Gold Medal.

### Degree of Bachelor of Science

Brown, Alan Coatsworth, B.Sc., (Ci.), Winnipeg, Man.
Bubbis, Nathan Simon, B.Sc., (Ci.), Winnipeg, Man.
Dunlop, Duthie MacIntosh, B.Sc., (Ci.), Winnipeg, Man.
Lupton, Mac Joseph, B.Sc., (Ci.), Winnipeg, Man.
McCann, William Neil, B.Sc., (Ci.), Regina, Sask.
Mitchell, William Reginald, B.Sc., (Ci.), Winnipeg, Man.
Moore, Robert Hugh, B.Sc., (El.), Winnipeg, Man.
Sandilands, Adam, B.Sc., (El.), Winnipeg, Man.
Wallman, Clifford George, B.Sc., (El.), Winnipeg, Man.

### Degree of Master of Science

Woodhall, Thomas Latimer, B.Sc., (Univ. of Manitoba '30); M.Sc., (El.), Winnipeg, Man.

## University of Alberta

### Honours

Hayes, Herman R., Edmonton, Alta.—B.Sc., (Ci.); Honours in Civil Engineering with First Class General Standing.

### Degree of Bachelor of Science

Barnhouse, Frank William, B.Sc., (El.), Edmonton, Alta.
Burke, John Abel, B.Sc., (El.), Lethbridge, Alta.
Brownie, Frank Austin, B.Sc., (Ci.), Calgary, Alta.
Davis, Ralph Cargill, B.Sc., Etzikom, Alta.
Mair, Robert Comrie Mair, B.Sc., (Ci.), Edmonton, Alta.
Mason, George Anthony, B.Sc., (El.), Calgary, Alta.
Montgomery, James William, B.Sc., (Ci.), Wetaskiwin, Alta.
Pidoux, John Leslie, B.Sc., (Ci.), Edmonton, Alta.
Pitfield, Barclay Wallace, B.Sc., (Ci.), Edmonton, Alta.

### Degree of Master of Science

Jackson, Kenneth Arthur, B.Sc., (Univ. of Alberta '32); M.Sc., (El.), Pincher Creek, Alta.

## University of British Columbia

### Degree of Bachelor of Applied Science

Stirling, Andrew Grote, B.A.Sc., (Min.), Kelowna, B.C.
Thorne, Henry Leonard, B.A.Sc., (Geol.), Vancouver, B.C.

## University of Toronto

### Degree of Bachelor of Applied Science (with honours)

Girdwood, Arthur James, B.A.Sc., (El.), Barrie, Ont.
Lyman, Stuart Lauchland, B.A.Sc., (El.), Dundas, Ont.

### Degree of Bachelor of Science

Green, John Scott, B.A.Sc., (Mech.), Hagersville, Ont.

### Degree of Master of Applied Science

Bridgland, Charles James, B.A.Sc., (Univ. of Toronto '33); M.A.Sc., Toronto, Ont.
Hammond, Rowland Ernest, B.A.Sc., (Univ. of Toronto '33); M.A.Sc., Angus, Ont.

## Ecole Polytechnique

### Honours, Medals and Prizes

Faure, Marcel A., Outremont, Que.—B.A.Sc., (Ci.); The Ernest Cormier's Prize.
Fleury, Maurice, Outremont, Que.—B.A.Sc., (Ci.); Bronze Medal offered by Association des Anciens Elèves de l'Ecole Polytechnique.
Paquet, Jean M., Quebec, Que.—B.A.Sc., (Ci.); Honours in Civil Engineering; Silver Medal offered by Association des Anciens Elèves de l'Ecole Polytechnique.
Vincent, Paul, Outremont, Que.—B.A.Sc., (Ci.); Honours in Civil Engineering; Bronze Medal offered by Association des Anciens Elèves de l'Ecole Polytechnique.

### Degree of Bachelor of Applied Science

Lefebvre, Jean, B.A.Sc., (Ci.), Outremont, Que.
Descoteaux, Paul R., B.A.Sc., (Ci.), Montreal, Que.

# RECENT ADDITIONS TO THE LIBRARY

### Proceedings, Transactions, etc.

Institution of Mechanical Engineers: Proceedings Vol. 125, 1933.
Institution of Civil Engineers: Proceedings, Vol. 235, 1932-1933.

### Reports, etc.

*Ontario, Department of Mines:*
Bulletin 91, Report on the Mining Accidents in Ontario in 1933.
Bulletin 94, Mines and Metallurgical Works in Ontario in 1933.
*Canada, Department of Mines, Mines Branch:*
Investigations in Ore Dressing and Metallurgy, 1932.
Investigations of Fuels and Fuel Testing 1932.
*Quebec, Department of Municipal Affairs:*
Statistical Year Book 1933.
*Canada, National Research Council:*
Research Activities 1933-1934.
*Lethbridge Northern Irrigation District:*
Annual Report 1933.
*British Engineers Association:*
Classified Handbook of Members and Their Manufactures, 1934.
*Canada, Department of Mines, Geological Survey:*
Memoir 171, Geology and Ore Deposits of Copper Mountain, B.C.
*Canadian Electrical Association:*
Advance Reports for the 44th Annual Convention, June 1934.
*American Public Health Association:*
Chlorination in Sewage Treatment.
*Corporation of Professional Engineers of Quebec:*
List of Members 1934.
*Association of Professional Engineers of Ontario:*
By-laws, List of Members, etc., 1934.

### Technical Books, etc., Received

A History of the Growth of the Steam Engine, by R. H. Thurston (*Kegan Paul, Trench and Co., London*). (Presented by Mr. R. J. Durley, M.E.I.C.)
The Case for Railway Unification, an Address by E. W. Beatty.
Applied Hydro and Aero Mechanics, by Prandtl and Tietjens (*McGraw-Hill Book Company*). (Engineering Societies Monographs.)
Fundamentals of Hydro and Aero Mechanics, by Prandtl and Tietjens (*McGraw-Hill Book Company*). (Engineering Societies Monographs.)
Theory of Elasticity, by Timoshenko (*McGraw-Hill Book Company*). (Engineering Societies Monographs.)

# BULLETINS

*Pumps*—A 4-page folder received from Worthington Pump and Machinery Corporation, Harrison, N.J., gives particulars of Worthington single-stage volute Type R centrifugal pumps.

*Pulverized Fuel Equipment*—Foster Wheeler Corporation, New York, have issued a 24-page bulletin containing information regarding their aero type impact mill and Hardinge type tricone ball mill pulverizers. General information on auxiliary equipment used in pulverized fuel systems such as intervane and cross jet burners, level controllers for ball mills, dividers for unit systems, switching valves, etc. is given.

*Waste Heat Boilers*—A 12-page booklet received from Foster Wheeler Corporation, New York, describes the various applications of waste heat muffler boilers as applied to Diesel engines, natural gas engines, and blast furnace gas engines ranging from 90 to 7,000 h.p. It also describes waste heat water heaters used for heating process or service water with the heat in the exhaust gases of internal combustion engines.

*Steel Sheet Piling*—A 4-page circular received from Canadian Sheet Piling Company Limited, Montreal, gives particulars of steel sheet piling used in the extension of the Ouseburn quay, Newcastle-on-Tyne.

*Centrifugal Blowers*—The Roots-Connersville Blower Corporation, Connersville, Ind., have issued a 4-page folder containing particulars of type OI single-stage blower for handling air or gas under pressure or vacuum. These are made in capacities up to 8,000 cubic feet per minute at pressures up to 3 pounds.

*Speed Reducers*—A 12-page booklet received from the Hamilton Gear and Machine Company, Toronto, Ont., describes small size worm gear speed reducers and gives information on how to select the correct size of reducers which are made in a varied number of sizes and types.

*Radiators*—The Dominion Automatic Water Heater Company Limited, Toronto, have issued a 12-page bulletin giving particulars and dimension of types of Richvar convector type cast iron radiators, for steam, hot water, vapour or vacuum.

*Portable Instruments*—A 4-page folder received from the Roller-Smith Company, New York, N.Y. describes a line of portable measuring instruments known as Types NPD and NPA which includes direct current ammeters, voltmeters, milli-voltmeters and milli-ammeters of all ranges.

*Control Switches*—The Roller-Smith Company, New York, have issued Catalogue No. 9, an 8-page booklet describing Type R rotary instrument and control switches for switch-boards and control panels.

*Signaling Systems and Devices*—A 56-page catalogue published by Edwards and Company of Canada, Limited, Montreal, contains particulars regarding the various types of equipment manufactured by the company which includes a large range of signaling systems and devices.

## The Institute's Committee on Unemployment

At a meeting of The Institute's Unemployment Committee of which Mr. D. C. Tennant, M.E.I.C., is chairman, held on June 6th, 1934, progress made during the past year was reviewed and particulars submitted to Council. The following summary of this report is published for the information of the membership.

To check employment conditions since January 1st, 1934, when the last report of the Committee was submitted, a letter was sent to all Branches in April, requesting particulars of conditions in their districts. The replies received indicate that considerable improvement has taken place in conditions generally. This is mostly apparent in mechanical, chemical, mining and metallurgical lines, with some slight improvement in civil engineering in some parts of the country.

The Committee estimates that there has been a reduction of 25 per cent in the unemployment of members since January 1st. Actually, however, this does not reduce the number of members registered in the Employment Service Bureau, as a number of 1934 graduates have recently been listed. Placements by The Institute's Employment Service Bureau during the last few months show an improvement over 1933 of approximately 150 per cent. Positions vacant and listed with the Bureau also show an increase over a year ago, although these are still very few in numbers, and in most cases special qualifications are demanded. Due to the confidential nature of the enquiries or to the large number of members already registered and available, it has been found unnecessary to advertise most of these positions.

All members should be urged to register with the Bureau and thus have up-to-date records of their experience available on file.

Recent reports also indicate that there is a decrease in the number of members at present in need of relief.

Few placements on the supervisory staffs of the Department of National Defence Camps have been recorded during the past six months, and any further supervisory appointments will depend on the total strength of the personnel in the camps. During the spring months this dropped considerably, and as the supervisory staffs have not been decreased in proportion it is doubtful whether the Department will engage many engineers in the near future.

The Committee, in closing its report, observes that although there has been some improvement in employment conditions, it is still necessary to take the situation seriously and maintain efforts to find employment for members and other engineers. The Institute Committee can only make suggestions and depends on the Branch Employment Committees to obtain the necessary information as to local conditions, urge unemployed members to file their records, and inform local unemployed members and Headquarters of any local activities which seem likely to result in the employment of engineers.

Branch Employment Committees are asked to continue to investigate conditions in their districts, as a report on the unemployment situation will be requested during the early fall in order that some forecast may be made as to the measures which will be necessary to assist unemployed members during the coming winter.

## The Institute's Membership Committee

The activities of The Institute's Membership Committee in the past year have recently been reviewed, and particulars presented to Council, and it is believed that the following information will be of interest.

It will be remembered that this Committee of which Mr. D. C. Tennant, M.E.I.C., is chairman, after its appointment in February, 1933, sent out a circular letter to all Branches drawing attention to the need for activity as regards membership, and outlining a proposed course of procedure. This was followed in June, 1933, with a circular to all corporate members, enclosing a form on which each member was invited to fill in the names of prospective members.

As a result, a number of the Branches appointed special Membership Committees; in other cases the Branch Executive Committees undertook to act, and the names of over two hundred engineers who were considered eligible for membership were received at Headquarters. These names after classification were sent to the Branches concerned for action. The results to October, 1933, were contained in a report presented to the Plenary Meeting of Council, and this, with a further note by the chairman of the Committee, was presented at the Annual Meeting of The Institute in February, 1934, and printed in the February, 1934, issue of The Journal.

The number of new members obtained from among the names submitted as mentioned above was disappointing, but the Committee takes an optimistic view of the situation, as during the past twelve months the number of new members obtained shows a marked increase in comparison to the previous twelve months. It is believed that the membership campaign last spring was indirectly responsible for this, together with the reduction of entrance fees, and the assistance given many members by the Employment Service Bureau. The Committee believes that this improvement will continue, and will extend, provided that Branch efforts are not relaxed. It is hoped to obtain at least three hundred applications per annum, the approximate number required each year to fill the vacancies caused by deaths, resignations, etc. The Committee also urges that an increased effort should be made to interest students in the activities of The Institute through the formation of Junior Sections and other means. It has been noted that where attention has been given to this in the past, a notable increase in the admission of Students has been apparent.

# BRANCH NEWS

## Calgary Branch

*J. Dow, M.E.I.C., Secretary-Treasurer.*
*H. W. Tooker, A.M.E.I.C., Branch News Editor.*

On the evening of May 3rd, 1934, the members of the Calgary Branch and their friends witnessed two interesting reels of motion pictures depicting the construction and operation of the British Grid system, on which work was started in 1926.

Prior to the pictures being shown, G. H. Thompson, A.M.E.I.C., gave a short introductory address explaining the films and their object.

The first film presented a comprehensive survey of the activities in the important industries which went to the creation of the grid, the making of basic materials, like iron and steel, aluminum, etc., for the fabrication of the conductors and cables, switching apparatus and other equipment, and finally the erection of the towers and the completion of the transmission system. The grid was shown in operation and the movement of the electricity traced from the great modern generating stations to points where it is tapped off for distribution to the consumer. The picture then went on to show the enormous quantities of materials used and the sequence of casting 90,000 tons of steel required for the transmission towers, also the factory which provided upwards of 12,000 tons of aluminum for overhead lines.

The production of copper wire for the manufacture of cables was shown in detail and the sequence of smelting, refining, drawing and annealing emphasized the many processes involved in the manufacture of the product.

The final section of the picture was devoted to the actual construction of the grid, the preparation of the foundations, the erection of the towers and the stringing of the conductors. It also showed the erection of the 487-foot Thames towers at Dagenham, the tallest of the grid. The film concluded by showing in succession the main features of the grid.

The grid was shown in operation, tracing the movement of electricity from its production in a selected power station to its use by the consumer. Glimpses into the interior of one of the new generating stations were shown, also the switching station which furnished very effective pictures of load dispatching.

The films, which occupied some two and a half hours, gave an excellent idea of the enormous amount of time and work spent in the construction of such a complete and efficient service as the British Grid system.

## Hamilton Branch

*A. Love, A.M.E.I.C., Secretary-Treasurer.*
*V. S. Thompson, A.M.E.I.C., Branch News Editor.*

The May meeting of the Branch was held in the Science hall of McMaster University, and in spite of the call of spring there was an attendance of about seventy members and friends. H. B. Stuart, A.M.E.I.C., occupied the chair, and there were also present E. G. Cameron, A.M.E.I.C., of St. Catharines, vice-president of the zone; also C. G. Moon, A.M.E.I.C., a member of the executive of the Niagara Peninsula Branch.

The speakers at this meeting were both Hamilton men, A. B. Dove, S.E.I.C., assistant to the superintendent of the Canada Works, Steel Company of Canada, and Mr. C. D. Meals, wire rope engineer of the B. Greening Wire Company.

### Corrosion, Wire-Drawing and Galvanizing

Mr. Dove's subject was "Corrosion, Wire-Drawing, and Galvanizing." Using black-board illustrations, he outlined the simpler manufacturing of wire from the rod through pickling, baking and drawing, touching on the changes produced in the physical properties of the steel by the cold drawing process. The changes and pressures produced upon the rod, he stated, were dependent upon the yield point of the steel, while this, in turn depended upon the analysis of the steel under fabrication.

Corrosion was the next subject reviewed and the history of corrosion theories was covered in part.

The process of hot galvanizing of wire was covered, the speaker explaining in the course of his talk why each portion of the equipment was used. The wire was heat treated before processing to permit control of the physical properties; the pickling tanks removed scale; the water tanks removed the products of the pickling reactions; the flux deoxidized the wire and actual galvanizing took place in the spelter pan.

The spelter coating, he stated, was not merely zinc but a series of combinations varying from almost pure zinc at the surface to almost pure iron at the base, but consisting mainly in three layers—a bonding layer, one of brittle zinc-iron alloy, and finally a soft, easily formed layer of spelter.

In conclusion, Mr. Dove spoke of testing methods, showing by actual experimental results that the Preece test was not a true test of quantity of zinc present, and demonstrating how this may be shown by coating methods using the A.S.T.M. formula where $C$ (weight of coating) = $163\,dr$.

$$r = \frac{\text{Weight after coating} - \text{weight before}}{\text{Weight before}}$$

$d$ = diameter of wire in inches
$C$ = ounces zinc per square foot

The talk concluded with a discussion of various points brought up in the course of the lecture and was heartily entered into by those present.

### Wire Rope Manufacture and its Applications

Mr. Meals spoke on "Wire Rope Manufacture and its Applications." He opened his address with the statement that 1934 is the centennial year of wire rope as it was in 1834 that Albert of Clausthal in Germany first made rope of soft iron wire. In 1836 Smith and Hood made wire rope in England and Roebling in 1841 in America. All these ropes were made by hand in the same manner in which hemp ropes were made.

In 1840, Newall in England was granted a patent for a machine for making wire rope but it was not until 1875 that the development of the various constructions of rope was started. Lang of England, patented Lang lay rope in 1879 and Batchelor patented the 18 by 7 non-rotating rope in 1884. Latch and Batchelor patented locked wire cable in 1884 and flattened strand ropes in 1888, while Conners of Bridgeport, Conn., patented tru-lay preformed wire rope in 1923.

Transportation was the prime-mover in the development of wire rope, chiefly the removal of coal from mines. Later they were used for canal transportation and suspension bridges. Modern high buildings and deep mines as well as many engineering and construction feats of to-day would hardly be practicable without wire rope.

Although wire drawing has been practised since the earliest times the first tempered steel wire was made in England in 1854. This opened up the field of development of the high strength steel wire of today. Prior to this the tensile strength was about 90,000 pounds per square inch while modern improved plough steel wire will develop 280,000 pounds per square inch. Recent wire rope research has indicated that the lower strength wire will better withstand bending stresses than the higher strength wire under certain conditions of operation.

The grade of steel has little influence on the flexibility of the rope, which is a function of the construction and the lay of the rope. Regular lay ropes are those having the exterior wires of the rope running parallel to the longitudinal axis of the rope. Lang lay ropes have the exterior wires running diagonally across the longitudinal axis of the rope.

The reserve strength of a wire rope is the strength of the inner wires, granting that corrosion has not affected them. The outer wires are subjected to deterioration from breakage and abrasion. The reserve strengths vary from 18 per cent for a 6 by 7 rope to 58 per cent for a 6 by 37 rope.

The speaker stressed the importance of proper lubrication for wire rope and gave some valuable tables on the efficiency of different kinds of fittings.

H. A. Lumsden, M.E.I.C., in moving a vote of thanks to the two speakers, voiced the feelings of all present.

Mr. E. G. Cameron addressed the meeting briefly and expressed his gratification at being elected vice-president and promised all assistance to the Branch which it was in his power to give.

This meeting closed the Branch activities for the spring, and we are looking forward to another interesting series of meetings in the fall.

## Moncton Branch

*V. C. Blackett, A.M.E.I.C., Secretary-Treasurer.*

On April 10th, 1934, a combined meeting of Moncton Branch and the Engineering Society of Mount Allison was held at Mount Allison University, Sackville. T. H. Dickson, B.Sc., A.M.E.I.C., delivered a very interesting illustrated address on "Streamlined Vehicles." C. Baggs, President of the Engineering Society, was in the chair and introduced the speaker.

### Streamlined Vehicles

The word "streamlined" is used frequently and in a somewhat loose way. One hears of streamlined cars, trains, planes and boats, and in many cases there is little actual streamlining; possibly in a car it consists of the removal of the exterior sun-visor and a slight increase in the angle of slope of the wind-shield.

Although the word "streamlined" is modern, the principle is not, Nature knew about it thousands of years ago. Consider the swallow. the eagles and hawks among the birds; the whippet and greyhound among the animals and the sword-fish, shark and tarpon among fish. All these creatures are examples of nature's streamlining; the swallow might have been a model for the Schneider Cup winning seaplane; the retractile landing gear used on some high speed planes is just a logical result of the study of a bird, for almost every bird tucks his feet up under his body when flying.

The rounded nose and tapering tail of the fish mentioned are merely to cut down resistance when swimming.

The slim body, pointed nose, graceful head and slim legs of the greyhound all indicate ability to travel fast and the cross-section of the greyhound's leg is similar to a section of a plane's strut.

One may wonder why this streamlining is necessary, and as it has always existed why more has not been heard about it in the past. However the principal reason is that it is not of much importance at vehicle speeds under 30 miles per hour, and does not increase appreciably until 50 miles per hour.

Actually air resistance increases as the square of the speed, so that, if the speed is doubled, the air resistance becomes four times as great.

If all other factors were equal, four times as much horse-power would be required, actually with an automobile eight times is about the figure, as wheel friction, bearing friction, in fact, all mechanical friction increases also in proportion to the speed, and the total friction varies as the cube of the speed. This is one of the main reasons for the continually increasing horse-power of automobiles.

Wind resistance losses are divided into the following: 1, head-on resistance; 2, skin or side resistance; 3, eddy currents caused by suction at the rear of the car or train.

These three components depend on cross-sectional area, direction of the wind and general type of construction, with head-on resistance usually the largest of the three, and that depends on the shape, a semi-circular shape being the most satisfactory.

The skin or side resistance depends on the general surface, a smooth unbroken surface being that which offers the lowest resistance; for this reason, all windows should be glazed as nearly flush with the surface as possible; hinges, door handles, rivets, etc. should be either eliminated or set in as much as possible. Any part which has to project should not do so abruptly, but should be built with a streamlined housing.

The eddy currents caused by suction at the rear have a powerful retarding effect on the car. A bicycle, ridden behind a sedan or bus, is pulled along with little effort, in fact a record of 72 miles per hour was made in this way. This same effect can be noted by rowing a boat in the wake of a large steamer. A perfect rear end for a car would be approximately wedge shaped.

In conclusion, the speaker described in detail the new high speed streamlined trains that are being given so much publicity. The description was illustrated by photographs kindly supplied by the Union Pacific Railway.

A vote of thanks was tendered Mr. Dickson on motion of Allan Millar, seconded by James English.

## Ottawa Branch

*F. C. C. Lynch, A.M.E.I.C., Secretary-Treasurer.*

The last regular noon luncheon of the spring season was held at the Chateau Laurier on May 3rd, 1934, at which J. Clark Reilly, of Ottawa, manager of the Canadian Construction Association, and a member of the National Construction Council, was the guest speaker. His subject was "What the Construction Industry Means to Canada."

What the Construction Industry Means to Canada

Mr. Reilly reviewed the construction industry in Canada for the past few decades, quoting figures to indicate the present status of the industry. Thus, for sixty-one cities in Canada the aggregate amount of building permits issued for March, 1934, was $1,089,481 as compared with $10,634,491 for March, 1926, and $24,068,018 for March, 1929. The last mentioned was the peak point of construction in recent years.

Labour costs, assuming those for 1913 as 100, were represented by the figure 158.0 in 1933 and by a maximum figure of 203.2 in 1930. The wholesale prices of building materials, with reference to 1926 as 100, were 78.3 in 1933 or 24 per cent lower than the average from 1920 to 1933.

Mr. Reilly stressed the importance of the construction industry in its relationship to the unemployment situation. He claimed that no one actually knows how many persons are now unemployed in Canada, although in March of the present year some 1,436,000 persons were receiving relief, as compared with 1,569,000 persons a year previously. To offset this, however, relief costs are rising as the individual resources of those on relief are diminishing.

Control of governmental and municipal construction would go a long way toward offsetting periodic unemployment, stated Mr. Reilly. If large items of such construction could be held over and undertaken during those periods when private building enterprise is inactive, it would tend to take up the slack in employment that would otherwise result. He quoted W. D. Black, M.E.I.C., of Hamilton, in this connection, who presented a paper on this subject at the last annual meeting of The Engineering Institute at Montreal.

Mr. Reilly's address was accompanied by lantern slides illustrative of modern trends in the construction industry.

Alan K. Hay, A.M.E.I.C., chairman of the local Branch of The Institute presided, and in addition head table guests included: Major-General A. G. L. McNaughton, M.E.I.C., Dr. H. M. Tory, R. J. Durley, M.E.I.C., General Secretary of The Engineering Institute of Canada, A. J. Hazelgrove, Group Captain E. W. Stedman, M.E.I.C., Wing Commander W. R. Kenny, A.M.E.I.C., J. Albert Ewart, A.M.E.I.C., T. W. Fuller, Hugh J. Graham, J. E. N. Cauchon, A.M.E.I.C., T. A. McElhanney, A.M.E.I.C., and Dr. R. W. Boyle, M.E.I.C.

## Niagara Peninsula Branch

*P. A. Dewey, A.M.E.I.C., Secretary-Treasurer.*
*C. G. Moon, A.M.E.I.C., Branch News Editor.*

The Branch held the annual meeting at the Fox-Head inn at Niagara Falls on May 17th, 1934, with W. R. Manock, A.M.E.I.C,. in the chair, and Colonel Morrow of old Fort Niagara as the principal speaker.

President F. P. Shearwood, M.E.I.C., honoured the Branch by coming up from Montreal, and among other visitors were H. B. Stuart, A.M.E.I.C., and Messrs. E. P. Muntz, M.E.I.C., F. W. Paulin, M.E.I.C., and Alex. Love, A.M.E.I.C., from Hamilton; Messrs. J. D. Burbank, A.M.E.I.C., and R. Dunstan from Buffalo, and Mr. A. E. H. Fair, President of the Chemical Society of St. Catharines, and Colonel C. H. Vandersluys of Niagara Falls.

Following the dinner, Walter Jackson, M.E.I.C., introduced the President, who spoke briefly upon the affairs of The Institute. They were not in good shape just at the present time, but with careful economy being practised, the prospects appeared to be brightening, and he hoped that it would not be long before the printing of Transactions could be resumed. His thought was that it might be advisable to modify The Journal somewhat and carry therein general items of news and papers which were of a descriptive nature, while the more technical subjects and discussions could be carried in The Transactions in a form which would be suitable for permanent filing. There was not enough discussion at the present time and it is possible that more value would be derived if the original papers and the discussions were brought together in one volume. The vote on the By-laws was very small, about 30 per cent, but to his mind this did not convey indifference but rather it was a sign of indecision as to whether the time was yet ripe for a change and whether some further discussion was not advisable.

The Russian-Japanese Campaign in Manchuria

Mr. John Jackson, M.E.I.C., then introduced Colonel Morrow, who described "The Russian-Japanese Campaign in Manchuria." The treaty of Portsmouth had granted to Japan "paramount rights" in Manchuria and she has never failed to realize that this region forms her natural outlet for expansion as she is barred from the United States, Canada, Australia and New Zealand. Every such expansive movement, however, carried within it the seeds of a possible war unless the greatest tact and diplomacy are used. The Chinese Eastern Railway and the northern border along the Amoor river, are the danger points. China is quiescent and torn by internecine warfare and banditry, but Russia is uneasy fearing a clash between her armed railway guards and the Japs and fearing to remove them and leave her half interest in the Chinese Eastern Railway unprotected. The Japs have made Russia a fair offer of some thirty million dollars for her interest and, if this offer is not accepted, it is possible that Japan will not only take over the railway but, as a protective measure, take such military steps along the eastern end of the Trans-Siberian Railway as to effectually prevent retaliation by Russian troops. Trade makes and unmakes empires, and despite Japanese industrialism there still remains great possibilities for trade between the western world and China, Japan and Manchuria. Japan will not interfere seriously with the Chinese trade, said Colonel Morrow, and with the opening up of Manchuria, a still greater market may be foreseen.

## Peterborough Branch

*H. R. Sills, Jr.E.I.C., Secretary.*
*E. J Davies, Jr.E.I.C., Branch News Editor.*

Annual Inspection Trip

The annual inspection trip of the Branch was held on Saturday, June 1st, 1934, when sixty-five members and guests motored to Oshawa, Ontario, for a visit to the plant of the General Motors of Canada Ltd. The tour was under the capable supervision of Lieut.-Colonel F. Chappell, A.M.E.I.C., who explained each feature and operation in a most interesting manner.

The first point of interest was the modern and well equipped hospital, and particularly the optical department. A recent visitor from Mexico was so impressed with the completeness of this department that he obtained a complete specification for a similar installation in his own plant. It was explained that all new employees were given a thorough medical examination, particularly those who had been unemployed for some time, as this enabled the company to check on features which otherwise might constitute an accident hazard.

A photographic bird's-eye view of the complete plant at Oshawa as well as affiliated plants in other cities, and a photographic production chart was explained, then the various departments were visited as follows: wood storage and drying, wood and metal body parts, body assembly, body painting, cloth and leather cutting, metal trim, upholstery, wiring and hardware assembly, chassis assembly and final assembly of complete car, radiator and fender department, test and check up department and shipping department.

One was impressed with the production system which enabled so many departments to operate with such smooth co-ordination, and turn out the product at so great a speed. Another feature was the realization of the great number of outside companies, mostly Canadian, which contributed their products towards the building of a car.

J. W. Pierce, M.E.I.C., Branch chairman, expressed to Colonel Chappell and the General Motors Co. Ltd. the thanks and appreciation of the Branch for a very interesting and profitable afternoon.

## Quebec Branch

*Jules Joyal, A.M.E.I.C., Secretary-Treasurer.*

Mardi soir, le 17 avril 1934, la Section de Québec avait le plaisir et l'honneur d'entendre Monsieur J. A. Lalonde, A.M.E.I.C., Ingénieur en Chef de A. Janin & Compagnie Limitée de Montréal, dans une conférence illustrée intitulée

La Sous-Structure et les Approches du Pont du Lac St-Louis

La base de la causerie de Monsieur Lalonde fut le texte publié sous le titre susmentionné dans le numéro de mars 1934 du Journal de l'Institut, et les nombreuses projections illustrant les diverses phases de l'exécution des travaux, commentées et expliquées par le conférencier, rendirent cette conférence très instructive; tous ceux qui étaient présents furent des plus satisfaits de leur soirée.

Le conférencier fut présenté par Monsieur Hector Cimon, M.E.I.C., Président de notre section et Monsieur Ivan E. Vallée, A.M.E.I.C., Sous-Ministre et Ingénieur en Chef au Ministère des Travaux Publics de Québec fut chargé de le remercier.

Il est à noter que Monsieur Vallée est bien au courant de ce projet puisqu'il a agi comme ingénieur-conseil dans l'étude et l'exécution de ce projet de pont.

L'Honorable Honoré Mercier, Ministre des Terres et Forêts dans le gouvernement de Québec, que l'on pourrait à juste titre appeler le papa de ce projet, nous fit l'honneur d'assister à cette réunion et de nous adresser quelques mots.

Nous croyons intéresser nos lecteurs en donnant ici un bref historique de ce pont:

Les origines de ce projet de liaison des deux rives du St-Laurent, près de Lachine, remontent à 1910. C'est alors qu'une requête demandant l'établissement d'une voie carrossable sur le pont du chemin de fer Pacifique Canadien, qui traverse la rivière à cet endroit, fut présentée au Département des Travaux Publics de la Province de Québec, par les municipalités de plusieurs comtés avoisinant l'Ile de Montréal. Mais la "grande guerre" qui survint quelques années après, captant toutes les attentions ainsi que toutes les ressources, fit nécessairement reléguer le projet dans l'ombre et, ce ne fut que douze ans plus tard que la question fut ramenée au jour. On revint alors à la charge pour solliciter de nouveau cette amélioration dont le coût devait s'élever à quelques $2,300,000.00.

Toutefois, en présence de l'importance que prenait le développement du réseau routier du district environnant et l'augmentation de la circulation, on abandonna, en 1927, cette idée de l'addition d'une voie carrossable sur le pont du chemin de fer pour proposer la construction d'un pont-route indépendant à quelques cent vingt pieds en aval.

Des plans préliminaires furent alors dressés pour ce nouveau projet par les ingénieurs du Département des Travaux Publics et la législature provinciale élabora une loi, pourvoyant à la construction et à l'entretien du pont projeté ainsi qu'à la formation d'une commission dite "Corporation du Pont du Lac St-Louis" qui devait s'occuper de son exécution. Deux ans plus tard un amendement fut ajouté à cette législation par lequel le Gouvernement de la Province se portait garant des déficits qui pourraient résulter de cette entreprise jusqu'à concurrence des deux-tiers. La même année, une autre loi, émanant du pouvoir fédéral celle-ci fut également sanctionnée pour autoriser la construction du projet et c'est alors que le gouvernement provincial assuma cette nouvelle obligation de garantir 100% du déficit.

Lorsque l'on en vint à l'étude approfondie des perspectives de développement futur de la circulation, on se rendit compte des difficultés que présenterait l'accès au pont ainsi que du danger de congestion possible du trafic sur les approches si le site primitivement projeté, à proximité du pont du chemin de fer, était adopté; et, après examen de quelques autres endroits, le choix d'un nouveau site fut définitivement fixé en un point situé à quelque distance en aval.

A la suite de ces travaux préliminaires et de l'adoption définitive du site choisi par le Département des Travaux Publics, la Corporation du Pont du Lac St-Louis, dont l'Honorable Grothé est président, nomma Monsieur O. Lefebvre, M.E.I.C., ingénieur en chef de la Commission et Monsieur Ivan E. Vallée comme ingénieur-conseil. Les plans définitifs furent alors préparés en vue de la demande des soumissions et les travaux de construction commencèrent à l'automne 1932.

## Saguenay Branch

*J. W. Ward, A.M.E.I.C., Secretary-Treasurer.*

On Wednesday evening, May 9th, 1934, at the offices of the Aluminum Company of Canada Limited, Arvida, Que., a meeting of the Saguenay Branch was held, at which thirty-five members and guests were present. F. Newell, M.E.I.C., of the Dominion Bridge Company, and Mr. E. Normand of the A. Janin Company, who with P. L. Pratley, M.E.I.C., the speaker of the evening, had come to Chicoutimi from Montreal to make a final inspection of the recently completed Chicoutimi-St. Anne bridge, were also present.

Due to the unavoidable absence of the chairman, A. W. Whitaker, Jr., A.M.E.I.C., also the vice-chairman, G. E. Lamothe, A.M.E.I.C., the chair was taken by N. F. McCaghey, A.M.E.I.C., our chairman of last year. In his introductory remarks Mr. McCaghey mentioned that the branch executive had tried for a long time to get Mr. Pratley to address the Branch, but something had always turned up to prevent it. The opportunity finally presented itself during his trip of inspection of the Chicoutimi-St. Anne bridge.

Recent Bridge Construction in the Province of Quebec

The subject of the address was "Recent Bridge Construction in the Province of Quebec."

Mr. Pratley first described the Montreal Harbour bridge, showing by means of a map the various proposed sites, pointing out some of the difficulties in connection with each scheme. This was followed by a description—well illustrated with slides—of the nature of the river bed, types of foundations for piers, and methods of construction of these foundations and piers. Particularly interesting was the description of the caisson work.

The steel work, which was designed, constructed and erected by the Dominion Bridge Company, was next described and illustrated. Many of the beams and trusses were of massive proportions, and great skill was shown in the way in which they were erected and temporarily supported until the spans were completed. The finished bridge presents a very pleasing appearance and it must be with a feeling of pride that Mr. Pratley and all of his associates look upon this great engineering work.

A number of other bridges in the province in which the speaker as consulting engineer was interested, were also described. These included, among others, the Chicoutimi-St. Anne bridge, which spans the Saguenay river at Chicoutimi, the Chibougamo railway bridge at Isle-Maligne, and the bascule bridge at Sorel. This last bridge is of particular interest as it is the first bascule bridge, erected in Canada, to have been designed solely by Canadian engineers. While on this point the speaker mentioned the difficulty our engineers had in the past to convince our own government that they were capable of designing and building these special moving span bridges. It had taken years of effort on the part of Canadian designers to make the government see the light, and this bridge at Sorel is ample proof that it can be done, for not only does this bridge present a very pleasing appearance but it works perfectly.

In moving a vote of thanks, Mr. P. E. Radley mentioned our good fortune in having this opportunity to hear this talk by Mr. Pratley. During the last few years the number of prominent engineers visiting this district who were willing to speak were very few indeed.

## Winnipeg Branch

*E. W. M. James, A.M.E.I.C., Secretary-Treasurer.*
*E. V. Caton, M.E.I.C., Branch News Editor.*

New Fertilizer Plant at Trail

On Thursday, April 12th, 1934, a joint luncheon meeting was held with the local branch of the Mining Institute, at which Mr. R. W. Diamond, of the Consolidated Mining and Smelting Company, presented a very interesting paper on the new fertilizer plant at Trail, B.C.

Mr. Diamond pointed out that this fertilizer development is a result of the 26 per cent sulphur content of the ore from the Sullivan Mine at Kimberley. This sulphur is combined with lead and zinc in the form of sulphides and during smelting operations large quantities of sulphur dioxide are produced. Previous to 1931 this gas was allowed to escape into the atmosphere, as there was no economical use for it. However, it appeared that during certain wind conditions this gas would be blown over the United States border and damages to vegetation were claimed by nearby residents of the state of Washington.

Therefore it was decided that in order to overcome the smoke nuisance it would be necessary to fix this sulphur dioxide in the form of sulphuric acid, which would in turn be used to make various fertilizers.

For the production of the acid three contact process plants were constructed for a capacity of 375 tons of 100 per cent sulphuric acid per day.

Since ammonium sulphate is a valuable fertilizer, ammonia is first produced from its elements nitrogen and hydrogen. Hydrogen is obtained by means of electrolysis of water, and the plant produces on the average of 9 tons of hydrogen and 72 tons of oxygen per day. For the production of nitrogen two standard Claude liquid air units are used in which air is first liquefied and the nitrogen obtained by fractional distillation, the capacity being 44 tons of nitrogen per day.

In producing ammonia, these two gases are mixed in the proportion by volume of 3 of hydrogen to 1 of nitrogen, and after compression of about 250 atmospheres is passed into a synthesis column where under the influence of heat and a catalytic agent the gases combine to form ammonia $NH_3$. This ammonia is then combined with sulphuric acid to make ammonium sulphate, the capacity at the present time being 200 tons of sulphate per day.

Another branch of the fertilizer department is the phosphoric acid plant. Here phosphate rock, which is imported from the state of Montana, is ground and treated with sulphuric acid, the reaction resulting in the production of phosphoric acid and ordinary gypsum.

With the four raw materials, sulphuric acid, ammonium sulphate, phosphate rock and phosphoric acid, it is possible to obtain the following fertilizers:

1. Ammonia + Sulphuric Acid = Ammonium Sulphate.
2. Ammonia + Phosphoric Acid + Sulphuric Acid = a wide range of Ammonium Phosphate-Sulphate products.
3. Ammonia + Phosphoric Acid = Ammonium Phosphate.
4. Phosphate Rock + Sulphuric Acid = Superphosphate.
5. Phosphate Rock + Phosphoric Acid = Triple Superphosphate.

The great number of chemical fertilizers on the market is always confusing to the layman, but it is apparent that a large variety is required because of varying soil, moisture, temperature, and crop conditions. In these days of over-production and of low prices for agricultural products, the wisdom of fertilization is often questioned. The answer is evident and convincing—if farmers are to prosper, they must farm a smaller acreage of better lands more intensively, and secure lower unit production costs.

Mr. Diamond illustrated his talk with slides and motion pictures.

At the conclusion of the address a vote of thanks was tendered to the speaker by F. V. Seibert, M.E.I.C.

# EMPLOYMENT SERVICE BUREAU

**The Service is operated for the benefit of members of The Engineering Institute of Canada, and for industrial and other organizations employing technically trained men—without charge to either party.**

*All correspondence should be addressed to*

**The Employment Service Bureau, The Engineering Institute of Canada**
**2050 Mansfield Street, Montreal**

## Situations Wanted

MECHANICAL ENGINEER, Canadian, with technical training and executive experience in both Canadian and American industries, particularly plant layout, equipment, planning and production control methods, is open for employment with company desirous of improving manufacturing methods, lowering costs and preparing for business expansion. Apply to Box No. 35-W.

MECHANICAL ENGINEER, A.M.E.I.C. Married. Experience in machine shops, erection and maintenance of industrial plant mechanical and structural design. Reads German, French, Dutch and Spanish. Seeks any suitable position. Apply to Box No. 84-W.

INDUSTRIAL ENGINEER, B.SC., McGill Univ. Age 29. Married. Mechanical and electrical engineering experience with four large Canadian companies; including supervision of manufacture of various products, reduction of manufacturing costs, factory planning and investigation of piece work systems. Available on short notice. Apply to Box No. 132-W.

MECHANICAL ENGINEER, graduate McGill Univ. Experience on hydro-electric power construction and design and installation of equipment of pulp and paper mills. Desires position as mechanical engineer in an industrial plant or pulp and paper mill, or as representative on the sale of heavy machinery. Apply to Box No. 142-W.

PURCHASING ENGINEER, graduate mechanical engineer, Canadian, married, 34 years of age, with 13 years' experience in the industrial field, including design, construction and operation, 8 years of which had to do with the development of specifications and ordering of equipment and materials for plant extensions and maintenance; one year engaged on sale of surplus construction equipment. Full details upon request. Apply to Box No. 161-W.

CIVIL ENGINEER, age 44, open for employment anywhere, experience covers about 20 years' active work, including 7 years on municipal engineering, 2 years as Town Manager, 3 years on railway construction, 3 years on the staff of a provincial highway department, 2 years as contractor's superintendent on pavement construction. Apply to Box No. 216 W.

REINFORCED CONCRETE ENGINEER, B.SC., P.E.Q., eight years experience in construction design of industrial buildings, office buildings, apartment houses, etc. Age 30. Married. Apply to Box No. 257 W.

MECHANICAL ENGINEER, age 28, nine years all round experience, Grad. Inst. of Mech. Engs. England, S.E.I.C. Technical and practical training with first class English firm of general engineers; shop, foundry and drawing office experience in steam and Diesel engines, asphalt, concrete machinery, boilers, power plants, road rollers, etc. Experience in heating and ventilation design and equipment; 18 months designing draughtsman with Montreal consulting engineers. 2½ years sales experience, steam and hot water heating systems, power plant equipment, machinery, oil-burning apparatus. Canadian 4th class Marine Engineers Certificate; C.N.S. experience. Available at short notice. Apply to Box No. 270-W.

DESIGNING DRAUGHTSMAN, experience in layout of steam power house equipment and piping. Wide experience in mechanical drive and details of machinery, gearing, and hoists. Accustomed to layout of small mill buildings of steel and timber, structural design and details. Good references. Present location Montreal. Apply to Box No. 329-W.

PLANE-TABLE TOPOGRAPHER, B.SC., in C.E. Thoroughly experienced in modern field mapping methods including ground control for aerial surveys. Fast and efficient in surveys for construction, hydro-electric and geological investigations. Apply to Box No. 431-W.

ELECTRICAL ENGINEER, B.SC., A.M.E.I.C., AM.A.I.E.E., age 30, single. Eight years experience H.E. and steam power plants, substations, etc., shop layouts, steel and concrete design. Location immaterial. Available immediately. Apply to Box No. 435-W.

CIVIL ENGINEER, B.A.SC., and C.E., A.M.E.I.C., age 30, married. Experience over the last ten years covers construction on hydro-electric and railway work as instrumentman and resident engineer. Also office work on teaching and design, investigations and hydraulic works, reinforced concrete, bridge foundations and caissons. Location immaterial. Available at once. Apply to Box No. 447-W.

SALES ENGINEER, M A.SC. Univ. of Toronto, wishes to represent firm selling building products or other engineering commodities, as their representative in Western Canada. Located in Winnipeg. Apply to Box No. 467-W.

## Situations Wanted

CIVIL ENGINEER, B.SC., A.M.E.I.C., with six years experience in paper mill and hydro-electric work, desires position in western Canada. Capable of handling reinforced concrete and steel design, paper mill equipment and piping layout, estimates, field surveys, or acting as resident engineer on construction. Now on west coast and available at once. Apply to Box No. 482-W.

MECHANICAL ENGINEER, B.SC. Age 28, married. Four and a half years on industrial plant maintenance and construction, including shop production work and pulp and paper mill control. Also two and a half years on structural steel and reinforced concrete design. Available at once. Apply to Box No. 521-W.

CIVIL ENGINEER, Canadian, married, twenty-five years' technical and executive experience, specialized knowledge of industrial housing problems and the administration of industrial towns, also town planning and municipal engineering, desires new connection. Available on reasonable notice. Personal interview sought. Apply to Box No. 544-W.

### Employment Service Bureau

This bureau is maintained by The Engineering Institute of Canada for the benefit of members and organizations employing technically trained men.

An enquiry addressed to 2050 Mansfield Street, Montreal, will bring full information concerning the services offered Details can also be obtained from Branch secretaries who are located in the larger centres throughout Canada.

Brief announcements of men available and positions vacant will be published without charge in The Engineering Journal and the Bulletin. Replies addressed in care of the required box number will be forwarded to the advertiser without delay.

An additional service also offered those who are unemployed or wish to change their positions, is the opportunity of placing their names and records on file at 2050 Mansfield Street for consideration by employers wishing to employ engineers. This is of great assistance as many employers will not advertise or wish to locate a suitable man on short notice. If desired the information contained in these records can be kept confidential.

Forms for registration purposes may be obtained from The Institute Headquarters or Branch secretaries.

ELECTRICAL AND MECHANICAL ENGINEER, B.SC., A.M.E.I.C. Experience includes C.G.E. Students' Test Course and six years in engineering dept. of same company on design of electrical equipment.Four summers as instrumentman on surveying and highway construction. Several years experience in accounting previous to attending university. Desires position with industrial concern where the combination of technical and business experience will be of value. Apply to Box No. 564-W.

CIVIL ENGINEER, age 25, single, graduate. Creditable record on responsible hydro and railroad work in both Eastern and Western Canada. Apply to Box No. 567-W.

MECHANICAL ENGINEER, A.M.E.I.C., with twenty years experience on mechanical and structural design, desires connection. Available at once. Apply to Box No. 571-W.

MECHANICAL ENGINEER, B.A.SC., '30, desires position to gain experience, and which offers opportunity for advancement. Experience in pulp and paper mill and one year in mechanical department of large electrical company. Location immaterial. Available immediately. Apply to Box No. 577-W.

DOMINION LAND SURVEYOR, and graduate engineer with extensive experience on legal, topographic and plane-table surveys and field and office use of aero-photographs, desires employment either in Canada or abroad. Available at once. Apply to Box No. 589-W.

CHEMICAL ENGINEER, S.E.I.C., B.SC., University of Alberta, '30. Age 31. Single. Six seasons' practical laboratory experience, three as chief chemist and three as assistant chemist in cement plant; one year's p.g. work in physical chemistry; three years' experience teaching. Desires position in any industry with chemical control. Available immediately. Apply to Box No. 609-W.

## Situations Wanted

DESIGNING ENGINEER AND ESTIMATOR, grad. Univ. of Toronto in C.E., A.M.E.I.C., twenty years experience in structural steel, construction and municipal work. Available at once. Apply to Box No. 613-W.

CIVIL ENGINEER, A.M.E.I.C., R.P.E., Ontario; three years construction engineer on industrial plants; fourteen years in charge of construction of hydraulic power developments, tower lines, sub-stations, etc.; four years as executive in charge of construction and development of harbours, including railways, docks, warehouses, hydraulic dredging, land reclamation, etc. Apply to Box No. 647-W.

ELECTRICAL ENGINEER, B.SC. in E.E. (Univ. of Man., '30). Age 25. Two year Can. Westinghouse Apprentice Course. Depts.—Switchboard assembly, general draughting office, switchboard engineering, test office. One year's experience since then designing and rewinding small motors and transformers. Location immaterial. Apply to Box No. 651-W.

MECHANICAL ENGINEER, A.M.E.I.C., Canadian, technically trained; six years drawing office. Office experience, including general design and plant layout. Also two years general shop work, including machine, pattern and foundry experience, desires position with industrial firm in capacity of production engineer or estimator. Available on short notice. Apply to Box No. 676-W.

DIESEL ENGINEER. Erection and industrial engineer, A.M.E.I.C., technically trained mechanical engineer with English and Canadian experience in erection and operation of steam and Diesel equipment in power house and mines, pumping, rock drilling, air compressors. Experienced in industrial and steel works operations including rolling mills, quarries, sales. Open for position on maintenance, operation or sales engineer. Location immaterial. Apply to Box No. 682-W.

MECHANICAL AND STRUCTURAL ENGINEER. Six years experience with prominent manufacturer, designing, heating and power boilers, boiler installations, coal and ash handling equipment. Good practical knowledge of steel plate work welding. Also wide experience in designing, estimating and detailing structural steel for buildings and bridges. Good education. Have held position of responsibility. Above can be verified by best of references. Available at once. Apply to Box No. 692-W.

ELECTRICAL AND CIVIL ENGINEER, B.SC., Elec., 29, B.SC., Civil '33. Age 27. JR.E.I.C. Undergraduate experience in surveying and concrete foundations; also four months with Canadian General Electric Co. Thirty-three months in engineering office of a large electrical manufacturing company since graduation. Good experience in layouts, switching diagrams, specifications and pricing. Best of references. Available immediately. Apply to Box No. 693-W.

MECHANICAL ENGINEER, B.SC., '27, JR.E.I.C. Four years maintenance of high speed Diesel engines units, 200 to 1,300 h.p. Also maintenance of D.C. and A.C. electrical systems and machinery. Draughting experience. Westinghouse apprenticeship course. Practical mechanical and electrical engineer with a special study of high speed Diesel engine design, application and operation. Location in western or eastern Canada immaterial. Apply to Box No. 703-W.

COMBUSTION ENGINEER, R.P.E., Manitoba, A.M.E.I.C. Wide experience with all classes of fuels. Expert designer and draughtsman on modern steam power plants. Experienced in publicity work. Well known throughout the west. Location, Winnipeg or the west. Available at once. Apply to Box No. 713-W.

ELECTRICAL ENGINEER, B.SC., University of N.B., '31. Experience includes three months field work with Saint John Harbour Reconstruction. Apply to Box No. 722-W.

MECHANICAL ENGINEER, age 41, married. Eleven years designing experience with project of outstanding magnitude. Machinery layouts, checking, estimating and inspecting. Twelve years previous engineering, including draughting, machine shop and two years chemical laboratory. Highest references. Apply to Box No. 723-W.

CIVIL ENGINEER, B.SC. (Alta. '31), S.E.I.C. Experience includes three seasons in charge of survey party. Transitman on railway maintenance, and concrete bridge designing Nature of work and location immaterial. Apply to Box No. 724-W.

YOUNG CIVIL ENGINEER, B.SC. (Univ. of N.B. '31), with experience as rodman and checker on railroad construction, is open for a position. Apply to Box No. 728-W.

DESIGNING ENGINEER, M.SC. (McGill Univ.), D.L.S., A.M.E.I.C., P.E.Q. Experience in design and construction of water power plants, transmission lines, field investigations of storage, hydraulic calculations and reports. Also paper mill construction, railways, highways, and in design and construction of bridges and buildings. Available at once. Apply to Box No. 729-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.SC., Univ. of B.C. '30. Single, age 24. Sixteen months with the Allis-Chalmers Mfg. Co. as student engineer. Experience includes foundry production, erection and operation of steam turbines, erection of hydraulic machinery, and testing texropes and centrifugal pumps. Location immaterial. Available at once. Apply to Box No. 735-W.

CIVIL ENGINEER, M.SC., A.M.E.I.C., R.P.E. (Ont.), ten years experience in municipal and highway engineering Read, write and talk French. Married. Served in France. Will go anywhere at any time. Experienced journalist. Apply to Box No. 737-W.

## Situations Wanted

RADIO AND ELECTRICAL ENGINEER, B.sc. '31, S.E.I.C. Age 27. Experience in installation of power and lighting equipment. Temporary operator in radio station; studio experience with part time announcing. Two summers in switchboard and installation department of telephone company, eight months on extensive survey layouts. Interested in sales work of electrical or radio equipment. Available on short notice. Location immaterial. Apply to Box No. 740-W.

CIVIL ENGINEER, graduate '29. Married. One year building construction, one year hydro-electric construction in South America, fourteen months resident engineer on road construction. Working knowledge of Spanish. Apply to Box No. 744-W.

SALES ENGINEER, B.sc., McGill, 1923. A.M.E.I.C. Age 33. Married. Extensive experience in building construction. Thoroughly familiar with steel building products; last five years in charge of structural and reinforcing steel sales for company in New York state. Available at once. Located in Canada. Apply to Box No 749-W.

CIVIL ENGINEER, S.E.I.C., B.sc. Queen's Univ. '29. Age 25. Married. Three years experience as construction supt. and estimator for contracting firm. Experience includes general building, bridges, sewer work, concrete, boiler settings, sand blasting of bridges and spray painting. Available at once. Apply to Box No. 776-W.

CIVIL ENGINEER, B.sc., '25, JR.E.I.C., P.E.Q., married. Desires position, preferably with construction firm. Experience includes railway, monument and mill building construction. Available immediately. Apply to Box No. 780-W.

DRAUGHTSMAN, experience in civil engineering, forestry engineering, land surveying and house construction. Good references. Apply to Box No. 781-W.

ELECTRICAL AND SALES ENGINEER, S.E.I.C., grad. '28. Experience includes one year test course, one year switchboard design and two years switchboard and switching equipment sales with large electrical manufacturing company. Three summers Pilot Officer with R.C.A.F. Available at once. Apply to Box No. 788-W.

ELECTRICAL ENGINEER desires position as engineer or manager for industrial plant or factory. Over ten year diversified electrical and mechanical experience in the industrial field. Apply to Box No. 795-W.

MECHANICAL AND INDUSTRIAL ENGINEER, S.E.I.C., B.sc. in Mech., (Queen's, '32) and M.Eng. in Indust., (McGill, '34). Age 25. Single. Forty months as moulder's helper, machinist, etc. in foundries, machine shops, and on hydro-electric construction. Now completing two-year Rockefeller Foundation Fellowship at McGill. Good references. Available on short notice. Apply to Box No. 797-W.

CIVIL ENGINEER, S.E.I.C., graduate '30, age 23, single. Experience includes mining surveys, assistant on highway location and construction, and assistant on large construction work. Steel and concrete layout and design. Apply to Box No. 809-W.

CIVIL ENGINEER, college graduate, age 27, single. Exrerience includes surveying, draughting concrete construction and design, street paving both asphalt and concrete. Available at once; will consider anything and go anywhere. Apply to Box No. 816-W.

CIVIL ENGINEER, B.E. (Sask. Univ. '32), S.E.I.C. Single. Experience in city street improvement; sewer and water extensions. Good draughtsman. References. Available at once. Location immaterial. Apply to Box No. 818-W.

CIVIL ENGINEER, B.sc., A.M.E.I.C., with fifteen years experience mostly in pulp and paper mill work, reinforced concrete and structural steel design, field surveys, layout of mechanical equipment, piping. Available at once. Apply to Box No. 825-W.

ELECTRICAL ENGINEER, S.E.I.C., grad. '29, age 24, married; experience includes one year Students Test Course, sixteen months in distribution transformer design and eight months as assistant foreman in charge of industrial control and switchgear tests. Location immaterial. Available at once. Apply to Box No. 828-W.

CIVIL ENGINEER, B.A.Sc., D.L.S., O.L.S., A.M.E.I.C., age 46, married. Twelve years exporience in charge of legal field surveys. Owns own surveying equipment. Eight years on technioal, administrative, and editorial office work. Experienced in writing. Desires position on survey work, assisting in or in chargo of preparation of house organ, on staff of technical or semi-technical magazine, or on publicity, editorial or administrative office work. Available at once. Will consider any salary, and any location. Apply to Box No. 831-W.

CIVIL ENGINEER, S.E.I.O., B.sc. '32 (Univ. of N.B.). Age 25 married Two years experience in power line construction and maintenance; ono year of highway construction; one summer surveying for power plant site, location and spur railway line construction. Available at once. Location immaterial Apply to Box No. 840-W.

CIVIL ENGINEER, B sc. '15, A.M.E.I.O., married, extensive experience in responsible position on railway construction, also highways, bridges and water supplies. Position desired as engineer or superintendent. Available at once Apply to Box No 841-W

## Situations Wanted

CIVIL ENGINEER, B.sc. (Alta. '31), S.E.I.C., age 24. Experience, three summers on railroad maintenance, and seven months on highway location as instrumentman. Willing to do anything, anywhere, but would prefer connection with designing or construction firm on structural works. Available immediately. Apply to Box No. 846-W

BRIDGE AND STRUCTURAL ENGINEER, A.M.E.I.C., McGill. Twenty-five years' experience on bridge and structural staffs. Until recently employed. Familiar with all late designs, construction, and practices in all Canadian fabricating plants. Desirous of employment in any responsible position, sales, fabrication or construction. Apply to Box No. 851-W.

STRUCTURAL ENGINEER, B.A.Sc., A.M.E.I.C. Twenty-two years experience in design of bridges and all types of buildings in structural steel and reinforced concrete. Three years experience in railway construction and land surveying. Apply to Box No. 856-W.

MECHANICAL ENGINEER, B.sc. '32, S.E.I.C. Good draughtsman. Undergraduate experience:—One year moulding shop practice; two years pipe fitting and sheet metal work; one year draughting and tracing on paper mill layout; six months machine shop practice; and eight months fuel investigation and power heating plant testing. Desires position offering experience in steam power plants or heating and ventilating design. Will go anywhere. Apply to Box No. 858-W.

MECHANICAL ENGINEER, age 31, graduate Sheffield (England) 1921; apprenticeship with firm manufacturing steam turbine generators and auxiliaries and subsequent experience in design, erection, operation and inspection of same. Marine experience B.O.T certificate thoroughly conversant with Canadian plants and equipment. Available on short notice. Any location. Box No. 860-W.

CHEMICAL ENGINEER, B.sc. (McGill '21), A.M.E.I.C., age 36, married; three years since graduation with pulp and paper mills; eight years in shops, estimating and sales divisions of well-known gas engineering and construction companies in the United States. Excellent references. Available on short notice. Apply to Box No. 866-W.

CONSTRUCTION ENGINEER (Toronto Univ. of '07). Experience includes hydro-electric, municipal and railroad work. Available immediately. Location immaterial. Apply to Box No. 886-W.

ELECTRICAL ENGINEER, graduate 1929, S.E.I.C. Single. Experience includes two years with electrical manufacturing concern and one on highway construction work. Available at once. Will go anywhere. Apply to Box No. 887-W.

CIVIL ENGINEER, B.sc., Montreal 1930, age 26, single, French and English, desires position technical or non-technical in engineering, industrial or commercial fields, sales or promotion work. Experience includes three years in municipal engineering on paving, sewage, waterworks, filter plant equipment, layout of buildings, etc. Available immediately. Apply to Box No. 891-W.

ELECTRICAL ENGINEER, grad. Univ. of N.B. '31. Experienced in surveying and draughting, requires position. Available at once. Will go anywhere. Apply to Box No. 893-W.

CIVIL ENGINEER, B.A.Sc., JR.E.I.C., age 29, single. Experience includes two years in pulp mill as draughtsman and designer on additions, maintenance and plant layout. Three and a half years in the Toronto Buildings Department checking steel, reinforced concrete, and architectural plans. Available at once. Location immaterial. At present in Toronto. Apply to Box No. 899-W.

DESIGNING ENGINEER, A.M.E.I.C. Permanent and executive position preferred but not essential. Fifteen years experience in designing power plants, engine and fan rooms, kitchens and laundries. Thoroughly familiar with plumbing and ventilating work, pneumatic tubes, and refrigeration, also heating, electrical work, and specifications. Apply to Box No. 913-W.

CIVIL ENGINEER, B.sc., '25, McGill Univ., JR.E.I.C., P.E.Q., age 32, married. Experience as rodman and instrumentman on track maintenance. Seven and one-half years with Canadian paper company, as assistant office engineer handling all classes of engineering problems in connection with woods operations, i.e., road buildings, piers, booms, timber bridges, depots, dams, etc. Apply to Box No. 933-W.

ELECTRICAL ENGINEER, Dipl. of Eng., B.sc. (Dalhousie Univ.), S.B. and S.M. in E.E. (Mass. Inst. of Tech.), Canadian. Married. Seven and a half years' experience in design, construction and operation of hydro, steam and industrial plants. For past sixteen months field office electrical engineer on 510,000 h.p. hydro-electric project. Available at once. Apply to Box No. 936-W.

CIVIL ENGINEER, B.sc., O.P.E. Exporience includes several yoars on municipal work-dosign and construction of sewers, steel and concrete bridgos, watermains and pavoments. Available at once. Apply to Box No. 950-W.

CIVIL ENGINEER, B.sc. (Univ. of Sask. '33), S.E.I.C., ago 28, single. Experience in testing hydro-electric equipment, draughting, surveying, city street, improvements, technical photography. Available at once. Location immaterial. Apply to Box No. 986-W.

ELECTRICAL ENGINEER, S.E.I.C., B.sc., (N.S. Tech. Coll., '33), desires work. Experience in transmission line construction. Location or class of work immaterial. Apply to Box No. 1010-W.

## Situations Wanted

ENGINEER SUPERINTENDENT, age 44. Engineering and business training, executive ability, tactful, energetic. Had charge of several large projects. Intimate knowledge of costs and prices, reports and estimates. Available immediately. Any location. Apply to Box No. 1021-W.

CIVIL ENGINEER, B.sc. (Queen's 14), A.M.E.I.C., Dominion Land Surveyor, 5 months' special course at the University of London, England, in municipal hygiene and reinforced concrete construction. Experience covers legal and topographio surveys, plane tabling and stadia surveying, railway and highway construction, drainage and excavation work. Available at once. Apply Box No. 1035-W.

ELECTRICAL ENGINEER AND GEOPHYSICIST. Age 36. Married. Seven years experience in geophysical exploration using seismic, magnetic and electrical methods. Two years experience with the Western Electric Company of Chicago, working on equipment and magnetic materials research. Experienced in radio and telephone work, also specializing in precise electrical measurements, resistance determinations, ground potentials and similar problems of ground current distribution. Apply to Box No. 1063-W.

ELECTRICAL ENGINEER, B.A.Sc. Univ. Toronto '28. Experience includes Can. Gen. Elec. Co. Test Course. Also more than two years in the engineering dept. of the same company. Available on short notice. Preferred location central or eastern Canada. Apply to Box No. 1075-W.

ELECTRICAL ENGINEER, B.sc. Married. Eight years electrical experience, including operation, maintenance and construction work, electrical design work on large power development, mechanical ability, experienced photographer, employed in electrical capacity at present. Available on reasonable notice. Apply to Box No. 1076-W.

GRADUATE IN MECHANICAL ENGINEERING, 1927, desires opportunity in Diesel engine field, preferably in design and development work. Skilled draughtsman and clever in design. Familiar with basic theories of the Diesel engine and in touch with recent developments and applications. Anxious to obtain a foothold with up-to-date company. No objection to shopwork or other duties as a start but would prefer shopwork and assembly if possible. Apply to Box No. 1081-W.

CIVIL ENGINEER, age 27, graduate 1930, single. Experience includes detailing, designing and estimating structural steel, plate work and pressure vessels; also hydrographio surveying. Available at once. Apply to Box No. 1111-W.

ELECTRICAL ENGINEER, B.sc., in E E. (Univ. of N.B. '34), S.E.I.C. Experience in bridge and road construction and auto repairing, desires position in industrial or power plant. Any locality. References on request. Apply to Box No. 1114-W.

CIVIL ENGINEER, B.sc. Sask. '30. S.E.I.C. Age 24 years. Experience in municipal engineering, including sewer and water construction, sidewalk construction, paving, storm sewer design, draughting, precise levelling, and roinforced concrete bridge construction. Unmarried. Available at once. Will go anywhere. Apply to Box No. 1115-W.

ELECTRICAL ENGINEER, B.sc.E.E. (Univ. of N.B. '31). C.G.E. Test Course included industrial control, induction motors and transformers; the transformer test included desk work for two months on computing losses, efficiencies, etc. Available at once. Apply to Box No. 1119-W.

MECHANICAL ENGINEER, B.A.Sc. (Univ. of B.C.), M.S. (Univ. of Pittsburgh). Canadian. Age 26. Single. One year graduate student course, W.E. and M. Co., East Pittsburgh. Three and a half years engineering research in mechanics with the same company. Location immaterial. Available at once. Apply to Box No. 1123-W.

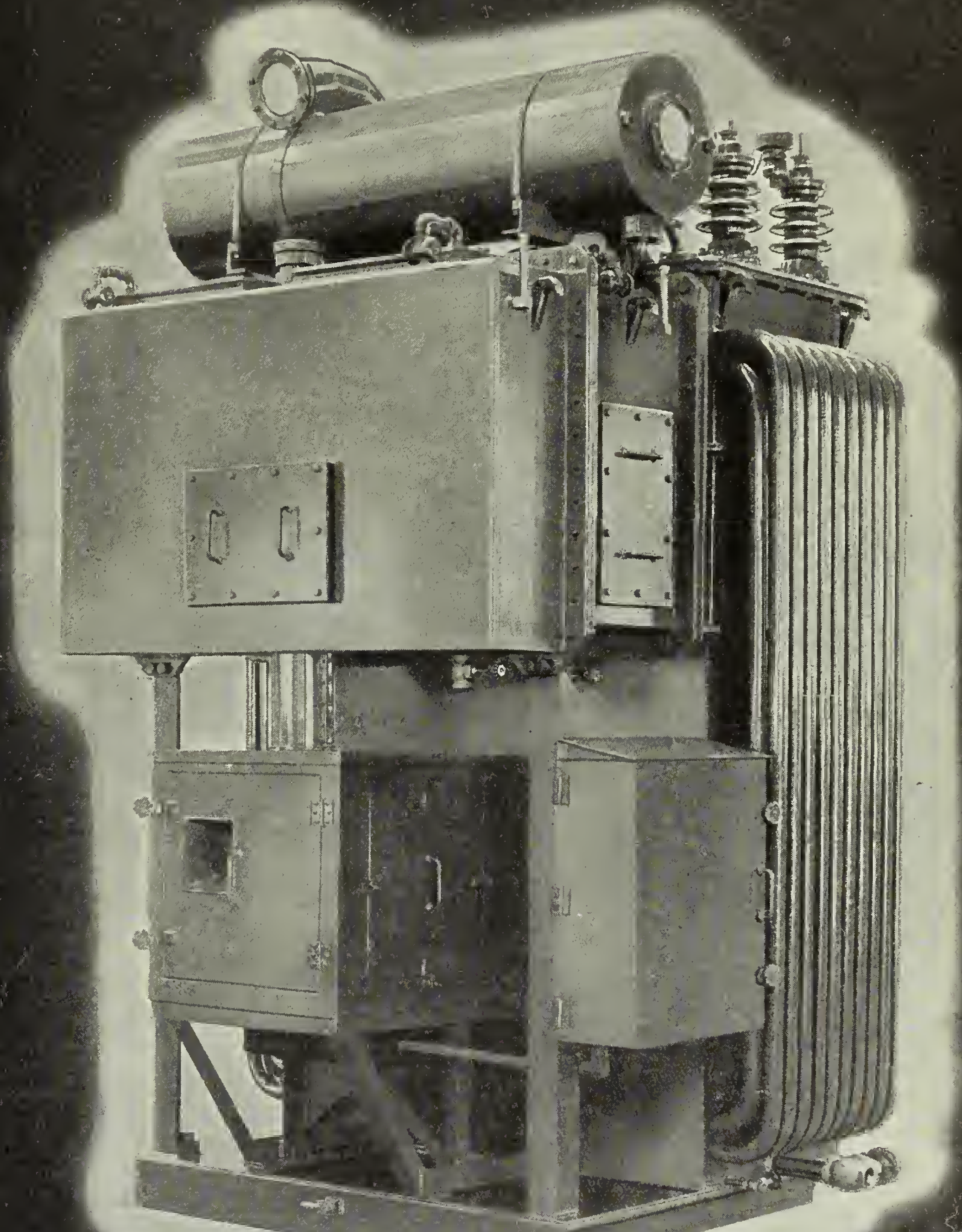
GEODETIC AND TOPOGRAPHICAL ENGINEER, D.L.S., M.E.I.C. Experience in all kinds of geodetic and topographical surveys, especially photo-topography, well versed in all kinds of air photo surveys; Canadian and U.S. patent method of determining position and elevations of points from air photographs. Available at once anywhere in Canada or the United States. Apply to Box No. 1127-W.

PETROLEUM CHEMIST, B.sc. in Chem. Eng. Age 25, Single. One and a half years experience as assistant chemist. Capable of taking charge in small refinery. Wishes position anywhere in Canada. Apply to Box No. 1130-W.

ELECTRICAL ENGINEER. B.sc., Queen's '33. Single, age 23. Anxious to gain experience. Present experience installing small private hydro-electric plant. Location immaterial. Available at once. Apply to Box No. 1137-W.

CIVIL ENGINEER, A.M.E.I.C., with over twenty years experience in field and office on construction, maintenance, surveying, location, etc., desires position preferably of a permanent nature. At present near Montreal, but willing to locate anywhere. Apply to Box No. 1168-W.

# GENERAL ELECTRIC
# LOAD-RATIO CONTROL
# POWER TRANSFORMERS



G.E. AUTOMATIC VOLTAGE REGULATING TRANSFORMER

◆ ◆ ◆

TO GIVE 7.5 PER CENT BOOST AND LOWER ON A 9000 KV-A. 12000 VOLT CIRCUIT

◆ ◆ ◆

SUPPLIED TO THE MONTREAL ISLAND POWER CO.

**MADE IN CANADA**

## CANADIAN GENERAL ELECTRIC
COMPANY LIMITED

Head Office - Toronto — Sales and Engineering Offices in Principal Cities

34 DAI

# Purchasers' Classified Directory

## *A Selected List of Equipment, Apparatus and Supplies*

For Alphabetical List of Advertisers see page 16.

A

**Acids:**
Canadian Industries Limited.
**Aerial Survey:**
Canadian Airways Ltd.
**Ammeters and Voltmeters:**
Bepco Canada Ltd.
Crompton Parkinson (Canada) Ltd.
**Angles, Steel:**
Bethlehem Steel Export Corp.
**Ash Handling Equipment:**
Babcock-Wilcox & Goldie McCulloch Ltd.
Combustion Engineering Corp. Ltd.
**Asphalt:**
Barrett Co. Ltd.
**Axles, Steel, Forged:**
Dominion Foundries & Steel Ltd
Dominion Steel & Coal Corpn. Ltd.

B

**Ball Mills:**
Dominion Engineering Works Limited.
Wm. Kennedy & Sons Ltd.
Foster Wheeler Ltd.
Wm. Hamilton Div. Canadian Vickers Ltd.
**Balls, Steel and Bronze:**
Can. S.K.F. Co. Ltd.
Wm Kennedy & Sons Ltd.
**Barking Drums:**
Canadian Ingersoll-Rand Company, Limited.
**Bars, Steel and Iron:**
Bethlehem Steel Export Corp.
Dominion Foundries & Steel Ltd.
Dominion Steel & Coal Corpn. Ltd.
**Bearings, Ball and Roller:**
Can. S.K.F. Co. Ltd.
**Billets, Blooms, Slabs:**
Bethlehem Steel Export Corp.
Dominion Foundries & Steel Ltd.
**Bins:**
Canada Cement Co. Ltd.
**Blasting Materials:**
Canadian Industries Limited.
**Blowers, Centrifugal:**
Can. Ingersoll-Rand Co. Ltd.
B. F. Sturtevant Co. of Can. Ltd.
**Blue Print Machinery:**
Montreal Blue Print Co.
**Boilers:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Canadian Vickers Ltd.
Combustion Engineering Corp. Ltd.
Foster Wheeler Limited.
E. Leonard & Sons Ltd.
Vulcan Iron Wks. Ltd.
**Boilers, Electric:**
Can. General Electric Co. Ltd.
Dominion Engineering Works Limited.
Northern Electric Co. Ltd.
**Boilers, Portable:**
Foster Wheeler Ltd.
E. Leonard & Sons Ltd.
**Boxes, Cable Junction:**
Northern Electric Co. Ltd.
**Braces, Cross Arm, Steel, Plain or Galvanized:**
Northern Electric Co. Ltd.
**Brackets, Ball Bearing:**
Can. S.K.F. Co. Ltd.
**Brakes, Air:**
Can. General Elec. Co. Ltd.
**Brakes, Magnetic Clutch:**
Northern Electric Co. Ltd.
**Bridge-Meggers:**
Northern Electric Co. Ltd.
**Bridges:**
Canada Cement Co. Ltd.
Canadian Vickers Ltd.
Dominion Bridge Co. Ltd.
**Bucket Elevators:**
Jeffrey Mfg. Co. Ltd.
**Buildings, Steel:**
Dominion Bridge Co. Ltd.

C

**Cables, Copper and Galvanized:**
Northern Electric Co. Ltd.
**Cables, Electric, Bare and Insulated:**
Can. Westinghouse Co. Ltd.
Can. General Electric Co. Ltd.
Northern Electric Co. Ltd.
**Caissons, Barges:**
Dominion Bridge Co. Ltd.
**Cameras:**
Associated Screen News Ltd.
**Capacitors:**
Bepco Canada Ltd.
Can. Westinghouse Co. Ltd.
Lancashire Dynamo & Crypto Co. of Can. Ltd.
**Castings, Brass:**
The Superheater Co. Ltd.
**Castings, Iron:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Dominion Engineering Works.
Foster Wheeler Ltd.
Wm. Kennedy & Sons Ltd.
E. Leonard & Sons Ltd.
The Superheater Co. Ltd.
Vulcan Iron Wks. Ltd.
**Castings, Alloy Steel:**
Dominion Foundries & Steel, Ltd.
**Castings, Steel:**
Dominion Foundries & Steel Ltd
Wm. Kennedy & Sons Ltd.
Vulcan Iron Wks. Ltd.
**Catenary Materials:**
Can. Ohio Brass Co. Ltd.
**Cement Manufacturers:**
Canada Cement Co. Ltd.
**Chains, Silent and Roller:**
Hamilton Gear & Machine Co.
Jeffrey Mfg. Co Ltd
**Channels:**
Bethlehem Steel Export Corp.
**Chemicals:**
Canadian Industries Limited.
**Chemists:**
Milton Hersey Co. Ltd.
Roast Laboratories Reg'd.
**Chippers, Pneumatic:**
Canadian Ingersoll-Rand Company, Limited.
**Choke Coils:**
Ferranti Electric Co.
**Circuit Breakers:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.
**Clarifiers, Filter:**
Bepco Canada Ltd.
Crompton Parkinson (Canada) Ltd.
**Clutches, Ball Bearing Friction:**
Can. S.K.F. Co. Ltd.
**Clutches, Magnetic**
Northern Electric Co. Ltd.
**Coal Handling Equipment:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Combustion Engineering Corp. Ltd.
**Combustion Control Equipment:**
Bailey Meter Co. Ltd.
**Compressors, Air and Gas:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Canadian Ingersoll-Rand Company, Limited.
**Concrete:**
Canada Cement Co. Ltd.
**Condensers, Steam:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Canadian Ingersoll-Rand Company, Limited.
Foster Wheeler Limited.
**Condensers, Synchronous and Static:**
Bepco Canada Ltd.
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Crompton Parkinson (Canada) Ltd.
Harland Eng. Co. of Can. Ltd.
Lancashire Dynamo & Crypto Co. of Can. Ltd.
Northern Electric Co. Ltd.
Bruce Peebles (Canada) Ltd.
**Conditioning Systems, Air:**
B. F Sturtevant Co. of Can. Ltd.
**Conduit:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co Ltd.
**Conduit, Underground Fibre, and Underfloor Duct:**
Northern Electric Co. Ltd.
**Controllers, Electric:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.
**Couplings:**
Dart Union Co. Ltd.
Dresser Mfg Co. Ltd.
**Couplings, Flexible;**
Dominion Engineering Works Limited.
Dresser Mfg. Co. Ltd.
**Couplings, Flexible:**
Wm. Hamilton Div. Canadian Vickers Ltd.
Hamilton Gear & Machine Co.
Wm. Kennedy & Sons Ltd.
**Cranes, Hand and Power:**
Dominion Bridge Co.
**Cranes, Locomotive:**
Dominion Hoist & Shovel Co. Ltd.
**Cranes, Shovel, Gasoline Crawler, Pillar:**
Canadian Vickers Ltd.
Dominion Hoist & Shovel Co. Ltd.
**Crowbars:**
B. J. Coghlin Co. Ltd.
**Crushers, Coal and Stone:**
Canadian Ingersoll-Rand Company, Limited.
Jeffrey Mfg. Co. Ltd.
Wm. Kennedy & Sons Ltd.

D

**Dimmers:**
Northern Electric Co. Ltd.
**Disposal Plants, Sewage:**
W. J. Westaway Co. Ltd.
**Ditchers:**
Dominion Hoist & Shovel Co. Ltd.
**Drills, Pneumatic:**
Canadian Ingersoll-Rand Company, Limited.
**Dynamite:**
Canadian Industries Limited.

E

**Economizers, Fuel:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Combustion Engineering Corp. Ltd.
Foster Wheeler Limited.
B. F. Sturtevant Co. of Can. Ltd.
**Elbows:**
Dart Union Co. Ltd.
**Electric Blasting Caps:**
Canadian Industries Limited.
**Electric Railway Car Couplers:**
Can. Ohio Brass Co. Ltd.
**Electrical Repair Work:**
Montreal Armature Works.
**Electrical Supplies:**
Can. General Elec. Co. Ltd.
Can. Ohio Brass Co Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.
**Electrification Materials, Steam Road:**
Can. Ohio Brass Co. Ltd.
**Engines, Diesel and Semi-Diesel:**
Canadian Ingersoll-Rand Company, Limited.
Harland Eng. Co. of Can. Ltd.
**Engines, Gas and Oil:**
Canadian Ingersoll-Rand Company, Limited.
**Engines, Steam:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Canadian Vickers Ltd.
Harland Eng. Co. of Can. Ltd.
E. Leonard & Sons Ltd.
**Evaporators:**
Foster Wheeler Limited.
**Expansion Joints:**
Foster Wheeler Limited.
**Explosives:**
Canadian Industries Limited.

F

**Feed Water Heaters, Locomotive:**
The Superheater Co. Ltd.
**Filtration Plants, Water:**
W. J. Westaway Co. Ltd.
**Finishes:**
Canadian Industries Limited.
**Fire Alarm Apparatus:**
Northern Electric Co. Ltd.
**Floodlights:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.
**Floor Stands:**
Jenkins Bros. Ltd.
**Floors:**
Canada Cement Co. Ltd.
**Forcite:**
Canadian Industries Limited
**Forgings:**
Bethlehem Steel Export Corp.
Dominion Steel & Coal Corpn. Ltd
**Foundations:**
Canada Cement Co. Ltd.

G

**Gaskets, Asbestos, Fibrous, Metallic, Rubber:**
The Garlock Packing Co. of Can. Ltd.
**Gasoline Recovery Systems:**
Foster Wheeler Limited.
**Gates, Hydraulic Regulating:**
Canadian Vickers Ltd.
Dominion Bridge Co. Ltd.
**Gauges, Draft:**
Bailey Meter Co. Ltd.
**Gear Reductions:**
Hamilton Gear & Machine Co.
**Gears:**
Dominion Bridge Co. Ltd.
Dominion Engineering Works Limited.
Hamilton Gear & Machine Co.
Wm. Kennedy & Sons Ltd.
**Generators:**
Bepco Canada Ltd.
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Crompton Parkinson (Canada) Ltd.
Harland Eng. Co. of Can. Ltd.
Lancashire Dynamo & Crypto Co. of Can. Ltd.
Northern Electric Co. Ltd.
Bruce Peebles (Canada) Ltd.
**Governors, Pump:**
Bailey Meter Co. Ltd.
**Governors, Turbine:**
Dominion Engineering Works Limited.
**Gratings, M. & M. Safety:**
Dominion Bridge Co. Ltd.

H

**Hangers, Ball and Roller Bearing:**
Can. S.K.F. Co. Ltd.
**Headlights, Electric Railway:**
Can. General Elec. Co. Ltd.
Can. Ohio Brass Co. Ltd.
Can. Westinghouse Co. Ltd.
**Heat Exchange Equipment:**
Foster Wheeler Limited.
**Heating Systems:**
C. A. Dunham Co. Ltd.
**Hoists, Air, Steam and Electric:**
Canadian Ingersoll-Rand Company, Limited.
Dominion Hoist & Shovel Co. Ltd.
Wm. Hamilton Div. Canadian Vickers Ltd.
**Humidifying Equipment:**
W. J. Westaway Co. Ltd.

I

**Incinerators:**
Canada Cement Co. Ltd.
**Indicator Posts:**
Jenkins Bros. Ltd.
**Industrial Electric Control:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.
**Injectors, Locomotive, Exhaust Steam:**
The Superheater Co Ltd.
**Inspection of Materials:**
J. T. Donald & Co. Ltd.
Milton Hersey Co. Ltd.
**Instruments, Electric:**
Bepco Canada Ltd.
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Crompton Parkinson (Canada) Ltd.
Ferranti Electric Ltd.
Moloney Electric Co. of Canada, Ltd.
Northern Electric Co. Ltd.
**Insulating Materials:**
Canadian Industries Limited.
**Insulators, Porcelain:**
Can. Ohio Brass Co. Ltd.
Northern Electric Co. Ltd.
**Intercoolers:**
Foster Wheeler Limited.

J

**Journal Bearings and Boxes, Railway:**
Can. S.K.F. Co. Ltd.

L

**Lacquers:**
Canadian Industries Limited.
**Lantern Slides:**
Associated Screen News Ltd.
**Leading Wire:**
Canadian Industries Limited.

# Purchasers' Classified Directory

**Library Films:**
Associated Screen News Ltd.
**Lighting Equipment, Industrial and Street:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.
**Lightning Arresters:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Ferranti Electric Ltd.
Northern Electric Co. Ltd.
**Line Materials:**
Can. Ohio Brass Co. Ltd.
Northern Electric Co. Ltd.
**Locomotives, Electric:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.

**M**

**Machinery, Hydraulic:**
Dominion Engineering Works Limited.
**Machinery, Metal and Wood-Working:**
Dominion Engineering Works Limited.
**Magnetic Separators:**
Northern Electric Co. Ltd.
**Material Handling Equipment:**
Jeffrey Mfg. Co. Ltd.
**Metallurgists:**
Roast Laboratories Reg'd.
**Meters, Boiler, and Coal:**
Bailey Meter Co. Ltd.
**Meters, Electric:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Ferranti Electric Ltd.
Northern Electric Co. Ltd.
**Meters, Flow:**
Bailey Meter Co. Ltd.
Neptune-National Meters Ltd.
**Meters, Liquid (Hot or Cold):**
Bailey Meter Co. Ltd.
Neptune-National Meters Ltd.
**Mine Cars:**
Canadian Vickers Ltd.
**Mining Machinery:**
Canadian Ingersoll-Rand Company, Limited.
Canadian Vickers Ltd.
Dominion Engineering Works Limited.
**Motion Pictures:**
Associated Screen News Ltd.
**Motors, Electric:**
Bepco Canada Ltd.
The Can. Fairbanks-Morse Co. Ltd.
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Crompton Parkinson (Canada) Ltd.
Harland Eng. Co. of Can. Ltd.
Lancashire Dynamo & Crypto Co. of Can. Ltd.
Northern Electric Co. Ltd.
Bruce Peebles (Canada) Ltd.
**Moulded Goods, Rubber and Asbestos:**
The Garlock Packing Co. of Can. Ltd.

**O**

**Oil Burning Equipment:**
Bethlehem Steel Export Corp.
**Oil Refining Equipment:**
Foster Wheeler Limited.
**Ornamental Iron:**
Vulcan Iron Wks. Ltd.

**P**

**Packings, Asbestos, Cotton and Flax, Metal, Rubber:**
The Garlock Packing Co. of Can. Ltd.
**Paints, all purposes:**
Canadian Industries Limited.
**Paving Materials:**
Barrett Co. Ltd.
**Penstocks:**
Canadian Vickers Ltd.
**Phase Rotation Indicators:**
Ferranti Electric Ltd.
**Photographs, Commercial and Portrait:**
Associated Screen News Ltd.
**Piling, Steel Sheet:**
Bethlehem Steel Export Corp.
**Pillow Blocks, Plain, Ball and Roller Bearing:**
Can. S.K.F. Co. Ltd.
**Pinions:**
Hamilton Gear & Machine Co.
**Pipe, Wood Stave:**
Canadian Wood Pipe & Tanks Ltd.
**Pipe Coils:**
The Superheater Co. Ltd.
**Pipe Couplings and Nipples:**
Dart Union Co. Ltd.
**Plates, Steel:**
Bethlehem Steel Export Corp
Dominion Foundries & Steel Ltd.
**Pneumatic Tools:**
Canadian Ingersoll-Rand Company Ltd.
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Can. Ohio Brass Co. Ltd.
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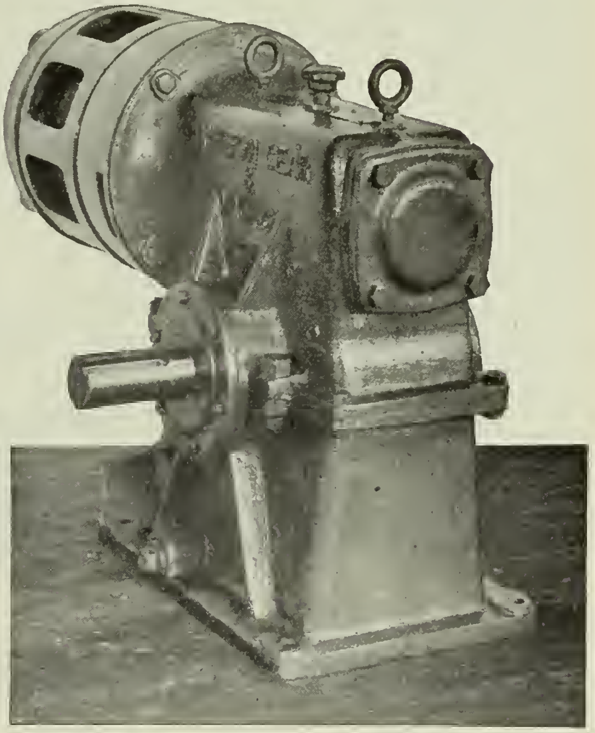

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# THE ENGINEERING JOURNAL

VOL. XVII
No. 8

THE ENGINEERING INSTITUTE OF CANADA FOUNDED 1887

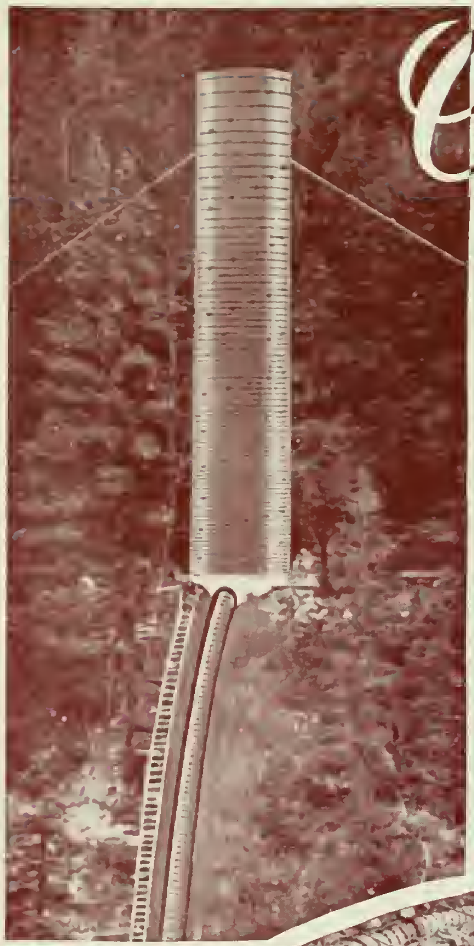
AUGUST
1934

## *In this issue*



PUBLISHED MONTHLY BY
THE ENGINEERING INSTITUTE *of* CANADA

# Canadian
## Wood Pipe & Tanks
### SELECTED BY PIONEER MINE



THE NEW CANADIAN BUTT JOINT illustrated at left below, was used for the first time at the Pioneer Gold Mines, largest producer in Bridge River. After a year's service in blistering heat and sub-zero cold, this new joint is absolutely rigid and tight.

David Sloan, Managing Director of Pioneer Mine, stated on June 15th: "We can thoroughly recommend the new end joint made on continuous wood stave pipe which we bought from Canadian Wood Pipe & Tanks Ltd. last summer. The head on the lower end of the pipe is 300 feet. The weather did not go below 15 degrees below zero this winter. There were no leaks in the end joints. We think it okay."

The Canadian Butt Joint, obtainable only with Canadian Continuous Stave Wood Pipe, is supplied at no extra cost. Specify Canadian Continuous Stave or Wire Wound Wood Pipe and Canadian Wood Tanks.

*Pioneer Mine hydro-electric pipe line is 30 to 42 inches diameter and more than a mile and a half long. Surge tank is 12 feet diameter and 70 feet high.*

**Canadian Wood Pipe & Tanks**
**Limited**
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# Guard–

*The power industry recognizes that a thousand or more "black eyes" to customer relations and economical operation, lie in the manifold service hazards of an antiquated distribution system. Engineers and management, alike, are now giving their best thought and consideration to this important area where investment, service, and operating values are concentrated.*

# THE AREA of CONCENTRATION

## These O-B Distribution Products Give Added Assurance to the Success of Your Plans « « «

A REVERSION to the simple truth that the millions of dollars invested in power plant equipment, transmission systems, and in sub-stations is spent only for the purpose of delivering energy to customers' meters, has cast the spot-light of attention upon the distribution system—the area of concentration.

On many properties, active work is under way to guard this area. Old and uneconomical distribution transformers are being replaced. Distribution systems are undergoing rehabilitation. Slip-shod or any-old-way construction in alleys and streets is giving way to well-laid construction—planned with thoroughness and foresight. In this planning, it seems apparent that what is good practice and what are good materials for the highest-voltage lines, are likewise good for the distribution system. For years, the O-B trade mark has been synonymous with utmost dependability in high-voltage transmission. O-B has many distribution necessities, all branded with this same mark of dependability. In guarding the distribution area, where investment, operating, and service values are concentrated, why not turn to O-B products for the added assurance they can give to the success of your plans for the distribution system. They cost no more, and they cost less when viewed from the standpoint of long life and freedom from trouble.

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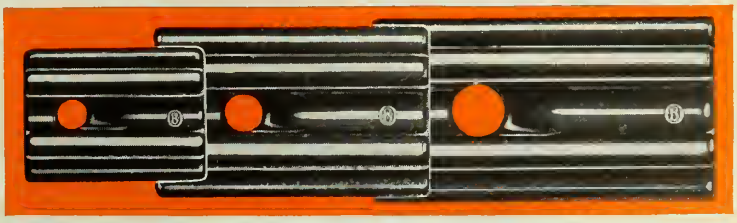
*A Wide Variety of Easily-Put-Up Strain and Suspension Clamps to Delight the Men on the Pole.*



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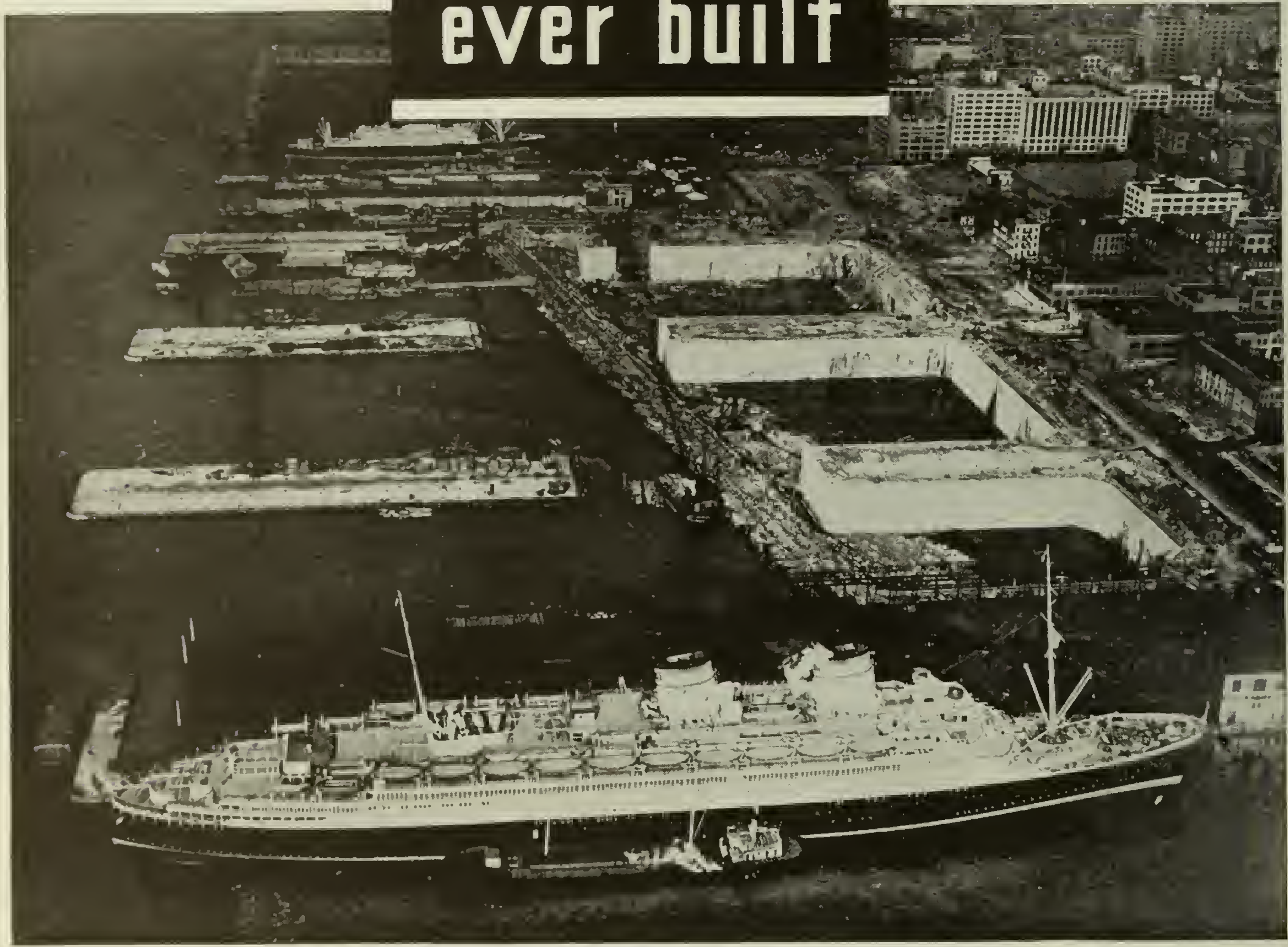
# The Largest Cellular Cofferdam ever built



*Contractor: Allen N. Spooner and Son, Inc.; Consulting Engineer: H. A. Sloane.* Photograph from Wide World

This 1500 ft. x 300 ft. cellular cofferdam, the largest ever built, was used in the construction of three piers in the Hudson River at New York City. It consisted of 43 pockets, filled with earth material, and extended from between 46th and 47th Streets to 52nd Street.

The cofferdam was built of 15-in. x $\frac{3}{8}$-in. straight-web Bethlehem Steel Sheet Piling. About 7500 tons were required, in lengths ranging from 46 ft. to 96 ft.—the latter the longest unspliced length of sheet piling ever used.

As the cofferdam was unwatered, the rock in the basins between the piers was excavated in the dry to a depth of 46 ft. below mean low tide, or 54 ft. below maximum high tide. The concrete portions of the piers were constructed, resting on solid rock, and the timber foundations were built for the outer portions of the piers.

Following removal of the steel piling, the outer, timber piers were extended shoreward to meet the concrete portions. The finished piers are 1100 ft. x 125 ft.

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# BETHLEHEM STEEL SHEET PILING

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## THE JOURNAL OF THE ENGINEERING INSTITUTE OF CANADA

*"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"*

**August 1934** **Volume XVII, No. 8**

## CONTENTS



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# The Substructure of the Reconstructed Second Narrows Bridge

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**Paper presented at the Western Professional Meeting of The Engineering Institute of Canada, held in Vancouver on July 11th to 14th, 1934.**

SUMMARY.—The steel bridge carrying highway and railway traffic over the Second Narrows of Vancouver Harbour four and a half miles above the city, has been reconstructed after its wreck in 1930. The paper traces the events leading to the selection of the new design and discusses the difficulties which had to be overcome in building the substructure for the new lift span. Two new piers were put in by caisson work carried out in strong tidal currents and one existing pier was demolished.

The Second Narrows bridge crosses the Burrard Inlet at a point approximately in the middle of the Vancouver Harbour Commissioners' territory and at the eastern boundary of the city of Vancouver, 4½ miles from the business centre. It was originally constructed in 1924 and 1925 after many years of consideration and several interruptions. The work executed at that date is described in the Minutes of Proceedings of the Institution of Civil Engineers, Vol. 225, pp. 321-352, where an illustrated paper by Mr. A. D. Swan, M.E.I.C., and some discussion will be found. Since that date, however, the bridge has suffered from numerous accidents of major or minor importance, most of which have been of the nature of collisions between vessels and the structure due to tidal conditions and to the location of the piers and the opening span relative to the waterway. Figure 1 gives a line diagram of the layout as referred to in the above mentioned paper, and Fig. 2 is a photograph of the bridge as then completed.

The following list of accidents, Table I, is taken from technical and daily press reports and serves to indicate that the passage of vessels and log-booms has been hazardous at times, although undoubtedly an examination of some of the instances would disclose insufficient care on the part of the navigators.

TABLE I

ACCIDENTS AT SECOND NARROWS BRIDGE

| | | |
|---|---|---|
| Sept. 8, 1924 | Logs in tow of tug *Shamrock* fouled pier | $16,000 |
| Nov. 3, 1924 | Log-boom broken up in collision with pier, Cliff Towing Co. | 400 |
| Sept. 30, 1925 | Tug *MT No. 1* sunk in collision with bridge | 3,000 |
| Sept. 30, 1925 | Vancouver Lumber Co. scow damaged | 700 |
| Nov. 26, 1925 | SS. *Canadian Ranger* drifted into bridge, saved by tug | unstated |
| Dec. 1, 1925 | Tug *Lorgnette* collided with pier | unstated |
| Jan. 5, 1926 | SS. *Canadian Ranger* hit north pier | 1,070 |
| Jan. 9, 1926 | Oil tanker *Mina Brea* hit pier | 8,000 |
| Feb. 25, 1926 | Oil tanker *Mina Brea* collided with pier again | 1,200 |
| Feb. 27, 1926 | Oil tanker *Vancolite* hit pier | 1,000 |
| April 11, 1926 | Boom of logs broken up, lost | 600 |
| April 14, 1926 | Cliff Towing Co. scow damaged | 3,000 |
| April 14, 1926 | Gas boat *Chummy 2* struck pier, crushed by scow, sank | unstated |
| May 5, 1926 | Scow in tow of *Seal Swell* collided with pier | 1,040 |
| May 25, 1926 | Tug *Pacific Monarch* hit pier | unstated |
| July 26, 1926 | Boom in tow of *B.C. Boy* hit pier No. 2 | unstated |
| Mar. 10, 1927 | S.S. *Eurana* struck fixed span | $30,000 |
| | Tug *Shamrock* fouled pier | 9,694 |
| April 24, 1928 | S.S. *Norwich City* struck fixed span | 50,000 |
| April , 1930 | S.S. *Losmar* collided with pier 4A (Fig. 3) | 75,000 |
| Sept. 19, 1930 | Hulk *Pacific Gatherer* towed by Tug *Lorne* struck 300-foot span becoming wedged beneath it. Incoming tide caused hulk to lift span from bearings throwing it into Inlet | 140,000 |

NOTE—Minor accidents not included.

The adoption by the Vancouver Harbour Commissioners of a new by-law, in 1931, rendering it obligatory for vessels over a certain size to pass the bridge only against the tide, has minimized the chance of collision and strict enforcement of this by-law should be demanded by all interested parties.

The bridge was built privately by the Burrard Inlet Tunnel and Bridge Company under certain agreements with the local municipalities as to a guarantee of bond interest, and the contracting company (The Northern Construction Company) accepted part of its compensation in securities. In addition, as Mr. Swan's paper points out, they undertook certain heavy responsibilities in respect of the unknown foundation conditions. Figure 1, which is taken from plate 5 of Mr. Swan's paper, shows that the superstructure between the timber trestle approaches consisted of four fixed spans and one bascule span of the Strauss overhead type, the latter furnishing a 175-foot opening toward the south side of the navigable water. The substructure supporting these spans included concrete piers numbered from the north 00, 0, 1, 2, 3, 4, 4A, 5, of which No. 2 is the most interesting both in the original construction and for present considerations. Piers numbers 00, 0, 1, 5 and 4A, as rebuilt after one of the accidents, consist of reinforced concrete cylinders sunk into gravel or into the sandstone rock, but pier 2 was of pneumatic construction and presented exceptional difficulties on account of the nature of the bottom encountered during sinking. As to capacity, the bridge carries a single line of railway between its trusses and a 10-foot highway on either side with a narrow footwalk outside the eastern highway only.

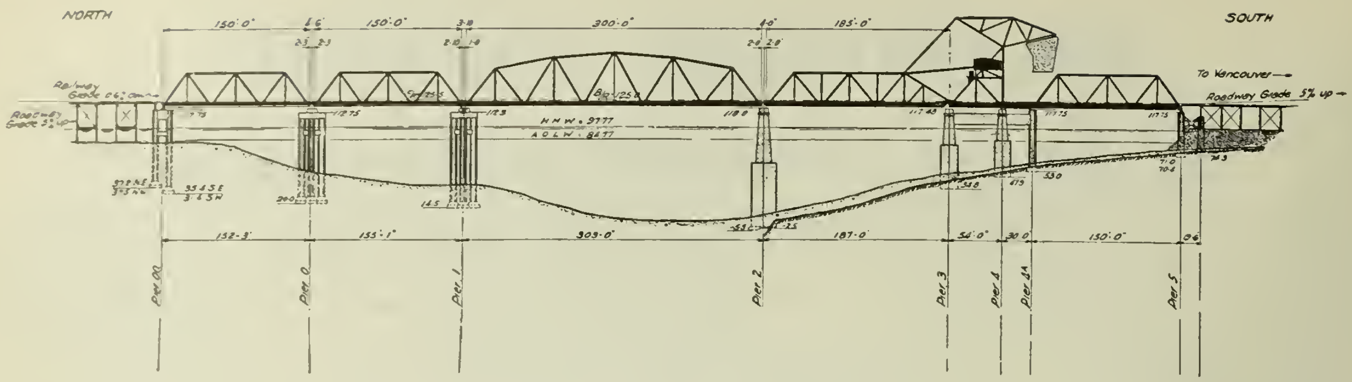


Fig. 1—Elevation of Original Bridge.

The reconstruction work of which this paper treats was occasioned by the catastrophe of September 19th, 1930, when the 300-foot fixed span between piers 1 and 2 was lifted off its supports and pushed into the water as a result of the rising tide acting on a vessel, the *Pacific Gatherer*, which had become jammed under the span (see Fig. 4). The span was salvaged, more or less, and examined as to condition but in spite of many rumours and press notices as to the possibility of restoring it to service, it was ultimately cut up and shipped as scrap to Japan. Nothing was done toward replacing it and the bridge was simply left in an incomplete and useless condition for three and three-quarter years.

The Second Narrows bridge had been a paying venture during its active but checkered life, forming as it did a very useful and popular link between the city of Vancouver and the north shore municipalities. In 1928 and 1929, for example, the traffic figures were reported as follows:—

| | 1928 | 1929 |
|---|---|---|
| Persons | 2,349,400 | 2,693,694 |
| Vehicles (autos and cycles) | 850,824 | 979,465 |
| Trucks, etc. | 140,741 | 164,510 |

and it can readily be understood that the interruption of such a facility for a period of years constituted a severe inconvenience to the population immediately affected, which had probably been built up as a result of the original construction of the bridge.

The sequence of accidents and the cessation of revenue naturally ate into the financial resources of the owning company and a receiver was appointed on February 23rd, 1932, on request of the bondholders. In spite of continuous pressure from public opinion and the press, satisfactory means could not be found to finance the rehabilitation until December, 1932, when the Federal government finally came to the rescue and an Order-in-Council was passed authorizing the Vancouver Harbour Commissioners to acquire the bridge and its appurtenances in order to undertake reconstruction. The intention was that by this means money could be obtained through the Department of Marine to effect the necessary work and that ownership would remain with the department until the expenses involved in such reconstruction had been recovered from revenue, after which the bridge would revert to the receiver.

The author's firm had been asked to advise the Vancouver Harbour Commissioners on the technical features of a scheme proposed by contracting companies to the Receiver previous to this Order-in-Council, and continued in this capacity when the Commissioners took over these new responsibilities. Under the new conditions, however, the methods of awarding a contract which had previously been under discussion, were abandoned in favour of open bids on prepared plans and the engineers' suggestion to make adequate borings in the neighbourhood of the existing pier 2 was immediately put into effect by the Commissioners under Colonel Monsarrat's personal direction. These borings were made in January, 1933, and are illustrated in Fig. 5. Meanwhile, office studies were being made by the author's firm of the schemes already proposed by the local contractors, and all variations therefrom, with a view to finding means of removing the causes for criticism which had gained for the bridge the epithet "A menace to navigation."* The foundation conditions were of extreme importance in all these studies. The earlier experiences at the site of pier 2 were, therefore, carefully investigated and all pertinent information assiduously canvassed. As several of the suggested schemes involved further foundations alongside the existing piers 1 and 2, and as some of these schemes would have involved also the distribution of heavy loads between new and old piers, the best obtainable knowledge regarding the foundation material was felt to be absolutely essential.

A general principle had by this time seemingly established itself in the minds of all those interested in the reconstruction, that the navigating channel should be moved from the present location between piers 2 and 3 to a new location between piers 1 and 2 and that a vertical lift span over this navigable channel should replace the existing bascule. The immediate problem was thus the precise method of supporting the towers for this vertical lift span and confining the total cost of reconstruction within

Fig. 2—Original Second Narrows Bridge.

the sum authorized by the Order-in-Council. Working from the information in the Institution of Civil Engineers' paper, several plans had been made by the author's firm, who had tentatively been appointed by the receiver under the earlier conditions of reconstruction, and other schemes had been advanced by the local contracting companies who

*From judgment of Privy Council re appeal of owners of steamship *Eurana* which collided with the bridge on the 10th of March, 1927—see Engineering News Record, December 2nd, 1931.

had been negotiating with the receiver for the work. Borings had been looked upon as almost impracticable during these earlier considerations by many parties, as the current and tidal conditions rendered such an undertaking very difficult; but in the engineers' opinion the difficulties that existed during the initial construction were to some extent diminished by the fact that the bridge itself formed a working platform for drilling apparatus and, as a matter of fact, after adequate consideration had been given

**Fig. 3—Accident in April 1930, 150-foot span being cut up.**

to the problem, borings were carried out successfully without undue trouble. When, in March, 1933, the author's firm were appointed engineers by the Vancouver Harbour Commissioners acting for the Department of Marine, the borings had been completed, and the opinion definitely arrived at, that any attempt to found a new pier or piers in front of or alongside pier 2 would be fraught with grave uncertainties and would, therefore, be unsound practice. Figure 6 is being included to show several of the proposed ideas which at this point had to be abandoned but some of which are of sufficient interest to be mentioned, at least descriptively. Technical reasons against their adoption may perhaps be of interest and will be briefly stated before proceeding to the scheme actually carried out.

The schemes considered and abandoned fall into various categories distinguished by the treatment accorded two

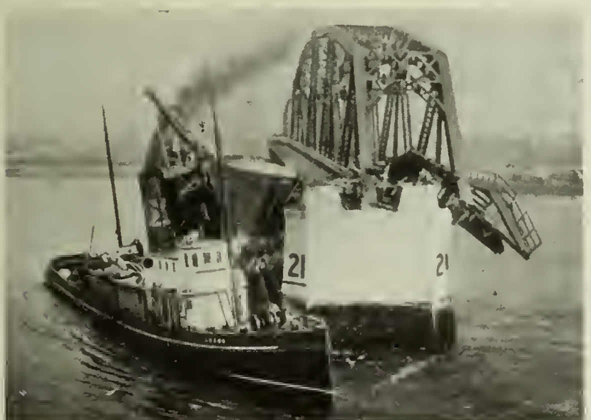

**Fig. 4—The *Pacific Gatherer* under Span, September 1930.**

or three principal features. There are those schemes which involved the old 300-foot span contemplated at the time as being still serviceable and capable of being refitted for use as a lift span. Alternatively, there were those schemes which anticipated the construction of an entirely new span, either of 300 feet or some slightly shorter length. The retention or abandonment of the existing bascule span was also a feature by which the schemes can be classified. Again, there were certain schemes which included new pier sites as distinct from the enlargement of old pier sites. Many types of piers were considered; the principal methods of construction being: sheet steel piling, generally by the cage method, Fig. 6a; reinforced concrete cylinders somewhat similar to those used in the existing piers 1 and 0, these being for additions to the piers 1 and 2; and pneumatic or open caissons, for entirely new piers.

Major events occurred during the discussion of the project which ruled out some of the proposed schemes and which controlled in various ways the features to which allusion has been made. For instance, in the first place a decision was arrived at by the government departments concerned that they did not want to retain the present bascule opening and would not be party to the spending of any sum for the mere purpose of such retention. This attitude, based on the known unwillingness of navigators to use the bascule opening if some more desirable opening to the north were provided, was stiffened by the prospect of dismantling and re-using most of the existing machinery for the new span and so reducing the new capital cost. Secondly, the borings which were taken in January, 1933, showed the impracticability of sinking auxiliary piers adjacent to pier 2 with sufficient certainty and satisfaction. The lack of overburden in certain areas militated against all piling schemes, some of which, particularly the cage scheme illustrated in Fig. 6a, were otherwise very favourably

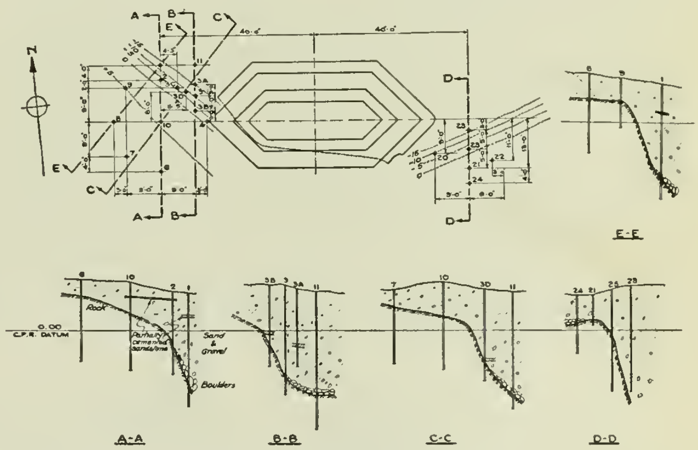


**Fig. 5—Plan and Sections Showing Borings Adjacent to Pier 2.**

regarded. The prospect of having to found some cylinders on rock, others on gravel, and even in some cases the same cylinder partly on rock and partly on gravel, did not appeal to the engineers. Caisson construction so close to the old pier was not looked on with favour and thus, gradually but definitely, all schemes for the enlargement of pier 2 were discarded in favour of an entirely new pier. Thirdly, the assumption that the old 300-foot fixed span could be rehabilitated was finally abandoned, although the present author cannot state exactly when and by whom the decision to scrap it was actually made. However, advantage was taken thereafter of the economy to be obtained by the adoption of a somewhat shorter span of higher strength steel which would thus impose much lighter loads on the towers and substructure.

The preference for placing the new pier 2 to the south instead of to the north of the old pier 2 was dictated by considerations arising from both the first and the second of the above mentioned events. A site to the south would obviously be on rock and within reach of reasonable working pressures for pneumatic construction. To the north, on the other hand, the depth of water increased and the bottom became gravel and, although an open caisson could undoubtedly have been sunk with or without the use of an artificial sand island, as indicated on Fig. 6f, the fear of creating a serious raceway for the tidal currents between the old and new piers and the resulting tendency to excessive scour around the bases of these piers was felt to be a powerful argument against placing a new pier in this locality. Furthermore, the position of the corresponding new pier 1 would also have been awkward with a lift span of 282 feet or thereabouts. A similar tidal raceway would have been created and the prospect of demolishing the old pier 1 was not viewed with much assurance.

Referring to the figures of the abandoned schemes, these will indicate without further explanation whether or no the bascule span was to be retained, whether or no the old 300-foot span or a new lift span was to be used, and whether the substructure was designed as an enlargement of existing piers or as a pair of new piers.

Figure 6b, scheme 1, which in regard to its superstructure closely follows that submitted by the Dominion Bridge Company in March, 1932, involved a pair of towers each consisting of eight vertical posts and connected at their tops by horizontal bracing trusses. The counterweights were on the outsides and called for four sheaves per tower while both the lift span and the bascule were housed between the inside legs of each pair of towers. The substructure to support these rectangular towers was, of course, distinctly long in the east and west direction and involved the sinking of eight cylinders for the north pier and four for the south.

Figure 6c, scheme 2, also evolved by the Dominion Bridge Company as far as the superstructure is concerned, counted upon a new lift span, some small modification at the nose of the bascule and north flanking spans, and rectangular towers seated upon transverse loading girders. In this case the bascule trusses and the lift span trusses were housed between the inside legs of the tower posts, but the cantilevered roadways were cut off short of the tower construction and a suitable portion built over the pier. The substructure for this case was alternatively designed as being of reinforced concrete cylinders or of steel sheet piling prisms, the shape of these prisms being such as to present cut-waters up- and down-stream and provide bearings for the transverse loading girders. Two sheaves per tower were required and counterweights were placed on the longitudinal centreline of the bridge as is the normal practice.

Figure 6d, scheme 3, was a later development resulting out of consultations between the Dominion Bridge Company and the author's firm during the period when the receiver was considering the reconstruction of the bridge. The scheme, as illustrated, involved towers of the more

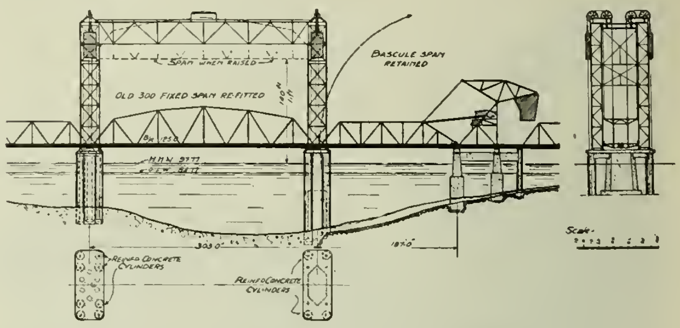


Fig. 6b—Abandoned Scheme No. 1, March 1932.

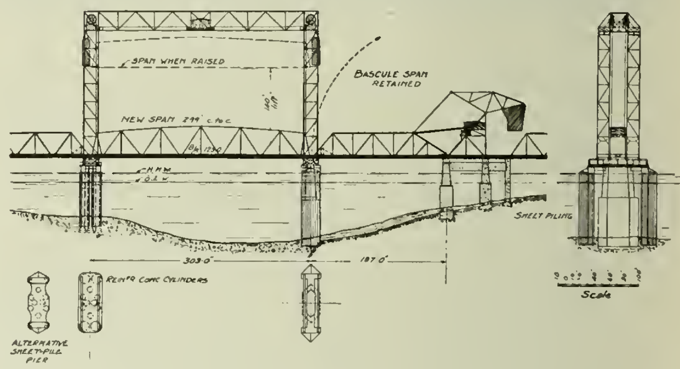


Fig. 6c—Abandoned Scheme No. 2, June 1932.

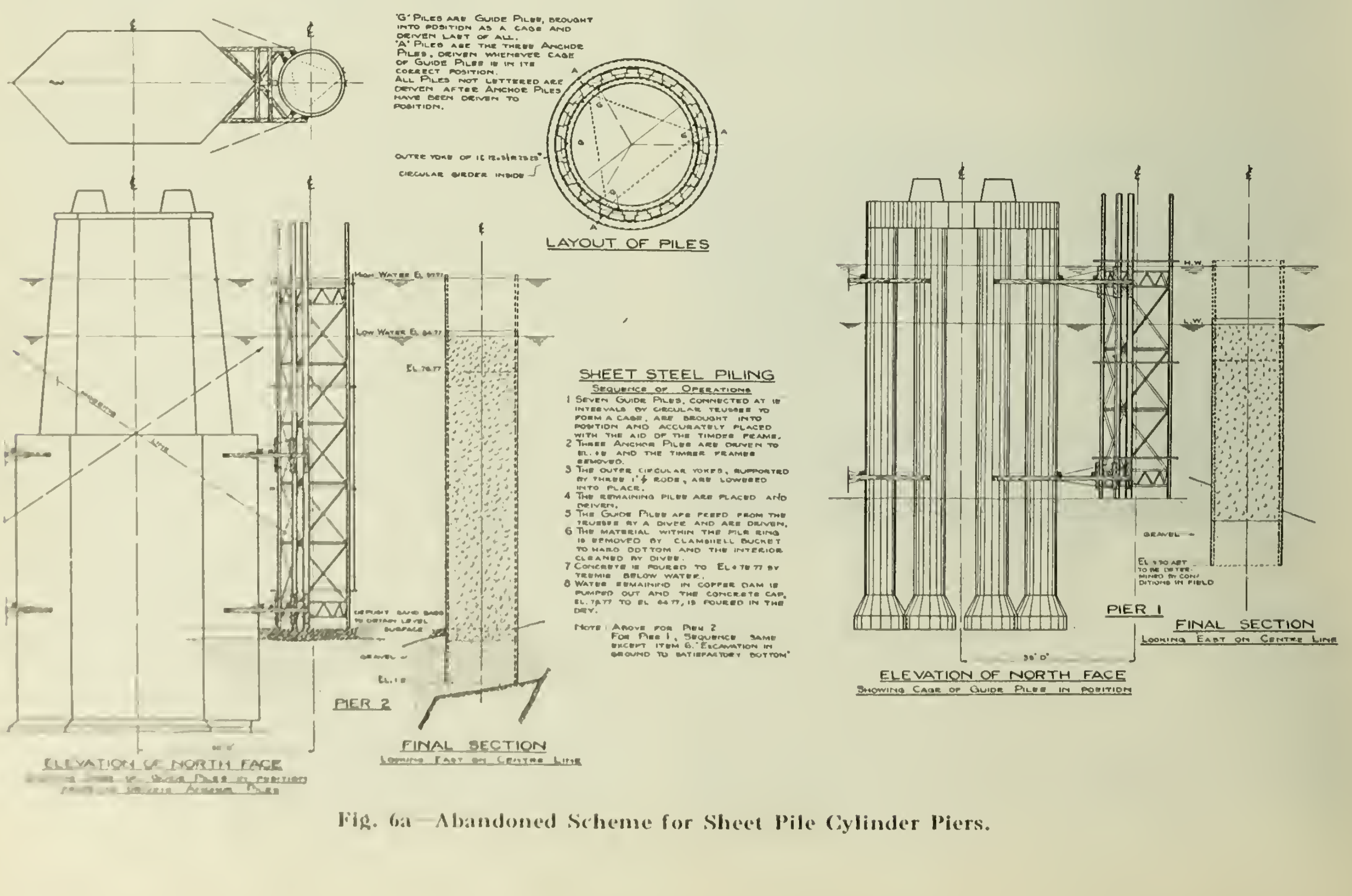


Fig. 6a—Abandoned Scheme for Sheet Pile Cylinder Piers.

usual type carried on two legs 78 feet apart, which legs were seated entirely on new cylindrical steel sheet piling piers. The interior posts shown on the side elevation were merely guides for the span movements and not intended to take any vertical load. In view of the prospective uneven settlement of the two piling cylinders, they were not rigidly connected across the top but jacking arrangements were provided whereby the superstructure could be maintained on an even keel. Each of the two cylinders at each

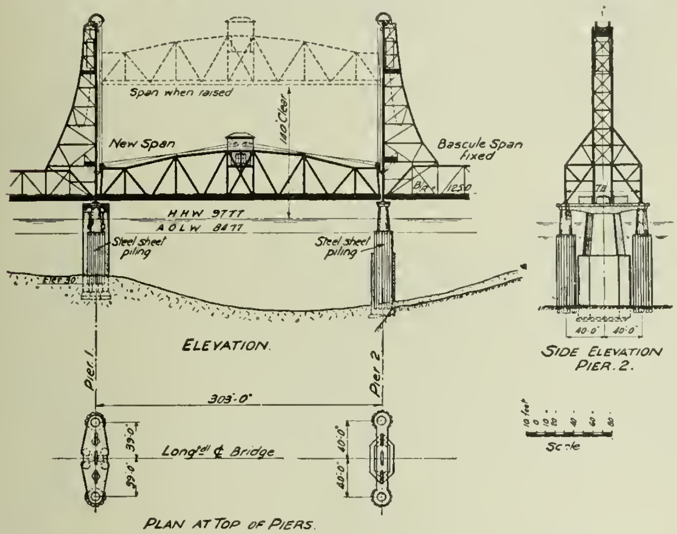


**Fig. 6d—Abandoned Scheme No. 3, December 1932.**

pier was narrowed down at its top to pass through a circular hole in the horizontal beam. This horizontal beam was designed to carry its own weight as a cantilever on the old pier and to absorb any lateral forces which might be delivered at the feet of the tower legs on the new piers. Alternative designs for the substructure were made in which lozenge shaped steel piling piers were used instead of cylinders and various devices were studied for taking care of uneven settlement.

Figure 6e, scheme 4, was an early scheme suggested largely by the Hamilton Bridge Company for using the old span, retaining the bascule, and moving the navigating channel further to the north.

Figure 6f, scheme 5, was an adaptation of scheme 4 using a new and shorter lift span.

The layout finally recommended to the Department of Marine, and approved by the Department of Public Works in Order-in-Council P.C. 651, is indicated in Fig. 7, which is the engineers' drawing No. 4 and which forms part of the subsequent contract. This layout calls for two piers numbered 1B and 2B south of the old piers 1 and 2 respectively, but south by different distances. The old pier 1 remains in the structure; the old pier 2 is demolished, thus providing a clear channel at low water level of 272 feet with a span of 286 feet between centres of the new main piers. This compares with the old channel of 175 feet and the span of 187 feet between piers. The new layout thus provides almost 100 feet wider fairway for navigation.

The new vertical lift span is designed to rise 117 feet 3 inches and to give, when raised, 140 feet clearance above high water level which is 97.77 to the harbour or C.P.R. datum. As is usual in such bridges an emergency lift of 3 feet extra is rendered possible by the structural and mechanical provisions. The towers are supported on flanking spans, that to the north being a new span, that to the south being the shortened moving leaf of the existing bascule. This bascule is cut to 129 feet in length by the removal of two panels and a large portion of the dismantled steel was used to make up the 70-foot flanking span to the north. The counterweight mass and the counterweight truss and tower of the bascule bridge were not removed, and must not be removed in the future without definite study of the resulting stress conditions in the remaining portion of the bascule span. Some of the balancing blocks have been removed and will be re-used, and much of the machinery including the main motors, the standby gas engine, gears, and bearings, are also reinstalled in the new machinery house at the centre of the lift span. Figure 7 shows that by spacing the new pier 2B, 53 feet south of the old, a solid rock foundation was obtained and all uncertainty removed. The new pier could thus be dimensioned to suit requirements and all superimposed loads would be borne on one shaft. Similarly, pier 1B being sunk in gravel of fairly well established properties, would be designed to meet loading requirements without any trouble from uneven settlement. In the engineers' specifications, pier 2B was stipulated to be pneumatic in order that the rock might be bared for visual inspection. For pier 1B the choice between pneumatic and open sinking was left with the bidders in the instructions issued with the call for substructure tenders; but the engineers showed, on their construction drawings, an open-dredging caisson. They felt that with the necessity of providing air plant for one caisson, the extra cost of pneumatic as against open sinking of the second caisson would not be serious and that the experience of the different contractors might lead them to differing preferences. Bidders were required to state their choice in their tender so that the engineers would be the better guided in comparing prices. Bidders were also warned of the difficulty of controlling floating caissons in the currents, eddies, and tide conditions bound to be encountered at this site and were required to visit the site as well as to submit their experience in similar work together with evidence as to their qualifications in resources and personnel.

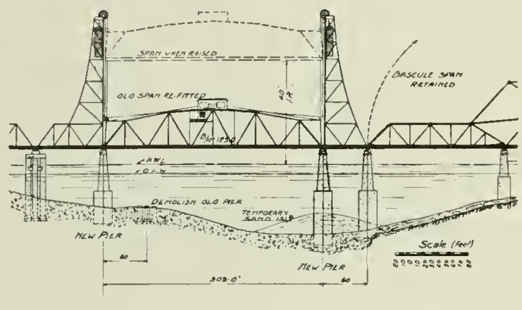


**Fig. 6e—Abandoned Scheme No. 4, March 1932.**

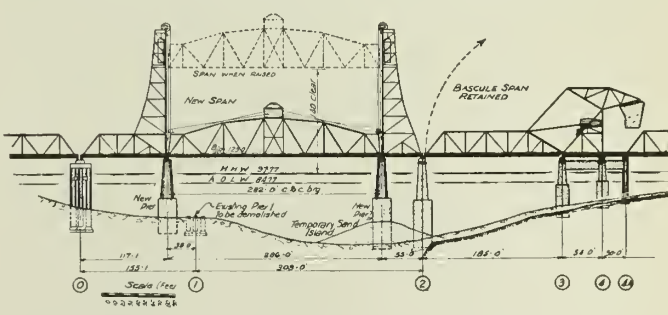


**Fig. 6f—Abandoned Scheme No. 5, February 1933.**

A glance at the map (Fig. 8) will serve to indicate that two fresh water rivers, known as Lynn creek and Seymour creek, flow into the inlet immediately west and east of the bridge approach. At different stages of the tide and at different seasons of the year the effect of these creeks on the direction of the flow in the channel at the bridge site varies widely. Moreover, the difference in specific gravity between the fresh and salt water tends to complicate the situation with respect to the intensity of current at various

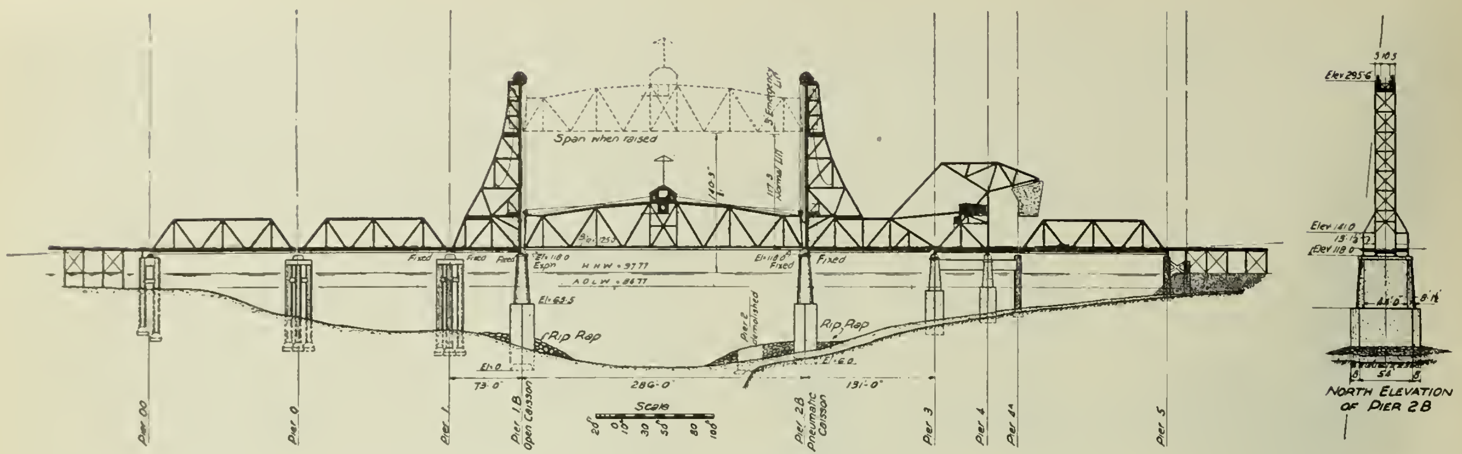


Fig. 7—Elevation of Reconstructed Bridge.

depths. All of this makes it evident that not only special vessels, such as the floating caissons, but also the ordinary type of steamer or even barges and log tows, must be very carefully handled and need to be provided with plenty of operating room even when the tides appear to be slack on the surface. The tidal phenomena are, in addition, unusual in respect of the sequence of high and low tides, in so much as the difference between the low and two neighbouring highs is sometimes extremely small and other times as much as 15 feet as will be seen from typical diagrams Fig. 9. Another complication is the fact that the new tides seem to flood in on the south side of the inlet west of the Second Narrows bridge and then to shoot across to the north on the surface adjacent to, practically parallel to, but in the opposite direction from, the flow of Seymour creek. This of course causes unusual eddies, particularly evident at the bridge site and around the piers as constructed. It was the knowledge that these extraordinary conditions exist and are undoubtedly responsible for many of the major and minor accidents to navigation in this vicinity, that led the engineers to emphasize the necessity of a close acquaintance with the actual conditions and with the hazardous type of work resulting therefrom.

As is usual in these cases, the need of a tremendous hurry was discovered as soon as the engineers had been appointed and every effort had to be made to expedite the preparation of plans and specifications sufficient for tendering purposes. Fortunately, the studies and inquiries which had been made previous to actual appointment enabled the engineers to reach their conclusions, make their recommendations to the departments of government concerned, secure tentative approvals and issue the call for tenders within a few days, so that invitations to bid were advertised on March 17th, 1933, and tenders were received in Montreal on April 18th. All bidders chose to sink pier 1B by an open-dredging caisson and the Foundation Company of Canada, Limited, were recommended to the Department of Marine for the award of the contract. The tender form required a lump sum bid for the work shown on the drawings and described in the specifications, and also unit prices for additions or deductions and for variations in depth. The successful bidder quoted $333,733 as the lump sum, which was between 91 and 92 per cent of the engineers' estimate, and even with the payment for extra depth in 2B and other small additions consequent upon the completion of the superstructure drawings the cost to the Vancouver Harbour Commissioners does not exceed 96 per cent of the engineers' estimate.

The general design of these two new piers is indicated in the various figures and is dimensioned on Fig. 10 which is taken from engineers' drawing No. 5. The shafts above elevation 65.5 are identical, are 10 feet wide by 54 feet long under the coping, and batter at the rate of 1 in 16 to 16 feet 3 inches by 60 feet 3 inches at the point where they sit on the base. The shafts are semi-circular at their east and west ends but the base caissons are pointed, the included angle at the noses being 108 degrees. The bases are slightly different in dimension due to loads and foundation material, pier 1B being 24 feet wide inside the sheathing and pier 2B being 22 feet. The corresponding overall lengths are respectively 71 feet 5½ inches and 69 feet 11¾ inches nose to nose. These dimensions ensured that for all the specified loads, tension in the concrete was avoided and toe pressures on the river bed were within the working values of the materials encountered. For pier 2B, which was sunk into the sandstone rock, the units at the bottom of the shaft, elevation 65.5, are shown on Fig. 11. For determining maximum and minimum pressures the water level was considered as either low or high tide; concrete was taken as weighing 150 or 147 pounds per cubic foot; wind was considered as being from the north, south, east, or west and acting on towers, spans, train, and pier, or any combination of these; current pressure was considered as from ebb or flood tide; the span was considered as up or down; live load was considered as off or on, accompanied by impact or not, and producing traction or not; eccentricity of superimposed loading was allowed for; the presence of timber was considered in estimating the weight of the pier; temperature was taken as ranging between 0 degrees and 120 degrees and skin friction was admitted or neglected. The most adverse possible combinations were determined by numerous separate calculations and the units indicated in the figures are, therefore, such as are hardly likely to occur in fact. In figuring the current a surface velocity of 11 feet per second was used and it was assumed that this velocity would also persist down to elevation 75, from which point

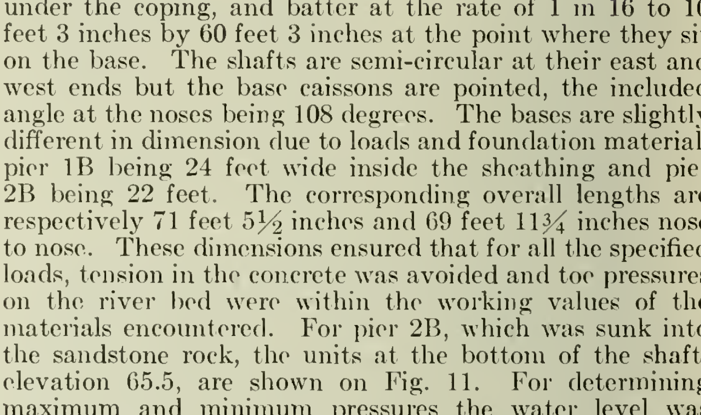


Fig. 8—Location Map.

down the velocity would reduce parabolically to zero at the top of the riprap, which is about elevation 37 for pier 1B and about elevation 30 for pier 2B. Coefficient $k$ in the formula for pressure $P = W . k . \frac{v^2}{2g}$ was taken at ¾ for the semicircular ended shaft and 4/3 for the pointed caisson. To allow for cross currents 20 per cent of the pressure, as figured for the east and west direction acting on the ends of the piers, was assumed as acting in a north or south direction on the sides of the piers. As will be mentioned later, the caisson for 2B was not quite accurately placed and the resulting eccentricity of the upper shaft weight and the superimposed loading altered the base pressures from those shown in Fig. 12 to those shown in Fig. 13. Table II, showing conditions of loading, will assist the reader in understanding the references to case numbers on the figures.

In view of the fact that pier 2B sits on what appears to be solid rock, the relieving effect of buoyancy or flotation may be absent and alternative calculations were made on this basis. Figure 14 shows that for the pier as built the maximum unit pressure, under the most adverse combinations imaginable, comes on the south west shoulder and reaches 12 tons per square foot under the assumptions

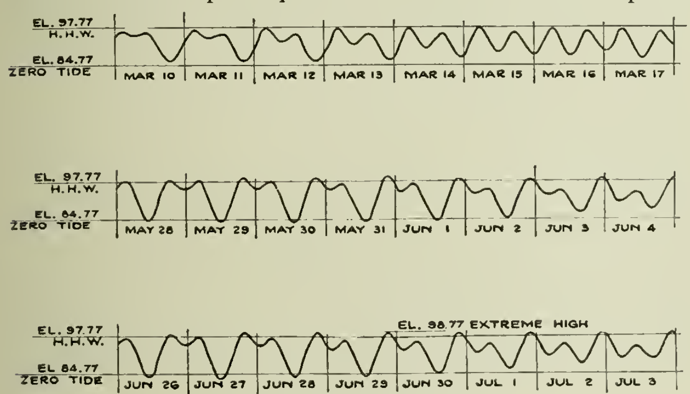


**Fig. 9—Types of Tides.**

adopted. Recapitulating these assumptions for this figured condition, they include no buoyancy; concrete at 150 pounds; high water; full live load, impact and traction; coldest temperature; actual eccentricity of shaft and superimposed loads; east wind on tower, span, train and pier; flood current at 7½ miles per hour (case $3_d$).

For pier 1B in gravel the corresponding values are given on Fig. 15.

A fair idea of the general stability of the structure may be obtained from the end elevation on Fig. 7, showing pier 2B and the superimposed tower, where a battered line is drawn from the centre of one sheave to the pier nose at the base elevation. This line batters 27 feet 6 inches in

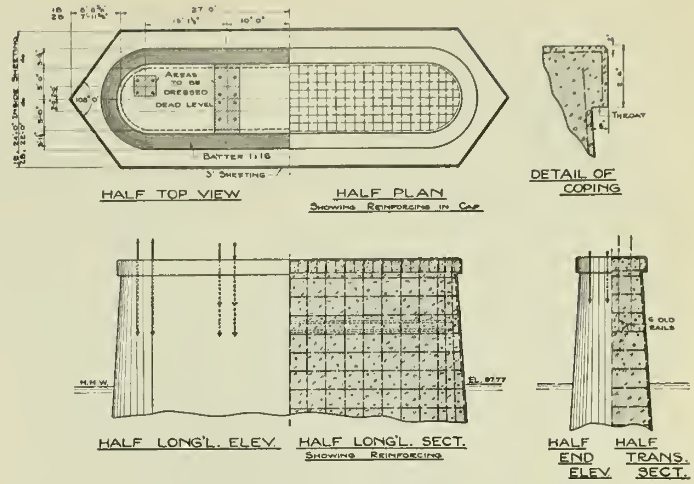


**Fig. 10—Detail of Tops of Piers 1B and 2B.**

the vertical height of 289 feet 6 inches and lies entirely within the pier.

Immediately upon the award of the contract, detailed drawings of the cutting edges and of the timber caissons, following in general the sketches prepared by the engineers, were put in hand by the contractor and agreement was arrived at sufficiently quickly to permit steelwork to be ordered in Vancouver during July. The Foundation Company had arranged an association with the Pacific Salvage Company of Vancouver by virtue of which the personnel and equipment of the latter company were to be available for caisson construction and water-transport. This association proved very satisfactory, as ample marine plant was thus provided for all contingencies, superintendents and foremen familiar with the local conditions were secured for responsible direction of this portion of the work, and space properly fitted for timber-ship-building was provided for the construction, launching, and floating of the caissons.

By the middle of August the author was able to inspect the cutting edge and working chamber of the pneumatic caisson of pier 2B, in the shops of the Western Bridge Company, and by August 21st this framework was set on the specially built ways at the Pacific Salvage Company's dock in North Vancouver. (Fig. 19.) Figure 16 shows the transverse and longitudinal sections of the working chamber. The latter is of ¼-inch plate suitably stiffened and all-welded, while the cutting edge is partly riveted and is of heavier material. Three shafts penetrate the ceiling of the working chamber and the usual supply of pipes for high and low pressure air, water, light, whistles, and telephones, grouting, etc., was installed.

On September 5th the caisson was timbered to 16 feet above the cutting edge and launched. The concreting plant

Table II

Pier 2B. Conditions of Loading

| ITEM | COMBINATION | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 3a | 3b | 3c | 3d | 4 | 4b | 5 | 5c |
| Tide | low | high | low | low | high | low | high | high | high | high | high |
| Current pressure from | N | N | E | W | W | W or E | W | E | W | E | E or W |
| Wind from | N | N | E | W | W | W or E | W | E | W | E | E or W |
| Concrete weight (pounds per cubic foot) | 150 | 147 | 150 | 150 | 150 | 150 | 150 | 147 | 150 | 147 | 147 |
| Span | down | up | down | down | down | down | down | up | up | down | down |
| Live load | yes | no | yes | yes | yes | yes | yes | no | no | yes | yes |
| Impact | yes | none | yes | yes | yes | yes | yes | none | none | no | no |
| Traction push from | N | none | N | N | N | N | N | none | none | N | N |
| Temperature | low | low | low | low | low | low | low | low | low | low | low |
| Eccentricity due to misplacement | yes | yes | yes | yes | yes | no | yes | yes | yes | yes | no |
| Buoyancy allowed for | yes | yes | yes | yes | no | yes | no | yes | no | yes | yes |

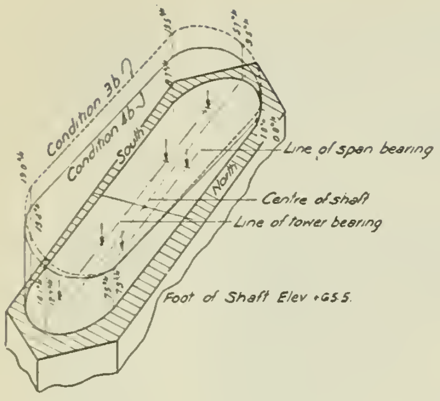


Fig. 11—Pier 2B Governing Pressures at Base of Shaft.

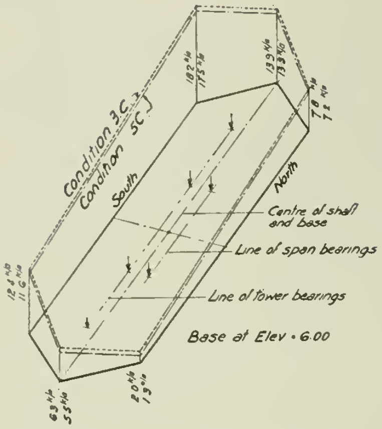


Fig. 12—Pier 2B Governing Pressures if Sunk correctly assuming Buoyancy.

had been completed by this date and was mounted on a scow alongside, so that on September 9th 117 cubic yards were poured into the cutting edge, increasing the draught to 12 feet 6 inches from 6 feet 9 inches. On the mixer scow (Fig. 17), beside the steam raising plant and driving engine, were a timber tower, with the necessary chutes, and an inundator with batch measuring apparatus and hoppers for the storage of aggregates.

From this point on the caisson was constructed by raising the timber work, consisting of waling, strutting, and sheathing, in stages and concreting the walls to preserve stability. A plan of the caisson for pier 2B is also shown in Fig. 16 and indicates the wells which were watered, de-watered, and concreted to suit flotation requirements during towing and sinking operations as illustrated in Fig. 18. A fairly elaborate system of anchorage had been prepared in advance for holding the caisson and the various craft in their proper places and Fig. 20 indicates the general arrangement, while the photograph Fig. 21 shows one of the 30-ton concrete anchor blocks being tipped overboard. The basic idea was to moor two large scows 30 feet by 90 feet, one on either side of a space to be occupied by the caisson, and to tow the caisson upstream on the flood tide, pushing and hauling it into place by means of a big derrick boat and hoisting engines mounted on the scows.

The caisson weighed 2,600 tons, including 1,045 yards of concrete, when ready for towing, and drew 62 feet with 32 feet 6 inches of freeboard. It was towed up the inlet to its final site on October 12th, the river bottom having been previously levelled-off by dredging and the deposition of gravel in bags. On arrival at the site a smaller sized tug boat picked up the chain from the 30-ton west main anchor and also took hold of the 1¾-inch cable attached to the western towing bridle on the caisson. The eastern towing bridle was hooked onto the cable and tackle extending from the east main anchor, so that by operating the hoists on the scows the whole line from anchor to anchor could be tautened and the caisson itself moved up- and down-stream in this line. Struts of logs, 3 feet or 4 feet in diameter, were later placed between the scows, fore and aft of the caisson, to keep them apart and 1¼-inch cables run off another drum on the hoists served to keep the scows from separating. After checking for position east and west, water was admitted into the caisson and the latter was sunk, to ground on the bottom at about half ebb tide. The west side anchor lines were then interchanged and crossed, similar to those on the east side, so that they would have more purchase in keeping the scows in position. The cutting edge settled down at about elevation 20, the south west corner being on the exposed rock. During the night, and probably due to several causes such as cross currents, eddies and tides, uneven bottom, non-uniform pull on the anchor lines, etc., the caisson walked and settled to a different position, which is indicated on Fig. 22.

The contractors were prepared to pump out the caisson and lift it in the hope of securing a more accurate placement, but Colonel Monsarrat, who was present during these operations, was of the opinion that the error was not of serious consequence and that the difficult conditions of handling were such that improvement could not be guaranteed even if attempted. He, therefore, accepted the first placement as being within the margin of play allowed for. The caisson moved somewhat more during sinking, and this subsequent movement increased the deviation from exact placement, so that finally the situation at elevation 65.5 was that shown as final on Fig. 22. For purposes of calculation this situation was also assumed to obtain at elevation 6, the assumption being more or less justified by

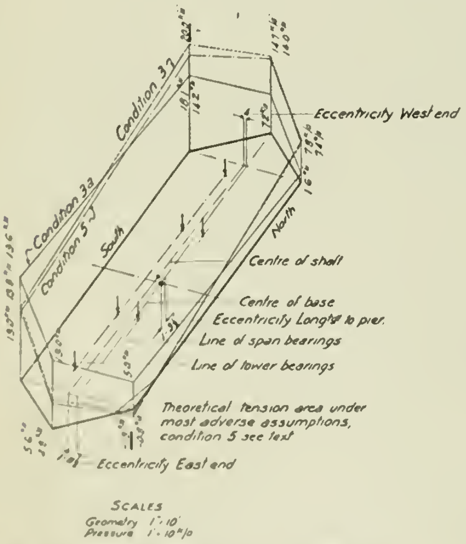


Fig. 13—Pier 2B Governing Pressures as Sunk assuming Buoyancy.

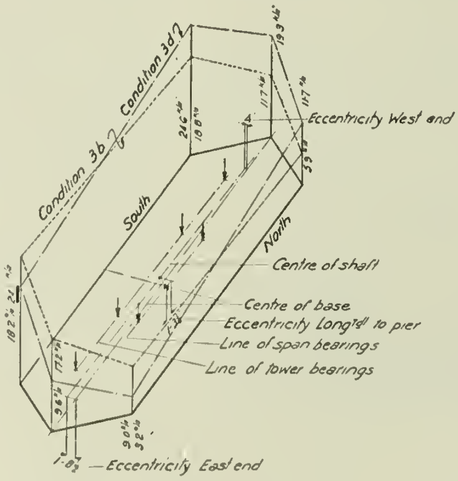


Fig. 14—Pier 2B Governing Pressures as Sunk but without Buoyancy.

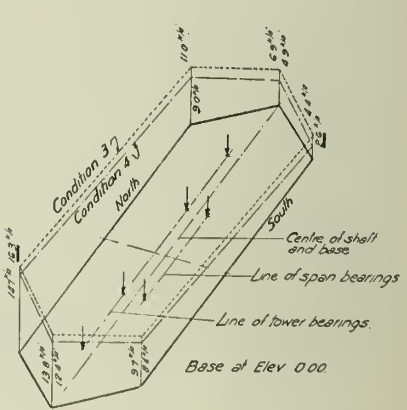


Fig. 15—Pier 1B Governing Pressures.

the continuous care given during excavation to keeping the caisson plumb.

The photographs, Fig. 23, were taken on October 12th, during the towing operations.

During the early part of October the pneumatic plant with its motors, air compressors, hospital lock, change houses, etc., had been installed at the south end of the bridge, on the shore alongside and under the timber trestle, and piping laid along the bascule span ready to connect up to the locks and the working chamber. The locks were assembled on shore and then fitted in place on the caisson about October 17th and on the 19th the men were entered into the chamber with air pressures up to about 33 pounds per square inch. Two Sullivan angle compound, electrically-driven compressors furnished the air, one single-stage producing 1,565 cubic feet at low pressure for the men, the other 2-stage producing 750 cubic feet per minute at high pressures for tools. Three portable Ingersoll-Rand gas-driven compressors, having a total rated capacity of 860 cubic feet per minute, were provided as a standby for emergency use.

The west end was excavated first, after the fitting of all conveniences and devices to the caisson and the preliminary cleaning had been carried out, and the cutting edge was taken down to elevation 14 before rock was available at the north east corner to support the caisson for its entire periphery. Some attempts were made to "throw" the caisson back toward the true position but without avail, and concreting by tremie in the interior pockets was carried out vigorously from the time when the cutting edge was finally completely landed on rock. The rock was not of uniform character, some of it being a greyish green sandstone and some a type of limestone shale or indurated clay. This latter was soft enough on exposure to the atmosphere to be cut with a knife and was not felt to be sufficiently solid for bearing purposes. Even the sandstone seemed to be only in process of formation, particularly in parts. It was not at all difficult to break up and seemed to occur in layers or lenses. At the south west corner the first rock encountered was harder than the average but at the north east corner the soft shaley material was met and this only

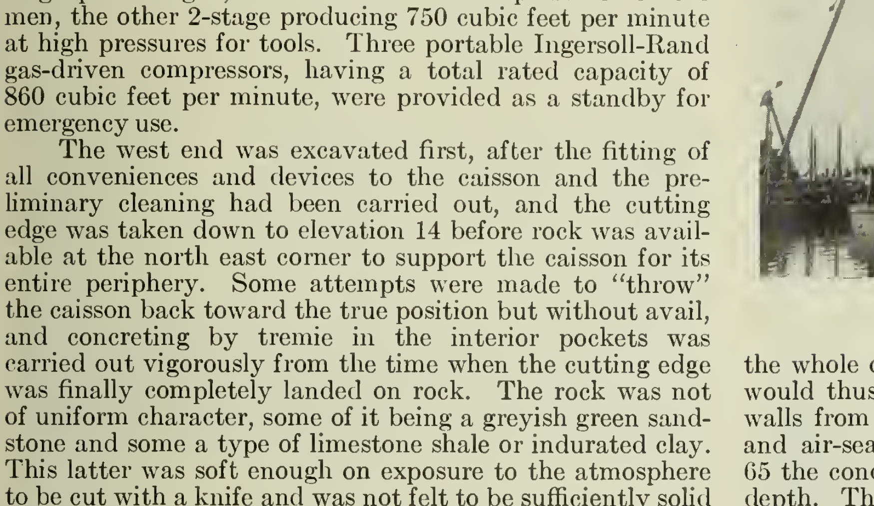


**Fig. 16—Pneumatic Caisson for Pier 2B.**

became distinctly harder after considerable excavation. At the expected final elevation (elevation + 8) the rock at the west end was again hard and was much more closely grained but at the east end was far from uniform and still of a shaley nature. The cutting edge was, therefore, sunk to about elevation 6, when the rock under the east nose became harder and better. At this point all rock seemed to be sound and solid and there was no indication that greater uniformity could be found at lower elevations, so that this condition was accepted and the cutting edge founded at elevation about 5.6 referred to in the figures as elevation 6.0. Instructions were given on November 28th to concrete the working chamber, and this was completed the next day. Grouting followed, after which the air equipment was dismantled, and the concrete in pockets carried up to elevation approximately 51.3. It had originally been expected to pump out at this stage completely and pour all the remaining concrete entirely in the dry. Had this been possible

**Fig. 17—Mixer Scow.**

the whole of the concrete surface exposed to the sea water would thus have been poured in the dry. As it was, the walls from elevation 20 to elevation 53 were actually dry and air-seasoned but between elevation 53 and elevation 65 the concrete was poured into still water of a few inches depth. The mix was, therefore, temporarily enriched to the 8 sacks per yard specified for concrete in or under water and was gradually reduced to the regular dry mix requirement of 5.6 sacks to the yard as the top of the caisson, elevation 65.5, was reached. A continuous pour of 540 yards brought the base to this level on December 14th.

A point of interest which arose during the final sinking operations was the need of kentledge. This need arose from the extra buoyancy which occurred, due both to sinking two feet deeper, and to extra high tides reaching as high as elevation 100. The caisson was weighted down with heavy metal rings and was also strutted from the bascule span, which was itself loaded.

The ready-mix concrete used for filling the pockets and completing the base of pier 2B was delivered by Diethers Limited from the yards of Champion and White, on Main street, about four miles away from the site. A fleet of ten trucks, of the revolving drum type, each of 3 yards capacity, operated at the rate of 15 trucks per hour during the day. The 540-yard batch began to be poured at 1.40 p.m. on the 13th and was finished at 4.10 a.m. on the 14th, elapsed time being about fourteen and a half hours, making an average of 32½ yards per hour. Naturally the rate of supply slackened at times, particularly around 5 to 6 p.m., but later reached 50 yards per hour during the night when the roads were all clear and the round trip of a truck could be speeded up from the normal forty minutes occupied during day-time hours.

The upper shaft of the pier was then carefully laid out for the setting of forms so that on the 18th a pour of concrete to elevation 82 was made followed on the 22nd by one to elevation 90 and on the 23rd by one to elevation 99. The

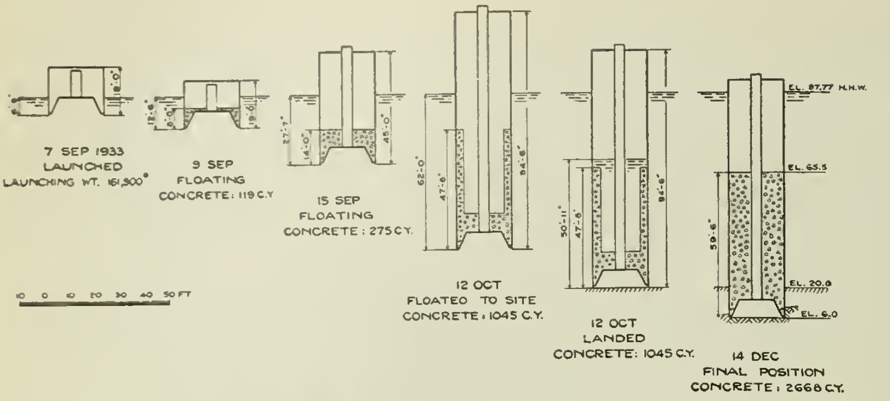


Fig. 18—Pier 2B—Floating and Sinking Diagrams.

creek. In grading these aggregates the same procedure was followed as for pier 2B. In the case of materials from Seymour creek only screened aggregates were permitted, because the plant was equipped with a disc crusher, which produced a very large proportion of flats.

The inspection of the materials and the design of the mix were carried out for the engineers by Macdonald and Macdonald, inspection engineers of Vancouver, B.C., these inspectors being under the control of the resident engineer on the work. A typical design sheet for dry concrete gives the following information:—

heavy anchor bolts, 3½ inches diameter, 15 feet and 15 feet 6 inches long, and about 12 feet 6 inches in the pier, belonging to the superimposed tower bases, were finally set on December 28th and the concreting completed to elevation 118 on the 30th, this being exactly the schedule requirement. Dressing the seats for these tower bases began early in the new year when the concrete had had the


Fig. 19—Cutting Edge of Caisson for Pier 2B.

opportunity to set, and on January 15th the superstructure contractors set the base slabs in place.

The total net yardage of concrete placed in the pier was 4,039 to make which 25,536 sacks of cement were used. The specification called for a strength-designed concrete exhibiting a minimum of 2,500 pounds per square inch after twenty-eight days, with a further provision, as already stated, that concrete poured into sea-water or under sea-water in the pockets should contain eight sacks per yard.

The sand and gravel used in the construction of both caissons and for the shaft and base of pier 2B were brought by scow from a pit on the Fraser river. After screening, the various sizes were recombined to give aggregates conforming to the requirements of the specifications. Oversizes were crushed and used in the coarse aggregate.

For the shaft and base of pier 1B, aggregates were brought to the mixing plant by truck from nearby pits. About half of the aggregates came from a dry pit and half from the bed of Seymour

Material from Diether's Maryhill Pit, Sampled as Loaded on Scow

| *Coarse Aggregate* | Per cent retained | | Total per cent coarser than given sieve |
|---|---|---|---|
| Remaining on 1½-inch sieve | 43.00 per cent | | 43.00 per cent |
| Remaining on ¾-inch sieve | 39.50 per cent | | 82.50 per cent |
| Remaining on ⅜-inch sieve | 13.70 per cent | | 96.20 per cent |
| Remaining on No. 4 sieve | 3.00 per cent | plus 5 | 99.20 per cent |
| Passing the No. 4 sieve | .80 per cent | sieves | 500.00 per cent |
| Fineness modulus 8.2 | 100.00 per cent | | 820.90 per cent |
| *Fine Aggregate* | | | |
| Remaining on No. 4 sieve | 00.00 per cent | | 00.00 per cent |
| Remaining on No. 8 sieve | 11.00 per cent | | 11.00 per cent |
| Remaining on No. 16 sieve | 14.70 per cent | | 25.70 per cent |
| Remaining on No. 30 sieve | 25.40 per cent | | 51.10 per cent |
| Remaining on No. 50 sieve | 37.00 per cent | | 88.10 per cent |
| Remaining on No. 100 sieve | 10.00 per cent | | 98.10 per cent |
| Passing the No. 100 sieve | 1.90 per cent | | .... |
| Fineness modulus 2.7 | 100.00 per cent | | 274.00 per cent |

Moisture in sand... 4.8 per cent    Bulking in gravel... 7.0 per cent
Bulking in sand.... 27.0 per cent    Loss by decantation. 0.7 per cent
Organic test....... O.K.

*Designed mix for 2,500 pounds concrete, 5-inch slump*

Curve "A," "Design and Control," allows 5.3 volumes dry rodded mixed aggregate per sack of cement.

$$\frac{5.3 \text{ volumes}}{.85 \text{ shrinkage factor}} = 6.1 \text{ volumes separated aggregates.}$$

Proportioning for grading factor of 5.7:—44 per cent sand, 56 per cent gravel.

$6.1 \times 44$ per cent $= 2.6$ } Nominal mix: 1-2.6-3.4
$6.1 \times 56$ per cent $= 3.4$ }

Allowance for bulking in gravel:
$3.4 \times 1.07 = 3.6$    Field mix: 1-2.6-3.6

and the resulting strength tests showed 1,608 at seven days and 2,830 at twenty-eight days. The general run of tests

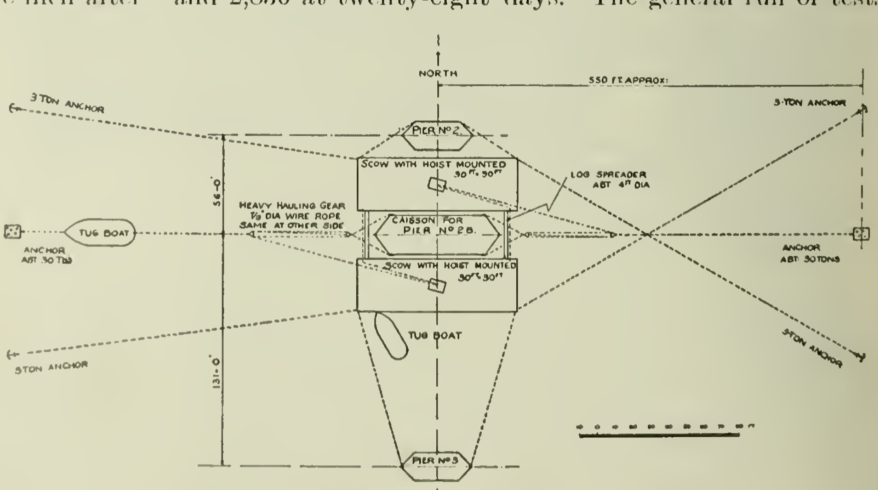


Fig. 20—Pier 2B—Anchoring System for Caisson.

of the eight-sack concrete poured under water showed from 3,350 to 3,500 pounds per square inch at twenty-eight days, the specimens in each case being actually taken from below water level as poured.

The programme for the construction of pier 1B was so laid out that the work would follow at a convenient interval behind that of 2B for all the stages where the same personnel and equipment could be used for both. The steel cutting edge was also built by the Western Bridge Company as subcontractors, was received on the building ways of the Pacific Salvage Company on September 12th, and timbering was commenced at once. Figure 24 shows the steel assembly being landed from scows on which it had been towed from False creek to North Vancouver and Fig. 25 is made to illustrate the construction of this cutting edge. The differences between it and that for pier 2B will be apparent. In addition to the slightly larger overall dimensions, caisson 1B has three cross-walls for the support of

Fig. 21—Placing 30-ton Anchor for 2B, October 11th, 1933.

which steel cutting edges are also provided. These are about 2 feet 6 inches higher than the circumferential edge. The latter consists of a 10-inch at 20-pound channel section backed downwards, acting as the main bearing member, but the cross-walls are provided with bent nose plates designed to be filled with reinforced concrete. Being an open-dredging caisson there is no ceiling as in the case of the pneumatic caisson, but the skin plate on all the cutting edges is of $\frac{1}{4}$-inch thickness stiffened by welded channel sections. The vertical outside sheathing plate is $\frac{3}{8}$ths thick and extends 32 inches upwards from the cutting edge to which it is connected by countersunk stitch rivets and a $\frac{3}{8}$ths continuous weld.

Above the steel frame the caisson is of timber construction, as illustrated in the figure, covered outside the wales with vertical T and G sheathing dressed to $2\frac{3}{4}$ inches. The circumferential concrete walls are 40 inches in thickness and the cross-walls are 48 inches. All these walls were poured in stages after launching, and the timber strutting, except that which was actually bedded in the walls, was all designed to be removable and to leave four large dredging-wells. Above elevation 60 the design included timber struts directly above the concrete cross-walls and a closely spaced system of timber wales above and replacing the side walls. The resulting four dredging-wells were open-sheeted with vertical planking 3-inch by 8-inch at 16-inch centres, so that the essential members of the framework would be protected against damage from buckets during excavation. All timber above elevation 65.5 was subsequently removed; the interior struts during the building of the shaft, and the exterior walls after completion.

To permit the caisson to float after launching, a false or temporary floor of timber was constructed before launching just above the cutting edge. Dynamite charges were placed by divers in holes prepared to receive them.

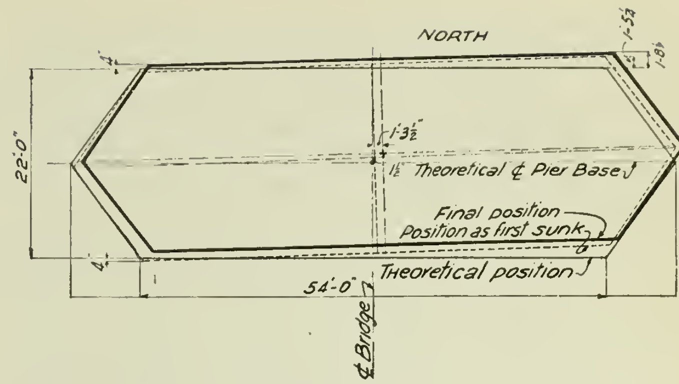


Fig. 22—Pier 2B—Plan showing Deviation from Theoretical Position.

When the caisson had been centred on its final site and sunk by water ballast, the floor was blown out and the flotation destroyed. Figure 26, taken from the contractor's drawing No. 18, shows a few of the stages of construction between launching and sinking. The caisson was launched at 4 p.m. on September 29th when the timbering had been completed up to 20 feet above the cutting edge. During the operation of launching, the caisson skewed slightly (Fig. 27) and one corner overhung the skidways. A floating crane pulled the caisson down into the water but some warp was left in the framework as a result of this experience. The caisson was, therefore, put into dry-dock the next day and overhauled. The caulking of the sides was found to have held up very well, but that around the false bottom had loosened when the corner of the caisson skewed on the ways, and had to be tightened. On refloating on October 2nd no evidence of damage remained and the warp had seemingly disappeared. On October 5th, when the

Fig. 23—Caisson 2B—October 12th, 1933. Taken from Roadway.

Fig. 24—Steel Assembly being Landed from Scows.

timbering had been carried up 32 feet above the cutting edge, the latter was filled with concrete to a height of 15 feet after which the caisson drew 19 feet 6 inches of water. From this point on a regular succession of building up, sheeting, forming, placing reinforcing, and concreting was pursued until the timber framing had reached a point 89 feet above the cutting edge, and the concrete in the walls had been poured up to a height of 52 feet 8 inches.

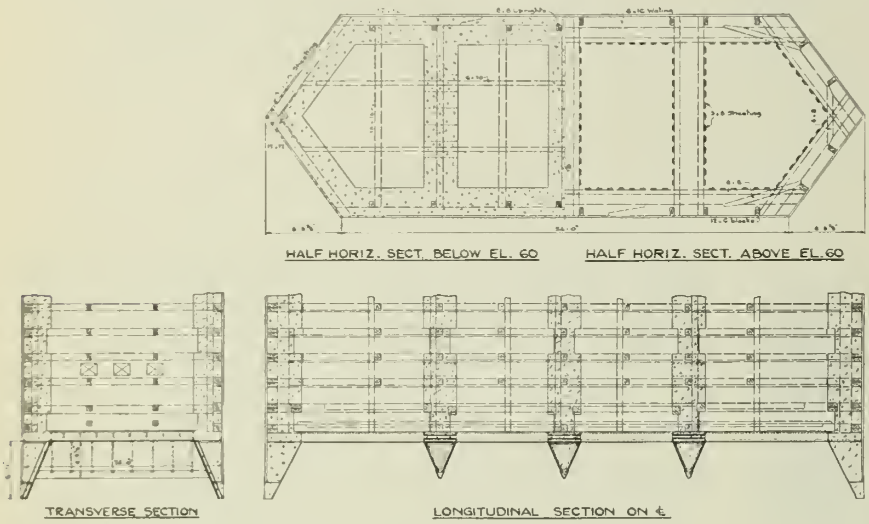


Fig. 25—Open Caisson for Pier 1B.

Preparations were then made for floating the caisson up the inlet and setting it in its proper place. The anchorage system used for mooring scows alongside the caisson of pier 2B was lifted and transferred to the site of 1B where it was finally reassembled as shown on Fig. 31. The bottom was levelled off, at about elevation 24, by a clamshell excavator, the caisson was pumped out and cleaned, and on November 9th, when tide and weather conditions were favourable, the vessel was towed into position, filled with water by opening the valves provided and thus sunk. It reached its place at 11.40 a.m., just previous to high tide and grounded as the tide fell, hitting bottom just before 2 p.m. at about half tide.

The concreting plant used for pouring pier 1B consisted of a one cubic yard Ransom mixer equipped with a scale for weighing the cement and aggregates. The stone and sand bins were erected above the floor of the roadway. The mixer itself was carried on a platform suspended under the railroad track, immediately adjacent to and north of pier 1, and discharged into a hopper from which the concrete was transported to the pier by means of a belt conveyor. A stiff-leg derrick with a long guyed wooden boom was also set up on pier 1 to aid the floating derricks in moving the caisson and also to handle the excavating buckets. On Fig. 31, already referred to, it will be noticed that for this pier the scows were respectively east and west, or ahead and astern, of the caisson instead of alongside, the floating derricks being brought up to the south while the fixed derrick above described operated from the north.

Concreting was resumed on November 14th, the circumferential and cross-walls being poured up to 60 feet above the cutting edge on this day. The extra weight seemed to be sufficient to disturb the foundation material to some extent and initiate scour on the south side. The caisson began to settle unevenly and scow loads of rock being excavated from pier 2B were immediately dumped along the south edge in order to arrest this tendency. This was recognized as a temporary provision only and proved quite inadequate in itself, but was immediately followed by the depositing of heavy quarry riprap along the short side of the caisson between the south east shoulder and the east nose. Simultaneously, jetting along the northern edge was arranged for in order to permit the sinking of this edge if the south side continued to settle from natural causes. Considerable movement and tilting actually took place about this time, the difference in elevation on the top wale, which was 89 feet above the cutting edge, becoming as much as 4 feet 2 inches. The caisson originally grounded with its cutting edge at elevation 23.3 on the average and fairly level, but on November 16th the south east corner was down to 18.3 feet while the north west corner was at about 22.5 feet. The current and tide conditions were quite unfavourable on the evening of this day so that the caisson was attached by cable to pier 0. The photograph Fig. 29 was taken on November 17th and indicates the condition of affairs substantially as it is described, which was practically the worst situation encountered. On the 18th the continuous placing of heavy riprap began to have the desired effect. Some of the water ballast was pumped out and the caisson gradually righted itself. A check for position indicated that the translational and rotational movements had been rather too much to leave uncorrected, so that on the 20th, at 4 p.m., the caisson was dewatered and refloated. No difficulty whatever was experienced in this operation or in handling it and resinking it; so that finally it was successfully located with a degree of accuracy which was definitely satisfactory.

Riprap continued to be supplied in large sizes and ample quantities. Two panels of the railway floor steel of the old 300-foot span were found to be available and these were dropped to the bottom south east of the south east shoulder and acted as grids holding the granite riprap in

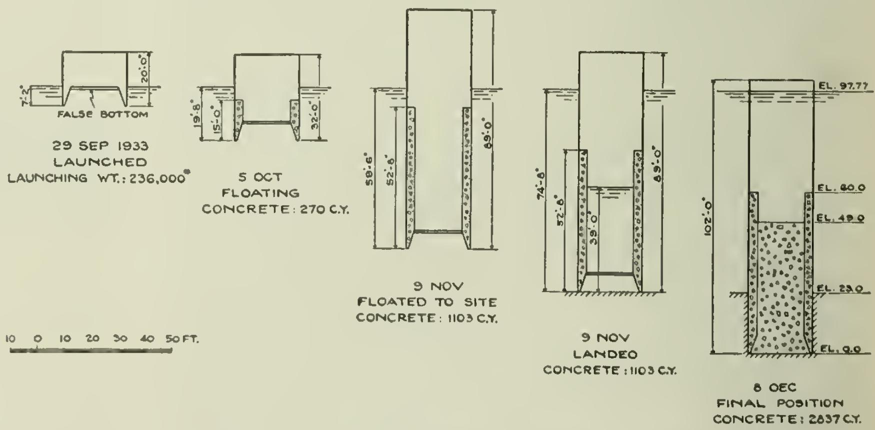


Fig. 26—Pier 1B—Floating and Sinking Diagrams.

place and helping to reduce the scour to negligible proportions.

On November 23rd the caisson was completely filled with water and the temporary timber floor was shot out, pocket by pocket. After the material floated up by this process had been cleared away, dredging in the wells was undertaken. Both the derrick on pier 1 and one of the floating derricks were used for this purpose and the work was continued all night. By 7 p.m. the next day the cutting edge was very nearly level at an average elevation of 13.72 and excavation work was delayed at this point while the remaining 13-foot strake of caisson wall was added. Every opportunity offered by slack tides was taken to increase the riprap toward the south-west, south, south-east, and east borders of the caisson where the divers reported that the scour had been most apparent. The material excavated from caisson 1B was very constant in character and a scow-load of it is photographed in Fig. 28 where the presence of an ordinary envelope 7½ inches by 4 inches will assist in estimating the size. This gravel was quite clean and of mixed grades up to 6 inches or 8 inches diameter and was judged to form excellent bearing material at the specified depths. A 2-yard clamshell bucket and a one-yard orange peel grab were used by the contractors for the excavation and were very effective in lowering the caisson. On November 30th the cutting edge was down to elevation 1.0 and the interior portions were below the final specified elevation of 0. Operations were, therefore, stopped so that any natural settlement might take place during the night. Very little actually occurred so that two small dynamite charges were inserted, one toward each nose, to gently jar the caisson down to a final position where stability could be assumed. Elevations taken on December 2nd showed the cutting edge to have come to rest on a very even and level periphery, on an average elevation of −0.36. Riprap was still being placed at all slack tides and ultimately some 3,800 to 4,000 tons were used at this pier, very closely in accord with the original intentions and estimates, this quantity being placed as carefully as possible following check soundings which were made every few days as the slack tides permitted. Simultaneously, scow loads of granite riprap were also dumped around the upstream end of pier 2B to fulfil the requirements of the specifications, until the south side and the east end were satisfactorily protected. In view of the prospective demolition of old pier 2, the final placing of riprap on the north side of pier 2B was delayed insofar as the debris from demolition would undoubtedly act to a certain extent as protective riprap and surveys would need to be made after the demolition.


**Fig. 27—Caisson 1B stuck on Ways at Launching, at Point of Sliding Off.**

Concreting in the pockets of caisson 1B was commenced during the evening of December 4th.

The mixer discharged onto a belt conveyor which in turn fed the hopper, from which chutes or tubes depended leading to the bellmouth of the 10-inch tremie pipes. The centre pockets, numbers 2 and 3, were first filled by continuous pouring up to elevation 49 by which time large deposits of laitance had gathered in the bottom of the two end pockets, 1 and 4. This laitance was quite soft and could be readily removed by suction pumps guided by divers. Great care was demanded in completely evacuating this laitance and when pocket 4 at the east end had also been concreted to elevation 49, pouring had to cease while pocket 1 at the west end was thoroughly cleared. On December 8th this last pocket was then filled to the same elevation and all concrete was given several days to set. An additional 6 feet of timber sheeting was added to the top of the caisson to prevent waves from breaking over, and pumping out was then attempted on the 14th. It was soon noticed that the pumps could not unwater the caisson and an exhaustive examination failed to disclose any major defect to which this fact could be attributed. Extra pumps were added and canvas was placed outside the sheeting. Divers who had been sent inside to examine the caulking in the seams began to locate numerous small leaks as soon as any headway was made with the dewatering process, and it now became apparent that the straining of the caisson walls during the periods of uneven settlement was responsible for this temporary trouble. On December 19th, by dint of much effort, the water was successfully lowered to elevation 60. The side walls were thus revealed and further pumping bared the top of the concrete in the pockets. Again laitance had to be dealt with and considerable quantities were loosened and cleaned off until the concrete surfaces were acceptable for further pouring. Leaks were caulked, pumping being maintained, and on the 23rd all the pockets were filled to elevation 58.5 with dry concrete. The weather had meantime become somewhat wintry and heat was applied to the mixing water for the succeeding lift of 293 yards which finished the base of the pier at elevation 65.5.

**Fig. 28—Gravel from Bottom of Open Caisson 1B. White Patch is envelope about 4 by 7½ inches. November 30th, 1933.**

**Fig. 29—Caisson 1B from northwest, November 17th, 1933.**

The shaft above this level was merely a repetition of that for pier 2B and needs no further comment beyond noting the need of altering the chuting system as the height of the shaft grew. The coping was reached on January

11th, the daily reports showing that the outside temperature at this time was approximately 43 degrees. The total net yardage in this pier was 4,804 cubic yards to the making of which 30,959 sacks of cement contributed.

Dismantling of plant on caisson walls followed during the middle of the month and upon the concrete becoming sufficiently well set the bearing areas were dressed to receive the steel bedplates. On both piers the outside surface of the shaft was rubbed and finished with a coat of

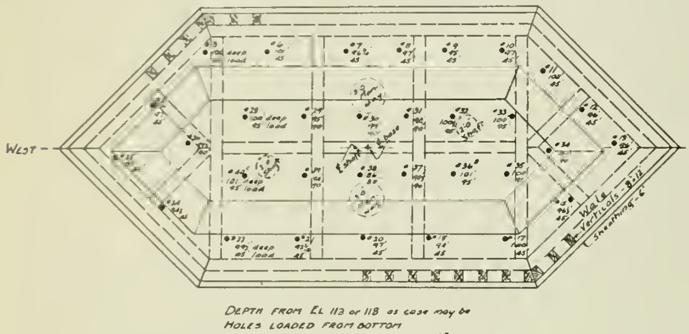


**Fig. 30—Layout of Blasting Holes, Pier 2.**

cement-wash to improve the general appearance, but the submerged portions, particularly between tides, quickly acquired a coating of marine slime to which doubtless molluscs will cling in the near future. Experience with teredo and other local marine life ensures that the exposed untreated timber will be eaten away within a few years. Examination of the existing structural steelwork shows that even on the painted surfaces above the roadway level a type of green moss flourishes comfortably.

The remaining work of the substructure contract was the demolition of the old pier 2. The specification called for this old pier to be taken down to an elevation determined by the riprap requirements. Manifestly, the debris would need to be distributed by drags up- and down-stream so that no obstruction would be caused to the normal flow of water. A tentative line shown on the drawings as the line of riprapping to the north of the new pier served to give the bidders an indication of the amount of demolition involved. The clause inserted into the instructions-to-bidders in this connection reads as follows:—

> "Clause 45: In demolishing the existing pier No. 2, as indicated on the drawings, numerous light shots should be used. No heavy blasting will be permitted, and the greatest care must be exercised to avoid any damage being done to any other parts of the work. The Contractor must submit his proposed method for handling this work, for the approval of the Engineer."

Furthermore, each superstructure bidder was asked to state in his tender:—

> "Clause 4 (a): Whether or not he will require the old pier No. 2 to be retained intact for his use during the work of dismantling the end of the existing bascule span."

All bidders replied negatively to this question, so that the substructure contractors were given full liberty as to where in their programme the demolition should occur. They, very naturally, found the old pier useful during all mooring operations and early decided to leave its destruction until completion of the new piers.

The method adopted for demolition was to drill numerous holes from the top to about elevation 18, the central ones vertically and the side ones slightly inclined so as to approach the surface of the base at the lower levels. It was then intended to charge these holes with dynamite and to detonate the charges according to some preconceived plan. The precise plan was modified from time to time as further opinion was brought to bear on the scheme and ultimately the engineer's approval was asked for an arrangement by which thirty-two holes were to be shot in groups of three at intervals ranging from 0.8 to 2.2 seconds covering a total period of 12.8 seconds. In December, 1933, the idea had been to blow off the north side in layers at intervals wide enough apart to permit examination of the effect of the first blast before shooting the second. By this means it was hoped that the concussive effect transmitted through the water would be directed generally northward and that the standing portion of the old pier would serve to protect the new pier 2B.

Subsequent expert advice to the Foundation Company led them to doubt the efficacy of this method, particularly in respect of the uncertainty as to what might happen to the unshot holes, whether loaded or unloaded, during the shooting of the first layer or series. The revised scheme was, therefore, to shoot in layers to the east but with all holes loaded and wired for delayed firing as above indicated. The presence of steel tie-rods, timber framing, three or four man- and material-shafts, none of which could be very

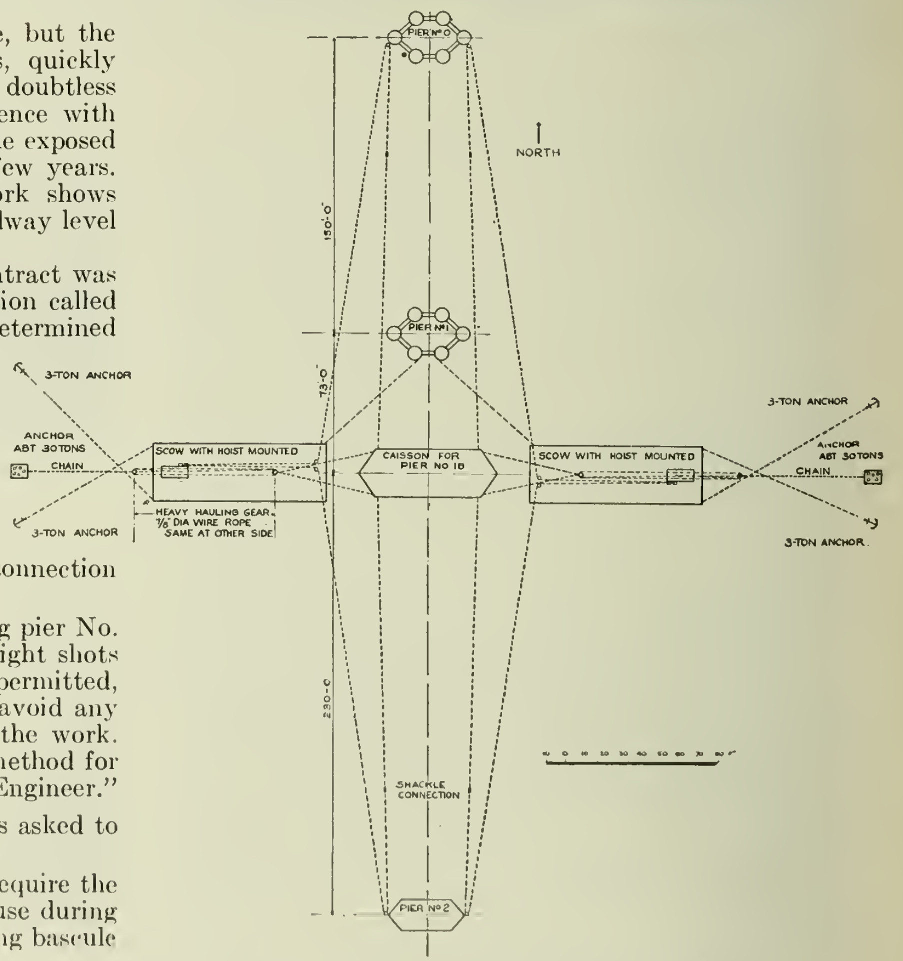


**Fig. 31—Pier 1B—Anchoring System for Caisson.**

definitely located from the incomplete plans available, not only interfered with drilling progress, but raised some doubts as to the degree of break-up and shattering which might finally be achieved. The drill holes, roughly located on Fig. 30, were mostly of 3-inch diameter although five holes, numbers 8, 9, 10, 11, 12, were only of 2-inch diameter. The charges were from 45 feet to 100 feet in depth per hole, were of 2½-inch or 1½-inch diameter, 60 per cent dynamite and, in the case of the outer holes, the 45 feet of charge extended from the bottom up to approximately elevation 65, the joint between base and upper shaft. In all, nearly 5,000 pounds of dynamite was used.

The blast was fired on the night of March 1st but listening witnesses all agree that, instead of 11 distinct shots separated by intervals averaging 1.2 seconds, there were firstly 2 or 3, or possibly 4, such distinct shots, after which came one huge blast wherein all the remaining charges detonated together, which of course was directly contrary to what had been required and planned for.

The pier was well demolished although a considerable amount of dredging and dragging had to be done to satisfactorily spread the debris, and several lengths of old steel manshaft had to be pulled off and taken away.

Unfortunately, the concentrated blast vibrated the neighbouring new pier 2B and caused some spalling at the construction joint at elevation 99, as well as some local distortion in the steelwork immediately connected to the anchor bolts which had been built into the concrete. The two outer panels of the bascule span had been removed sometime previously, by the superstructure contractors, and the remaining portion, partly disconnected, had been tied down by new material to these embedded anchors, as the removal of dead weight had interfered with the condition of balance previously existing between the bascule span and its counterweight. There were probably some 50 or 60 tons of uplift per truss actually being transmitted through the anchorage system to the new pier at the time of the blast, and the initial lateral amplitude of the vibration although immediately dampened by inertia, by stress in the steel span, and by water pressures, was sufficient to bend certain of the steel parts beyond the elastic limit.

A very thorough survey of the pier and the span was initiated on the morning of March 2nd, by the resident engineer and responsible representatives of both the contracting companies. The author, who arrived at the site a few days later, completed this survey and issued all the necessary instructions for repairs, and saw all of these repairs commenced and most of them carried out. The spalled parts were removed and a complete band around the pier at elevation 99 was cut out by air tools so as to bare the temperature steel for 2 feet below and above the construction joint. This band was cut about 6 inches deep at the joint itself and uniformly feathered off up and down. All steel was reinforced by the addition of spliced material thoroughly wrapped with steel wire. Furthermore, a continuous mesh was built up around the whole band behind the steel rods and gun-driven concrete (Gunite) applied under air-pressure. The band was thus refilled and, after completion, was found to ring hard and true under severe inspection. As a further precaution, a number of grout holes were drilled from the top downwards to approximately elevation 93 and, after heavy dowels had been inserted in the circumferential holes, these latter were grouted up and then the interior holes grouted under pressure in order to ensure that no voids had been left in any portion of the joint at elevation 99.

The repairs to the steelwork were promptly and simply carried out under the author's personal supervision, and superstructure erection then proceeded in the normal manner.

Dragging the debris, placing riprap, and the necessary sounding operations continued during favourable tide conditions throughout the month of April, at the end of which month the substructure contract was considered complete.

Incidentally, it might here be noted that the reduction in low-tide waterway, as between the reconstructed bridge and the original bridge, is just under 3,000 square feet or about 7½ per cent.

A twelve-day strike of compressed air workers, during November, almost as soon as they had started work after long periods of unemployment, hindered operations to some extent and aroused some concern for the safety of the caisson. The fair wage schedule drawn up by the Federal Department of Labour had been incorporated into the tender form and subsequently into the contract, but the settlement of the strike, which was accomplished by conferences between the interested parties, the Federal fair-wage officer, and the Provincial Deputy Minister of Labour, resulted in an increase of wages to sandhogs, lock tenders, and allied classes of labour.

For the Foundation Company of Canada, Mr. A. G. Mackay was superintendent in charge of the work at the site, and Mr. J. W. Roland, M.E.I.C., was resident engineer for the author's firm. Acknowledgment is gladly made to the Foundation Company (Mr. R. R. Holland, vice-president) for permission to use some of their sketches, and to the resident-engineer for illustrative progress photographs.

# Main Cables and Suspenders for Suspension Bridges

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**Presented before the Montreal Branch of The Engineering Institute of Canada, April 5th, 1934.**

SUMMARY.—The paper contains useful data, specifications and information based on recent practice as to the physical properties of steel wire for bridges, the various types of main cable and their characteristics, and the results of tests. Particulars regarding suspender ropes and end fastenings for wire ropes are also given.

Steel wire is the strongest material available to the bridge engineer and offers unsurpassed advantages for the main tension members of suspension bridges, the main cables and suspender ropes.

Bridge wire is, preferably, made from acid open hearth steel, as experience has shown that a "pure process product," such as acid steel, is more consistent in quality than a "purified product," like basic open hearth steel.

This wire is a cold-drawn product, in which cold-working greatly increases the elastic limit and tensile strength of the steel, and the only cases where cold-drawn bridge wire has not been used were for the Mount Hope and Ambassador bridges. On these bridges, a heat-treated wire was used, and the high strength was secured, not so much from the wire drawing as from the heat-treatment which formed a continuous process with the cleaning and galvanizing of the wire.

While heat-treated bridge wire was a costly and an unsuccessful experiment, as the cables had to be dismantled, it resulted in further improvements in the standard cold-drawn wire. Since the building of the Brooklyn bridge fifty years ago there has been a steady improvement in the physical properties of steel bridge wire, which is shown in Table I.

Table I
Bridge Wire Strengths

| Bridge | Date Finished | Span Feet | Diameter Wire Inches | Finish | Tensile Properties Breaking (Pounds per square inch) | Yield point (Pounds per square inch) |
|---|---|---|---|---|---|---|
| Brooklyn | 1883 | 1,595 | .187 | galvanized | 160,000 | ....... |
| Williamsburg | 1903 | 1,600 | .192 | bright | 200,000 | ....... |
| Manhattan | 1909 | 1,470 | .195 | galvanized | 212,000 | 134,000 |
| Bear Mountain | 1924 | 1,632 | .195 | galvanized | 218,000 | 149,000 |
| Philadelphia | 1926 | 1,750 | .196 | galvanized | 223,000 | 150,000 |
| Ambassador | 1930 | 1,850 | .195 | galvanized | 225,000 | 170,000 |
| George Washington | 1932 | 3,500 | .196 | galvanized | 234,000 | 184,000 |

In the case of the heat-treated wire, first used on the Ambassador bridge, the yield point was 190,000 pounds per square inch on wire of 225,000 pounds per square inch breaking strength.

On bridges prior to the Brooklyn bridge, the main cable wires were usually .148 inch in diameter and 90,000 pounds per square inch strength. High-strength "patented" steel wire was first introduced to the trade in 1854 by a British wire mill in Birmingham, England.

With the data pertaining to recent developments in bridge wire available, a specification may be compiled as follows:

Specifications for Galvanized Steel Bridge Wire

For the main cables, suspenders and hand ropes, the wire shall be of acid open hearth steel and be cold-drawn.

Physical Properties

| | |
|---|---|
| Tensile strength, pounds per square inch* | 220,000 minimum; 225,000 average |
| Yield point, pounds per square inch* | 165,000 minimum |
| Elongation in 10 inches while under tension | 4 per cent minimum |
| Reduction in area | 30 per cent minimum |
| Modulus of elasticity, pounds per square inch | 27,500,000 minimum |
| Diameter tolerance (on No. 6 wire) | + .003 inch |

*On gross cross-section, including galvanizing.

The yield point is the unit stress that will produce an elongation of 0.75 per cent in 10 inches.

Chemical Properties

| | | |
|---|---|---|
| Carbon | 0.85 maximum | (+10 per cent on check analyses) |
| Manganese | 0.70 maximum | (+10 per cent on check analyses) |
| Phosphor | 0.04 maximum | (+25 per cent on check analyses) |
| Sulphur | 0.04 maximum | (+25 per cent on check analyses) |
| Silicon | 0.30 maximum | (+10 per cent on check analyses) |

The galvanizing bath shall consist of 99.75 per cent pure zinc, containing not more than 0.03 per cent of iron and it shall be applied in the molten state on the wire, so that the wire shall have an average gauge of not more than 0.005 inch larger than the bright wire.

The galvanized wire shall be capable of coiling around a mandrel 1.5 times its own diameter without signs of fracture and shall bend continuously around a 1-inch diameter mandrel, for a No. 6 bridge wire, without developing cracks in the galvanizing that are visible to the naked eye.

All galvanized wire shall be capable of withstanding the Preece test; immersions in a standard solution of copper sulphate, without showing a bright metallic copper deposit on the samples, to the following requirements:—

Wires .064 to .079 inches diameter —3 one-minute immersions.
Wires .080 to .092 inches diameter —3 one-minute and 1 one-half-minute immersions.
Wires .093 inches diameter and larger—4 one-minute immersions.

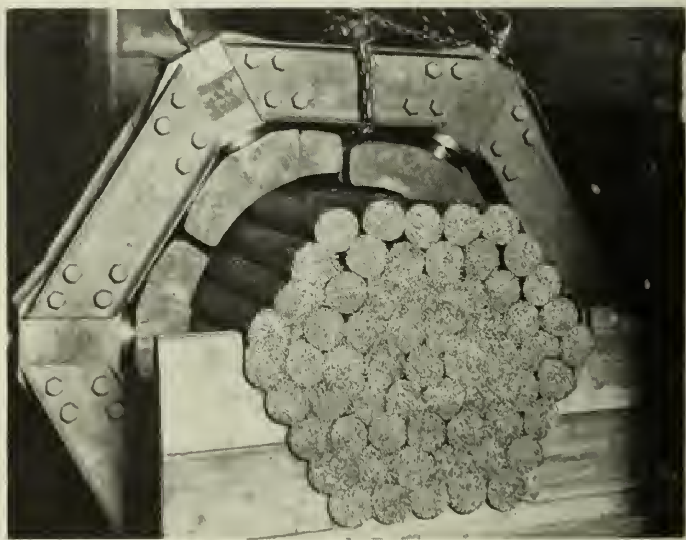


**Fig. 1 Type (a) Main Cable as Initially Fabricated—Philadelphia Bridge.**

## MAIN CABLES

Main cables of suspension bridges are of four types in their structural details and methods of fabrication, and these may be arbitrarily classified as:—

(*a*) Cables of parallel wires, spun in the air.
(*b*) Cables of parallel wires, laid up on the ground at the bridge site.
(*c*) Cables of a multiple of rope strands, as fabricated in the shop and laid parallel in the cable.
(*d*) Cables of one or a multiple of wire ropes, as fabricated in the shop and laid parallel in the cable.

Too many factors are involved to give any definite rules regarding the range of application of these types of main cables, but considering the recent trend in cable design, the following are given, again arbitrarily:—

Type (*a*) main cables for heavy and long span bridges, 1,400 feet and longer.

Type (*c*) main cables on moderate and heavy bridges of spans 300 to 1,500 feet.

Type (*d*) main cables on light and moderately heavy bridges of spans up to 500 feet long.

Type (*b*) main cables were used extensively by the early French and American bridge builders and recently on three bridges: the 700- and 689-foot span bridges over the Ohio river at Portsmouth and Steubenville, Ohio, respectively and the 802-foot span bridge over the Gila river at Dome, Arizona; all built in 1927 and 1928. It is doubtful if this type of main cable will be used again, as the type (*c*) main cables offer many advantages.

Type (*a*) main cables have been used on spans shorter than 1,400 feet but there is a limit, as was found on the 705-foot span Kingston, N.Y., bridge, built in 1922. This span was too short to attain the desired uniformity in tension in the No. 6 bridge wire used, although a smaller diameter wire would have eliminated this trouble.

### Main Cables—Type (*a*)

The No. 6 bridge wire is generally utilized for type (*a*) main cables and is the largest size used to date; however, wires of other diameters may be used and their properties are noted in Table II.

Table II

Properties of Galvanized Steel Bridge Wire

| Size No. | Diameter of wire-Inches Bright | Galvanized | —Galvanized wires— Area Square inches | Weight per 100 feet pounds | Breaking strength at 225,000 pounds per square inch |
|---|---|---|---|---|---|
| 6 | .192 | .196 | .03017 | 10 | 6,780 |
| 7 | .177 | .180 | .02545 | 8.5 | 5,730 |
| 8 | .162 | .165 | .02138 | 7.2 | 4,810 |
| 9 | .148 | .151 | .01791 | 6.0 | 4,030 |

Modulus of elasticity—28,000,000 to 29,500,000 pounds per square inch. For the main cable itself, the modulus may be taken as 27,500,000 pounds per square inch.

Type (*a*) main cables are usually considered as 100 per cent efficient; in the main span, equal tensions in the wires are undoubtedly attained but at the anchorages, the placing of the wire around the 20-inch strand shoe involves the human element and equal wire tensions are problematical.

Tests have been reported* of parallel wire strands which were laid up as carefully as possible, with either sockets or the wires laid around 20-inch strand shoes, at the ends and these are noted in Table III.

Table III

Tests of Parallel Wire Strands

| Wires Diameter Inches | Number | End fittings | Length feet | Aggregate Strength Pounds | Actual Strength Pounds | Efficiency Per cent |
|---|---|---|---|---|---|---|
| .194 | 306 | strand shoes | 28 | 1,974,206 | 1,880,000 | 95.2 |
| | | | | 2,002,688 | 1,883,000 | 94 |
| .197 | 37 | sockets | .. | 242,470 | 234,300 | 96 6 |
| .192 | 80 | sockets | 5 | 484,000 | 460,000 | 95 |
| | | | | 487,780 | 464,000 | 95.1 |

The modulus of elasticity of the 306 wire strands was 27,400,000 pounds per square inch.

As initially made the main cables are hexagonal, they are then compacted into a cylindrical shape, except over the saddles. The diameter $D$ of the finished cylindrical cable, in terms of $\delta$, the diameter of the individual wires, and $n$, the number of wires, is given quite accurately by equation (1) as

$$D = 1.12\,\delta\,\sqrt{n} \quad \ldots\ldots\ldots\ldots\ldots\ldots(1)$$

The largest cables are those of the George Washington bridge; each of the four cables is 35⅞ inches in diameter and consists of 61 strands of 434 wires .196 inch in diameter, or a total of 26,474 wires per cable.

The finished cylindrical cables are closely wound, wrapped with an annealed galvanized iron wire of .151 inches diameter, having a strength of approximately 65,000 pounds per square inch though in some cases a .135 inch wrapping wire has been used. This wrapping helps to exclude moisture and holds the mass of wires tightly together, preventing chafing and ensuring united stress action.

Fig. 2—Type (a) Main Cable as Compacted into Cylindrical Shape—Philadelphia Bridge.

The hexagonal shape of a cable as initially fabricated is shown in Fig. 1, this being one of the main cables of the Philadelphia bridge; the 61 strands, each of 306 wires .196 inch in diameter (18,666 wires total) are easily identified. The cable is 35½ inches across the corners.

The same main cable is shown in Fig. 2, after being compacted into the cylindrical shape and before being wound with the .151 inch diameter galvanized iron wrapping wire; the diameter of the cable as shown is 29-15/16 inches.

### Main Cables—Type (*c*)

Main cables of rope strands are not a recent idea, as George Morison proposed† in 1896, in the design of a 3,200-foot span railway suspension bridge over the Hudson river, to use 253-2⅛-inch diameter rope-strands in each of the four main cables. His proposal created considerable discussion at the time and this showed one unfavourable feature. Tests of the rope-strands with sockets on the ends showed some were only 80 per cent efficient. However, the method of fastening the sockets with split and solid wedges was crude and the sockets as attached to-day will develop 91 to 94 per cent of the aggregate strength of the wires, which represents the full efficiency of the rope-strands.

Prestressed rope-strands are not an innovation either, as Morison noted that "by adjusting the rope-strands

* Final Report of the Board of Engineers to the Delaware River Bridge Joint Commission, 1927.

†"Suspension Bridges—A Study," by G. S. Morison, Transactions Am. Soc. Civil Engineers, 1896.

under stress at the factory, it is believed that the length can be so accurately fixed that no further adjustment will be required on the bridge."

An eminent bridge engineer* stated recently that "the rope-strand cable offered an economy in cost and erection time, yielding greater strength with equal rigidity and that the shorter the span, below the equal-cost limit of 1,500 feet, the greater will be the economic advantage of this type of cable"; and their high breaking strength efficiency and high modulus of elasticity substantiate this statement.

One of the earliest, if not the first long span bridge having rope-strand main cables, is the 949-foot span bridge over the St. Maurice river at Grand'Mere, Que. erected in 1929. Since then quite a few highway bridges of this type have been built and these are listed in Table IV.

Table IV

"Rope-Strand" Main Cable Bridges

| Bridge | River | Date | Span Feet | Main Cables Rope-strands Inches |
|---|---|---|---|---|
| Grand'Mere, Que | St. Maurice | 1929 | 949 | 37-1¼ |
| Quequen, Argentine | Rio Grande Quequen | 1929 | 492 | 16-2 19/32 |
| Bucksport, Me | Penobscot | 1932 | 800 | 37-1⅜ |
| Maysville, Ohio | Ohio | 1932 | 1,060 | 6 at 15/16<br>55 at 1 9/16 |
| St. Johns, Ore | Willamette | 1932 | 1,207 | 91-1½ |
| Isle of Orleans, Que | St. Lawrence | * | 1,059 | 37-1⅜ |
| Ozark Mountains, Mo | Ozark Lake | 1933 | 225 | 4-1¼ |
| San Rafael (Dominican Republic, W.I.) | Rio Yaque del Norte | 1933 | 450 | 9-1⅜ |

*Under construction—1933-35.

The breaking strength $T$ of a rope-strand in terms of the individual wire strengths $S$ and the angle of lay $\alpha$ of the wires in the strand, is given quite accurately by equation (2).

$$T = \sum_{1}^{n} S \cos^3 \alpha \quad \ldots\ldots (2)$$

The efficiency of the "rope-strand" may be determined from this equation and will vary from 91 to 94 per cent, depending upon the construction and the length of lay of the rope-strand. The construction is fixed largely by the prevailing practice of limiting the outer wire diameters to a No. 6 bridge wire (.196 inch galvanized diameter) and the core wires to .208 inch in diameter.

The various constructions of rope-strands are shown in Fig. 3 and their properties are noted in Table V, the breaking strengths being based upon wire of 225,000 pounds per square inch strength.

Table V

Galvanized Steel Rope-Strands

| Diameter Inches | Construction | Area Square inches | Weight Per 100 feet pounds | Breaking Strengths Tons of 2,000 pounds |
|---|---|---|---|---|
| ¾ | 1×19 | .3330 | 116 | 35 |
| 13/16 | 1×19 | .3889 | 136 | 41 |
| ⅞ | 1×19 | .4540 | 158 | 48 |
| 15/16 | 1×19 | .5190 | 181 | 54 |
| 1 | 1×19 | .5882 | 205 | 62 |
| 1 1/16 | 1×26 | .6776 | 236 | 71 |
| 1⅛ | 1×26 | .7597 | 265 | 80 |
| 1 3/16 | 1×32 | .8635 | 301 | 91 |
| 1¼ | 1×32 | .9581 | 335 | 101 |
| 1 5/16 | 1×37 | 1.0711 | 374 | 113 |
| 1⅜ | 1×37 | 1.1755 | 410 | 121 |
| 1 7/16 | 1×56 | 1.2875 | 450 | 136 |
| 1½ | 1×56 | 1.4019 | 490 | 148 |
| 1 9/16 | 1×51 | 1.4816 | 516 | 155 |
| 1⅝ | 1×51 | 1.5937 | 555 | 166 |
| 1 11/16 | 1×61 | 1.7295 | 603 | 180 |
| 1¾ | 1×61 | 1.8605 | 648 | 191 |
| 1 13/16 | 1×77 | 1.9457 | 680 | 200 |
| 1⅞ | 1×77 | 2.0721 | 725 | 211 |
| 1 15/16 | 1×85 | 2.2169 | 775 | 229 |
| 2 | 1×85 | 2.3612 | 827 | 244 |
| 2⅛ | 1×91 | 2.7136 | 962 | 281 |
| 2 [illegible] | 1×109 | 2.9771 | 1,018 | 305 |
| 2 [illegible] | 1×116 | 3.3116 | 1,167 | 340 |
| 2½ | 1×127 | 3.7712 | 1,325 | 385 |

*D. B. Steinman in Engineering News-Record of March 17, 1932, page 387

Yield point load at 70 per cent of breaking strengths.

Modulus of elasticity up to 50 per cent of breaking strengths as a minimum, may be taken as:

1⅝ inch diameter and smaller ........ 24,000,000 pounds per square inch
1-11/16 inch to 2⅛ inches diameter .. 23,000,000 pounds per square inch
2¼ inches to 2½ inches diameter .... 21,000,000 pounds per square inch

Brazing or welding of the outer wires of rope-strands should not be allowed; this, however, does not apply to the inner wires.

Both right and left lay rope-strands are used in the same main cable in adjacent layers as shown in Fig. 4; as strands in adjacent layers, when of opposite lay, afford a better bearing surface and when the rope-strand stretches under stress, it rotates or untwists and the right and left lay strands neutralize this rolling effect in the cable.

Prestressing to 50 per cent of the breaking strength eliminates the constructional stretch and increases the elastic modulus. The strands are then measured to length under a tension equal to the calculated average dead-load stress and at the same time the saddle, centre of span, and cable-band points are marked on the strands from the calculated values. In addition the strands are marked with a continuous longitudinal stripe, so that any untwisting, which will increase the length, may be controlled in subsequent handling at the bridge site; this latter is an important consideration.

Variations in measured lengths can be kept within the limits of ± ½ inch per 1,000 feet of length. For the 2,722-foot length strands for the St. Johns, Oregon, bridge, the variation in measured lengths was ± 1 inch.

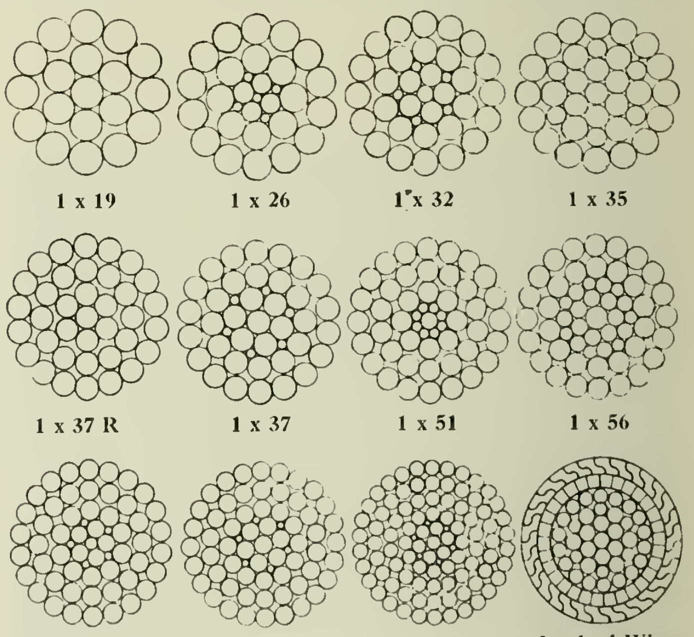



Fig. 3—Main Cable Rope-Strands.

Data covering rope-strands of various bridges are given in Table VI.

Table VI

Rope-Strands of Various Bridges

| Bridge | Strands Diameter Inches | Strands Type | Area Square inches | Breaking Strength Tons | Modulus of Elasticity Pounds per square inch |
|---|---|---|---|---|---|
| Grand'Mere | 1¼ | 1×35 | .9558 | 99.5 | 25,000,000 |
| Bucksport | 1⅜ | 1×37 | 1.1361 | 108 | 26,600,000 |
| St. Johns | 1½ | 1×51 | 1.3492 | 150 | 25,000,000 |
| Maysville | 1 9/16 | 1×59 | 1.4702 | 167 | 24,700,000 |

Rope-strand main cables are hexagonal in shape and wood and aluminum fillers have been used to make the finished cables cylindrical in shape, after which the cable is wrapped with a .151 inch galvanized annealed iron wire. The wrapping of the finished cylindrical cable is shown in Fig. 5. On the Maysville bridge the six-corner rope-strands were made smaller in diameter, which made the cable more cylindrical in shape, and effected a saving in the weight of the fillers.

With a more careful planning of the main cable cross-section the fillers could be eliminated entirely, or if wrapped in its hexagonal shape, the cable would hardly be objection-

**Fig. 4—Right and Left Lay Rope Strands in Adjacent Layers—Maysville Bridge.**

able æsthetically and certainly a cable so wrapped would be as effective and more economical. The main cables of the Cologne-Mulheim bridge over the Rhine river in Germany were left hexagonal in shape and were not wrapped.

Tightly grouped rope-strand main cables are not a requisite, as main cables with the rope-strands arranged in tiers, with an open space between each rope-strand, have been utilized for some time past by the continental European bridge engineers.

In some respects this open grouping of the rope-strands has merit, in that each rope-strand is susceptible to inspection and maintenance; the heavy compression of strand on strand over the tower saddles is eliminated; the cable-band design is simplified and the bridge, with the seemingly heavier main cables, is aesthetically improved. One of the main cables of the Ozark Mountain bridge as noted in Table IV, is shown in Fig. 6.

Continental European engineers favour the locked wire strand (see Fig. 3), not galvanized and claim the following advantages: (1) compactness, (2) smooth outer surface and (3) sealing against moisture by the locked outer wires; (1) and (2) are admissible and desirable; (3) is questionable, as it is extremely doubtful if the locked wires fit so snugly that moisture is excluded.

Furthermore, locked wire strands are objectionable in that (*a*) the interior bright wires cannot be examined for their condition regarding corrosion; (*b*) the "strength/weight" factor is approximately 20 per cent higher than that of the rope-strands and (*c*) the modulus values are somewhat lower.

The data in Table VII on a few sizes of locked wire strands may be of interest for comparison with the rope-strands:—

Table VII

Locked Wire Strands—Not Galvanized

| | | | | | | |
|---|---|---|---|---|---|---|
| Diameter—Inches..... | ¾ | 1 | 1¼ | 1½ | 1¾ | 2 |
| Area, square inches.... | .3710 | .6711 | 1.0141 | 1.4386 | 1.9031 | 2.5498 |
| Wgt. per 100 feet lbs.. | 133 | 239 | 373 | 558 | 750 | 967 |
| Strength—tons........ | 33 | 60 | 93 | 136 | 182 | 240 |

Modulus of elasticity 20,000,000 to 23,000,000 pounds per square inch.

The two main cables of the Cologne-Mulheim highway suspension bridge of 1,033.45-foot main span, each consisted of 37 locked wire strands, not galvanized, 3.15 inches in diameter, and each of these strands possessed the following physical properties:

Metallic area..........6.595 square inches
Breaking strength......652.5 tons
Weight per linear foot..24.66 pounds
Unit wire strengths.....192,000 to 213,500 pounds per square inch
Modulus of elasticity...22,800,000 pounds per square inch of strands prestressed to 265 tons for two hours' duration.

Main Cables—Type (*d*)

Wire ropes for main cables are not as economical in price or strength as rope-strands but offer an advantage in ease of handling and less likelihood of being damaged by the erectors.

These ropes are made up with 6 strands covering either a strand centre or an independent wire rope centre; the former is preferable as the rope is more compact and results in a higher modulus of elasticity value. The strength of these wire ropes may be calculated from equation (3), the

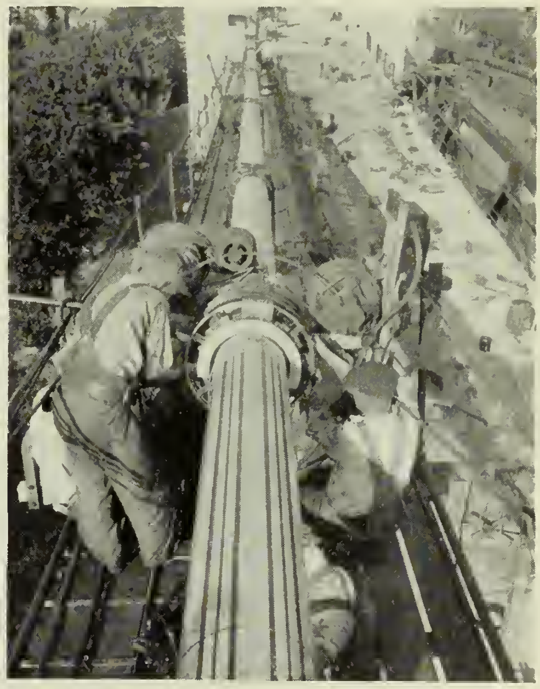


**Fig. 5—Wrapping the Maysville Strand Cable which was made Cylindrical in Shape by the use of Aluminum Fillers.**

first term being for the 6 outer strands and the second term that of the strand centre:

$$T = N \cos \beta \sum_{1}^{n} S \cos^3 \alpha + \kappa \sum_{1}^{n} S \cos^3 \alpha \quad \ldots\ldots\ldots (3)$$

in which,

$N$ = number of outer strands in rope.
$S$ = strength of the individual wires.
$\kappa$ = construction factor, having a value of 0.80 to 0.85.
$\beta$ = angle of lay of the outer strands in the rope.
$\alpha$ = angle of lay of the wires in the strand.

Three constructions of main cable wire ropes are shown in Fig. 7 and the properties are listed in Table VIII, the breaking strengths being based upon commercial steel wire of 215,000 pounds per square inch.

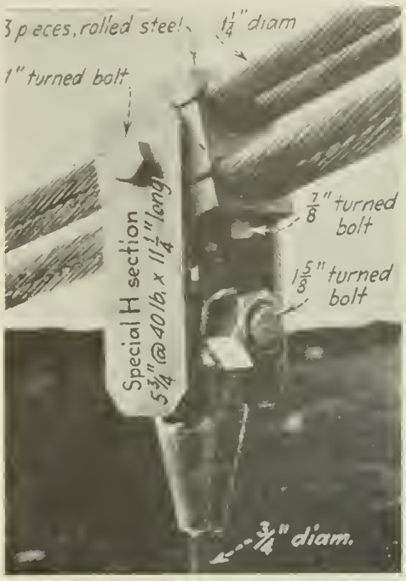



**Fig. 6—Main Cable with Cable-Band and Suspender Strand Connection—Ozark Mountain Bridge.**

Table VIII

Galvanized Steel Wire Ropes for Main Cables

| Diameter Inches | Construction | Area Square inches | Weight Per 100 feet pounds | Breaking Strength Tons |
|---|---|---|---|---|
| ¾ | 6×7/1×19 | .2596 | 95 | 25 |
| ⅞ | 6×7/1×19 | .3566 | 134 | 35 |
| 1 | 6×7/1×19 | .4628 | 170 | 45 |
| 1⅛ | 6×7/1×19 | .5841 | 214 | 56 |
| 1¼ | 6×7/1×19 | .7257 | 267 | 70 |
| 1⅜ | 6×7/1×19 | .8742 | 321 | 84 |
| 1½ | 6×7/1×19 | 1.0367 | 381 | 100 |
| 1⅝ | 6×19/1×37 | 1.3211 | 485 | 126 |
| 1¾ | 6×19/1×37 | 1.5298 | 562 | 146 |
| 1⅞ | 6×19/1×37 | 1.7610 | 646 | 168 |
| 2 | 6×19/1×37 | 1.9916 | 732 | 190 |
| 2⅛ | 6×19/1×37 | 2.2474 | 825 | 215 |
| 2¼ | 6×19/1×37 | 2.5393 | 935 | 242 |
| 2⅜ | 6×19/1×37 | 2.8171 | 1,035 | 269 |
| 2½ | 6×19/1×37 | 3.1243 | 1,147 | 298 |
| 2⅝ | 6×19/1×37 | 3.4320 | 1,260 | 328 |
| 2¾ | 6×19/1×37 | 3.7623 | 1,380 | 355 |
| 2⅞ | 6×37/1×61 | 3.9301 | 1,445 | 371 |
| 3 | 6×37/1×61 | 4.2827 | 1,575 | 405 |
| 3¼ | 6×37/1×61 | 4.9958 | 1,835 | 472 |
| 3½ | 6×37/1×61 | 5.8081 | 2,135 | 549 |
| 3¾ | 6×37/1×61 | 6.6834 | 2,460 | 631 |

The moduli of elasticity, which are approximate as the manufacturing facilities of the rope maker will be a factor, are as follows:

| Construction | As manufactured Pounds per square inch | Prestressed at 30 per cent of strength Pounds per square inch |
|---|---|---|
| 6×7/1×19 | 18,000,000 | 20,000,000 |
| 6×19/1×37 | 16,000,000 | 18,000,000 |
| 6×37/1×61 | 14,000,000 | 17,000,000 |

The 460-foot span highway bridge over the Bulkley River canyon in British Columbia, erected in 1931, has main cables of 19-1½ inches diameter wire ropes and wood fillers were used to make the finished cable cylindrical in shape and the cables were wrapped with canvas and galvanized wire to exclude moisture. These ropes were prestressed at the bridge site.

### Suspender Ropes

Suspender ropes are made with an independent wire rope centre and the constructions are as shown in Fig. 8. The strength of these ropes may be calculated from equation (4):

$$T = N \cos \beta \sum_{1}^{n} S \cos^3 \alpha + \kappa N_1 \cos \beta_1 \sum_{1}^{n} S \cos^3 \alpha \quad (4)$$

in which the nomenclature is the same as given for equation (3); the value of $\kappa$ being taken as 0.80 and of $N_1$ in the second term for the independent wire rope centre, as 7 instead of 6.

The properties of these ropes are noted in Table IX, the breaking strengths being based upon wire of 225,000 pounds per square inch strength.

Table IX

Galvanized Steel Suspender Ropes

| Diameter Inches | Construction | Area Square inches | Weight Per 100 feet pounds | Breaking Strength Tons |
|---|---|---|---|---|
| ⅝ | 6×7/7×7 | .1780 | 66 | 17 |
| ¾ | 6×7/7×7 | .2526 | 94 | 24 |
| ⅞ | 6×7/7×7 | .3447 | 129 | 33 |
| 1 | 6×7/7×7 | .4494 | 168 | 43 |
| 1⅛ | 6×7/7×7 | .5676 | 212 | 54 |
| 1¼ | 6×7/7×7 | .7057 | 264 | 68 |
| 1⅜ | 6×7/7×7 | .8466 | 316 | 81 |
| 1½ | 6×19/7×7 | 1.0682 | 400 | 103 |
| 1⅝ | 6×19/7×7 | 1.2604 | 470 | 121 |
| 1¾ | 6×19/7×7 | 1.4493 | 580 | 139 |
| 1⅞ | 6×19/7×7 | 1.6674 | 623 | 160 |
| 2 | 6×19/7×7 | 1.8950 | 710 | 182 |
| 2⅛ | 6×37/7×7 | 2.0850 | 780 | 200 |
| 2¼ | 6×37/7×7 | 2.3470 | 880 | 225 |
| 2⅜ | 6×37/7×7 | 2.6186 | 980 | 252 |
| 2½ | 6×37/7×7 | 2.8744 | 1,075 | 276 |
| 2⅝ | 6×37/7×7 | 3.1803 | 1,190 | 306 |
| 2¾ | 6×37/7×7 | 3.4928 | 1,305 | 336 |
| 2⅞ | 6×37/7×7 | 3.8262 | 1,430 | 368 |
| 3 | 6×37/7×7 | 4.1727 | 1,560 | 402 |

The moduli of elasticity will be approximately as follows:

| Construction | As manufactured Pounds per square inch | Prestressed at 25 per cent of strength Pounds per square inch |
|---|---|---|
| 6×7/7×7 | 15,000,000 | 18,000,000 |
| 6×19/7×7 | 12,000,000 | 16,000,000 |
| 6×37/7×7 | 11,000,000 | 15,000,000 |

The diameter tolerances are generally as given in Table X.

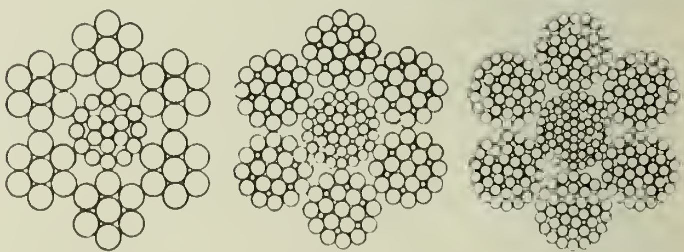
Table X

Diameter Tolerances of Suspender Ropes

| Nominal Diameter | Oversize | Undersize |
|---|---|---|
| ¾ inch and smaller | 1/32 inch | 0 |
| ⅞ inch to 1½ inch | 1/16 inch | 0 |
| 1⅝ inch to 2¼ inch | 3/32 inch | 0 |
| 2⅜ inches and larger | ⅛ inch | 0 |

On moderate and long span bridges, the suspender ropes are looped over the cable-bands on the main cables, as shown in Fig. 2; there will be a loss of strength due to this bending, and the strength of the rope so bent may be calculated from equation (5).

$$T_1 = \kappa_1 e A \left( t - \frac{E_r \delta}{D_1 + d} \right) \quad (5)$$



**6 x 7/1 x 19 6 x 19/1 x 37 6 x 37/1 x 61**

**Fig. 7—Main Cable Wire Ropes.**

in which,

$T_1$ = breaking strength of rope bent over cable-band.

$A$ = metallic area of rope, square inches.

$t$ = unit tensile strength of wire, pounds per square inch.

$E_r$ = modulus of elasticity of rope as manufactured.
$d$ = diameter of suspender rope in inches.
$\delta$ = diameter of outer wires of rope, which are as follows:
$6 \times 7$ rope $.107\, d$.
$6 \times 19$ rope $.065\, d$.
$6 \times 37$ rope $.046\, d$.
$D_1$ = tread diameter of groove of cable-band.
$e$ = efficiency of rope construction as determined from equation (4) or from strengths given in Table X.
$k_1$ = correction factor, of the following values,

| $D_1/d$ | 8 | 10 | 12 | 14 and larger |
|---|---|---|---|---|
| $k_1$ | 1.08 | 1.055 | 1.03 | 1.00 |

Suspender ropes have always been made regular lay but recent tests as made by A. S. Rairden* show that a Lang lay rope bent over a cable-band is more efficient. However a Lang lay rope is inherently cranky and the advantages gained will be offset by the chances of damaging the rope in handling at the bridge site, unless a preformed Tru-lay Lang lay rope is used, but the increased price of the Tru-lay rope excludes its usage.

Data pertaining to the suspender ropes as used on various bridges are listed in Table XI:

Table XI
Suspender Ropes of Various Bridges

| Bridge | Diameter Inches | Type | Area Square Inches | Strength—Tons Single Part | Strength—Tons Double Part | Modulus of Elasticity as manfd Pounds per square inch | Modulus of Elasticity Pre-stressed Pounds per square inch |
|---|---|---|---|---|---|---|---|
| Portsmouth..... | 1¼ | 6×7/7×7 | .7352 | ..... | ..... | 12,000,000 | 16,300,000 |
| Mount Hope.... | 1⅜ | 6×7/7×7 | .8611 | 80 | ..... | 16,000,000 | 20,500,000 |
| Ambassador..... | 1⅞ | 6×19*W*/7×7 | 1.6678 | 151.5 | ..... | 12,000,000 | 16,000,000 |
| Philadelphia.... | 2¼ | 6×37*R*/7×7 | 2.2262 | 218.3 | 194.2 | 8,000,000 | 12,000,000 |
| Geo. Washington | 2⅞ | 6×37*W*/6 ×7/1×19 | 4.0474 | 389.3 | 333.8 | 13,500,000 | 18,000,000 |

The values of $D_1/d$ for the Philadelphia and the George Washington bridges were 14.2 and 13.6 respectively and the corresponding loss in rope strengths, as bent over the cable-bands, were 11 and 14.3 per cent.

Galvanized steel rope-strands, as listed in Table V and shown in Fig. 3, may be used for the suspenders as they offer maximum strength with minimum stretch but under no consideration should they be used in double part by looping or bending over the cable-bands.

## END FASTENINGS

The terminal or end fittings on the rope-strands, the wire ropes for the main cables and also the suspender ropes, are sockets. These are attached in the usual manner by brooming out the cleaned wires and pouring molten zinc over them into the basket of the socket; under no consideration should the wires be bent back hook shape.

In order to keep the compression of the zinc cone within allowable limits the proportions of the socket baskets are as follows:—

| | Length of taper | Included taper |
|---|---|---|
| Rope strands for main cables..... | $5\, d$ | .320 inches per inch |
| Wire ropes for main cables....... | $4.25\, d$ | .320 inches per inch |
| Suspender ropes................ | $4\, d$ | .300 inches per inch |

*Discussion in Carstarphen's "Effects of Bending Wire Rope" in Transactions Am. Soc. Civil Engineers, 1933.

To prevent movement between the socket and the zinc cone, either by rotating of the socket or "backing-out" of the cone, an annular ring is machined or cast in the socket basket and a hole drilled or two steel pins are set into the side of the socket projecting into the basket and the zinc poured over them.

For the designer, the following maximum unit working stresses are suggested:

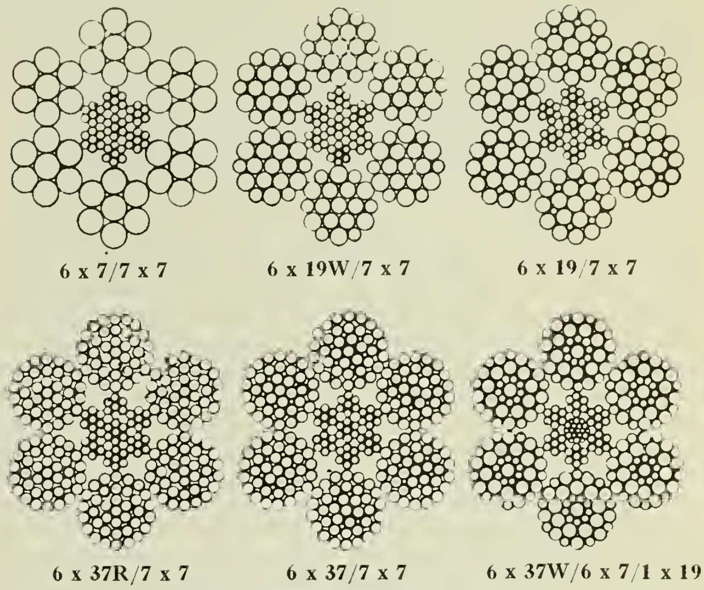


Fig. 8—Suspender Ropes.

Allowable Working Stresses

| | |
|---|---|
| *Main Cables* | |
| Parallel wire cables—type (*a*) | 80,000 pounds per square inch |
| Rope-strand cables—type (*c*) | 75,000 pounds per square inch |
| Wire rope cables —type (*d*) | 65,000 pounds per square inch |
| *Suspender Ropes* | 48,000 pounds per square inch |

D. B. Steinman in his excellent book "Suspension Bridges" states that "bridge engineers have been too conservative in the past in fixing wire cable working stresses, in comparison with stresses permitted for other materials, and that stresses as high as 100,000 pounds per square inch or even higher may safely be used for this unexcelled bridge material for the main cables."

Considering the advances that have been made in the analyses of stresses in suspension bridges and in the quality of steel bridge wire in recent years, the higher working stresses suggested by Dr. Steinman are quite in order. In the past, ever increasing values have been used, as indicated from the following maximum stresses allowed on various bridges:—

| Bridge | Date | Max. Stresses—Pounds per square inch Main Cables | Suspenders |
|---|---|---|---|
| Brooklyn | 1883 | 47,500 | .... |
| Williamsburg | 1903 | 50,300 | .... |
| Manhattan | 1909 | 73,000 | .... |
| Philadelphia | 1926 | 72,000 | 45,000 |
| Cologne-Mulheim | 1929 | 81,000 | .... |
| Ambassador | 1930 | 76,000 | 30,000 |
| George Washington | 1932 | 82,000 | 35,000 |

# Residential Heating as a Public Utility

## With Particular Reference to Residential District Service as Practised in Winnipeg, Manitoba

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*Consulting Engineer, Toronto, Ont.*

SUMMARY—The author discusses the application of district heating in three areas in Winnipeg, chiefly residential in character. The largest system distributes steam to some twelve-hundred customers. The others supply steam to apartment blocks, schools, etc., and hot water to residences. Notes are given on the boiler equipment required to use Saskatchewan lignite, the methods of measuring the heat supplied to customers and on construction methods and difficulties.

In the following will be included consideration of the applications, principles and advantages inherent in the utility along with particulars of the author's experiences in the design, construction and operation of two systems of heat distribution throughout the residential areas in Winnipeg, Manitoba. Whereas a long drawn out house heating season combined with high costs of fuel warrant this type of public utility as a sound investment in Winnipeg and in other north western cities, there exist in a number of metropolitan districts in eastern Canada certain conditions favourable to the practice, and to an even greater degree than in the west. A few such may be noted: the considerable areas in several cities in which high class houses are densely built; the urgent need for a cleaner atmosphere as well as the cleaner home conditions which attend the distribution of heat from a single fuel burning station; the not inconsiderable lessening of street traffic which results from cessation of the retail distribution of huge quantities of coal, and the collection of ashes, a feature of no little importance in consideration of the existence generally of narrow thoroughfares already overcrowded with traffic of all sorts; and the fact that members of these communities can well afford the cost of the higher standard of home conditions which attend the entry of this clean, convenient and not unreasonably expensive domestic service. If there is, as seems to be recognized in many quarters, a real prospect of growth of the business of supplying equipment for "conditioning" the air of the home, there should be anticipated with equal degree of probability, the development of the business of heat distribution, an enterprise which offers no small field for qualified engineers, and a fresh field for sound investment.

The subject discussed covers several phases of heat supply:

(*a*) A single source of heat for duplex homes.

(*b*) A central source of heat for groups of buildings under single management; as exemplified by:
- McGill University buildings, Montreal,
- Parliament and other government buildings, Ottawa,
- University of Toronto and other buildings, Toronto,
- Toronto Terminal Railway Company including the Royal York hotel, Union station, Custom House and railway yards.

(*c*) Distribution throughout the business district of heat from electric power stations, as in North Battleford, Sask., Brandon, Man., London, Ont. and in Winnipeg, Man.

(*d*) Heat distributed through business districts by private corporations as in Lockport, N.Y.; by New York Steam Company in New York city; by Detroit Edison subsidiary in Detroit, Mich., and in many other cities of the United States.

(*e*) Heat distributed throughout closely built higher class residential areas of certain cities, instances of which form the main subject of this discussion.

Two papers—"Central Heating System of the City of Winnipeg" by G. W. Oliver, and "The Central Heating Plant of the Toronto Terminal Railway Company, Toronto" by J. A. Shaw—were presented before The Engineering Institute of Canada in February 1932 on the occasion of its General Professional Meeting. The former described the public utility originally erected as a long term outlet for a steam electric standby to the municipal electric utility of the western city; the latter paper describes a privately owned service. Both papers describe systems designed essentially to serve commercial buildings and entities and both cover engineering details of the investment quite fully, along with load and certain operating data.

Central heating—as a public utility—began in America at Lockport, N.Y., in 1877 and there were developed several of the items of equipment required by this type of service. Many corporations in cities of the United States and a few in cities of western Canada are now engaged in the distribution and sale of heat. Most of these sell steam, and base their measurements and their sales accounts on the quantity of condensate derived from its use. A few efforts to provide heating service through the medium of hot water have met but moderate success and because of the difficulty of measurement of heat as delivered, the practice of flat rate charges has been general. This opens the door to widespread waste by the customer, with consequent unreasonable demand upon the system, not only for fuel consumed in heating the water, but also in excess boiler plant and distribution pipe line investment.

Steam heat has been distributed by public service bodies in Brandon, Man., and in Battleford, Sask., for some years, and with commercial success, although necessarily on a moderate scale.

Mr. Shaw gave five reasons for the use of central heat at the Toronto terminals:

1. The elimination of boilers, with attendant noise and dust, from the various buildings, together with the trucking of coal and ashes, one plant replacing eight.

2. The saving of space in expensive locations for more remunerative undertakings, by eliminating boiler rooms and stacks.

3. The removal of smoke and gases from public areas.

4. A decrease of at least 25 per cent in the total fuel required, and a further reduction in cost by the use of a lower quality of coal.

5. Greater safety from fire.

All five apply as excellent reasons for central heating service throughout any compact business district.

With respect to central heating service for residential areas of cities there are certain other advantages:

6. Elimination of the house to house distribution of coal, and avoidance of the concomitant dust from coal and ashes in the house greatly lessens the housewifely duties and reduces the frequency and expense of house decoration. This dust free benefit accrues to the community through clearer atmosphere and cleaner exterior conditions.

7. Freedom from these dusts, and the maintenance of more uniform temperature within the home improves family health.

8. Reduction of fire hazard is recognized by the fire insurance companies through reduction in their premium rates.

9. Basements, hitherto dusty and devoted to the heating boiler and its fuel become real increments to the living rooms; afford playrooms for children, clubrooms for adults, or may otherwise add about ten per cent or more to the utilizable value of the home.

10. Hire of help for furnace attention is avoided, and this item affects partially the possible increment of the cost of central heat over the cost of fuels otherwise purchased.

11. Central heat may be at first classed as a luxury. It really is a domestic service greater than its name implies. As such it should cost the user more than his fuel, and as experience of its advantages is had, the customer forgets its "luxury" feature, and soon considers it a necessity.

12. Reduction of street traffic follows elimination of the use of trucks for distributing coal and collecting ashes.

Further remarks will be confined to central heating services in Winnipeg and the experiences gained through over three years association with their design, construction and operation.

### Central Heating in Winnipeg

There are four separate corporations distributing heat in Winnipeg:

Winnipeg Service Company generating steam from coal and from electricity serves the principal buildings within the most centrally located city block, whose south east corner is at Portage avenue and Main street. Not crossing any public thoroughfare it possesses no city franchise.

**Fig. 1—Wall Street Steam Station.**

The City of Winnipeg Hydro-Electric System distributes steam throughout almost one square mile of the business district, and its system surrounds the area served by the Winnipeg Service Company.

Winnipeg Heating Company, Limited, having obtained a city franchise in 1928, distributes steam throughout Crescentwood, a high class residential district occupying over one-half square mile south of the Assiniboine river.

Northern Public Service Corporation, Limited obtained a franchise in 1930 covering River Heights adjoining Crescentwood on the west and also the area north of the Assiniboine river and chiefly lying south of Portage avenue and west of Sherbrooke street, each district about one-half square mile in extent. This company distributes steam as demanded by apartment blocks, schools, churches and hospitals, and distributes hot water to residences, with but few exceptions.

The author was associated with the Winnipeg Heating Company chiefly in design and supervision of the steam generating plant, but also assisted in obtaining the franchise. During 1930 and 1931 he was in direct charge of designs, purchases and construction for the Northern Public Service Corporation, also assisting in matters of operation in association with Messrs. B. W. Parker and C. A. Clendenning, A.M.E.I.C.

### Winnipeg Heating Company, Limited

In 1931-32 there were about twelve hundred customers, representing nearly eighty per cent saturation along the frontage of distribution. Saturated steam is distributed through wrought steel pipe laid upon cast iron rollers and frames within concrete conduits located generally in lanes. Generated steam pressure, usually in the neighbourhood of 125 pounds per square inch gauge, is reduced at station exit to pressures proportionate to the load and varying from 75 down to 35 pounds per square inch, the object being to maintain at least 15 pounds pressure at the extreme of the longest lateral. The largest street main is 12 inches in diameter, and the smallest lateral is 2 inches. Service pipes to residences are 1 inch in diameter. Mains are insulated with 1-inch asbestos sponge felt and laterals with 1-inch asbestocel. A greater thickness of felt and use of that material throughout would result in economy through reduced transmission losses, which now average over 25 per cent during the season.

Slip type expansion joints anchored to the floor were placed in manholes located at approximately 300-foot intervals. Pipe lines are anchored to conduit walls midway between manholes, using angle iron welded to the pipe. All pipe joints are welded, excepting at service connections and on service pipes.

In most residences heat from the steam purchased is transferred to the hot water system through a condenser (or "pig") set in the basement. The steam fills the cast iron chamber while the water is circulated through the copper tubing, usually through the house furnace jacket, and through the radiation system by thermal head. The condensed steam is passed through a radiator located usually in the first floor hallway, through a screen and a trap and a bucket type meter to the sewer. The supply of heat is intermittently controlled by means of a thermostat, and an electric motor operated globe valve.

A few residences equipped with steam radiation are served through a reducing valve, and the condensate is measured and wasted to sewer in the manner described above.

Residences equipped for air heating are served in the following manner: The furnace is removed from the shell and in its place is set a bank of radiators of area sufficient for the demand. Steam, through a reducing valve, is fed, condensed, measured and condensate wasted in the usual manner. It will be noted that on account of the steam temperature lying between 215 and 250 degrees giving the radiation surfaces a heat release capacity of 250 British thermal units per square foot per hour, the space within the shell of the displaced furnace is generally ample for the house requirements.

The steam generating plant of the Winnipeg Heating Company is located about one-half mile south of the Assiniboine river, and on the south margin of the occupied portion of the franchise area. Fuel is hauled to the station by truck and is dumped into a storage bin of moderate dimensions which occupies the south section of the section. Fuel haulage charges require the use of coals of high heat value at this station. The original plant consists of three 500-h.p. watertube boilers equipped with unit pulverizers; one boiler only is provided with air preheater. Furnaces are roomy and complete combustion is attained before the gases enter the tube banks, which have three passes. At

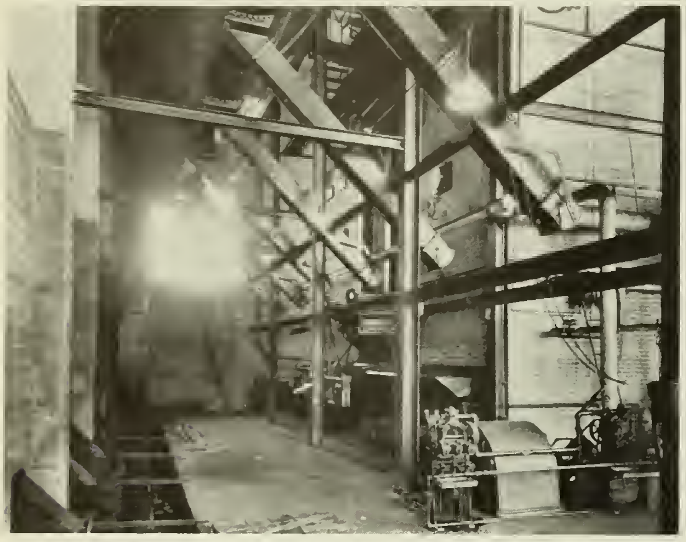

Fig. 2—Boilers 1 and 2, Wall Street Steam Station.

first it was attempted to collect dust from waste gases by means of cyclones and exhaust fans, in the effort to avoid the construction of an unsightly tall chimney; the results were not entirely satisfactory, and, partly for this reason and partly because of additional release capacity required by increase of sales, a neat Custodis chimney was erected during the second year of operation. The station is an attractive building of red brick panelled, and the entire assembly in its present and ultimate form is quite in keeping with the high class of residences thereabout.

Increase of demand required the addition of two larger boilers of 870-h.p. rating; these are equipped with underfeed stokers of the Jones type. All boilers are of the Kidwell design, furnished by Canadian Vickers, Limited.

On account of the very moderate plant load factor in central heating service it is essential that capital charges be kept to a minimum; other than feedwater heaters there are therefore no auxiliaries provided for purposes of steam generating economy.

This type of boiler delivers steam with a superheat of from 20 to 40 degrees; a slight additional superheat succeeds passage through the outlet reducing valve, and this characteristic assists in minimizing condensation in the distribution lines.

Ashes are removed by hand and are disposed of by truck to selected waste areas in the neighbourhood, or are removed by municipal users for lane paving purposes.

In 1932 earnings were sufficient to carry all operating and fixed charges.

Northern Public Service Corporation, Limited

After considerable laboratory study and also a field test by the promoters, this company was organized and in 1930 was granted the municipal franchise heretofore mentioned. The plans were based on the distribution of heated water to all customer homes equipped with hot water radiation or with hot air systems. It was at once recognized that *(a)* control of the rate and quantity of water supply must be had, and *(b)* that the heat extracted from this circulated water must be measured as the basis of charge for service. Both objectives have been accomplished.

*District No. 1—Sherbrooke Franchise*

Designs were begun in May and field construction was begun in July 1930, and service was first rendered in December of that year. The system includes a steam station; a steam main with return line for condensate passing through the middle of the franchise area; heat exchanger pumping stations at approximately 1,000-foot intervals along the steam main; hot water circulating flow and return systems of distribution lines from each exchange-station; and sundry steam line branches to apartments, churches, schools, a large hospital and a municipal library.

In general the steam main lies along Westminster avenue, and the distribution lines lie along lanes which are available throughout the franchise area.

Wall street steam station, an attractive brick and concrete building with chimney, is located just north of Portage avenue alongside the southerly end of a terminal yard of the Canadian Pacific Railway Company. The first installation of two 790-h.p. Kidwell boilers, equipped with Jones underfeed stokers, has been increased by the addition of a third boiler of 870 h.p.; space is available in the station for a fourth boiler when required. The only important auxiliary is a feed water heater which receives the condensate returned from the heat exchanger stations and the makeup required to replace that lost through steam sales. Feed water pumps are in duplicate, one motor driven, the other steam turbine driven, both furnished by Mather and Platt.

Coal, dumped from railway cars into a track hopper enclosed along the west side of the station, is elevated by means of an endless bucket conveyor into an overhead bunker of 300 tons capacity. It is fed by gated chutes through portable weigh lorries into the stoker hoppers. Ashes, raked from below the rear dump plates of the stokers, are carried by chain conveyors to the main bucket elevator and disposed of outside the end of the station, where they are removed by purchaser users.

After a long series of tests of various Canadian coals, the principal supply meantime coming from Pennsylvania coals from lakehead docks, a mixture of coking coal from western Alberta and lignite from southern Saskatchewan has been adopted as standard. The use of lignite prevents solid coking and also reduces wall clinkering to almost zero, and the use of the coking coal prevents the air casting of the friable lignite to the dump plates. A minimum cost of fuel per thousand pounds of steam is also attained.

It must be remembered that Manitoba is the neutral ground west of which coal of high value from the United States fields cannot be sold, even with the advantage which it possesses as a return cargo for the ore boats from Duluth; and east of which the coals from Alberta of values increasing as their source moves westward, cannot be delivered without large transport bonuses. The western coal used costs less than $8 per ton and the Saskatchewan lignite costs less than $3 per ton delivered at the steam station. Resultant steam costs for fuel are in the neighbourhood of 34 cents per thousand pounds. The heat value of this fuel mixture varies between 8,800 and 9,000 B.t.u. per pound.

Before designing the Renfrew steam station for district No. 2, the area covered by the southerly or River Heights franchise, a series of experiments with the use of lignite from the Estevan field were carried on at the Wall street station, on stoker elements modified for the purpose. As a result of these experiments, and following a thorough study by engineers of the company, of equipment used in North Dakota and elsewhere for the burning of similar lignite, it was decided to use lignite alone, as the fuel in the new station. The equipment selected will be described later.

*Heat Exchanger Stations*

These are located under garages on lots located close to the route of the steam main. Their equipment consists of two or more twin units of horizontal condensers; duplicate centrifugal water pumps, one motor, the other turbine driven; on the return side of the circulating system, twin air pressure tanks on the circulating system for the purpose of regulation and of maintaining the house radiation system full of water; and temperature controls on condensate discharge. The condensate passes through Leeds water meters to the steam station via an uninsulated welded wrought steel pipe line located in the conduit which carries the steam main.

The outgoing hot water, at a temperature of 210 to 215 degrees F. and a pressure of about 45 pounds per square inch gauge, is distributed through headers parallel to the steam main conduit to laterals located generally in the three lanes adjacent to the heat exchanger station. A back pressure of 15 pounds per square inch gauge is maintained on the return circulation line, and all overflow pipes and equalizer tanks in the attics of customers are closed off. The distribution layout from each heat exchanger station, for service to a maximum of six hundred average homes, required station outlet pipes of 6 inches diameter, headers across lane ends of 5 inches diameter, and laterals of 3 inches, never larger than 4 inches, the diameter tapering downward by standard differentials through 3, 2½ to 2 inches. All these laterals are valved in manholes on the header line.

These limits for pipe dimensions would not have been sufficient were it not that the company established control of the rate of hot water consumption in combination with a practical and accurate measurement of the quantity of heat shown monthly by each customer. Since hot water radiation can discharge only about 150 B.t.u. per hour per square foot into the room at usual interior temperatures, a needle valve set to permit a draught of not more than one-half gallon of hot water per minute per 100 square feet of house radiation was placed in the ½-inch house delivery line.

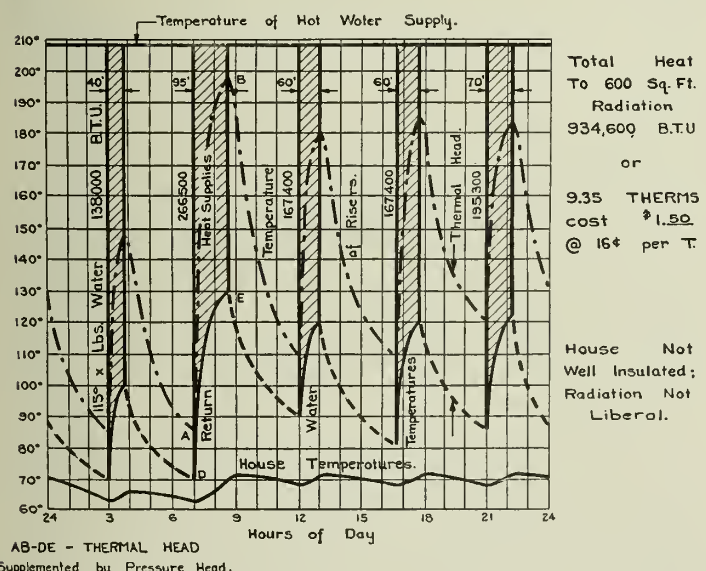


**Fig. 3—Hot Draught from Hot Water Supply System on Cold Day.**

The distribution lines and service pipes are enclosed in conduits of creosoted fir laid with about two feet of earth cover for the lines and one foot for the services. Hot water pipes are insulated with 1 inch of asbestos sponge felt; return lines are bare. The average temperature of water returned to the exchanger station is found to be in the neighbourhood of 140 degrees F.; that from individual services varies as is described later.

*Distribution System*

Under the conditions of practical service a given pipe size will deliver about four times as much heat when carrying water as when carrying steam, e.g. with steam at 20 pounds per square inch gauge pressure and a velocity of 10,000 feet per minute a 6-inch pipe will convey about 210,000 B.t.u. per minute; the same pipe size carrying water at 212 degrees F., from which in practice an average of

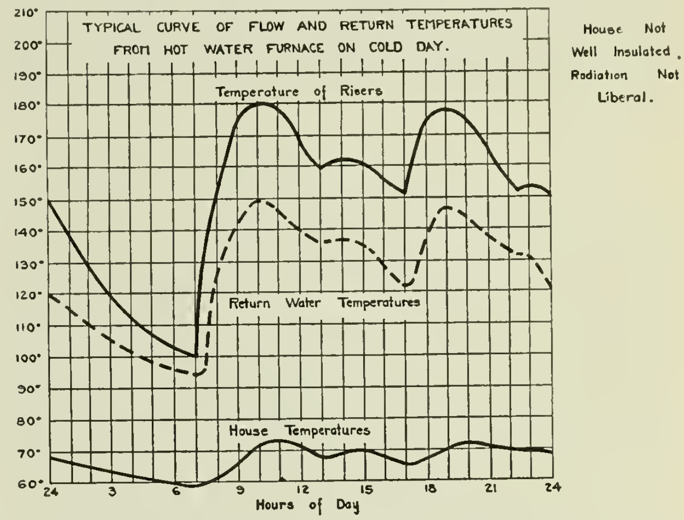


**Fig. 4—Flow and Return Temperatures from Hot Water Furnace on Cold Day.**

about 90 B.t.u. per pound can be usefully delivered, will convey about 850,000 B.t.u. per minute with a water velocity of 10 feet per second.

In Winnipeg practice the maximum distances for conveyance are about one mile and a quarter for steam and one-quarter mile for water. Steam mains vary in size downward from 18 inches, and laterals down to 3 inches; water mains and laterals from 6 to 2 inches, necessarily as duplicate piping. Costs of insulation and of conduits and manholes cause investment for lines of equal diameter to be nearly alike for the two systems of distribution. Because of the fact that the "morning warm up" occurs about the same hour in all homes the diversity factor governing gross peak draught of heat from the exchanger station is large. The duration of this draught, except in the coldest weather, is commonly less than one-half an hour however, and the pressure drop in the lateral is less than 20 pounds per square inch gauge leaving a minimum differential between "flow" and "return" lines of 10 pounds per square inch available for the most distant house served.

In order that water of high temperature may be available at all homes it is the practice to equip each lateral end with a sylphon controlled bypass between the "flow" and the "return" line. There is a temperature drop in laterals of not over 7 degrees F. below the temperature of water sent out from the pumping station. This feature is attained only by excellent insulation of the "flow" line.

In order to minimize the cost for manholes it is the practice to establish U-bends in the lateral at intervals of about 400 feet, the pipes being firmly anchored midway between bends. Services are screwed to nipples welded into lateral pipes, clearances in service box connections to lateral conduit being made sufficient to prevent binding as expansion or contraction alters the length of lateral sections between anchor points.

*House Services*

Wrought steel service pipes one inch in diameter lead from the lateral to within the basement of the house. Gate valves are furnished on both lines inside this entrance. Pipes one-half inch in diameter lead the water to the furnace jacket, the flow line being equipped with a strainer, the needle valve above mentioned, and a motor operated weighted control valve governed by the house thermostat. The heat meter is located on the return line leaving the "return" header on the furnace. Circulation through the house piping is forced by the pressure differential between "flow" and "return" lateral pipes, aided by the natural "thermal" head within the circulation system of the house. When the control valve is closed the circulation of heated water within the system continues under the influence of this head. It is thus important that no air be allowed to pass through the furnace, its draughts being sealed and the smoke pipe damper closed, obviating wasteful cooling of the considerable body of hot water in the furnace jacket.

*Heat Meter*

This unique device was designed and developed by the company's engineers and its function is to determine the quantity of British thermal units extracted by the customers' radiation system from the hot water supplied from without. Its essentials are a control valve with two ports and two pipe connections operating in parallel. On one leg a water meter is located and the other leg a bypass. The quantity of water diverted through the bypass rises as the temperature of the returned water rises, the valve being so adjusted that the proportion of returned water flowing through the water meter corresponds to the heat extracted from the hot water delivered to the house and this water is for all practical purposes at uniform temperature. Tests and practice prove this type of meter to be correct to within 2 per cent for all return temperatures over a 100-degree range above 90 degrees F., which is the limit of the minimum return temperature measured. Whenever, by reason of excess capacity in house radiation, considerable returned water is of a lower temperature than 90 degrees F., the bypass valve can be so adjusted to determine the facts as to heat consumption.

*Temperature of Returned Water*

The determination of these temperatures was early known to be necessary, and a great number of studies of house heat losses were made in various house systems with differing radiation characteristics. Consideration of the sequence of events following the admission of hot water to the relatively cool radiation system shows:

(1) A rise in temperature of water in the furnace jacket, and a coincident discharge of water at low temperature to return laterals.

(2) A rather prompt rise in temperature of the water in radiators and a slower rise in temperature of the return water.

(3) The temperature of water entering each radiator approximates that of hot water supplied to the system; and the rate of rise of the temperature of water discharged by the radiators lessens.

(4) If the flow be continued for a sufficient period, the temperature of the return water reaches a maximum; this temperature is lower from a system of unduly large area of radiation than from a system whose radiation is barely sufficient to maintain proper house temperature.

In practice it is found that the temperature of return water asymptotic to time is seldom reached with any system, because the house temperature reaches the setting of the thermostat and the valve governing admission of hot water is automatically closed before that stage occurs; unless the thermostat setting has been lowered manually or by clock for the sleeping period even the morning warm-up is of less duration than that necessary to reach a maximum return water temperature.

It is also found that only in very cold weather is the control valve opened by the thermostat more than four times during twenty-four hours. In mild weather, it is seldom necessary to draw hot water into the radiation more frequently than two or three times in the same period of time. For individual customers these frequencies vary and are dependent on such factors as the degree of house insulation limiting house heat losses; the relative area of radiation surfaces; the style of house construction affecting air movement within; the domestic habits with regard to ventilation and the admission of cold air from without; and the character of house occupation with respect to the radiation surfaces and the ventilation methods and practices in individual rooms.

*Hot Water Heating and Hot Air House Systems*

Since the discharge of heat from hot-water-filled radiators does not average over 150 B.t.u. per hour, there is not accommodation for a large enough area of radiation within the galvanized iron shell of the original furnace. The practice therefore is to set up in place of the furnace a bank of radiators of suitable gross surface area and to enclose it within a new rectangular sheet steel shell. In order to minimize the expense for radiators it is usual to force the air circulation by aid of a motor operated fan, the air riser and the return pipes being connected in the usual manner.

*District No. 2—River Heights Franchise*

Service to this area was begun in October, 1930, the construction of a second substation and the laying of the distribution lines having been commenced in July of that year. Some three hundred homes were supplied. In 1931 a third heat exchanger station was built, along with additional street and lane construction, and a brick steam generating station was erected alongside the railway tracks near the centre of the area ultimately to be served. During the winter of 1930-31 the required steam supply was purchased from the extended main of the Winnipeg Heating Company, the latter company's affairs having been taken over by the backers of the Northern Public Service Corporation, namely, the Middle West Utilities Company of Canada. During the second season a saturation of about 65 per cent was obtained throughout the area occupied by the hot water laterals. Many homes built here during 1931 were not equipped with a furnace, the owners depending upon central service for their heat supply.

*Steam Station for District No. 2, Northern Public Service Company*

As a result of the studies and tests carried on by its engineers the company decided to design this station to use slack lignite from the Saskatchewan field. This fuel is very friable, even dusty; it contains about 33 per cent of moisture and from 5 to 7 per cent of ash; it has a heat value of not over 7,000 B.t.u. per pound, unless selected or cleaned at the mine, when the content may rise to 7,400 B.t.u. Its cost delivered on cars at the railway siding is less than $3 per ton.

As a result of the intensive efforts made during many years in North Dakota and in Canada, the proper style of grate and design of furnace for its efficient consumption had been determined. A fairly thin fire bed is required, also a non sifting grate arranged either for dumping in sections, or as a chain grate with very small air passages. As mentioned previously it is important that capital expense be minimized in such services, and pyramid grates mounted for sectional dumping were chosen rather than Harrington stokers. The author had observed the latter type of equipment working in Dakota at 300 per cent of boiler rating and with as high as 18 per cent $CO_2$ in the stack gases. The capacities and efficiencies attainable with pyramid grates as furnished by Riley Engineering and Supply Company proved quite as high as desired. The first boiler installed, the only one to date, in this station has a quadruple grate each of two dumping sections. Air for each grate is under separate control and is forced into the respective ash pit by means of a steam turbine blower. Fuel is fed to each grate by an individual "kicker" or overthrow stoker. Fuel from the railway car to the station hoppers is handled as in the Wall street station before described.

The station is built to accommodate a second boiler, and a feed-water heater of sufficient capacity for two 870-h.p. Kidwells is installed.

**Fig. 5—Lateral Expansion Loop on Hot Water Line.**

The outgoing steam main, passing along the main highway traversing the franchise area, is connected to the end of the main of the Winnipeg Heating Company. Interchange or sale of steam in either direction is metered through Bailey meters installed in a manhole located at the east end of the Northern Public Service Corporation main.

### Construction Features

Lanes in general are 16 feet wide, and the conduit location chosen by the city engineer lay 5 feet from one margin. The U-bends taking up pipe length changes due to temperature variations lie between that alignment and the nearby lane limit. Except in rare instances the only manhole in a lane is that at the extreme end of the lateral sheltering the thermally controlled bypass from the flow to the return line.

Trenches were excavated with an Austin excavator having a cross belt for side discharge. In order that conduit lumber, pipe, and insulation might be economically distributed, and to facilitate progress in conduit and pipe laying, most of the excavated earth was removed in trucks loaded from the cross belt. This earth was transported to adjacent lanes for use in backfilling trenches; the remainder was wasted to dumps for lot filling.

Conduits were constructed of creosoted fir lumber which had been sized and rebated to permit firm assembly. All conduit fastenings are exterior to the box, thus avoiding the drilling of creosoted material, and accurate cutting of lumber to lengths.

Steam pipe lines are drained by use of Armstrong inverted bucket traps, discharging to the sewer through the manhole in which they are located, or in some instances, to the return condensate line. The Winnipeg Heating Company use Dunham traps discharging to the sewer.

Condensate lines are kept full of water, preferably condensate, throughout the year for the purpose of minimizing corrosion. They discharge into an open type feedwater heater at the steam station and are equipped with dirt trays.

From July 1st to December 31st, 1930, 19,400 feet of conduit carrying 46,000 feet of main and lateral pipe, and 20,640 feet of service boxes were laid; also one steam station and three heat exchanger stations were built and put into service. In 1931, 25,000 feet of conduit, 46,000 feet of pipe in mains and laterals, 21,500 feet of service boxes were laid. The Renfrew steam station and two other exchanger stations were built. Over twelve hundred customers were connected during these first two seasons.

The speed of construction during the half season of 1930 may be compared with the Indianapolis job of 1932 as described in Adsco Advocate, No. 1, Vol. V—47,247 feet of single pipe main in eighty-one days.

### Building Foundations

The surface soil of Winnipeg and the surrounding areas is a lacustrine clay carrying up to fifty per cent of moisture. Even when underdrained it possesses but a moderate bearing power; subsoils undrained have less; changes in moisture content of surface soils alters their volume—and the elevation of the superficies. As a consequence of these characteristics settlement of buildings erected on spread footings, and on "floating" foundations follows during a considerable period. Limestone rock, in some places covered with boulder clay or hardpan, underlies the area at a depth of about 45 feet below the average surface.

The buildings for these two heating utilities are erected upon spread footings of reinforced concrete, the unit loading being kept at about two tons per square foot, and as uniform as possible for all walls so as to ensure uniformity of settlement and avoid distortion of the structure. Success in this feature has attended the designs in all three steam stations. All chimneys stand upon nests of piles driven to refusal. All foundations are underdrained and gravel backfill was used.

Boilers rest upon reinforced concrete slabs independent of the footings of the station walls. Stokered furnaces have

**Fig. 6—Insulating Laterals for Hot Water Line, Academy Road.**

stood as designed and built. The three furnaces fed by pulverizers have settled irregularly and one has been rebuilt. The cause of settlement was due to the high temperature of the combustion chamber which caused excessive drying out of the clays beneath the foundation slab, and in an uneven degree over the area. The floor of the rebuilt combustion chamber has been heavily insulated to prevent recurrence of this experience.

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## Engineering as a Profession

On this side of the Atlantic the term engineer suggests to the ordinary citizen either an experienced railway man who drives a locomotive, or a youth in khaki who peers through a three-legged telescope and whose mysterious activities finally result, somehow, in the construction of an enormous dam or bridge. The public in fact is hardly aware that engineering is a profession. It is therefore reasonable to enquire just what is a professional engineer and what is implied by the word profession as applied to engineering.

There are a multitude of occupations whose practitioners claim the title of engineer; some of these can properly be classed as professional work, while in other cases the claim is put forward by a man who has had no training as an engineer in an endeavour to obtain a status or consideration to which his technical requirements and occupation do not really entitle him.

In discussing this matter, reference is often made to two of the "learned" professions, law and medicine, and engineers sometimes feel a slight tinge of envy when they note the manner in which lawyers and doctors (to say nothing of architects) have been able to regulate their professional activities and their relations with the public. They have undertaken certain duties towards their clients and have justly obtained certain rights and privileges which are duly safeguarded. The engineer asks himself to what extent is it possible or desirable to build up a like system for engineering work, with the two-fold aim of protecting the public against incompetent practitioners and protecting the members of the profession against improper or unfair competition.

Such a system necessarily involves the establishment of an approved standard of general and professional training, and adequate control of the right to practise.

In Canada much has already been done along these lines, but much remains to be accomplished. The Engineering Institute of Canada, like most other societies of similar standing, has insisted upon certain educational and professional qualifications before membership is granted, and has emphasized the value of systematic training and a high standard of professional attainment. The Professional Associations have continued the work by obtaining, in some of the provinces at any rate, adequate powers to give legal authority to requirements of the kind. Progress is being made, but is necessarily slow, by reason of many difficulties, some external to the profession, and others due to the very nature of engineering work.

In framing any scheme for the regulation of our professional work, consideration has to be given to such matters as the great diversity of engineering activities, the various kinds of training required for their successful prosecution, the engineer's relation to the employers or clients for whom he acts, and the extent to which his work is specialized. It must not be forgotten that in order to be successful, his efforts must always meet definite financial requirements. In some cases, for example, his services are performed for the purpose of selling engineering materials or equipment, his training and experience enabling him to advise the purchaser as to the selection he should make to obtain the best and most economical results. It will be seen that in many aspects of the engineer's work, his profession differs essentially from that of the lawyer or medical man, for the engineer is always limited by economic considerations, and he deals with materials and their utilization, rather than with people and their troubles and difficulties.

An admirable survey of the many problems relating to engineering as a profession was given by the President of the American Society of Civil Engineers at the Annual Convention of the Society which has just been held in Vancouver together with The Institute's Western Professional Meeting. President Eddy's address* points out that a profession has been defined as a vocation characterized by specialized educational training, which has for its purpose the supply of disinterested counsel and services in return for a definite compensation, "apart from expectation of other business gain." He enquires as to how far engineering, as practised to-day, complies with these requirements, and comes to the conclusion that engineering is certainly a profession in the sense contemplated by the definition, and further, that in view of the dependence of the engineer's work upon the application of so many sciences, it may fairly be regarded as a learned profession. Taking his own special branch as an example, Mr. Eddy remarks that the sanitary engineer has recourse to hydrology, chemistry and bacteriology for information as to the quantity and quality of a water supply; to hydraulics and applied mechanics for the design of his structures; to metallurgy, soil mechanics and many other branches in connection with others of his problems. The trend to-day is towards an ever-increasing application of scientific knowledge and the utilization of the results of research, and this applies to all branches of engineering.

These increased demands on the engineer's scientific knowledge have involved marked development in engineering education, and post graduate work, either scholastic or extra-mural, is now "a necessity for one who is to secure more than mediocrity in engineering."

Many engineers exercise both technical and business functions, which are not easy to separate. A contractor, for example, may function as an engineer in planning his methods of handling construction, while carrying on the business of managing, organizing and financing his work.

*"Trends in Engineering as a Profession in the United States of America." Address at the Annual Convention, Vancouver, B.C., July 11th, 1934, by Harrison P. Eddy, President American Society of Civil Engineers.

The technically trained sales-engineer in many cases renders strictly professional engineering services on behalf of his employer, and along with this development there has arisen a tendency on the part of large corporations towards commercializing engineering practice, which Mr. Eddy deplores. He has observed the growth of industrial and other companies whose operations in the field of engineering advice and design have encroached greatly upon the independent practice of the individual professional engineer. It is also noteworthy that an increasing proportion of the engineering profession consists of employees instead of independent practitioners, and this change has been accompanied by more detailed specialization, so much so that in many cases an engineer finds himself occupied continuously with problems of substantially the same kind, his work thus giving him no opportunity for broad experience.

As regards engineering societies, Mr. Eddy remarks that these perform an indispensable service, but there is to some extent overlapping and duplication of effort in their work of disseminating professional knowledge. In the United States he notes that greater stress is now being laid on the organization of the profession, as is shown by the fact that twenty-eight states now have registration laws, while the voluntary societies have made great efforts to foster the social branches of their work, particularly in connection with the unemployment of their members. He concludes that "the trend is unmistakeable towards better things for the community, the profession and the individual engineer, to be secured in large measure by the co-operative effort of engineers made effective through engineering societies." The task which he outlines for these bodies is a huge one, and effective advance cannot be made without the individual participation of their members in the societies' work.

If the desired aim is to be reached, organizations like The Institute, whose main object is the acquirement and interchange of professional knowledge, must work in harmony with those other bodies whose duty it is to regulate the practice of professional engineering.

Ultimately the public estimation of the engineer as a professional man depends upon the competence, integrity and personal character of individual members of the profession. Membership in our engineering societies and professional associations must be regarded by the public as a guarantee of these qualities if professional recognition is to be generally accorded to the engineer.

# The Western Professional Meeting 1934

There are few places in Canada which offer greater attractions for a summer meeting than Vancouver. The amenities of the city, ideal weather, scenery of great natural beauty and the hospitality characteristic of the west all combined to ensure an enjoyable gathering. This year's Western Professional Meeting was noteworthy, as being the first of The Institute's meetings to be held at the same time and place as the Annual Convention of our friends the American Society of Civil Engineers.

Seymour Falls Water Intake, Vancouver, B.C.

Arrangements for the joint event were in the hands of a local committee of members of both societies, under the chairmanship of E. A. Cleveland, M.E.I.C., M.Am.Soc.C.E.,* on which both the Vancouver and the Victoria Branches of The Institute were represented and the committee gave ample proof of its organizing and executive ability, for the programme went without a hitch. Just before the opening day when the secretaries of the two societies met the secretary of the committee there was little to be done except to express appreciation of the completeness with which all details had been cared for.

An advance party of society members from the east reached Vancouver on July 9th, and a number of them proceeded to Victoria, where they were met by President Shearwood and the Chairman of the Victoria Branch of The Institute, H. L. Swan, M.E.I.C. The party made a tour of the city, visited Butchart's gardens and next morning motored to Nanaimo, reaching Vancouver in the afternoon. The main body of American and Canadian visitors also arrived in Vancouver on the 10th.

After registration at the Hotel Vancouver on the morning of Wednesday, July 11th, the members of both organizations gathered for a joint meeting at which they were welcomed by his Worship the Mayor of Vancouver. Following this, President Shearwood expressed the pleasure of The Institute members in meeting those of the American Society and President Eddy, after replying, delivered his

* *Secretary:* J. C. Oliver, Jun.Am.Soc.C.E.

I. C. Barltrop, A.M.E.I.C.
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P. H. Buchan, A.M.E.I.C.
E. E. Carpenter, M.E.I.C., M.Am.Soc.C.E.
A. H. Finlay, Assoc.M.Am.Soc.C.E.
A. E. Foreman, M.E.I.C.
J. R. Grant, M.E.I.C., M.Am.Soc.C.E.
Frank Lee, M.E.I.C., M.Am.Soc.C.E.
H. N. Macpherson, A.M.E.I.C.
H. B. Muckleston, M.E.I.C., M.Am.Soc.C.E.
W. H. Powell, M.E.I.C.
J. Robertson, A.M.E.I.C.
W. O. Scott, A.M.E.I.C.
H. L. Swan, M.E.I.C.
G. A. Walkem, M.E.I.C.
C. E. Webb, M.E.I.C.
A. S. Wootton, M.E.I.C.
G. R. Wright, A.M.E.I.C.

presidential address to which reference is made elsewhere in this issue of The Journal. Passing from society business for a time, the large audience listened with interest to a breezy talk by Commander B. L. Johnson, D.S.O., R.N.R., on the varied problems and prospects which confront the navigator of a steamship while proceeding through the inside passage from Vancouver to Alaska ports.

*Courtesy of Gowen Sutton Co.*

**Vancouver by night**

At luncheon, in the unavoidable absence of A. S. Gentles, M.E.I.C., President of the Association of Professional Engineers of British Columbia, who was to have spoken, Dr. E. E. Brydone-Jack, M.E.I.C., gave an illuminating account of the growth and work of that Association. This was much appreciated, particularly by listeners from the United States, where the problem of registration has been treated in a manner somewhat different from that adopted in Canada. The speaker outlined the provisions of the legislation effective in British Columbia and referred in some detail to the working of the system adopted there for enrolling aspirants to the profession, first as pupils admitted to study and then as engineers-in-training in preparation for their formal registration as professional engineers in the province.

In the afternoon a joint technical session was held, at which papers were given on the development of the Columbia River Drainage Area, a subject of international interest, specially in view of the very large scale of the development contemplated on the United States portion of the river. Major J. C. MacDonald, M.E.I.C., sketched the situation on the Canadian side, and was followed by C. W. Webb, M.E.I.C., and J. P. Forde, M.E.I.C., so that both provincial and Dominion officers contributed to the discussion. American engineers then presented papers dealing with the large projects on which the United States government is embarking lower down the river at Bonneville and elsewhere, for developing power, improving navigation, and providing for irrigation and reclamation.

The President of the American Society of Civil Engineers took the chair at the joint dinner in the evening, at which Judge F. W. Howay, a notable authority on the early history of British Columbia, delighted his hearers with the story of the adventures and achievements of the party of Royal Engineers sent to the colony in 1858, who carried on their work of exploration and development till 1865. Many of them remained as settlers, and their descendants are now esteemed citizens of the province. The Judge's address included many characteristic touches illustrating the difficulties of official administration in dealing with the small but active and unruly population which inhabited the Cariboo district in those early days. A programme of song, dance, recitation and dialogue, directed by W. H. Powell, M.E.I.C., formed an enjoyable conclusion to a dinner which all agreed was one of the best ever held.

The serious work of both societies was resumed on the morning of Thursday, July 12th, when separate professional sessions were held, and the committee was able to report a total registration of more than four hundred and fifty.

The various technical divisions of the American Society of Civil Engineers dealt with and discussed no less than twelve papers, one of which, on the projected British Columbia-Yukon-Alaska highway, was of particular interest to Canadians. It was comforting to hear that of the 2,204 miles between Vancouver and Fairbanks, more than 1,000 miles have already been built, and that the cost of the remainder, from Hazelton through northern British Columbia into the Yukon and then on into Alaska, will only be $14,000,000, provided the cheapest type of construction is employed.

The four papers presented at the technical sessions of The Institute were well attended and gave rise to active discussion. The first paper, on the Highway System of British Columbia, by Patrick Philip, M.E.I.C., chief engineer of the Department of Public Works of the Province, dealt with questions of administration, organization and operation, as well as construction, and great interest was shown in the standard type of timber bridges which the department has developed. Mr. Philip was followed by J. M. Wardle, M.E.I.C., chief engineer, National Parks of Canada, who described the work carried on by his department on their portion of the highway around the Big Bend of the

**Dinner of The Engineering Institute of Canada and the American Society of Civil Engineers, Hotel Vancouver.**

Columbia from Golden to Revelstoke. His remarks were illustrated by an admirable film showing construction work in progress on that section.

The Town Planning Aspects of Vancouver and Fraser River Harbours were treated by W. G. Swan, M.E.I.C., who outlined the problems of administration, zoning, transportation and industrial development. The discussion was opened by J. A. Walker, the resident engineer of the Vancouver Town Planning Commission.

S.S. *Princess Louise* at Powell River, July 13th, 1934.

In the afternoon G. M. Gilbert, A.M.E.I.C., described the construction of the new intercepting sewer in English Bay. The information given respecting the somewhat difficult work on the submerged outfall was greatly appreciated, and C. Brakenridge, M.E.I.C., the city engineer of Vancouver, led the interesting discussion which followed.

The final paper of the series, on the substructure of the reconstructed Second Narrows Bridge, Vancouver, by P. L. Pratley, M.E.I.C., was presented, in the absence of the author, by J. P. MacKenzie, A.M.E.I.C. It described the events leading to the reconstruction of the bridge, and treated of the methods adopted and difficulties encountered, in building the substructure for the new lift span. Additional light on the subject was thrown by W. Smaill, M.E.I.C., in opening the discussion on this important paper.

After these technical exercises, the members were glad to take part in the first social event of the meeting in the evening, and the resources of the transportation committee were taxed to provide enough cars for the two hundred members and ladies who took the climb of 4,000 feet to Grouse Mountain Chalet, where a delightful dinner-dance was held. On this occasion Mr. Wardle kindly brought and exhibited films of wild life in the Canadian National Parks,—bear, buffalo and beaver. The pictures showing the beaver living and working under natural conditions were of special interest to engineers. Early in the evening atmospheric conditions were not all that could be desired, but later on the clouds parted, and gave a striking glimpse of the lights of the city far below.

The whole of Friday the 13th was devoted to a steamer trip to Powell River in the C.P.S.S. *Princess Louise.* Any fears which the superstitious might have had were proved groundless by the complete success of the outing. Reaching Powell River at one o'clock, parties were formed and conducted round the mill by well-informed guides under the instructions of Mr. D. H. Parker, the resident manager, and Mr. R. Bell-Irving, A.M.E.I.C., one of the directors. Members from the east, accustomed to six-inch sticks of pulpwood, were naturally interested in the operations of a mill whose pulpwood comes in logs more nearly six feet than six inches in diameter.

Leaving about five o'clock, the return voyage was cheered by a good dinner, followed by dancing and bridge, and the expedition disembarked at ten p.m. with a keen appreciation of the kindness of the Powell River Company and their officials, and the excellence of the arrangements for everyone's comfort on board the boat.

Some of the delegates had to leave Vancouver on Friday evening, but those who were able to remain and take part in Saturday's excursions were amply repaid. A large party motored to the Ruskin Hydro-Electric plant of the British Columbia Electric Railway Company, and after inspecting the plant, which has an ultimate capacity of 188,000 h.p., were hospitably entertained at luncheon by the company. They later drove to Seymour Falls, some eleven miles from the mouth of Seymour Creek. Here they met the party coming direct from Vancouver, and visited both the upper and lower intakes of the Greater Vancouver Water District. Not many cities on this continent are favoured with a natural water supply so abundant and so pure as Vancouver, where the city's very productive watershed, of some 13,000 acres, is owned and rigidly protected by the District.

Special arrangements for the visit were made through the kindness of the Chief Commissioner, E. A. Cleveland, M.E.I.C. The excursion was not only of technical interest, but was rendered more enjoyable by the beauty of the surroundings and the hospitality of the officers of the District.

This event brought to a close a gathering on which all who took part in it will look back with pleasure, and which will do much to broaden and maintain the cordial relations between The Engineering Institute of Canada and the American Society of Civil Engineers. Many of our British Columbia members belong to both organizations and were delighted to take part in welcoming their fellow members of the Society.

It is sincerely to be hoped that international meetings of this kind will take place more frequently in the future and that they may assist, as this one certainly has, in making the aims and work of Canadian engineers better known in the United States.

## The Engineering Institute of Canada Prize Awards 1934

Eleven prizes known as "The Engineering Institute of Canada Prizes" are offered annually for competition among the registered students in the year prior to the graduating year in the engineering schools and applied science faculties of universities giving a degree course throughout Canada.

Each prize consists of twenty-five dollars in cash, and having in view that one of the objects of The Institute is to facilitate the acquirement and interchange of professional knowledge among its members, it has been the desire of The Institute that the method of award should be determined by the appropriate authority in each school or university so that the prize may be given to the student who, in the year prior to his graduating year, in any department of engineering has proved himself most deserving as disclosed by the examination results of the year in combination with his activities in the students' engineering organization, or in the local branch of a recognized engineering society.

The following are the prize awards for 1934:

| | |
|---|---|
| Royal Military College—1933 | Howard Crawford DeBlois, S.E.I.C. |
| University of Alberta | Robert Fraser Logie |
| University of British Columbia | Percy R. Sandwell |
| University of Saskatchewan | Lawrence Crawley Sentence |
| Queen's University | Joseph M. Whyte |
| University of Manitoba | James Munroe Dale |
| Nova Scotia Technical College | Charles Abbot Wright, S.E.I.C. |
| The University of New Brunswick | Wilfrid E. Smith |
| University of Toronto | Robert Hewitt, S.E.I.C. |
| Ecole Polytechnique | Yvon-Roma Tasse, S.E.I.C. |
| McGill University | Charles Peter Paton |

## Engagement of Engineers by Ontario Municipalities

In accordance with the directions of Council the following circular letter has been forwarded to the corporate members of The Institute residing in the province of Ontario:

Dear Sir:—

I have been directed by Council to draw the attention of corporate members of The Institute residing in Ontario to a matter dealt with by Mr. H. D. Anger, Barrister, of Toronto, in his recent address before the Toronto Branch of The Institute, which was printed in The Engineering Journal for May, 1934, pages 207-218.

The particular point to which your attention is called is referred to in Section B-6 of Mr. Anger's address, commencing at the foot of page 213, and refers to the case of engineers who are retained or engaged by municipal councils in Ontario. In Ontario, under the Ontario Municipal Act, such engagement, to be effective, must be of a formal nature and by a by-law passed by the municipality under its common seal, failing which such engagement is void.

This has led to cases in which an engineer, having completed or practically completed his work for a municipality, has found himself unable to recover his fees when payment has been refused after a change of administration.

In the opinion of Council it is important that members undertaking work for Ontario municipalities should invariably take steps to protect themselves by requiring compliance with the Ontario Municipal Act on the part of the corporations engaging them.

Yours very truly,
R. J. Durley, *Secretary.*

## OBITUARIES

### George Warren Fuller, M.E.I.C.

Deep regret is expressed in placing on record the death at New York, N.Y., on June 15th, 1934, of George Warren Fuller, M.E.I.C.

Born at Franklin, Mass., on December 21st, 1868, Mr. Fuller graduated from the Massachusetts Institute of Technology in 1890 with the degree of B.Sc., and later studied for about a year at the University of Berlin, and in the private office of Carl Piefke, engineer of the Berlin water works. About nine years were then devoted to research work on methods of purifying water and sewage from the biological, chemical and engineering viewpoints. He was with the Massachusetts State Board of Health for nearly five years, during the latter part of which he was in charge of the Lawrence Experiment Station. In 1895 Mr. Fuller went to Louisville, Ky., and for two years conducted experiments on the suitability of various processes of water filtration available at that time for purification of a turbid water having wide variations in composition such as the Ohio river at Louisville. Following the Louisville studies he was engaged on similar researches at Cincinnati, Ohio. In 1899 Mr. Fuller entered private practice in New York, N.Y., as consulting hydraulic engineer and sanitary expert. From 1901 to 1911 he was in partnership with the late Rudolph Hering under the firm name of Hering and Fuller. He then continued practice under his own name until 1916 when he formed a partnership with the late James R. McClintock, and continued practice under the firm name of Fuller and McClintock.

In 1917 and 1918 during the War, Mr. Fuller was a member of a Central Committee at Washington having to do with the engineering, planning and sanitation of the various army camps. He was consulting engineer to the United States Public Health Service, and also to the construction division of the army. Mr. Fuller was a member of the Franco-American Engineering Congress convened at Paris directly after the Armistice to consider various reconstruction and economic problems in France.

One of the many important works performed by Mr. Fuller in his special field of engineering was accomplished in 1924 and 1925 for the Sanitary District of Chicago, when as chairman of a board of experts he laboured on the problem of the advisability of installing a new system for disposing of the sewage of that city. For many years Mr. Fuller was connected with the improvement of sanitary conditions for New York City, serving as a consultant on sewerage and sewage disposal for the Metropolitan Sewerage Commission of New York. In 1928 and 1929 he reported to the city upon the Wards Island sewage treatment works, and his firm afterwards prepared the plans for this project. From 1906 to date Mr. Fuller has been consultant to the New York Board of Water Supply on various sanitary problems connected with the development of the Catskill reservoirs and supply system. During his professional career Mr. Fuller served as consulting engineer for major water works and sewerage improvements in more than one hundred and fifty large cities in the United States and abroad.

Mr. Fuller was a member and chairman of an Engineering Advisory Committee of the Reconstruction Commission of the State of New York, and adviser to the International Joint Commission on Boundary Waters between the United States and Canada.

He was chairman of the Committee on Promotion and Attendance for the World Engineering Congress at Tokyo, Japan, in 1929; a past-president of the American Water Works Association, and of the American Public Health Association; and past-vice-president and director of the American Society of Civil Engineers. He was also a member of the American Institute of Consulting Engineers, the American Society of Mechanical Engineers, the American Chemical Society, the American Society of Bacteriologists, the Institution of Civil Engineers of Great Britain, the Vereines Deutscher Ingenieure, L'Association Générale des Hygiénistes et Techniciens Municipaux of France, and The Franklin Institute. He was elected chairman of The Engineering Foundation in 1933, and held that office at the time of his death.

Mr. Fuller was the author of many professional papers, and three books: "Water Purification at Louisville," 1898; "Sewage Disposal," 1912; and "Solving Sewage Problems," 1926.

Mr. Fuller became a Member of The Engineering Institute of Canada on May 11th, 1912.

### Archibald Abercromby Bowman, M.E.I.C.

The membership of The Institute will learn with regret of the death at Montreal, on June 26th, 1934, of Archibald Abercromby Bowman, M.E.I.C.

Mr. Bowman was born at Forglen, Scotland, on March 8th, 1875, and received his early education in that town and at the High School in Glasgow, Scotland. He graduated from McGill University in 1899 with the degree of B.Sc., having served his apprenticeship as an engineer in the shops of the Nova Scotia Steel Company, New Glasgow, N.S., in 1891-1895.

Following graduation, Mr. Bowman was until 1900 draughtsman and erecting engineer with the James Cooper Manufacturing Company, Montreal, and in 1900-1901 he was assistant chief engineer with the Canadian Rubber Company, Montreal. In 1901 Mr. Bowman joined the staff of the Canadian Ingersoll-Rand Company, Limited, as salesman and erecting engineer, and remained with that company until the time of his death, occupying at various times the positions of branch manager at Winnipeg, Toronto, and Montreal, district sales manager, assistant to the general manager, and electrical and mechanical engineer. For the past few years Mr. Bowman was directly concerned with the company's export business.

Mr. Bowman joined The Institute (then the Canadian Society of Civil Engineers) as a Student on March 16th, 1899, and became an Associate Member on April 23rd, 1903, and a Member on April 20th, 1915.

### Frank Panneton, A.M.E.I.C.

Regret is expressed on placing on record the death at Three Rivers, Que., on July 14th, 1934, of Frank Panneton, A.M.E.I.C.

Mr. Panneton was born at Three Rivers on December 10th, 1892, and graduated from the Ecole Polytechnique, Montreal, in 1915 with the degree of B.A.Sc.

In 1915-1916 Mr. Panneton was engaged on survey work with the Dominion government, and following that was until 1924 engaged in private practice. In 1924 he became assistant engineer and chief designer for the city of Three Rivers, which position he held until the time of his death. He was known as an authority on municipal engineering and bridge design.

Mr. Panneton became an Associate Member of The Institute on October 18th, 1932.

### Harry Bonfield Pope, A.M.E.I.C.

It is with regret that we place on record the death at Montreal on July 24th, 1934, of Harry Bonfield Pope, A.M.E.I.C.

Mr. Pope was born at Peterborough, Ontario, on November 2nd, 1879, and following a students' course with the Canadian General Electric Company at Peterborough, he was in 1898-1903 engaged on construction work and switchboard operating with the Lachine Rapids Hydraulic and Land Company. In 1903 Mr. Pope joined the staff of the Montreal Light Heat and Power Company and until 1904 was assistant superintendent of the Lachine power house. From 1904 to 1906 he was in charge of three of the company's substations. In 1906 he became superintendent of the Chambly power house, and in 1910 he was appointed superintendent of the company's generating stations. At the time of his death Mr. Pope was general superintendent of the electrical departments of the Montreal Light Heat and Power Consolidated.

Mr. Pope became a Student of The Institute (then the Canadian Society of Civil Engineers) on January 14th, 1904, and transferred to the class of Associate Member on October 8th, 1910.

## PERSONALS

A. A. Ferguson, Jr., S.E.I.C., who was formerly inspection engineer with the Canadian Fire Underwriters' Association, is now associated with Messrs. Reed, Shaw and McNaught, Montreal. Mr. Ferguson graduated from McGill University in 1931 with the degree of B.Sc.

V. L. Richards, S.E.I.C., has joined the staff of the Canadian Hanson and Van Winkle Company, Limited, Toronto. Mr. Richards graduated from Queen's University in 1932 with the degree of B.Sc., and secured the degree of M.Eng. from McGill University in 1934.

John Morse, M.E.I.C., general superintendent, Shawinigan Water and Power Company Limited, Montreal, was elected president of the Canadian Electrical Association at the annual meeting of that organization held recently.

Malcolm D. Barclay, A.M.E.I.C., and C. C. Lindsay, A.M.E.I.C., are members of newly organized firm of M. D. Barclay Incorporated, Montreal, Quebec Land Surveyors and Civil Engineers.

W. H. Stuart, M.E.I.C., who until recently was superintendent of engineering and construction for the Hotel Department of the Canadian National Railways, has, as the result of the abolition of his position due to reorganization in the Canadian National Railways, become associated with the James Morrison Brass Manufacturing Company Limited of Toronto. Mr. Stuart's position is that of special representative, with headquarters at Montreal, handling the company's business with the railways, the larger industrials, engineers and contractors, and certain phases of the business at Ottawa.

C. K. McLeod, A.M.E.I.C., has been appointed exclusive distributor of Permutit water treating equipment of all types for the provinces of Quebec, Ontario, and the Maritimes, with offices in Montreal and Toronto. Mr. McLeod who was formerly a principal in the firm of Busfield, McLeod Limited has devoted a considerable portion of his time to the Permutit Company's products during the past eight years.

Immediately after graduation from McGill University with the degree of B.Sc. in chemical engineering in 1913,

C. K. McLEOD, A.M.E.I.C.

Mr. McLeod became plant chemist with the Canada Cement Company Limited, remaining with that concern for the next three years. In 1916 he was engaged on the inspection of explosives with the Imperial Ministry of Munitions and remained on this work until the end of 1918. In May 1919, he was appointed chief chemist for the Dominion Glass Company, and one year later became superintendent with the Consumers Glass Company. In May 1921 Mr. McLeod was with the Phoenix Bridge and Iron Works on design and sales of structural steel work. When this firm was taken over in October, 1923, by Canadian Vickers Limited, he occupied a similar position with the new organization. In 1925 he became manager of the Chemical Engineering Equipment Company, the name of which was later changed to Busfield, McLeod Limited.

Mr. McLeod is very well known to the membership of The Institute as Secretary-Treasurer of the Montreal Branch, which office he has held for a number of years.

Frederick Palmer, A.M.E.I.C., who has since 1929 been Canadian Government Trade Commissioner at Oslo, Norway, has been transferred to Bristol, England, where he will occupy the same position. Mr. Palmer has also occupied the position as Canadian Trade Commissioner in New York, Rotterdam, Holland, and Milan, Italy. He received his engineering training at the Nova Scotia Technical College. from which he graduated with the degree of S.B. in 1913, Following graduation he was with the Toronto Structural Steel Company Limited, in their shops at Toronto, and later on erection work at Lindsay and Ottawa. During 1915 he was for a short time on building construction in Halifax, after which he was appointed assistant engineer with Foley Brothers, Welch, Stewart and Fauquier on the Halifax Ocean Terminals. He was on active service overseas from 1916 until the end of the war, serving as a lieutenant in the heavy artillery and being awarded the Military Cross. Following the war Mr. Palmer was with the Nova Scotia Highways Commission. In 1927 Mr. Palmer resigned from the Department of Trade and Commerce of Canada, to take a position with the Ford Motor Company at their Antwerp branch in Belgium, but later rejoined the service.

A. G. L. Atwood, S.E.I.C., is now connected with the Iron Fireman Manufacturing Company of Canada, Montreal, as engineer in charge of installations. Mr. Atwood graduated from the Nova Scotia Technical College in 1927 with the degree of B.Sc., and was subsequently, until 1928, with the Northern Electric Company at Montreal. In 1928 he joined the staff of E. A. Ryan, M.E.I.C., consulting engineer, Montreal.

C. E. Webb, M.E.I.C., district chief engineer for British Columbia of the Dominion Water Power and Hydrometric Bureau, Department of the Interior, was the recipient of the degree of Civil Engineering at the recent convocation of the University of Toronto. Mr. Webb graduated from the University of Toronto in 1910 with the degree of B.A.Sc., and since 1913 has been in the service of the Department, from 1913 to 1918 as assistant engineer to the assistant chief engineer, from 1918 to 1925 as assistant chief engineer and from 1925 in his present capacity.

G. H. E. Dennison, A.M.E.I.C., has joined the staff of the Canadian Carborundum Company Limited at Niagara Falls, Ont., as sales and service engineer. Following graduation from the Royal Military College in 1920, Mr. Dennison was with the Algoma Steel Corporation. From 1921 to 1923 he was with the Lake Superior Paper Company, and from that time until 1927 was on the staff of the Spanish River Pulp and Paper Mills Limited, Sault Ste. Marie, Ont., as assistant hydraulic engineer. In 1927-1928 Mr. Dennison was chief draughtsman with the same company. From 1928 until 1930 he was engineer at the Sault Ste. Marie mill of the Abitibi Power and Paper Company, being engaged on electrical and mill design and the supervision of construction. In 1931 Mr. Dennison was again connected with the Algoma Steel Corporation at Sault Ste. Marie. Mr. Dennison takes a keen interest in the affairs of The Institute, and was appointed Secretary-Treasurer of the Sault Ste. Marie Branch in 1933.

# RECENT ADDITIONS TO THE LIBRARY

### Proceedings, Transactions, etc.

Institution of Mining and Metallurgy: Transactions, 1933.

### Reports, etc.

*Kenya and Uganda Railways and Harbours:*
  Report of the General Manager on the Administration for the year ended December, 1933.

*Queen's University:*
  Calendar of Faculty of Applied Science, Session 1934-1935.

*Canadian Transit Association:*
  Annual Report of Committees, 1934.
  Report of the Committee on Way and Structures, 1933-1934.

*University of Manitoba:*
  Calendar 1934-1935.

*Association of Professional Engineers of Nova Scotia:*
  List of Members, etc., 1934.

*Canada, Department of the Interior, Forest Service:*
  Circular 43—Strength of Lodgepole Pine Telephone Poles, J. B. Alexander.
  Circular 39—Design of Wooden Boxes, R. S. Millett.
  Circular 40—Open Tank Treatment of Red Pine Lumber, J. F. Harkom.
  Bulletin 86—Kiln-drying British Columbia Lumber.

*Canada, Department of Mines, Mines Branch:*
  Limestones of Canada, Part II, Maritime Provinces.
  Memorandum Series No. 61—Zinc Dust Consumption of Canadian Gold Mines 1931-32 and 33.

*Toronto Harbour Commissioners:*
  Annual Report, 1933.

*Institution of Mechanical Engineers:*
  List of Members.

### Technical Books, etc., Received

Universal Spiral Tables for Railroad and Electric Tramway Lines, by E. S. M. Lovelace, M.E.I.C.

Carnegie Pocket Companion, 1934. (*Carnegie Steel Company, Pittsburgh, Pa.*)

Steel Construction, January 1934. (*American Institute of Steel Construction.*)

Railways and Roads in Pioneer Development Overseas, by J. E. Holmstrom. (*P. S. King and Sons Limited, London.*)

The Engineering Index, 1933. (*American Society of Mechanical Engineers.*)

# BOOK REVIEWS

## Industrial Radiography

*By Ancel St. John and Herbert R. Isenburger, Wiley and Sons, New York, 1934. 6½ by 9¼ inches, 232 pages. Figs., photos. $3.50. Cloth.*

Reviewed by G. St. G. Sproule, M.E.I.C.* and H. T. Hamon†

This is an excellent book in every way: well planned, well written and well printed. The authors modestly assert that no attempt has been made to produce a scientific treatise; nevertheless the sections on fundamentals, clearly written as they are, are extensive enough to tax the comprehension of those who have not kept up their physics. Other sections are proportionally thorough. Operating details and interpretation, the phases with which most engineers will be chiefly concerned, are very complete and lucid in their treatment. Careful emphasis is placed on the need for thorough protection against the high voltages and dangerous radiations, and on how to attain it. The publication of this book is most timely.

A few years after the War, Dr. St. John gave a public lecture at McGill Physics building on application of X-ray other than medical, a comparatively new subject; since then industrial radiography has become a matter of course, and to some—for example the users of modern high pressure boilers and other "pressure vessels"—a matter of absolute necessity.

Last winter the Montreal Chapter, American Society for Metals, sponsored a very interesting lecture by the Victor X-Ray Corporation (G.E.) and the Metallurgical Department at McGill University is now radiographing welds, castings, etc., for local investigators. A new tool is well established in the hands of engineers.

One minor criticism might be made: regarding the use of the word "exograph." It seems hardly necessary to add a word of so dubious parentage to an already overburdened language.

*Assoc. Professor of Metallurgy, McGill University, Montreal.
†H. T. Hamon, Victor X-Ray Corporation, Montreal.

## Traffic Survey Engineering Manual

*Prepared under the direction of Sidney J. Williams, Director of Safety and Traffic Surveys, and Peter J. Stupka, Assistant Director of Traffic Surveys, Federal Civil Works Administration, by Burton W. Marsh, Director, Safety and Traffic Engineering, American Automobile Association, Earl J. Reader, Traffic Engineer, National Safety Council, and Maxwell N. Halsey, Traffic Engineer, National Bureau of Casualty and Surety Underwriters.*

The library of The Institute is in receipt of a 142-page mimeographed report entitled "Engineering Manual for Traffic Surveys" prepared under the direction of Sidney J. Williams and Peter J. Stupka, Director and Assistant Director of Safety and Traffic Surveys, Federal Civil Works Administration, U.S.A.

It is interesting to note that this manual developed in accordance with a national programme of uniform street traffic surveys throughout the United States, and is in connection with the operation of the Civil Works Administration and thus offers every community a chance to make a reliable traffic survey and further, helps to answer the problem of what kind of work to give the so-called "white collar" class.

Through having uniform studies it will be possible to compare results with data obtained in a similar manner in other cities and, if necessary, advice may be obtained from a Federal Civil Works Associate Director or Traffic Engineer, a number of whom have been appointed in various regions throughout the States. Further, each community making a survey is asked to submit certain summarized data to the Federal C.W.A. in order that national analyses and recommendations can be made.

The manual is divided into fifteen sections covering the method of organizing and conducting fourteen important studies of a traffic survey and includes copies of field and office forms and detailed instructions for their use.

Included are a General Introduction and Recommendations, Accident Analysis, Vehicle Volume Count, Vehicle Speed Study, Observance Studies, Traffic Law Enforcement, School Child Pedestrian Practices, Inquiry among Drivers, Street Parking and Cordon Count.

In the introduction are included particulars on the selection, training and supervision of the personnel who are to make the survey and further, for example, under the heading Accident Analysis provision is made to obtain data for a "Worst Corner" list, Collision and Condition diagrams and under Traffic Law Observance particulars are compiled on Vehicle and Pedestrian Observance of stop and go signals, Vehicles Observance of stop signs and Hand Signalling.

In fact, many advantageous studies are outlined, but as it is pointed out, all studies that might be desirable in some surveys cannot be included, however it makes an excellent guide and should prove of service to many municipal engineers.

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*The Toronto Industrial Commission* this year completes five years of operation. Since it was established in 1929, 122 industrial concerns, the majority of them either British or United States manufacturers, have made use of the services offered by the Commission and have commenced manufacturing operations in the Toronto area. Of this number, 101 are operating their own factories, occupying more than one million square feet of floor space, with plant investment of over $5,000,000, while the remainder are having their products made by Toronto manufacturers.

## The Multiplex Aero-Projector

*Mr. Heinz Gruner of the United States Corps of Engineers, Experimental Mapping Division, recently gave a most interesting address before the Ottawa Branch of The Institute, his subject being "The Multiplex Aero-Projector." A report of this appears on page 379 of this issue of The Journal. There were, however, many details of the working which time did not permit Mr. Gruner to cover, and Mr. F. H. Peters, M.E.I.C., has been good enough to give a few further details and his impressions of this equipment, which are given below.*

The multiplex aero-projector and accessories constitute a very portable equipment for small scale mapping of topography from the usual type of vertical air photographs—that is air photographs obtained by a single lens camera suspended vertically and photographing from a uniform altitude in parallel flights, making exposures at equal intervals to give an overlap in the line of flight of about sixty per cent. The spacing of the flights must be such as to give some side or lateral overlap in adjacent strips.

After the photography is obtained, the roll of film is developed and is passed uncut between two glass plates contained in a fixed reducing camera, which results in giving a print on glass, the original photograph 8 inches square being reduced in dimensions thereby to 1½-inch size. Provision is made in the reducer for adjusting the original exposed negatives into a fixed position so that the resulting reduced positives on glass will show calibration marks required for their subsequent insertion in the projector, in their correct position. The reduced diapositives are obtained on a very fine grained emulsion and the size of the reducing apparatus would indicate that a wide angled short focus lens is employed, a graded filter being used to obtain uniformity in the density of the reduction on glass, the reduction factor being about five times.

Nine projectors are supported on a horizontal bar which is adjustable in height and can be tipped and tilted within the range required. In these nine projectors are inserted nine diapositives or prints on glass of nine consecutive vertical air photographs taken in a strip. Each projector is equipped with a lens of about 2 inches focal length by which is projected on the tracing screen below an image enlarged about six times from the diapositive. Thus the projected image from which the plotting is done, is slightly larger in scale than the original field negative.

In setting and plotting, one overlap is examined at a time and use is made of complementary colours to produce a stereoscopic effect. The projection to be viewed by the left eye is for instance projected in a light of a colour which the left eye only can see. This is effected by using a red filter in the projector and a similar red filter spectacle glass over the left eye. The overlapping view is projected in a blue green light by similarly inserting a blue screen filter in the projector and a spectacle glass of blue green filter over the right eye. The observer is seated beside the table on which the projection is made, or on which the tracer screen is moved in a position in which his eye base roughly parallels the horizontal rod supporting the projectors, corresponding in direction to the strip of vertical air photographs. For examination of the projected images a small circular white screen is employed. This screen is adjustable in height and can be moved by hand over the paper on which the plot is traced on its horseshoe support. The screen has a small index or floating mark centrally marked on it, or a small centrally illuminated hole vertically under which is the pencil which traces the features to be mapped. The manner of using the tracer and its construction is very similar to that described by the late Dr. E. Deville in a paper on the "Use of Wheatstone Stereoscope in Photographing Surveying," read before the Royal Society of Canada in 1902.

For orientation of a projector so that the diapositive occupies relatively to the plane of the map the same position which the photograph occupied relative to the horizontal plane when the view was taken, control stands somewhat similar to the tracer screen are employed. These are placed over each control point and set at its elevation called for by the scale of the plot. The distance between adjacent projector lenses corresponds to the respective air base expressed to the scale of the plot. It is understood that the mutual orientation of an adjacent pair of projectors can be made by examining and correcting the stereoscopic result in various portions of the projected images and the time consumed in this operation would appear to represent a very important part of the time employed in producing the map. After the first pair of projectors have been set in correct position, the third projector can be adjusted into correct orientation with the first two, and so on until the ninth or last projector on the horizontal bar is reached. If control is available at this point, the adjustment of the nine projectors to it can then be made. The drawing of contours is effected by setting the screen of the tracer at the elevation expressed to the plotting scale, above or below the datum plane, of such contour and guiding the tracer by hand over the paper in a manner to keep the index mark in apparent contact with the ground shown in relief in the plastic image. Plotting of features is effected by raising or lowering the tracer screen and moving it over the table until the index of the tracer just touches the ground at this feature in the plastic image, the pencil then being released to mark the position on the plan beneath it.

Comparing the use of the multiplex aero-projector with methods of plotting vertical air photographs employed by the Topographical Survey as described in the following paragraphs, it might be noted that apart from a reflecting stereoscope of the Wheatstone type, no other instrument is used by the latter organization.

Contact prints from the field negatives are examined in pairs under the stereoscope and the principal point base common to each pair of photographs is marked on the prints by the stereoscopic method, a procedure which involves about two minutes for each pair of photographs. Auxiliary points, one on either side of the principal point base and lying normal to it from the principal point a distance about equal to the principal point base are next selected and marked two for each photograph. These identical points are next identified and marked on adjacent prints, either visually or by using stereoscopic markers. Tie points to adjacent strips separated by four or five or more overlaps are similarly selected and marked. On the assumption that the photographs are angle true at the principal point, a strip structure is drawn to the approximate scale of the photography by the usual radial or intersection method, by which a plot showing the principal points, auxiliary points and tie points on a uniform scale is produced. The overall scale of this strip plot is determined by comparing the distance between ground control points as plotted with their true distance. This plot is made on transparent linen or Lumarith and the detail of topography, culture, and water features is next added. If contours are also to be shown, they are first drawn on the photographs—every second photograph of the strip, and are based on spot heights obtained in the field. These spot heights are supplemented in the office by use of a stereoscope equipped with grid plates and used for parallax measurements. Exposing at equal intervals in the air produces a uniform length of air base, and so the average length of air base can be determined from the principal point plot. Knowing the flying height, the focal length of the lens employed and the air base, parallax differences on the print corresponding to differences in relief of the ground can be obtained and used with the spot heights for fixing other additional heights on which the contouring is based. With the net work of heights the topographer draws the contours on the photographs as viewed in a reflecting stereoscope. The contours are then transferred to the strip plot, giving to each contour a displacement similar to that as shown by the plot of detail in its vicinity, and of about the same height.

When all the information to be included in the map is plotted on the strip, the whole is photographically or otherwise brought to the scale of the assembly and compiled on a projection sheet, from which the final drawing is made.

The photography is usually obtained by photographing with a wide angle single lens camera at or near the service ceiling of the aircraft. This gives a scale of photograph larger than that of the published map, but it is fixed by the equipment available and it would be preferable from an economic standpoint if this range were reduced.

Without having had experience with the multiplex aero-projector it is difficult to estimate its capacity or adaptability or order of accuracy, or to make a comparison with the graphical radial methods in use. It is in reality a camera plastica machine adapted for stereoscopic vision and equipped with a floating mark, and highly useful for instructional purposes.

## Centenary of Gottlieb Daimler

Of the many eminent German engineers of the latter half of the nineteenth century, Gottlieb Daimler, who was born on March 17th, 1834, a century ago, and died on March 7th, 1900, will always be remembered for his work on the internal-combustion engine and the construction of the first light high-speed engine using spirit as fuel. His patent for this type of engine was taken out in Germany on December 16th, 1883, and two years later, in the gardens at Cannstatt, he made his first trial with a vehicle fitted with one of his engines. That same year, Benz also brought out a motor vehicle, but whereas the speed of his engine was only between 200 r.p.m. and 300 r.p.m., the engines of Daimler revolved at 900 r.p.m., and were thus the forerunners of the petrol engines used to-day in motor cars and aircraft.

Daimler was born at Schorndorf, and became a mechanical engineer. From the shops of a machine-tool factory at Grafenstaden, in 1857, he entered Stuttgart polytechnic, and then had a varied experience in England and Germany. At the age of thirty-eight, in 1872, he became technical manager to Langen and Otto, who had founded the famous Gas-motorenfabrik Deutz A.-G., near Cologne. Together the partners had evolved the fairly successful atmospheric gas engine, and Otto was engaged on further experiments, which, as everyone knows, led him in 1876 to the invention of the all-important four-stroke cycle for internal-combustion engines. For many years the Deutz firm was fully occupied with the construction of the new "Otto" gas engines, but Daimler, realizing the possibility of further develpoments, left Langen and Otto, and in 1882 set up an experimental workshop at Cannstatt. He did not have to wait long for success, for in 1883 he was able to patent his high-speed spirit engine, and in the next two or three years built, first a form of motor-bicycle, then a motor car and a motor boat. In 1887 he sold the French rights for the use of his patents to M. Sarazin, who induced the engineering firm of Panhard and Levassor to take up the manufacture of motor cars. Daimler, himself, in 1890, founded at Cannstatt the well-known Daimler Motoren Gesellschaft, and with this he remained connected, mainly in an advisory capacity, until his death.—*Engineering.*

## Valuation of Non-Metallic Mineral Deposits

*by Marc Boyer, S.E.I.C.*

**Abstract of paper presented before the Quebec Branch of The Engineering Institute of Canada, February 12th, 1934.**

Mineral products may be subdivided into two groups: metallic and non-metallic. From an engineering point of view, these two groups parallel each other closely, but, if viewed from an economic standpoint, there is a strong distinction between them.

Any complex metallic ore found can be reduced to a metal of standard purity which can be marketed through some established sales channels, whereas the marketing of a non-metallic mineral involves intricate problems; the market price of the metal is another distinction between the two groups. Non-metallics are generally low-priced and abundant; therefore the geographic situation of the deposit becomes more important than when dealing with deposits of the higher-priced metallic ores.

Non-metallic substances may be divided into three groups:

1. Minerals whose "place value" (geographic situation) is paramount such as cement materials, clays, limestone, marble, salt, slate, etc.
2. Minerals whose physical and chemical characteristics are paramount, these are: graphite, asbestos, bauxite, talc, sulphur, etc.
3. Minerals for which specifications are rigid but where "place value" is also of importance; some of these are: barytes, bentonite, feldspar, magnesite, etc.

The elements of the valuation of non-metallic mineral deposits may be summarized as follows:

(*a*) Available market for the raw and finished product.
(*b*) Quality and extent of the deposit.
(*c*) Geographic situation or place value.
(*d*) Transportation facilities and costs.
(*e*) Mining and milling facilities and costs.
(*f*) Profitable return on investment.

*Available Markets:* In contrast with metallic ore deposits where the marketing problem is relatively simple, the question of securing a market for most non-metallic substances is difficult and often considered as more important than the deposit itself. When attempting a survey of the market with a view to opening up a new deposit, the following factors should be carefully weighed: the total tonnage absorbed within the area that can be served by the new deposit, price, importance of similar deposits in the district, strength of competitors, seasonal fluctuations, etc.

*Quality and Extent of Deposit:* These are important factors and it is paramount that the physical and chemical characteristics of the substance be known before it is offered for use to prospective consumers; should the quality respond to the accepted standard, one should then ascertain the extent of the deposit in view of estimating its total approximate value.

*Geographic Situation—Transportation:* As non-metallic mineral substances command a low price as compared to metals, their marketing radius is limited by prohibitive freight charges and by competition from similar deposits in adjoining districts. The distance from principal marketing centres and freight rates should be studied and compared with those of already established enterprises in the area.

*Mining and Milling:* A study of mining and milling costs should reveal whether these compare favourably with the costs of producers already established and if the expected margin of profit is sufficient to withstand a possible cut in price due to competition or to a possible momentary demoralized condition of the market.

*Profitable Return on Investment:* What is considered a profitable return on investment? This return is generally viewed in connection with the element of risk inherent to the enterprise; favourable conditions may not last long, new products may come in, tariffs and market centres may change, etc. An annual return of 25 to 40 per cent or 50 per cent on a highly speculative venture is not considered out of proportion by many experienced operators; however, on a ten year investment, 15 per cent would still be conservative.

The above information may appear elemental but many failures in the non-metallic mineral field are the direct result of one or more of these major points.

## Exposition of Power and Mechanical Engineering

The Eleventh National Exposition of Power and Mechanical Engineering will be held this year at the Grand Central Palace, New York, from December 3rd to 8th, 1934. Coming in December of the present year, the power show is an important point in a four-year period, including two years since the last one, and with two years before the 1936 power show. The outstanding success indicated for the exposition is coupled with increased purchasing power and renewed industrial modernization in all of the fields which it serves. The value of this year's event should be outstanding both to the exhibitors and to the men from engineering and industry who attend. As in the case of previous expositions, the International Exposition Company are managers, with Charles F. Roth personally in charge.

# BRANCH NEWS

## Hamilton Branch

*A. Love, A.M.E.I.C., Secretary-Treasurer.*
*Reported by T. S. Glover, A.M.E.I.C.*

Visit to Soaking Pit Building, Dominion Foundries and Steel Limited

Hamilton has many claims to distinction in addition to a rugby team and a mountain. The latest is the erection of the first "100 per cent Canadian" steel building.

Two parties of the Hamilton Branch members of The Institute visited the plant of the Dominion Foundries and Steel Limited on Saturday, June 9th, 1934. The new building contains a soaking pit and heating furnace, and embodies some very heavy steelwork. The main structure of the mill building was fabricated and erected by the Hamilton Bridge Company. Their part of the contract included columns of the conventional I section, but made of plates rolled by the Dominion Foundries and Steel in this plant and welded together. Another interesting feature was the crane runway which had beams made up of locally rolled plates welded together.

Original designs called for imported rolled sections for these parts but the structural sections were redesigned by the Dominion Foundries and Steel engineering staff so that Canadian steel could be used entirely. Angle sections were rolled either in Hamilton or at the Soo, while for purlins, locally rolled plates were pressed into channel shapes.

One particular advantage of using welded columns was clearly demonstrated on the columns which carried the crane runway, the flange carrying the crane load was made of thicker plate than the other. By this means of construction additional metal could be concentrated at the point where it was needed most.

Over four hundred thousand bricks were used in the furnace and pit construction. One particular brick could not be obtained in Canada but was imported from South Africa. The heavy beams and columns in this particular part, also of the welded type, were fabricated and erected by the Dominion Foundries and Steel.

The furnace equipment is of the very latest type on the North American continent and was all made locally.

About twenty-five members in the forenoon and forty in the afternoon took this opportunity of seeing the latest addition to Hamilton's industrial buildings, and they were received with the customary hospitality of the Dominion Foundries and Steel Limited.

## Lethbridge Branch

*E. A. Lawrence, S.E.I.C., Secretary-Treasurer.*
*Wm. Meldrum, A.M.E.I.C., Branch News Editor.*

On Monday evening, June 4th, 1934, a motion picture of the British Electrical Grid was shown at a special meeting of the Lethbridge Branch of The Engineering Institute of Canada, attended by about sixty, with C. S. Donaldson, A.M.E.I.C., presiding. These films, eight in number, were a presentation of the British Electrical Board which loaned them to The Engineering Institute of Canada to be shown at their different Branches throughout the Dominion. Six reels were on power, showing the manufacture of copper and aluminum conductors, high voltage cables, erection of steel towers and other equipment. The other two reels showed the operation of the generating and transmission system from the plants to the consumers.

Small individual electric power stations have been amalgamated into a single network which is called the British Electrical Grid.

In the head power station the electricity is generated by steam and transmitted to a transforming station where it is raised to 132,000 volts. At all receiving stations the incoming current is measured and half hourly records are made. Current is supplied in bulk for electric railways, being converted for use by the trains.

Receiving stations reduce the voltage from 132,000 to 33,000 and main grid distributing stations to 11,000 volts.

Following the projection of the films, J. T. Watson, A.M.E.I.C., gave a few explanatory remarks and answered several questions. A motion was passed tendering the thanks of the Branch to Mr. Cyril Watson who operated the projector and to G. H. Thompson, A.M.E.I.C., of the Calgary Power Company, and Mr. Forbes Roberts of the Montreal Engineering Works of Regina, through whose kindness the attainment of the films was made possible.

## London Branch

*H. A. McKay, A.M.E.I.C., Secretary-Treasurer.*
*J. R. Rostron, A.M.E.I.C., Branch News Editor.*

By kind invitation of our former Secretary, W. R. Smith, A.M.E.I.C., the annual outing of the Branch was held on June 23rd, 1934, at his residential farm west of Byron.

Mr. Smith boasts of a fair-sized swimming pool on his estate and several of the party took full advantage of it. Canoeing was also indulged in with a mimic towel battle between two of the canoeists.

The rifle shooting at targets proved very popular, the prizes going to Majors Ross and Dickinson and J. Young.

An "al fresco" supper was provided and much enjoyed.

Our host gave us an example of bare-back riding on a somewhat restive pony and while seated on its back was the recipient of a hearty vote of thanks for his hospitality, proposed by J. R. Rostron, A.M.E.I.C., which was unanimously carried.

## Moncton Branch

*V. C. Blackett, A.M.E.I.C., Secretary-Treasurer.*

ANNUAL MEETING

The annual meeting of the Branch was held on May 31st. Professor H. W. McKiel, M.E.I.C., chairman of the Branch, presided. The annual report and financial statement was presented and on motion adopted. The chairman read a letter which he had addressed to Rt. Hon. R. B. Bennett, Premier of Canada, supporting the action taken by Council in urging the Federal government to employ engineers to make detailed engineering studies of contemplated government works, before construction was commenced or tenders called for. A resolution was passed approving the chairman's letter. On motion of F. O. Condon, M.E.I.C., seconded by G. E. Smith, A.M.E.I.C., a vote of thanks was tendered the retiring officers, and also the members of the teaching staff of Mount Allison University for their generosity in furnishing speakers for Branch meetings during the year. The report of the scrutineers was received and the officers for 1934-35 announced.

Brief remarks were then made by the outgoing and incoming chairmen.

## Ottawa Branch

*F. C. C. Lynch, A.M.E.I.C., Secretary-Treasurer.*

INSPECTION OF C.R.C.O. BROADCASTING PLANT

On Saturday afternoon, May 26th, 1934, members of the Ottawa Branch and their friends made a tour of inspection of the recently completed modern equipment of the Ottawa station of the Canadian Radio Broadcasting Commission.

The party met at the studios of the Commission on the eighth floor of the Chateau Laurier, where they were shown the control equipment for the studios and were given a demonstration of a new and novel method of continuous recording. In this method, magnetic recording takes place on a long narrow steel tape, the modulation of speech or music being converted into variable density magnetism. The process is quite analagous to variable density movie sound-track systems.

When the tape bears a record, it may be filed away for future use or it may at any time be cleared of the record and used again for another one.

In the apparatus as at present designed, facilities for clearing the tape of a previous record, for recording a new one, and for sending out a record to be broadcast, are all included in the one instrument. It is a simple matter to record any broadcast on the tape at the same time as it is being sent out.

After their inspection of the studios the party motored to the transmitting station and antenna system, located at Hawthorne about five miles out of the city. Here the two 200-foot towers were inspected, as well as the transmitting station itself, which is housed in a neat newly-erected bungalow-type of building.

Guides to explain the various features of both studios and transmitter were made available by the Broadcasting Commission, through the courtesy of Lieutenant-Colonel W. A. Steel, A.M.E.I.C., Commissioner.

A NEW INSTRUMENT FOR PLOTTING FROM AERIAL PHOTOGRAPHS

A large number of the members of the Ottawa Branch availed themselves of an invitation to attend an evening meeting on June 15th, 1934, at the lecture hall of the National Research Laboratories, held under the auspices of the Associate Committee for Survey Research of that institution. At this meeting a demonstration lecture on photogrammetric apparatus was given by Mr. Heinz Gruner, of the United States Corps of Engineers, Experimental Mapping Division.

Mr. Gruner traced the history of the aerial camera and the development of methods of plotting from aerial photographs, paying particular attention first of all to such instruments as the aerocartograph and the stereoplanigraph. He then took up a considerable part of his time with an explanation of the multiplex aero-projector, a newly-designed instrument for the preparation of small-scale maps from aerial photographs. His address was illustrated by lantern slides and was followed by a demonstration with a multiplex aero-projector instrument, the latter having been set up for demonstration purposes by Mr. Gruner and by Mr. E. O. Messter, general manager of Zeiss-Aerotopograph, of Jena, Germany.

The multiplex aero-projector is a stereoscopic plotting instrument for producing maps by way of the simultaneous spatial projection of several overlapping vertical aerial photographs of a strip, or series obtained when the plane taking the photograph flies in a straight line. It is intended to have a place between primitive methods of plotting and the large and costly universal plotting machines which for many classes of work are unnecessarily precise. Whereas, for instance, the accuracy of contouring by the use of a stereoplanigraph may be about 1 to 1,500, in the multiplex aero-projector instrument it is only about 1 to 500.

Reduced negatives (1½ inches square) of two successive overlapping vertical aerial photographs are placed in two adjacent projectors, provision being allowed for the adjustment of these projectors in three dimensions to correspond in scale with the actual positions of the original photographs in space when taken. By transmitted light the photographs are projected downward, one through a blue filter and the other through a red filter. The combined images when intercepted at the proper place, and viewed through a pair of two-coloured spectacles (one lens blue and the other red) will give a clear and striking stereoscopic impression of the configuration of the ground. Methods are provided whereby the topographic data so viewed may be traced by the operator on to the plane surface of a drawing board beneath.

Any reasonable number of projectors may be employed in the instrument, consequently the strip of overlapping vertical aerial photographs may cover a corresponding distance in nature between points of control. In practice, as many as nine projectors have been regularly provided for the instrument. As may be expected, at least three points of control are required. The instrument gives best results when the plotting scale is five or six times that of the finished map.

Major E. L. M. Burns, A.M.E.I.C., of the Surveys Section of the Department of National Defence, acted as chairman of the meeting.

*Further details furnished by F. H. Peters, M.E.I.C., appear on page 377 of this issue.*

## Quebec Branch

*Jules Joyal, A.M.E.I.C., Secretary-Treasurer.*

Le 12 février 1934, au cours d'une soirée organisée par notre Section en vue de mettre en vedette nos jeunes ingénieurs de Québec, nous avons eu le plaisir d'entendre, en outre de MM. Marc Boyer, S.E.I.C., et E. D. Gray-Donald, A.M.E.I.C., Monsieur Maurice Royer, I.C., du bureau Ricard et Royer de Québec et directeur de l'Observatoire de la vieille capitale.

Les quelques notes qui vont suivre ne donnent qu'une pâle idée de l'intérêt soulevé par la causerie de M. Royer sur un sujet qui intéresse tout le monde: "La Météorologie Moderne."

LA METEOROLOGIE MODERNE

Les phénomènes météorologiques ont un rôle si important qu'ils ont été étudiés de tout temps, d'abord par de simples constatations, basées sur la seule appréciation et dont la nation du beau ou du mauvais temps est la note dominante, en correspondance avec certains faits particuliers ou signes précurseurs dont on s'est efforcé de reconnaître les conséquences; de ces remarques beaucoup ont donné naissance à des proverbes bien connus mais nous verrons par la suite que nous sommes loin de l'époque où l'on disait: "La lune a les cornes en l'air, on va avoir du *frette*."

Cependant, ces données transmises par les générations ne sont pas sans valeur et de nos jours encore, marins et paysans en tirent parfois des pronostics d'une grande justesse.

Toutefois, la science est plus exigeante et l'on s'est efforcé d'étudier rationnellement les lois de ces phénomènes fort complexes; les progrès de la Météorologie furent lents et les observations vraiment importantes ne datent que de l'invention du baromètre et du thermomètre dont les indications constituent la base fondamentale.

Le but de cette science doit tendre surtout à formuler des indications de plus en plus précises relativement à la prévision des temps, surtout à propos de la formation des orages, tempêtes, cyclones, ce qui est d'une importance capitale pour la sauvegarde de la récolte ou de la navigation; cette prévision s'affirme d'une nécessité impérieuse pour l'aviation dont le rôle, dans notre vie économique, devient chaque jour plus grand.

L'on sait que le baromètre indique la pression atmosphérique et qu'au baromètre bas correspondent les tempêtes et la pluie, tandis que le baromètre haut annonce habituellement du beau temps.

Depuis le milieu du siècle dernier, l'application du télégraphe à cette science a permis de suivre en quelque sortes les mouvements atmosphériques sur des cartes sur lesquelles on trace les lignes d'égale pression (isobars).

Le Service Météorologique du Canada fut organisé en 1872 et les résultats des observations quotidiennes de ce Service sont compilés sur des cartes qui révèlent le fait qu'il existe des centres de basse pression, d'autre de haute pression, et montrent qu'autour de ces centres les vents prennent des directions bien déterminées.

La comparaison de ces cartes qui se succèdent de jour en jour fait voir que ces centres eux-mêmes se déplacent ordinairement (au Canada) de l'ouest à l'est; ces cartes permettent aussi de constater qu'entre deux centres de pressions voisins il existe une zone de grands vents et de mauvais temps, zone qui se déplace en même temps que les centres de pression.

Le conférencier nous a aussi expliqué comment les vents de l'est marchent, en quelque sorte, de reculons; la zone de mauvais temps se déplace vers l'est tandis que le vent qui l'accompagne se dirige vers l'ouest.

## Sault Ste. Marie Branch

*H. O. Brown, A.M.E.I.C., Secretary-Treasurer.*

The regular monthly meeting of the Sault Ste. Marie Branch was held on Friday evening, May 25th, 1934, following the regular dinner at the Windsor hotel, with an attendance of thirty-two.

E. M. MacQuarrie, A.M.E.I.C., chairman of the Branch, was in the chair. The letter of resignation of G. H. E. Dennison, A.M.E.I.C., as secretary-treasurer was read and the appointment of H. O. Brown, A.M.E.I.C., as secretary-treasurer for the balance of the 1934 term by the executive was approved by the meeting. Mr. Dennison has taken a position with the Carborundum Company of Canada and the members of the Branch wish him every success in his new work.

After the business of the evening, the chairman introduced the speaker, D. S. Lloyd, A.M.E.I.C., chief engineer of the Dominion Oxygen Company Limited, Toronto, who addressed the meeting on "The Value of Engineering Supervision of Oxy-Acetylene Welding and Cutting."

Mr. Lloyd's address was well illustrated with lantern slides and the most up-to-date technique was explained by the speaker. The various machines now used for cutting, shaping and welding in the larger shops doing this work was a revelation to many present.

The Branch was pleased to have as visitors a number of engineers from the Carbide Company, Sault Ste. Marie, Michigan. The visitors expressed their thanks for the privilege of attending the dinner and the address, both of which they enjoyed very much. They also expressed a desire to have the opportunity to attend similar future meetings and it is trusted that such visits can be arranged.

There were also present for the address a number of welding operators from the local manufacturing plants who were given an opportunity to attend. These men asked several practical questions on operation after the address and these questions and answers added greatly to the information obtained on the subject.

The meeting closed with an expression of thanks from the Branch to Mr. Lloyd for his very interesting paper.

## An "All-Service" Vehicle for Passenger Transportation

**Abstract of a paper by Martin Schreiber, appearing in the June, 1934, issue of the S.A.E. Journal.**

Street car operation has demonstrated the efficiency and low cost of central-station power supply in the operation of local transportation vehicles. No other form of power has the same degree of efficiency as electricity in delivering the energy needed to perform varying quantities of work.

The trolley-bus on the other hand has many advantages; it is quieter and can accelerate faster than any other highway vehicle of equal seating capacity, moreover, its operation is not limited to trolley rails even if it does require overhead wires.

The gas motor bus for real flexibility in highway transportation has no equal. It is able to manœuvre freely in the flow of traffic and can run on and off to a garage by whatever route is most desirable. It can also detour on other highways than its usual route if necessary.

Is it possible to unite into one vehicle at a reasonable cost all the desirable qualities of street cars, trolley-buses and gas motor buses? The answer is yes, through the use of the gas-electric bus as now developed having a gas engine and an electric generator with two propulsion motors. By the addition of trolley poles and control mechanism to the gas electric bus one has a vehicle that may be used either as a trolley-bus when the engine and generator are omitted or as a motor bus by the simple operation of pulling down the trolley poles. Here is a vehicle that meets the requirements of the trolley bus or of the ordinary street motor bus, and at the same time, the generating and distribution portion of the plant of the street railway can be preserved.

At a recent experimental trial of the first all-service vehicle at Weehawken, N.J. in January, 1934, tests showed that this vehicle negotiated a 6 per cent grade operating as a trolley-bus at a maximum speed of 30 m.p.h. with a full load of 30 passengers. This compares with a normal maximum speed on the whole of ordinary gas-electric buses of 10 to 13 m.p.h.; street cars, 12 to 15 m.p.h.; gas mechanical buses, 15 to 18 m.p.h.; and private cars, 20 to 40 m.p.h.

The all-service vehicle was equipped with a 400 cubic inch poppet-valve engine which develops 105 h.p. at 2,000 r.p.m., a generator, and two propulsion motors. Seating capacity was 29 passengers.

Inasmuch as the gas-electric motor bus is the basis of the all-service vehicle, a few particulars may be of interest. These gas-electric units are simply standard buses manufactured by various companies with capacities ranging from 25 to 73 passengers. Generally the clutches, transmission and differentials were omitted and electric generating and propulsion motors added. The weight of the bus is approximately 1,400 pounds more for the two-motor and 1,100 pounds more for the single-motor equipment than comparable gas mechanical buses.

One of the principal points about the gas-electric bus is its ability to give an efficient account of itself as to upkeep. Things which have militated against the wider use of the gas-electric bus in the past are engineering performance, weight and fuel. These conditions have been largely rectified and higher speeds, compression and improved bearings with more positive lubrication are now available, and since 1925, the the weight per horse power for electric drives has been reduced about 10 per cent. It is true that the fuel cost is 15 per cent more to operate a gas-electric than a straight gas bus, but this additional cost requires only 4 per cent faster schedule to offset it and this is easily obtainable.

In conclusion, the all-service vehicle if compared with the gas motor bus will be found to be considerably more efficient for the same performance, inasmuch as the electric motors may be wound to take care of overloads without interfering with the efficiency of the average operation. The gas-electric features of the all-service vehicle not only eliminate clutch and transmission, but also the differential where there are two electric motors, so that on the whole it affords a smoother and quieter ride. The electric drive does not limit the position of the power plant which may even be placed cross-wise in the rear and under the body of the bus, where it can readily be accessible for repairs. Such an arrangement also lends itself to any replacement with improved power plants.

## List of New and Revised British Standard Specifications

(Issued during May, 1934)

B.S.S. No.

161—1934. Tungsten Filament General Service Electric Lamps. (Revision)
Covers general service lamps only. The remaining schedules for lamps other than general service remain in force and are renumbered B.S.S. No. 555—1934.

334—1934. Chemical Lead (Types A & B). (Revision.)
Provides for two qualities of chemical lead, "pure lead" and lead to which alloying elements have been added. Includes revision and amplification of all the methods of test.

541—1934. Determining the Rideal-Walker Coefficient of Disinfectants, Technique for.
Outline in close detail the method to be used for determining the Rideal-Walker Coefficient of Disinfectants.

548—1934. High Tensile Structural Steel for Bridges, etc., and General Building Construction.
Provides for steel of 37-43 tons per square inch. In other respects the form of the specification and requirements covered, follow closely the existing specification for ordinary mild steel for structural purposes (B.S.S. No. 15).

549—1934. Diacetone Alcohol.

551—1934. Normal Butyl Acetate.

552—1934. Amyl Acetate.

553—1934. Ethyl Acetate.
In these four specifications, limits for the physical and chemical characteristics of the material are laid down with the standard methods of test for determining these properties.

554—1934. Standard Temperature of Volumetric Glassware, Report on.
Standard reference temperature for British Standard volumetric glassware.

Copies of the new specifications may be obtained from the Publications Department, British Standards Institution, 28 Victoria Street, London, S.W.1, or, in Canada, from the Canadian Engineering Standards Association, 79 Sussex Street, Ottawa, Ont.

## Specifications for Classification of Coal According to Rank and Grade

Tentative specifications for the classification of coal according to rank and grade have recently been approved by a Sectional Committee on Classification of Coal which was organized in 1927 under the sponsorship of the American Society for Testing Materials and the rules of the American Standards Association, and draws its membership from various trade, technical and Governmental organizations interested in the composition, production, and utilization of coal.

The problem facing the committee was a difficult one. The composition and properties of coal vary over an extraordinarily wide range. Not only did the original plants from which the coal was formed vary in nature and kind, but the conditions surrounding the accumulation of the vegetable material differ greatly, as does the subsequent effect of pressure, temperature, and time in the geological ages that have followed the deposition of the original material.

An extended experimental study of the various kinds of coal found in the United States and Canada has been made. On this basis the committee has developed a system of classifying coal according to rank, ranging from lignite on the one hand to anthracite on the other.

The classification of coal according to *rank* is based on the composition and properties of the coal and essentially on those properties which are a result of the degree of metamorphism of the coal in its progressive alteration in the natural series from lignite to anthracite. This classification virtually is determined by nature and cannot be changed by preparing or washing the coal.

The classification of coal according to *grade* depends primarily upon the amount and nature of the impurities present, such as ash-forming constituents, sulphur, fusibility of ash, etc. The grade of a coal can be modified to some extent by methods of cleaning and preparation, and is expressed by its actual heating value as delivered and the percentage of fixed carbon, ash, sulphur, and fusibility of ash.

# Preliminary Notice

## of Applications for Admission and for Transfer

July 13th, 1934

The By-laws provide that the Council of The Institute shall approve, classify and elect candidates to membership and transfer from one grade of membership to a higher.

It is also provided that there shall be issued to all corporate members a list of the new applicants for admission and for transfer, containing a concise statement of the record of each applicant and the names of his references.

In order that the Council may determine justly the eligibility of each candidate, every member is asked to read carefully the list submitted herewith and to report promptly to the Secretary any facts which may affect the classification and selection of any of the candidates. In cases where the professional career of an applicant is known to any member, such member is specially invited to make a definite recommendation as to the proper classification of the candidate.*

If to your knowledge facts exist which are derogatory to the personal reputation of any applicant, they should be promptly communicated.

**Communications relating to applicants are considered by the Council as strictly confidential.**

The Council will consider the applications herein described in September, 1934.

R. J. Durley, Secretary.

* The professional requirements are as follows:—

**A Member** shall be at least thirty-five years of age, and shall have been engaged in some branch of engineering for at least twelve years, which period may include apprenticeship or pupilage in a qualified engineer's office, or a term of instruction in a school of engineering recognized by the Council. The term of twelve years may, at the discretion of the Council, be reduced to ten years in the case of a candidate for election who has graduated from a school of engineering recognized by the Council. In every case the candidate shall have held a position in which he had responsible charge for at least five years as an engineer qualified to design, direct or report on engineering projects. The occupancy of a chair as a professor in a faculty of applied science of engineering, after the candidate has attained the age of thirty years, shall be considered as responsible charge.

**An Associate Member** shall be at least twenty-seven years of age, and shall have been engaged in some branch of engineering for at least six years, which period may include apprenticeship or pupilage in a qualified engineer's office or a term of instruction in a school of engineering recognized by the Council. In every case a candidate for election shall have held a position of professional responsibility, in charge of work as principal or assistant, for at least two years. The occupancy of a chair as an assistant professor or associate professor in a faculty of applied science of engineering, after the candidate has attained the age of twenty-seven years, shall be considered as professional responsibility.

Every candidate who has not graduated from a school of engineering recognized by the Council shall be required to pass an examination before a board of examiners appointed by the Council. The candidate shall be examined on the theory and practice of engineering, with special reference to the branch of engineering in which he has been engaged, as set forth in Schedule C of the Rules and Regulations relating to Examinations for Admission. He must also pass the examinations specified in Sections 9 and 10, if not already passed, or else present evidence satisfactory to the examiners that he has attained an equivalent standard. Any or all of these examinations may be waived at the discretion of the Council if the candidate has held a position of professional responsibility for five or more years.

**A Junior** shall be at least twenty-one years of age, and shall have been engaged in some branch of engineering for at least four years. This period may be reduced to one year at the discretion of the Council if the candidate for election has graduated from a school of engineering recognized by the Council. He shall not remain in the class of Junior after he has attained the age of thirty-three years, unless in the opinion of Council special circumstances warrant the extension of this age limit.

Every candidate who has not graduated from a school of engineering recognized by the Council, or has not passed the examinations of the third year in such a course, shall be required to pass an examination in engineering science as set forth in Schedule B of the Rules and Regulations relating to Examinations for Admission. He must also pass the examinations specified in Section 10, if not already passed, or else present evidence satisfactory to the examiners that he has attained an equivalent standard.

**A Student** shall be at least seventeen years of age, and shall present a certificate of having passed an examination equivalent to the final examination of a high school, or the matriculation of an arts or science course in a school of engineering recognized by the Council.

He shall either be pursuing a course of instruction in a school of engineering recognized by the Council, in which case he shall not remain in the class of Student for more than two years after graduation; or he shall be receiving a practical training in the profession, in which case he shall pass an examination in such of the subjects set forth in Schedule A of the Rules and Regulations relating to Examinations for Admission as were not included in the high school or matriculation examination which he has already passed; he shall not remain in the class of Student after he has attained the age of twenty-seven years, unless in the opinion of Council special circumstances warrant the extension of this age limit.

**An Affiliate** shall be one who is not an engineer by profession but whose pursuits, scientific attainments or practical experience qualify him to co-operate with engineers in the advancement of professional knowledge.

The fact that candidates give the names of certain members as reference does not necessarily mean that their applications are endorsed by such members.

### FOR ADMISSION

ASSELIN—JEAN CHARLES LEANDRE, of La Tuque, Que., Born at Montreal, Jan. 24th, 1905; Educ., B.A.Sc., C.E., Ecole Polytechnique, Montreal, 1929; 1922, Quebec Streams Commission (survey); 1924 (summer), Dom. Water Power and Reclamation Service; 1925-26 (summers), Quebec Streams Commission; 1927, prospecting in Abitibi; 1928, Montreal Harbour Commissioners; 1929-32, field and office work with the late Fred. B. Brown, M.E.I.C.; 1932-34, field and office work, Quebec Streams Commission; at present, city engineer and manager, La Tuque, Que.

References: O. O. Lefebvre, P. E. Bourbonnière, J. P. Leclaire, H. Massue, H. A. Terreault.

BAIN—WILLIAM ALEXANDER, of Woodfibre, B.C., Born at Raphoe, Co. Donegal, Ireland, Sept. 25th, 1901; Educ., B.A.Sc. (Mech.), Univ. of B.C., 1926. R.P.E. of B.C.; Summer work—1921-22, mechanic, Britannia Mines. Instr'man., Geol. Survey. Mechanic, B.C. Silver Mines; 1926, safety engr., Brookes, Scanlon, O'Brien, Stillwater, B.C.; 1926-27, asst. elec'l. engr., Munic. of Point Grey; 1927-28, elect'l. contracting (ornamental street lighting); 1928-30, sales engr., power plant equipment; 1930, inspr., Vancouver Water Board and B.C. Electric Rly. (Penstocks, etc.); 1930 to date, constrn. engr., B.C. Pulp & Paper Co., special engrg. work and later res. engr., Woodfibre plant, B.C.

References: A. S. Gentles, W. H. Powell, W. O. C. Scott, P. H. Buchan, E. A. Wheatley.

BROWN—WILLIAM EDWARD, of Hamilton, Ont., Born at Bristol, England, June 12th, 1909; Educ., B.A.Sc., Univ. of Toronto, 1932; 1928 (summer), clerical work, Welland Ship Canal; 1929-30, preparation of monthly estimates on above; 1932-33, asst. engr., highway constrn., Rutherford and Ure, Engrs. and Surveyors, St. Catharines; 1933 to date, asst. foreman, rope dept., B. Greening Wire Co., Hamilton, Ont.

References: E. G. Cameron, G. F. Vollmer, C. R. Young, R. E. Smythe, C. G. Moon.

CAPE—JOHN MEREDITH, of Montreal, Que., Born at Montreal, April 29th, 1910; Educ., Two years Arts, McGill Univ. Grad., R.M.C., 1932; 1928 (summer), survey with Candn. International Paper; 1931 (summer), estimating dept., E. G. M. Cape & Co.; 1932-33, bldg. constrn., Enterprises Centrales-Françaises, Paris, France; 1933 to date, estimating, E. G. M. Cape & Co., Montreal, Que.

References: E. G. M. Cape, L. H. D. Sutherland, H. M. Jaquays, P. F. Sise, D. A. White.

CLARK—GEORGE, of 137 Eugenie St., Norwood Grove P.O., Man., Born at Baildon, Yorks., England, Nov. 14th, 1893; Educ., evening classes, electricity, maths., physics, St. Johns Technical School, Winnipeg. 1930, short course in geology, Univ. of Man.; 1910-11, chainman on constrn., C.P.R.; 1911-12, rodman on location, Medicine Hat-Calgary; 1912-13, rodman on constrn., Suffield S.W. br. and bridge over Bow River; 1916-19, dftsman. in field and office, Can. Nor. Rly.; 1919 to date, with C.N.R., as follows: 1919-20, transitman on location, various lines; 1920-25, dftsman. in office on land survey and gen. engrg. work; 1925 to date, res. engr. and dftsman. on water supply design and constrn., since 1930 on design and constrn. of modern electric drive automatic pumping installns.

References: H. A. Dixon, J. W. Porter, E. M. M. Hill, C. T. Barnes, T. C. Main, G. M. Pearston, W. Walkden.

COLPITTS—GORDON LLOYD, of Dartmouth, N.S., Born at Moncton, N.B., Sept. 6th, 1909; Educ., B.Sc. (Mech.), Nova Scotia Tech. Coll., 1933; 1928 (summer), instr'man., 1929-30, instr'man and chief of party, Laurentide Divn., and 1930 (Apr.-Sept.), asst. engr., lands and engrg. dept., Wayagamack Divn., Canada Power & Paper Corporation (now Consolidated Paper Corpn.); June 1933 to date, junior engr., Imperial Oil Refineries Ltd., Dartmouth, N.S.

References: R. L. Dunsmore, C. Scrymgeour, W. P. Copp, F. R. Faulkner, J. R. Freeman, W. B. Scott, A. A. Wickenden.

DUPUIS—RENE, of Quebec, Que., Bern at Pike River, Que., May 5th, 1898; Educ., B.A., College de St. Jean, St. Jean, Que., 1919. Elec. Engr., Univ. of Nancy, France, 1924; 1925-27, ap'ticeship., Can. Westinghouse Co., Hamilton, Ont.; 1927-28, Electric Service Corpn., Shawinigan Falls, Que.; 1928-30, repair shop, Shawinigan Water & Power Company, Three Rivers, Que.; 1930 to date, asst. supt., power divn., Quebec Power Company, Quebec, Que.

References: R. B. McDunnough, E. D Gray-Donald, J. U. Archambault, G. D. Moon, R. Wood, R. H. Mather, G. H. Cartwright, E. Drolet.

KING—ERIC CHARLES, of Island Falls, Sask., Born at Llanishen, Nr. Cardiff, Wales, Feb. 2nd, 1908; Educ., 1925-27, Technical Coll., South Wales and Monmouthshire, Cardiff; I.C.S., Grad. in Elec. Power House Course; 1924-25, ap'tice electr'n., Cooper & King, Electr'l. Contractors, and ap'tice steam engr., Penarth, Ponton & Dry Dock Co. Ltd., Cardiff, Wales; 1927-29, with Canadian Utilities Ltd., Calgary, as operator in power houses, plant office work, meter-reading and installn., etc., at Vegreville, Lloydminster, Watrous, Yorkton; 1929-30, field work, office work and Production tests, Meridian Oils Ltd., Calgary, Alta.; 1930-31, Calgary Power Company, lineman mtce. crew; 1931-33, unemployed; May 1933 to date, with Churchill River Power Co. Ltd., Island Falls power house as 3rd operator and latterly as relief second.

References: E. W. Bowness, G. H. Thompson, H. B. Sherman, R. Mackay, F. N. Rhodes.

MacGREGOR—KENNETH ROY, of Eganville, Ont., Born at Eganville, Nov. 6th, 1901; Educ., B.Sc. (Civil), Queen's Univ., 1925; 1924 (6 mos.), instr'man. and asst. engr., Renfrew County Highways; 1925 (May-Aug.), instr'man., hydrographic survey, Lake Nipigon; 1925-27, instr'man on prelim. layout and power house constrn. for H.E.P.C. of Ontario, at Hydro, Ont.; 1928-29, engr. and constrn. supt., Abana Mines, Dupuy, Que.; 1929-30, field engr. for Carter Hall Aldinger Co. at Seven Sisters power development, Manitoba; 1930-32, chief instr'man in charge of all layout for City of Winnipeg Hydro at Slave Falls, Man.; at present, foreman in charge, Race Horse Camp, Petewawa, Ont.

References: W. P. Wilgar, J. N. Stanley, W. L. LeRoy, J. W. Sanger, J. L. H. Bogart, D. S. Ellis.

MARCEAU—JULES P., of 5073 Bourbonniere St., Montreal, Que., Born at Montreal, Que., Aug. 25th, 1911; Educ., Diploma in Electricity, for three year day course, Montreal Technical School, 1929; 1929-1934, electr'l. and radio engrg. work, including power house, substation, metering, equipment, transmission and distribution lines, line inspr.

References: A. H. Pattenden, P. T. Davies, J. B. Woodyatt, J. S. H. Wurtele, J. A. L. Dansereau, L. S. Pariseau.

OLSEN—ALEKSANDER, of 5276 Saranac Ave., Snowdon, Montreal, Que., Born at Eidsvold, Norway, July 12th, 1890; Educ., Horten Navy College, Norway, 1906-08; 1908-10, dftsman., Myrens Engrg. Works, Oslo, Norway; 1910-12, machy. erection, Pusey & Jones, Wilmington, Del.; 1912-15, dftsman., John S. Metcalf Co., Montreal; 1915-16, office and machy. erection; 1916-17, designer, John S. Metcalf Co., Chicago; 1918-20, constrn. supt., mining refinery, Electro-kemisk, Oslo, Norway; 1920-23, engr. and asst. supt., constrn., Hofsfos Pulp & Paper Mills; 1923-25, engr. and supt., grain elevator constrn., Montreal Harbour, John S. Metcalf Co.; 1925-26, field engr., constrn., Montreal East, Ontario Gypsum Co.; 1926-27, night supt., Gatineau Mills constrn., Fraser Brace Co.; 1927-28, res. engr., elevator No. 3, Montreal Harbour, John S. Metcalf Co.; 1928-29, i/c of constrn., grain elevator, West Saint John, N.B., E. G. M. Cape Co.; 1929 to date, with the Atlas Construction Co., as follows: 1929-30, i/c of engrg. and machy. erection, Prescott grain elevator; 1930-32, supt., C.N.R. viaduct, Montreal; 1932-33, engr., Montreal Harbour concrete cribs; at present, estimator and engineer, Montreal.

References: A. S. Dawes, C. H. Gordon, L. Coke-Hill, H. R. Montgomery, G. B. Mitchell, G. R. Dalkin.

OLSON—HALDOR THEODORE, of Island Falls, Sask., Born at Dinant, Alta.; Educ., Diploma, Prov. Inst. of Technology, Calgary, 1927; I.C.S. Diploma in power house electric course; 1927-29, floorman and relief operator; 1929-30, interior wiring; 1930 to date, shift switchboard operator in charge of 36,000 kv.-a. hydro-electric central station with 110 kv. transmission system, Island Falls, Sask.

References: F. N. Rhodes, J. H. Ross, H. J. McLean, F. J. Robertson, S. J. Davies.

VERRIER—EDWARD JOHN, of Grand Falls, Nfld., Born at Rugby, England, Jan. 20th, 1899; Educ., 1916-21, Rugby Technical College (evenings); 1st Class Quebec Stat. Engr's. License; Assoc. Member, A.I.E.E.; 1916-21, five years articles at Messrs. Willans & Robinsons Ltd., Engrs., Rugby, England, and 1920-23, outside erection of steam turbines, English Electric Co. (amalgamated firms); 1923-24, student switchboard attendant, Preston Municipality; 1924-27, engr.-in-charge, Tembi Power House, S. Persia, Anglo-Persian Oil Co.; 1927-28, chief engr., Guayaguayare Field, Trinidad Leaseholds Ltd., (constrn.); 1928 (6 mos.), supt. of steam plants, Mexican Light, Heat & Power Co., Mexico City (resigned on account of altitude); 1929-31, asst. chief engr., Canada Sugar Refinery, Montreal; 1931 to date, supt. of steam plants and services, Anglo-Newfoundland Development Co., Grand Falls, Nfld.

References: K. G. Cameron, C. H. L. Jones, F. M. Pratt, H. S. Windeler, G. N. Thomas, N. S. Walsh.

WALKER—JOHN MARSHALL, of 7 Hammersmith Ave., Toronto, Ont., Born at Glasgow, Scotland, June 13th, 1890; Educ., Seven Winter Sessions (evening classes) at Technical Schools and home study. I.C.S. Course in Civil Engrg.; 1906-10, 4 years ap'ticeship, marine and gen. practical shop engrg., Dunsmuir & Jackson, Scotland, and Westman and Baker, and Can. Shipbldg. Co., Toronto; 1910-11, dftsman., Can. Gen. Elec. Co. Ltd.; 1911-14, surveying with the C.N.R., C.P.R., rlys. and bridges sections of the city of Toronto, and the Toronto Harbour Commnrs.; 1914-25, res. engr., Toronto Harbour Commnrs.; 1925-26, res. engr., Maple Leaf Stadium, Toronto; 1926-28, res. engr. on compressed air sewer tunnels, Toronto; 1928-30, with Nelson River Constrn. Co., concrete bridge, Lambton, docks, Hamilton, St. Clair Reservoir, Toronto, tunnel work, Leaside, as res. engr.; 1930-31, res. engr., water works tunnel, Toronto, and 1931 to date, engr. and chief dftsman., water supply section, Dept. of Works, Toronto. Surveys for large supply mains and preparation of plans for same. Also checking and general work re consultants' plans and drawings for filtration plant, pumping stations, surge tanks, etc.

References: E. L. Cousins, J. G. R. Wainwright, G. G. Powell, T. R. Loudon, G. Phelps, N. D. Wilson, A. U. Sanderson, W. E. Bonn.

YAPP—SPENCER RAYMOND ANTHONY, of Montreal, Que., Born at Batley, Yorks., England, Nov. 30th, 1900; Educ., B.Sc. (Eng.), Univ. of London, England, 1921; Assoc. Member, Inst. E.E. (Great Britain); 1920-25, Lancashire Dynamo & Motor Co., Manchester, England, through various shops, test beds and offices; 1925-27, Lancashire Dynamo & Motor Co. of Canada Ltd., sent over by the English company to their Canadian company as asst. engr., Toronto (head office); 1927-33, with same company, later changed to Lancashire Dynamo & Crypto Co. of Canada, Manager, Montreal (head office); 1933 to date, Bepco Canada Ltd. (British Electric Products) formed by amalgamation of Bruce Peebles Canada, Crompton Parkinson Canada, Hartland Engineering Co. of Canada, and Lancashire Dynamo & Crypto Co. of Canada, also representing Hackbridge Transformer Co. of Canada and Dubilier Condenser Co., manager, Montreal (head office).

References: F. Newell, R. H. Findlay, K. O. Whyte, H. S. VanPatter, C. E. Herd, J. B. Challies.

## FOR TRANSFER FROM THE CLASS OF ASSOCIATE MEMBER TO THAT OF MEMBER

KINGSTON—LAURENCE BRADLEY, of 300 Laurier Ave., Quebec, Que., Born at Ottawa, Ont., Aug. 3rd, 1886; Educ., B.Sc. (Civil), McGill Univ., 1908; 1905-06, dftsman. and topog'r., 1907 (4 mos.), transitman, Nat. Transcon. Rly.; 1908, transitman on land surveys; 1909-10, transitman for Smith, Kerry & Chace, on Metabetchouan Power Co. plant; 1910-13, res. engr. for same company on various plants, also on investigations and reports; 1913-15, engr. with Morrow & Beatty Ltd., on Abitibi Power & Paper Co. hydraulic development and paper mill; 1915-19, overseas, Capt., C.F.A.; 1919-21, mgr. for Morrow & Beatty Ltd., on Bathurst Lumber Co. hydro-electric development; 1921-22, engr. for same firm at head office; 1922-23, engr. with Walter J. Francis & Company, in charge of Paugan Falls investigation and report; 1923-24, engr. with G. L. Campbell, on Welland Canal sub-contract; 1925-26, works mgr., Dominion Safety Lockhert Co. Ltd.; 1926-27, res. engr. for George F. Hardy, M.E.I.C., on Ste. Anne Paper Co. Ltd. mill; 1927-29, constrn. engr., Anglo Canadian Pulp & Paper Mills Ltd.; 1929-32, chief engr., Quebec Logging Corpn. (subsidiary company of Anglo Canadian Pulp & Paper Mills and Ontario Paper Co.); 1932-33, res. engr. for George F. Hardy, M.E.I.C., consltg. engr., and for Anglo Canadian Pulp & Paper Mills management on the extension of the mill of its affiliated company, Anglo Newfoundland Development Co.; at present, engr., Gulf Pulp & Paper Co., Quebec Que. (*St. 1905, A.M. 1912.*)

References: J. G. G. Kerry, H. A. Morrow, H. L. Trotter, G. F. Hardy, W. I. Bishop, A. B. McEwen, P. A. Trost.

## FOR TRANSFER FROM THE CLASS OF JUNIOR

BELL—HARRY HEARTZ, of Calgary, Alta., Born at Halifax, N.S., Nov. 9th, 1906; Educ., B.Sc. (E.E.), Nova Scotia Tech. Coll., 1929. S.M. (Master of Science) in business and engrg. administration, Mass. Inst. Tech., 1933; 1924-25 (summers), surveyor, warm water survey, Canadian Atlantic Coast; 1927 (Aug.-Sept.), leveller, bldg. constrn., Anglin-Norcross; 1928 (June-Aug.), student ap'tice, shops of Can. Gen. Elec. Co., Peterborough, industrial control divn.; 1929-32, load and voltage survey of Calgary Power Company system; elect'l. and mech'l. design on 175 mile, 132,000 volt Ghost Edmonton transmission line; misc. operating, production and commercial work. May 1932-Nov. 1933, leave of absence for post-graduate work at Mass. Inst. Tech., at present with above company on special work on financial statements, budgeting, marketing of power and depreciation, with a continuance of transmission line calculations and design, also misc. operating work. (*St. 1928, Jr. 1931.*)

References: W. P. Copp, K. I. Dawson, F. R. Faulkner, H. J. McLean, H. B. [illegible], G. H. Thompson.

GOODMAN—JAMES EDWARD, of Kingston, Ont., Born at Perth, Ont., March 19th, 1901; Educ., B.Sc., Queen's Univ., 1931; 1917-25, working at the machy., elect'l. and constrn. trades as well as assisting engrs. in the field; 1926-27, instr'man., H.E.P.C. of Ontario; 1928-29, instr'man., Geodetic Survey; 1930-31, engr. on grading, paving and reinforced concrete bridges, Dept. of Public Highways; 1931 to date, County and Suburban Roads Engineer for Frontenac County, Kingston, Ont. (*Jr. 1931.*)

References: W. P. Wilgar, W. Casey, W. L. Malcolm, D. S. Ellis, R. A. Low.

GUTHRIE—KENNETH MACGREGOR, of Winnipeg, Man., Born at Guelph, Ont., August 9th, 1900; Educ., 1913-17, Ottawa Collegiate Institute; Professional study while serving with Air Force; 1917-18, cadet, R.F.C. and R.A.F.; 1918-19, pilot, R.A.F.; 1920-23, pilot and administrative duties, Air Board; 1923-34, pilot and administrative duties with the R.C.A.F., and at present Air Staff Officer, Mil. Dist. No. 10, Winnipeg. Administrative duties and flying, R.C.A.F. Station. Chief instructor to No. 12 (A.C.) Squadron, Winnipeg. (*Jr. 1926.*)

References: E. W. Stedman, A. Ferrier, J. A. Wilson, G. O. Johnson, J. L. Gordon.

HINCHCLIFFE—JOSEPH EDWARD, of Mono Road, Ont., Born at Macleod, Alta., Apr. 8th, 1897; Educ., B.Sc. (Civil), McGill Univ., 1926; 1925 (Summer), topog'l. dftsman., Southern Canada Power Co.; 1926-29, detailer, and 1929-33, checker, Canadian Bridge Co. Ltd., (Apr. 1933 laid off with all other dftsman., temporarily. Not engaged in professional work since). (*St. 1924, Jr. 1928.*)

References: C. M. Goodrich, A. E. West, R. C. Leslie, D. T. Alexander, F. J. Bridges, H. J. A. Chambers.

JACKSON—CARL HENRY, of 2317 Wilson Ave., Montreal, Que., Born at Montreal, Mar. 10th, 1900; Educ., B.Sc., McGill Univ., 1921; 1920-21 (summers), floorman and system operator, Southern Canada Power Co., Drummondville, Que.; 1921-22, instructor in elec'l. engrg., Univ. of Sask.; 1922-23, Can. Gen. Elec. Co. Ltd., Peterborough, Ont.; 1924 to date, gen. industrial engrg., including design, layout, inspection, supervision of installn. of equipment, Canadian Industries Ltd., Montreal, Que. (*St. 1921, Jr. 1923.*)

References: L. deB. McCrady, I. R. Tait, A. B. McEwen, C. K. McLeod, A. T. E. Smith, H. G. Thompson.

LAURENCE—EMILE, of Quebec, Que., Born at Montreal, Que., Feb. 28th, 1903; Educ., B.A.Sc., C.E., Ecole Polytechnique, 1926; 1922-23-24 (summers), land surveying and topog'l. surveying (plane table work); 1926-27, with Dufresne Constrn. Co., on Montreal-South Shore Bridge; 1927 (Feb.-Aug.), reinforced concrete design, Montreal Water Board; 1927-28, survey engr., Canadian Laundry Machinery Co.; 1928-29, steel designing, heating, ventilation, with L. A. St. Pierre, C.E.; 1929-30, steel detailing and designing, Dominion Bridge Company; 1930-31, estimating, Corporate Steel Products; Oct. 1931 to date, survey, design inspection, Dept. of Bridge Constrn., Dept. of Public Works, Quebec, Que. (*Jr. 1930.*)

References: I. E. Vallee, A. B. Normandin, O. Desjardins, C. Milot, R. Sauvage, T. M. Dechene, J. F. Brett, J. G. O'Donnell.

MARTIN—LUCIEN, of Quebec, Que., Born at Montreal, Oct. 8th, 1902; Educ., B.A., B.A.Sc., C.E., Ecole Polytechnique, Montreal, 1931; 1928-31 (summers), surveying and geology, Dept. of Mines, Quebec; 1931 to date, bridge constrn., Dept. of Public Works, Prov. of Quebec, Quebec, Que. (*Jr. 1932.*)

References: I. E. Vallee, O. Desjardins, C. Milot, A. B. Normandin, T. M. Dechene, R. Sauvage, P. Marcotte.

## FOR TRANSFER FROM THE CLASS OF STUDENT

ATWOOD—ARTHUR GERALD LYSONS, of Montreal, Que., Born at Bedford, N.S., Sept. 3rd, 1905; Educ., B.Sc. (Mech.), N.S. Tech. Coll., 1927; 1925 (summer), storekpr., Halifax Grain Elevator; 1926 (summer), Maritime Telegraph & Telephone Co.; 1927-28, equipment engrg. dept., Northern Electric Co., Montreal; 1928-33, with E. A. Ryan, M.E.I.C., consltg. engr., heating, ventilation and air con. design; 1934 (Jan.-Apr.), boiler design and layout, Babcock-Wilcox; at present, engr. in charge of installn. and pricing, Iron Fireman Mfg. Co. of Canada, Montreal, Que. (*St. 1927.*)

References: E. A. Ryan, F. A. Combe, A. C. J. Paine, H. J. Leitch, C. K. McLeod.

BOYER—MARC, of Quebec, Que., Born at Labelle, Que., Aug. 9th, 1905; Educ., B.A.Sc., C.E., Ecole Polytechnique, Montreal, 1928; 1932-33, partial student, 3rd and 4th year mining engrg., McGill Univ.; 1925-26-27 (summers), surveying party, Quebec Streams Commission; 1928-30, assayer, Cons. Mining & Smelting Co., Trail, B.C.; 1930 to date, mining inspector and technologist, Quebec Bureau of Mines, Quebec, Que. (*St. 1927.*)

References: A. Frigon, H. Cimon, A. B. Normandin, A. Lariviere, P. Methe, A. R. Decary, L. Beaudry, A. Boyer.

CROSSLAND—CHARLES WILFRED, of 19 Norbiton Ave., Kingston-on-Thames, England, Born at Barrie, Ont., Jan. 4th, 1906; Educ., B.Sc., McGill Univ., 1931; M.Sc., Mass. Inst. Tech., 1932; 1928-29 (summers), dftng.; 1933 to date, aircraft dftsman and technical asst., Hawker Aircraft Ltd., England. (*St. 1928.*)

References: C. M. McKergow, A. R. Roberts, E. Brown, R. DeL. French, L. R. Thomson, E. W. Stedman, S. J. Hungerford.

ELLIOT—DONALD GEORGE, of Montreal, Que., Born at Darjeeling, India, Oct. 14th, 1909; Educ., B.Sc. (1st Class Hons. in C.E.), Univ. of Edinburgh, 1930; 1930-31, dftsman and rodman, and 1931 to date, asst. engr., Messrs. Monsarrat & Pratley, Montreal, Que. (*S. 1930.*)

References: P. L. Pratley, C. N. Monsarrat, J. M. R. Fairbairn, J. W. Roland, R. F. Legget.

FRECKER—GEORGE ALAIN, of Halifax, N.S., Born at St. Pierre de Miquelon, June 29th, 1905; Educ., B.Sc. (E.E.), Nova Scotia Tech. Coll., 1932; 1929 (summer), asst. to field engr., Nfld. Mining Corpn.; 1932 to date, asst. prof. of engrg., St. Mary's College, Halifax, N.S. (*St. 1930.*)

References: F. R. Faulkner, G. C. Reid, S. C. Mifflen, S. Ball, G. H. Burchill.

## FOR TRANSFER FROM THE CLASS OF AFFILIATE

TOWNSEND—CHARLES ROWLATT, of Port Menier, Anticosti Island, Que., Born at Victoria, B.C., Feb. 9th, 1891; Educ., B.Sc., 1920; M.Sc., 1923, Univ. of N.B.; 1910-12, misc. work in saw mills, river driving, etc.; 1912-20, survey work on vacations, etc., except period spent overseas; 1920-23, air service divn., Laurentide Co. Ltd., aerial sketching, photography, etc.; 1923-30, logging divn., same company, and Canada Power & Paper Corpn., on various woods projects including constrn. of marine railroad, hydrographic surveys, reconnaissance surveys for logging flume, etc., etc.; 1930 (Feb.-Aug.), chief forester, Canada Power & Paper Corporation; Aug. 1930 to date, Anticosti Island manager, Consolidated Paper Corporation, Port Menier, Anticosti Is., Que. (*Affil. 1927.*)

References: W. B. Scott, H. O. Keay, H. E. Bates, T. R. McLagan, E. B. Wardle, H. G. Timmis.

## EMPLOYMENT SERVICE BUREAU

**The Service is operated for the benefit of members of The Engineering Institute of Canada, and for industrial and other organizations employing technically trained men—without charge to either party.**

*All correspondence should be addressed to*

**The Employment Service Bureau, The Engineering Institute of Canada**
**2050 Mansfield Street, Montreal**

### Situation Vacant

SALESMEN. A new company recently organized in Montreal desires men of good education and appearance whom they will train as salesmen for advertising specialties. Liberal commissions paid. Men with artistic tendencies preferred. Phone HA. 3642 for appointment.

### Situations Wanted

MECHANICAL ENGINEER, Canadian, with technical training and executive experience in both Canadian and American industries, particularly plant layout, equipment, planning and production control methods, is open for employment with company desirous of improving manufacturing methods, lowering costs and preparing for business expansion. Apply to Box No. 35-W.

MECHANICAL ENGINEER, A.M.E.I.C. Married. Experience in machine shops, erection and maintenance of industrial plant mechanical and structural design. Reads German, French, Dutch and Spanish. Seeks any suitable position. Apply to Box No. 84-W.

INDUSTRIAL ENGINEER, B.Sc., McGill Univ. Age 29. Married. Mechanical and electrical engineering experience with four large Canadian companies; including supervision of manufacture of various products, reduction of manufacturing costs, factory planning and investigation of piece work systems. Available on short notice. Apply to Box No. 132-W.

MECHANICAL ENGINEER, graduate McGill Univ. Experience on hydro-electric power construction and design and installation of equipment of pulp and paper mills. Desires position as mechanical engineer in an industrial plant or pulp and paper mill, or as representative on the sale of heavy machinery. Apply to Box No. 142-W.

PURCHASING ENGINEER, graduate mechanical engineer, Canadian, married, 34 years of age, with 13 years' experience in the industrial field, including design, construction and operation, 8 years of which had to do with the development of specifications and ordering of equipment and materials for plant extensions and maintenance; one year engaged on sale of surplus construction equipment. Full details upon request. Apply to Box No. 161-W.

CIVIL ENGINEER, age 44, open for employment anywhere, experience covers about 20 years' active work, including 7 years on municipal engineering, 2 years as Town Manager, 3 years on railway construction, 3 years on the staff of a provincial highway department, 2 years as contractor's superintendent on pavement construction. Apply to Box No. 216 W.

REINFORCED CONCRETE ENGINEER, B.Sc., P.E.Q., eight years experience in construction design of industrial buildings, office buildings, apartment houses, etc. Age 30. Married. Apply to Box No. 257 W.

MECHANICAL ENGINEER, age 28, nine years all round experience, Grad. Inst. of Mech. Engs. England, S.E.I.C. Technical and practical training with first class English firm of general engineers; shop, foundry and drawing office experience in steam and Diesel engines, asphalt, concrete machinery, boilers, power plants, road rollers, etc. Experience in heating and ventilation design and equipment; 18 months designing draughtsman with Montreal consulting engineers. 2½ years sales experience, steam and hot water heating systems, power plant equipment, machinery, oil-burning apparatus. Canadian 4th class Marine Engineers Certificate; C.N.S. experience. Available at short notice. Apply to Box No. 270-W.

DESIGNING DRAUGHTSMAN, experience in layout of steam power house equipment and piping. Wide experience in mechanical drive and details of machinery, gearing, and hoists. Accustomed to layout of small mill buildings of steel and timber, structural design and details. Good references. Present location Montreal. Apply to Box No. 329-W.

PLANE-TABLE TOPOGRAPHER, B.Sc., in C.E. Thoroughly experienced in modern field mapping methods including ground control for aerial surveys. Fast and efficient in surveys for construction, hydro-electric and geological investigations. Apply to Box No. 431-W.

ELECTRICAL ENGINEER, B.Sc., A.M.E.I.C., AM.A.I.E.E., age 30, single. Eight years experience H.E. and steam power plants, substations, etc., shop layouts, steel and concrete design. Location immaterial. Available immediately. Apply to Box No. 435-W.

CIVIL ENGINEER, B.A.Sc., and C.E., A.M.E.I.C., age 30, married. Experience over the last ten years covers construction on hydro-electric and railway work as instrumentman and resident engineer. Also office work on teaching and design, investigations and hydraulic works, reinforced concrete, bridge foundations and caissons. Location immaterial. Available at once. Apply to Box No. 447-W.

SALES ENGINEER, M A.Sc. Univ. of Toronto, wishes to represent firm selling building products or other engineering commodities, as their representative in Western Canada. Located in Winnipeg. Apply to Box No. 467-W.

### Situations Wanted

CIVIL ENGINEER, B.Sc., A.M.E.I.C., with six years experience in paper mill and hydro-electric work, desires position in western Canada. Capable of handling reinforced concrete and steel design, paper mill equipment and piping layout, estimates, field surveys, or acting as resident engineer on construction. Now on west coast and available at once. Apply to Box No. 482-W.

MECHANICAL ENGINEER, B.Sc. Age 28, married. Four and a half years on industrial plant maintenance and construction, including shop production work and pulp and paper mill control. Also two and a half years on structural steel and reinforced concrete design. Available at once. Apply to Box No. 521-W.

CIVIL ENGINEER, Canadian, married, twenty-five years' technical and executive experience, specialized knowledge of industrial housing problems and the administration of industrial towns, also town planning and municipal engineering, desires new connection. Available on reasonable notice. Personal interview sought. Apply to Box No. 544-W.

ELECTRICAL AND MECHANICAL ENGINEER, B.Sc., A.M.E.I.C. Experience includes C.G.E. Students' Test Course and six years in engineering dept. of same company on design of electrical equipment. Four summers as instrumentman on surveying and highway construction. Several years experience in accounting previous to attending university. Desires position with industrial concern where the combination of technical and business experience will be of value. Apply to Box No. 564-W.

#### Employment Service Bureau

This bureau is maintained by The Engineering Institute of Canada for the benefit of members and organizations employing technically trained men.

An enquiry addressed to 2050 Mansfield Street, Montreal, will bring full information concerning the services offered. Details can also be obtained from Branch secretaries who are located in the larger centres throughout Canada.

Brief announcements of men available and positions vacant will be published without charge in The Engineering Journal and the Bulletin. Replies addressed in care of the required box number will be forwarded to the advertiser without delay.

An additional service also offered those who are unemployed or wish to change their positions, is the opportunity of placing their names and records on file at 2050 Mansfield Street for consideration by employers wishing to employ engineers. This is of great assistance as many employers will not advertise or wish to locate a suitable man on short notice. If desired the information contained in these records can be kept confidential.

Forms for registration purposes may be obtained from The Institute Headquarters or Branch secretaries.

CIVIL ENGINEER, age 25, single, graduate. Creditable record on responsible hydro and railroad work in both Eastern and Western Canada. Apply to Box No. 567-W.

MECHANICAL ENGINEER, A.M.E.I.C., with twenty years experience on mechanical and structural design, desires connection. Available at once. Apply to Box No. 571-W.

MECHANICAL ENGINEER, B.A.Sc., '30, desires position to gain experience, and which offers opportunity for advancement. Experience in pulp and paper mill and one year in mechanical department of large electrical company. Location immaterial. Available immediately. Apply to Box No. 577-W.

DOMINION LAND SURVEYOR, and graduate engineer with extensive experience on legal, topographic and plane-table surveys and field and office use of aero-photographs, desires employment either in Canada or abroad. Available at once. Apply to Box No. 589-W.

CHEMICAL ENGINEER, S.E.I.C., B.Sc., University of Alberta, '30. Age 31. Single. Six seasons' practical laboratory experience, three as chief chemist and three as assistant chemist in cement plant; one year's p.g. work in physical chemistry; three years' experience teaching. Desires position in any industry with chemical control. Available immediately. Apply to Box No. 609-W.

### Situations Wanted

DESIGNING ENGINEER AND ESTIMATOR, grad. Univ. of Toronto in C.E., A.M.E.I.C., twenty years experience in structural steel, construction and municipal work. Available at once. Apply to Box No. 613-W.

CIVIL ENGINEER, A.M.E.I.C., R.P.E., Ontario; three years construction engineer on industrial plants; fourteen years in charge of construction of hydraulic power developments, tower lines, sub-stations, etc.; four years as executive in charge of construction and development of harbours, including railways, docks, warehouses, hydraulic dredging, land reclamation, etc. Apply to Box No. 647-W.

ELECTRICAL ENGINEER, B.Sc. in E.E. (Univ. of Man., '30). Age 25. Two year Can. Westinghouse Apprentice Course. Depts.—Switchboard assembly, general draughting office, switchboard engineering, test office. One year's experience since then designing and rewinding small motors and transformers. Location immaterial. Apply to Box No. 651-W.

MECHANICAL ENGINEER, A.M.E.I.C., Canadian, technically trained; six years drawing office. Office experience, including general design and plant layout. Also two years general shop work, including machine, pattern and foundry experience, desires position with industrial firm in capacity of production engineer or estimator. Available on short notice. Apply to Box No. 676-W.

DIESEL ENGINEER. Erection and industrial engineer, A.M.E.I.C., technically trained mechanical engineer with English and Canadian experience in erection and operation of steam and Diesel equipment in power house and mines, pumping, rock drilling, air compressors. Experienced in industrial and steel works operations including rolling mills, quarries, sales. Open for position on maintenance, operation or sales engineer. Location immaterial. Apply to Box No. 682-W.

MECHANICAL AND STRUCTURAL ENGINEER. Six years experience with prominent manufacturer, designing, heating and power boilers, boiler installations, coal and ash handling equipment. Good practical knowledge of steel plate work welding. Also wide experience in designing, estimating and detailing structural steel for buildings and bridges. Good education. Have held position of responsibility. Above can be verified by best of references. Available at once. Apply to Box No. 692-W.

ELECTRICAL AND CIVIL ENGINEER, B.Sc., Elec., 29, B.Sc., Civil '33. Age 27. JR.E.I.C. Undergraduate experience in surveying and concrete foundations; also four months with Canadian General Electric Co. Thirty-three months in engineering office of a large electrical manufacturing company since graduation. Good experience in layouts, switching diagrams, specifications and pricing. Best of references. Available immediately. Apply to Box No. 693-W.

MECHANICAL ENGINEER, B.Sc., '27, JR.E.I.C. Four years maintenance of high speed Diesel engines units, 200 to 1,300 h.p. Also maintenance of D.C. and A.C. electrical systems and machinery. Draughting experience. Westinghouse apprenticeship course. Practical mechanical and electrical engineer with a special study of high speed Diesel engine design, application and operation. Location in western or eastern Canada immaterial. Apply to Box No. 703-W.

COMBUSTION ENGINEER, R.P.E., Manitoba, A.M.E.I.C. Wide experience with all classes of fuels. Expert designer and draughtsman on modern steam power plants. Experienced in publicity work. Well known throughout the west. Location, Winnipeg or the west. Available at once. Apply to Box No. 713-W.

ELECTRICAL ENGINEER, B.Sc., University of N.B., '31. Experience includes three months field work with Saint John Harbour Reconstruction. Apply to Box No. 722-W.

MECHANICAL ENGINEER, age 41, married. Eleven years designing experience with project of outstanding magnitude. Machinery layouts, checking, estimating and inspecting. Twelve years previous engineering, including draughting, machine shop and two years chemical laboratory. Highest references. Apply to Box No. 723-W.

CIVIL ENGINEER, B.Sc. (Alta. '31), S.E.I.C. Experience includes three seasons in charge of survey party. Transitman on railway maintenance, and concrete bridge designing Nature of work and location immaterial. Apply to Box No. 724-W.

YOUNG CIVIL ENGINEER, B.Sc. (Univ. of N.B. '31), with experience as rodman and checker on railroad construction, is open for a position. Apply to Box No. 728-W.

DESIGNING ENGINEER, M.Sc. (McGill Univ.), D.L.S., A.M.E.I.C., P.E.Q. Experience in design and construction of water power plants, transmission lines, field investigations of storage, hydraulic calculations and reports. Also paper mill construction, railways, highways, and in design and construction of bridges and buildings. Available at once. Apply to Box No. 729-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.Sc., Univ. of B.C. '30. Single, age 24. Sixteen months with the Allis-Chalmers Mfg. Co. as student engineer. Experience includes foundry production, erection and operation of steam turbines, erection of hydraulic machinery, and testing texropes and centrifugal pumps. Location immaterial. Available at once. Apply to Box No. 735-W.

CIVIL ENGINEER, M.Sc., A.M.E.I.C., R.P.E. (Ont.), ten years experience in municipal and highway engineering Read, write and talk French. Married. Served in France. Will go anywhere at any time. Experienced journalist. Apply to Box No. 737-W.

## Situations Wanted

RADIO AND ELECTRICAL ENGINEER, B.sc. '31, S.E.I.C. Age 27. Experience in installation of power and lighting equipment. Temporary operator in radio station; studio experience with part time announcing. Two summers in switchboard and installation department of telephone company, eight months on extensive survey layouts. Interested in sales work of electrical or radio equipment. Available on short notice. Location immaterial. Apply to Box No. 740-W.

CIVIL ENGINEER, graduate '29. Married. One year building construction, one year hydro-electric construction in South America, fourteen months resident engineer on road construction. Working knowledge of Spanish. Apply to Box No. 744-W.

SALES ENGINEER, B.sc., McGill, 1923. A.M.E.I.C. Age 33. Married. Extensive experience in building construction. Thoroughly familiar with steel building products; last five years in charge of structural and reinforcing steel sales for company in New York state. Available at once. Located in Canada. Apply to Box No 749-W.

CIVIL ENGINEER, S.E.I.C., B.sc. Queen's Univ. '29. Age 25. Married. Three years experience as construction supt. and estimator for contracting firm. Experience includes general building, bridges, sewer work, concrete, boiler settings, sand blasting of bridges and spray painting. Available at once. Apply to Box No. 776-W.

CIVIL ENGINEER, B.sc., '25, Jr.E.I.C., P.E.Q., married. Desires position, preferably with construction firm. Experience includes railway, monument and mill building construction. Available immediately. Apply to Box No. 780-W.

DRAUGHTSMAN, experience in civil engineering, forestry engineering, land surveying and house construction. Good references. Apply to Box No. 781-W.

ELECTRICAL AND SALES ENGINEER, S.E.I.C., grad. '28. Experience includes one year test course, one year switchboard design and two years switchboard and switching equipment sales with large electrical manufacturing company. Three summers Pilot Officer with R.C.A.F. Available at once. Apply to Box No. 788-W.

ELECTRICAL ENGINEER desires position as engineer or manager for industrial plant or factory. Over ten year diversified electrical and mechanical experience in the industrial field. Apply to Box No. 795-W.

CIVIL ENGINEER, S.E.I.C., graduate '30, age 23, single. Experience includes mining surveys, assistant on highway location and construction, and assistant on large construction work. Steel and concrete layout and design. Apply to Box No. 809-W.

CIVIL ENGINEER, college graduate, age 27, single. Experience includes surveying, draughting concrete construction and design, street paving both asphalt and concrete. Available at once; will consider anything and go anywhere. Apply to Box No. 816-W.

CIVIL ENGINEER, B.E. (Sask. Univ. '32), S.E.I.C. Single. Experience in city street improvement; sewer and water extensions. Good draughtsman. References. Available at once. Location immaterial. Apply to Box No. 818-W.

CIVIL ENGINEER, B.sc., A.M.E.I.C., with fifteen years experience mostly in pulp and paper millwork, reinforced concrete and structural steel design, field surveys, layout of mechanical equipment, piping. Available at once. Apply to Box No. 825-W.

ELECTRICAL ENGINEER, S.E.I.C., grad. '29, age 24, married; experience includes one year Students Test Course, sixteen months in distribution transformer design and eight months as assistant foreman in charge of industrial control and switchgear tests. Location immaterial. Available at once. Apply to Box No. 828-W.

CIVIL ENGINEER, B.A.Sc., D.L.S., O.L.S., A.M.E.I.C., age 46, married. Twelve years experience in charge of legal field surveys. Owns own surveying equipment. Eight years on technical, administrative, and editorial office work. Experienced in writing. Desires position on survey work, assisting in or in charge of preparation of house organ, on staff of technical or semi-technical magazine, or on publicity, editorial or administrative office work. Available at once. Will consider any salary, and any location Apply to Box No. 831-W.

CIVIL ENGINEER, S.E.I.C., B.sc. '32 (Univ. of N.B). Age 25. married Two years experience in power line construction and maintenance; one year of highway construction; one summer surveying for power plant site, location and spur railway line construction. Available at once. Location immaterial. Apply to Box No. 840-W.

CIVIL ENGINEER, B.sc '15, A.M.E.I.C., married, extensive experience in responsible position on railway construction, also highways, bridges and water supplies. Position desired as engineer or superintendent. Available at once. Apply to Box No. 841-W

CIVIL ENGINEER, B.sc. (Alta '31), S.E.I.C., age 24. Experience, three summers on railroad maintenance, and seven months on highway location as instrumentman Willing to do anything, anywhere, but would prefer connection with designing or construction firm on structural works Available immediately Apply to Box No. 846-W.

## Situations Wanted

BRIDGE AND STRUCTURAL ENGINEER, A.M.E.I.C., McGill. Twenty-five years' experience on bridge and structural staffs. Until recently employed. Familiar with all late designs, construction, and practices in all Canadian fabricating plants. Desirous of employment in any responsible position, sales, fabrication or construction. Apply to Box No. 851-W.

STRUCTURAL ENGINEER, B.A.Sc., A.M.E.I.C. Twenty-two years experience in design of bridges and all types of buildings in structural steel and reinforced concrete. Three years experience in railway construction and land surveying. Apply to Box No. 856-W.

MECHANICAL ENGINEER, B.sc. '32, S.E.I.C. Good draughtsman. Undergraduate experience:—One year moulding shop practice; two years pipe fitting and sheet metal work; one year draughting and tracing on paper mill layout; six months machine shop practice; and eight months fuel investigation and power heating plant testing. Desires position offering experience in steam power plants or heating and ventilating design. Will go anywhere. Apply to Box No. 858-W.

MECHANICAL ENGINEER, age 31, graduate Sheffield (England) 1921; apprenticeship with firm manufacturing steam turbine generators and auxiliaries and subsequent experience in design, erection, operation and inspection of same. Marine experience B.O.T. certificate thoroughly conversant with Canadian plants and equipment. Available on short notice. Any location. Box No. 860-W.

CHEMICAL ENGINEER, B.sc. (McGill '21), A.M.E.I.C., age 36, married; three years since graduation with pulp and paper mills; eight years in shops, estimating and sales divisions of well-known gas engineering and construction companies in the United States. Excellent references. Available on short notice. Apply to Box No. 866-W.

CONSTRUCTION ENGINEER (Toronto Univ. of '07). Experience includes hydro-electric, municipal and railroad work. Available immediately. Location immaterial. Apply to Box No. 886-W.

ELECTRICAL ENGINEER, graduate 1929, S.E.I.C. Single. Experience includes two years with electrical manufacturing concern and one on highway construction work. Available at once. Will go anywhere. Apply to Box No. 887-W.

AGENCIES WANTED, Young engineer, B.A.Sc. in C.E., with business and sales experience, speaking fluent French, would consider representing a firm as agent for Montreal or the province of Quebec. Apply to Box No. 891-W.

ELECTRICAL ENGINEER, grad. Univ. of N.B. '31. Experienced in surveying and draughting, requires position. Available at once. Will go anywhere. Apply to Box No. 893-W.

CIVIL ENGINEER, B.A.Sc., Jr.E.I.C., age 29, single. Experience includes two years in pulp mill as draughtsman and designer on additions, maintenance and plant layout. Three and a half years in the Toronto Buildings Department checking steel, reinforced concrete, and architectural plans. Available at once. Location immaterial. At present in Toronto. Apply to Box No. 899-W.

DESIGNING ENGINEER, A.M.E.I.C. Permanent and executive position preferred but not essential. Fifteen years experience in designing power plants, engine and fan rooms, kitchens and laundries. Thoroughly familiar with plumbing and ventilating work, pneumatic tubes, and refrigeration, also heating, electrical work, and specifications. Apply to Box No. 913-W.

CIVIL ENGINEER, B.sc., '25, McGill Univ., Jr.E.I.C., P.E.Q., age 32, married. Experience as rodman and instrumentman on track maintenance. Seven and one-half years with Canadian paper company, as assistant office engineer handling all classes of engineering problems in connection with woods operations, i.e., road buildings, piers, booms, timber bridges, depots, dams, etc. Apply to Box No. 933-W.

ELECTRICAL ENGINEER, Dipl. of Eng., B.sc. (Dalhousie Univ.), S.B. and S.M. in E.E. (Mass. Inst. of Tech.), Canadian. Married. Seven and a half years' experience in design, construction and operation of hydro, steam and industrial plants. For past sixteen months field office electrical engineer on 510,000 h.p. hydro-electric project. Available at once. Apply to Box No. 936-W.

CIVIL ENGINEER, B.sc., O.P.E. Experience includes several years on municipal work-design and construction of sewers, steel and concrete bridges, watermains and pavements. Available at once. Apply to Box No. 950-W.

CIVIL ENGINEER, B.sc. (Univ. of Sask. '33), S.E.I.C., age 28, single. Experience in testing hydro-electric equipment, draughting, surveying, city street, improvements, technical photography Available at once. Location immaterial. Apply to Box No. 986-W.

ELECTRICAL ENGINEER, S.E.I.C., B.sc. (N.S. Tech. Coll., '33), desires work Experience in transmission line construction Location or class of work immaterial. Apply to Box No. 1010-W.

## Situations Wanted

ENGINEER SUPERINTENDENT, age 44. Engineering and business training, executive ability, tactful, energetic. Had charge of several large projects. Intimate knowledge of costs and prices, reports and estimates. Available immediately. Any location. Apply to Box No. 1021-W.

CIVIL ENGINEER, B.sc. (Queen's 14), A.M.E.I.C., Dominion Land Surveyor, 5 months' special course at the University of London, England, in municipal hygiene and reinforced concrete construction. Experience covers legal and topographic surveys, plane tabling and stadia surveying, railway and highway construction, drainage and excavation work. Available at once. Apply Box No. 1035-W.

ELECTRICAL ENGINEER AND GEOPHYSICIST. Age 36. Married. Seven years experience in geophysical exploration using seismic, magnetic and electrical methods. Two years experience with the Western Electric Company of Chicago, working on equipment and magnetic materials research. Experienced in radio and telephone work, also specializing in precise electrical measurements, resistance determinations, ground potentials and similar problems of ground current distribution. Apply to Box No. 1063-W.

ELECTRICAL ENGINEER, B.A.Sc. Univ. Toronto '28. Experience includes Can. Gen. Elec. Co. Test Course. Also more than two years in the engineering dept. of the same company. Available on short notice. Preferred location central or eastern Canada. Apply to Box No. 1075-W.

ELECTRICAL ENGINEER, B.sc. Married. Eight years electrical experience, including operation, maintenance and construction work, electrical design work on large power development, mechanical ability, experienced photographer, employed in electrical capacity at present. Available on reasonable notice. Apply to Box No. 1076-W.

GRADUATE IN MECHANICAL ENGINEERING, 1927, desires opportunity in Diesel engine field, preferably in design and development work. Skilled draughtsman and clever in design. Familiar with basic theories of the Diesel engine and in touch with recent developments and applications. Anxious to obtain a foothold with up-to-date company. No objection to shopwork or other duties as a start but would prefer shopwork and assembly if possible. Apply to Box No. 1081-W.

CIVIL ENGINEER, age 27, graduate 1930, single. Experience includes detailing, designing and estimating structural steel, plate work and pressure vessels; also hydrographic surveying. Available at once. Apply to Box No. 1111-W.

ELECTRICAL ENGINEER, B.sc., in E E. (Univ. of N.B. '34), S.E.I.C. Experience in bridge and road construction and auto repairing, desires position in industrial or power plant. Any locality. References on request. Apply to Box No. 1114-W.

CIVIL ENGINEER, B.sc. Sask. '30. S.E.I.C. Age 24 years. Experience in municipal engineering, including sewer and water construction, sidewalk construction, paving, storm sewer design, draughting, precise levelling, and reinforced concrete bridge construction. Unmarried. Available at once. Will go anywhere. Apply to Box No. 1115-W.

ELECTRICAL ENGINEER, B.sc.E.E. (Univ. of N.B. '31). C.G.E. Test Course included industrial control, induction motors and transformers; the transformer test included desk work for two months on computing losses, efficiencies, etc. Available at once. Apply to Box No. 1119-W.

MECHANICAL ENGINEER, B.A.Sc. (Univ. of B.C.), M.S. (Univ. of Pittsburgh). Canadian. Age 26. Single. One year graduate student course, W.E. and M. Co., East Pittsburgh. Three and a half years engineering research in mechanics with the same company. Location immaterial. Available at once. Apply to Box No. 1123-W.

GEODETIC AND TOPOGRAPHICAL ENGINEER, D.L.S., M.E.I.C. Experience in all kinds of geodetic and topographical surveys, especially photo-topography, well versed in all kinds of air photo surveys; Canadian and U.S. patent method of determining position and elevations of points from air photographs. Available at once anywhere in Canada or the United States. Apply to Box No. 1127-W.

PETROLEUM CHEMIST, B.sc. in Chem. Eng. Age 25, Single. One and a half years experience as assistant chemist. Capable of taking charge in small refinery. Wishes position anywhere in Canada. Apply to Box No. 1130-W.

ELECTRICAL ENGINEER. B.sc., Queen's '33. Single, age 23. Anxious to gain experience. Present experience installing small private hydro-electric plant. Location immaterial. Available at once. Apply to Box No. 1137-W.

CIVIL ENGINEER, A.M.E.I.C., with over twenty years experience in field and office on construction, maintenance, surveying, location, etc., desires position preferably of a permanent nature. At present near Montreal, but willing to locate anywhere. Apply to Box No. 1168-W.

# Purchasers' Classified Directory

*A Selected List of Equipment, Apparatus and Supplies*

For Alphabetical List of Advertisers see page 20.

A

**Acids:**
Canadian Industries Limited.
**Aerial Survey:**
Canadian Airways Ltd.
**Ammeters and Voltmeters:**
Bepco Canada Ltd.
Crompton Parkinson (Canada) Ltd.
**Angles, Steel:**
Bethlehem Steel Export Corp.
**Ash Handling Equipment:**
Babcock-Wilcox & Goldie McCulloch Ltd.
Combustion Engineering Corp. Ltd.
**Asphalt:**
Barrett Co. Ltd.
**Axles, Steel, Forged:**
Dominion Foundries & Steel Ltd
Dominion Steel & Coal Corpn. Ltd.

B

**Ball Mills:**
Dominion Engineering Works Limited.
Wm. Kennedy & Sons Ltd.
Foster Wheeler Ltd.
Wm. Hamilton Div. Canadian Vickers Ltd.
**Balls, Steel and Bronze:**
Can. S.K.F. Co. Ltd.
Wm Kennedy & Sons Ltd.
**Barking Drums:**
Canadian Ingersoll-Rand Company, Limited.
**Bars, Steel and Iron:**
Bethlehem Steel Export Corp.
Dominion Foundries & Steel Ltd.
Dominion Steel & Coal Corpn. Ltd.
**Bearings, Ball and Roller:**
Can. S.K.F. Co. Ltd.
**Billets, Blooms, Slabs:**
Bethlehem Steel Export Corp.
Dominion Foundries & Steel Ltd.
**Bins:**
Canada Cement Co. Ltd.
**Blasting Materials:**
Canadian Industries Limited.
**Blowers, Centrifugal:**
Can. Ingersoll-Rand Co. Ltd.
B. F. Sturtevant Co. of Can. Ltd.
**Blue Print Machinery:**
Montreal Blue Print Co.
**Boilers:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Canadian Vickers Ltd.
Combustion Engineering Corp. Ltd.
Foster Wheeler Limited.
E. Leonard & Sons Ltd.
Vulcan Iron Wks. Ltd.
**Boilers, Electric:**
Can. General Electric Co. Ltd.
Dominion Engineering Works Limited.
Northern Electric Co. Ltd.
**Boilers, Portable:**
Foster Wheeler Ltd.
E. Leonard & Sons Ltd.
**Boxes, Cable Junction:**
Northern Electric Co. Ltd.
**Braces, Cross Arm, Steel, Plain or Galvanized:**
Northern Electric Co. Ltd.
**Brackets, Ball Bearing:**
Can. S.K.F. Co. Ltd.
**Brakes, Air:**
Can. General Elec. Co. Ltd.
**Brakes, Magnetic Clutch:**
Northern Electric Co. Ltd.
**Bridge-Meggers:**
Northern Electric Co. Ltd.
**Bridges:**
Canada Cement Co. Ltd.
Canadian Vickers Ltd.
Dominion Bridge Co. Ltd.
**Bucket Elevators:**
Jeffrey Mfg. Co. Ltd.
**Buildings, Steel:**
Dominion Bridge Co. Ltd.

C

**Cables, Copper and Galvanized:**
Northern Electric Co. Ltd.
**Cables, Electric, Bare and Insulated:**
Can. Westinghouse Co. Ltd.
Can. General Electric Co. Ltd.
Northern Electric Co. Ltd.
**Caissons, Barges:**
Dominion Bridge Co. Ltd.
**Cameras:**
Associated Screen News Ltd.
**Capacitors:**
Bepco Canada Ltd.
Can. Westinghouse Co. Ltd.
Lancashire Dynamo & Crypto Co. of Can. Ltd.
**Castings, Brass:**
The Superheater Co. Ltd.
**Castings, Iron:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Dominion Engineering Works.
Foster Wheeler Ltd.
Wm. Kennedy & Sons Ltd.
E. Leonard & Sons Ltd.
The Superheater Co. Ltd.
Vulcan Iron Wks. Ltd.
**Castings, Alloy Steel:**
Dominion Foundries & Steel,Ltd.
**Castings, Steel:**
Dominion Foundries & Steel Ltd
Wm. Kennedy & Sons Ltd.
Vulcan Iron Wks. Ltd.
**Catenary Materials:**
Can. Ohio Brass Co. Ltd.
**Cement Manufacturers:**
Canada Cement Co. Ltd.
**Chains, Silent and Roller:**
Hamilton Gear & Machine Co.
Jeffrey Mfg. Co. Ltd
**Channels:**
Bethlehem Steel Export Corp.
**Chemicals:**
Canadian Industries Limited.
**Chemists:**
Milton Hersey Co. Ltd.
Roast Laboratories Reg'd.
**Chippers, Pneumatic:**
Canadian Ingersoll-Rand Company, Limited.
**Choke Coils:**
Ferranti Electric Co.
**Circuit Breakers:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.
**Clarifiers, Filter:**
Bepco Canada Ltd.
Crompton Parkinson (Canada) Ltd.
**Clutches, Ball Bearing Friction:**
Can. S.K.F. Co. Ltd.
**Clutches, Magnetic**
Northern Electric Co. Ltd.
**Coal Handling Equipment:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Combustion Engineering Corp. Ltd.
**Combustion Control Equipment:**
Bailey Meter Co. Ltd.
**Compressors, Air and Gas:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Canadian Ingersoll-Rand Company, Limited.
**Concrete:**
Canada Cement Co. Ltd.
**Condensers, Steam:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Canadian Ingersoll-Rand Company, Limited.
Foster Wheeler Limited.
**Condensers, Synchronous and Static:**
Bepco Canada Ltd.
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Crompton Parkinson (Canada) Ltd.
Harland Eng. Co. of Can. Ltd.
Lancashire Dynamo & Crypto Co. of Can. Ltd.
Northern Electric Co. Ltd.
Bruce Peebles (Canada) Ltd.
**Conditioning Systems, Air:**
B. F. Sturtevant Co. of Can. Ltd.
**Conduit:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co Ltd.
**Conduit, Underground Fibre, and Underfloor Duct:**
Northern Electric Co. Ltd.
**Controllers, Electric:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.
**Couplings:**
Dart Union Co. Ltd.
Dresser Mfg. Co. Ltd.
**Couplings, Flexible;**
Dominion Engineering Works Limited.
Dresser Mfg. Co. Ltd.
**Couplings, Flexible:**
Wm. Hamilton Div. Canadian Vickers Ltd.
Hamilton Gear & Machine Co.
Wm. Kennedy & Sons Ltd.
**Cranes, Hand and Power:**
Dominion Bridge Co.
**Cranes, Locomotive:**
Dominion Hoist & Shovel Co. Ltd.
**Cranes, Shovel, Gasoline Crawler, Pillar:**
Canadian Vickers Ltd.
Dominion Hoist & Shovel Co. Ltd.
**Crowbars:**
B. J. Coghlin Co. Ltd.
**Crushers, Coal and Stone:**
Canadian Ingersoll-Rand Company, Limited.
Jeffrey Mfg. Co. Ltd.
Wm. Kennedy & Sons Ltd.

D

**Dimmers:**
Northern Electric Co. Ltd.
**Disposal Plants, Sewage:**
W. J. Westaway Co. Ltd.
**Ditchers:**
Dominion Hoist & Shovel Co. Ltd.
**Drills, Pneumatic:**
Canadian Ingersoll-Rand Company, Limited.
**Dynamite:**
Canadian Industries Limited.

E

**Economizers, Fuel:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Combustion Engineering Corp. Ltd.
Foster Wheeler Limited.
B. F. Sturtevant Co. of Can. Ltd.
**Elbows:**
Dart Union Co. Ltd.
**Electric Blasting Caps:**
Canadian Industries Limited.
**Electric Railway Car Couplers:**
Can. Ohio Brass Co. Ltd.
**Electrical Repair Work:**
Montreal Armature Works.
**Electrical Supplies:**
Can. General Elec. Co. Ltd.
Can. Ohio Brass Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.
**Electrification Materials, Steam Road:**
Can. Ohio Brass Co. Ltd.
**Engines, Diesel and Semi-Diesel:**
Canadian Ingersoll-Rand Company, Limited.
Harland Eng. Co. of Can. Ltd.
**Engines, Gas and Oil:**
Canadian Ingersoll-Rand Company, Limited.
**Engines, Steam:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Canadian Vickers Ltd.
Harland Eng. Co. of Can. Ltd.
E. Leonard & Sons Ltd.
**Evaporators:**
Foster Wheeler Limited.
**Expansion Joints:**
Foster Wheeler Limited.
**Explosives:**
Canadian Industries Limited.

F

**Feed Water Heaters, Locomotive:**
The Superheater Co. Ltd.
**Filtration Plants, Water:**
W. J. Westaway Co. Ltd.
**Finishes:**
Canadian Industries Limited.
**Fire Alarm Apparatus:**
Northern Electric Co. Ltd.
**Floodlights:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.
**Floor Stands:**
Jenkins Bros. Ltd.
**Floors:**
Canada Cement Co. Ltd.
**Forcite:**
Canadian Industries Limited.
**Forgings:**
Bethlehem Steel Export Corp.
Dominion Steel & Coal Corpn. Ltd.
**Foundations:**
Canada Cement Co. Ltd.

G

**Gaskets, Asbestos, Fibrous, Metallic, Rubber:**
The Garlock Packing Co. of Can. Ltd.
**Gasoline Recovery Systems:**
Foster Wheeler Limited.
**Gates, Hydraulic Regulating:**
Canadian Vickers Ltd.
Dominion Bridge Co. Ltd.
**Gauges, Draft:**
Bailey Meter Co. Ltd.
Bristol Co. of Can. Ltd.
**Gear Reductions:**
Hamilton Gear & Machine Co.
**Gears:**
Dominion Bridge Co. Ltd.
Dominion Engineering Works Limited.
Hamilton Gear & Machine Co.
Wm. Kennedy & Sons Ltd.
**Generators:**
Bepco Canada Ltd.
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Crompton Parkinson (Canada) Ltd.
Harland Eng. Co. of Can. Ltd.
Lancashire Dynamo & Crypto Co. of Can. Ltd.
Northern Electric Co. Ltd.
Bruce Peebles (Canada) Ltd.
**Governors, Pump:**
Bailey Meter Co. Ltd.
**Governors, Turbine:**
Dominion Engineering Works Limited.
**Gratings, M. & M. Safety:**
Dominion Bridge Co. Ltd.

H

**Hangers, Ball and Roller Bearing:**
Can. S.K.F. Co. Ltd.
**Headlights, Electric Railway:**
Can. General Elec. Co. Ltd.
Can. Ohio Brass Co. Ltd.
Can. Westinghouse Co. Ltd.
**Heat Exchange Equipment:**
Foster Wheeler Limited.
**Heating Systems:**
C. A. Dunham Co. Ltd.
**Hoists, Air, Steam and Electric:**
Canadian Ingersoll-Rand Company, Limited.
Dominion Hoist & Shovel Co. Ltd.
Wm. Hamilton Div. Canadian Vickers Ltd.
**Humidifying Equipment:**
W. J. Westaway Co. Ltd.

I

**Incinerators:**
Canada Cement Co. Ltd.
**Indicator Posts:**
Jenkins Bros. Ltd.
**Industrial Electric Control:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.
**Injectors, Locomotive, Exhaust Steam:**
The Superheater Co Ltd.
**Inspection of Materials:**
J. T. Donald & Co. Ltd.
Milton Hersey Co. Ltd.
**Instruments, Electric:**
Bepco Canada Ltd.
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Crompton Parkinson (Canada) Ltd.
Ferranti Electric Ltd.
Moloney Electric Co. of Canada, Ltd.
Northern Electric Co. Ltd.
**Insulating Materials:**
Canadian Industries Limited.
**Insulators, Porcelain:**
Can. Ohio Brass Co. Ltd.
Northern Electric Co. Ltd.
**Intercoolers:**
Foster Wheeler Limited.

J

**Journal Bearings and Boxes, Railway:**
Can. S.K.F. Co. Ltd.

L

**Lacquers:**
Canadian Industries Limited.
**Lantern Slides:**
Associated Screen News Ltd.
**Leading Wire:**
Canadian Industries Limited.

# Purchasers' Classified Directory

**Library Films:**
- Associated Screen News Ltd.

**Lighting Equipment, Industrial and Street:**
- Can. General Elec. Co. Ltd.
- Can. Westinghouse Co. Ltd.
- Northern Electric Co. Ltd.

**Lightning Arresters:**
- Can. General Elec. Co. Ltd.
- Can. Westinghouse Co. Ltd.
- Ferranti Electric Ltd.
- Northern Electric Co. Ltd.

**Line Materials:**
- Can. Ohio Brass Co. Ltd.
- Northern Electric Co. Ltd.

**Locomotives, Electric:**
- Can. General Elec. Co. Ltd.
- Can. Westinghouse Co. Ltd.

### M

**Machinery, Hydraulic:**
- Dominion Engineering Works Limited.

**Machinery, Metal and Wood-Working:**
- Dominion Engineering Works Limited.

**Magnetic Separators:**
- Northern Electric Co. Ltd.

**Material Handling Equipment:**
- Jeffrey Mfg. Co. Ltd.

**Metallurgists:**
- Roast Laboratories Reg'd.

**Meters, Boiler, and Coal:**
- Bailey Meter Co. Ltd.

**Meters, Electric:**
- Bristol Co. of Can. Ltd.
- Can. General Elec. Co. Ltd.
- Can. Westinghouse Co. Ltd.
- Ferranti Electric Ltd.
- Northern Electric Co. Ltd.

**Meters, Flow:**
- Bailey Meter Co. Ltd.
- Neptune-National Meters Ltd.

**Meters, Liquid (Hot or Cold):**
- Bailey Meter Co. Ltd.
- Neptune-National Meters Ltd.

**Mine Cars:**
- Canadian Vickers Ltd.

**Mining Machinery:**
- Canadian Ingersoll-Rand Company, Limited.
- Canadian Vickers Ltd.
- Dominion Engineering Works Limited.

**Motion Pictures:**
- Associated Screen News Ltd.

**Motors, Electric:**
- Bepco Canada Ltd.
- The Can. Fairbanks-Morse Co. Ltd.
- Can. General Elec. Co. Ltd.
- Can. Westinghouse Co. Ltd.
- Crompton Parkinson (Canada) Ltd.
- Harland Eng. Co. of Can. Ltd.
- Lancashire Dynamo & Crypto Co. of Can. Ltd.
- Northern Electric Co. Ltd.
- Bruce Peebles (Canada) Ltd.

**Moulded Goods, Rubber and Asbestos:**
- The Garlock Packing Co. of Can. Ltd.

### O

**Oil Burning Equipment:**
- Bethlehem Steel Export Corp.

**Oil Refining Equipment:**
- Foster Wheeler Limited.

**Ornamental Iron:**
- Vulcan Iron Wks. Ltd.

### P

**Packings, Asbestos, Cotton and Flax, Metal, Rubber:**
- The Garlock Packing Co. of Can. Ltd.

**Paints, all purposes:**
- Canadian Industries Limited.

**Paving Materials:**
- Barrett Co. Ltd.

**Penstocks:**
- Canadian Vickers Ltd.

**Phase Rotation Indicators:**
- Ferranti Electric Ltd.

**Photographs, Commercial and Portrait:**
- Associated Screen News Ltd.

**Piling, Steel Sheet:**
- Bethlehem Steel Export Corp.

**Pillow Blocks, Plain, Ball and Roller Bearing:**
- Can. S.K.F. Co. Ltd.

**Pinions:**
- Hamilton Gear & Machine Co.

**Pipe, Wood Stave:**
- Canadian Wood Pipe & Tanks Ltd.

**Pipe Coils:**
- The Superheater Co. Ltd.

**Pipe Couplings and Nipples:**
- Dart Union Co. Ltd.

**Plates, Steel:**
- Bethlehem Steel Export Corp
- Dominion Foundries & Steel Ltd.

**Pneumatic Tools:**
- Canadian Ingersoll-Rand Company Ltd.

**Pole Line Hardware:**
- Can. Ohio Brass Co. Ltd.
- Northern Electric Co. Ltd.

**Polishes:**
- Canadian Industries Limited.

**Powder, Black and Sporting:**
- Canadian Industries Limited.

**Power Switchboards:**
- Bepco Canada Ltd.
- Can. General Elec. Co. Ltd.
- Can. Westinghouse Co. Ltd.
- Crompton Parkinson (Canada) Ltd.
- Harland Eng. Co. of Can. Ltd.
- Northern Electric Co. Ltd.

**Preheaters, Air:**
- Babcock-Wilcox & Goldie-McCulloch Ltd.
- Combustion Engineering Corp.
- Foster Wheeler Limited.

**Projectors:**
- Associated Screen News Ltd.

**Pulleys:**
- Plessisville Foundry.

**Pulleys, Ball Bearings, Loose:**
- Can. S.K.F. Co. Ltd.

**Pulp and Paper Mill Machinery:**
- Can. General Elec. Co. Ltd.
- Canadian Ingersoll-Rand Company, Limited
- Can. Westinghouse Co. Ltd
- Dominion Engineering Works Limited.
- Wm. Hamilton Div. Canadian Vickers Ltd.
- Harland Eng. Co. of Can. Ltd.

**Pulverized Fuel Systems:**
- Babcock-Wilcox & Goldie-McCulloch Ltd.
- Bethlehem Steel Export Corpn.
- Combustion Engineering Corp. Ltd.
- Foster Wheeler Limited.
- Wm. Kennedy & Sons Ltd.

**Pump Valves, Rubber:**
- The Garlock Packing Co. of Can. Ltd.

**Pumps:**
- Babcock-Wilcox & Goldie-McCulloch Ltd.
- Canadian Ingersoll-Rand Company, Limited.
- Foster Wheeler Limited.
- Wm. Hamilton Div. Canadian Vickers Ltd
- Harland Eng. Co. of Can. Ltd.

**Purifiers, Water:**
- W. J. Westaway Co. Ltd

### R

**Radiator Air Vents and Traps:**
- Jenkins Bros. Ltd.

**Radiator Valves:**
- Can. Ohio Brass Co. Ltd.
- Jenkins Bros. Ltd.

**Radio Receiving Sets:**
- Can. General Elec. Co. Ltd
- Can. Westinghouse Co. Ltd.
- Northern Electric Co. Ltd.

**Radio Transformers:**
- Ferranti Electric Ltd.

**Rail Bonds:**
- Can. Ohio Brass Co. Ltd
- U.S. Steel Products Co.

**Rail Braces and Joints:**
- B. J. Coghlin Co.

**Railway Equipment:**
- Can. General Elec. Co. Ltd.
- Canadian Ingersoll-Rand Company, Limited.
- Can. Ohio Brass Co. Ltd.

**Receivers, Air:**
- Canadian Ingersoll-Rand Com- Limited.
- E. Leonard & Sons Ltd.

**Recorders:**
- Bailey Meter Co. Ltd.
- Bristol Co. of Can. Ltd.

**Refrigerating Machinery:**
- Canadian Ingersoll-Rand Company, Limited.

**Regulators, Feed Water:**
- Bailey Meter Co. Ltd.

**Reservoirs:**
- Canada Cement Co. Ltd.

**Riveted Pipe:**
- Dominion Bridge Co. Ltd.

**Roads:**
- Canada Cement Co. Ltd.

**Road Machinery:**
- Plessisville Foundry.

**Rods:**
- Bethlehem Steel Export Corp.

**Rolls, Paper Machine:**
- Dominion Engineering Works Limited.

**Roofing, Prepared:**
- The Barrett Co. Ltd.

**Roofs, Built-up:**
- The Barrett Co. Ltd.

**Rope, Wire:**
- Dom. Wire Rope Co. Ltd.

### S

**Screening Equipment:**
- Canadian Ingersoll-Rand Company, Limited.
- Foster Wheeler Ltd.

**Separators, Electric:**
- Northern Electric Co. Ltd.

**Sewers:**
- Canada Cement Co. Ltd.

**Shingles, Prepared Asphalt:**
- The Barrett Co. Ltd.

**Shovels — Powered Electric or Gasoline:**
- Canadian Vickers Ltd.

**Smokestacks:**
- Canada Cement Co. Ltd.
- Canadian Vickers Ltd.
- Foster Wheeler Ltd.
- E. Leonard & Sons Ltd.

**Softeners, Water:**
- W. J. Westaway Co. Ltd.

**Sporting Powder:**
- Canadian Industries Limited.

**Springs — Automobile, Railway, Wire:**
- B. J. Coghlin Co. Ltd.

**Stains:**
- Canadian Industries Limited.

**Steam Plant Equipment:**
- Babcock-Wilcox & Goldie-McCulloch Ltd.
- Combustion Engineering Corp. Ltd.
- Foster Wheeler Limited.
- Harland Eng. Co. of Can. Ltd.

**Steel Plate Construction:**
- Canadian Vickers Ltd.
- Dominion Bridge Co. Ltd.
- Foster Wheeler Ltd.
- E. Leonard & Sons Ltd.

**Stokers:**
- Babcock-Wilcox & Goldie-McCulloch Ltd.
- Combustion Engineering Corp. Ltd.

**Structural Iron and Steel:**
- Canadian Vickers Ltd
- Dominion Bridge Co. Ltd
- Vulcan Iron Works Ltd.

**Superheaters:**
- Babcock-Wilcox & Goldie-McCulloch Ltd.
- Foster Wheeler Limited.
- The Superheater Co. Ltd.

**Surge Absorbers:**
- Ferranti Electric Ltd.

**Switchboards, Power Lighting:**
- Bepco Canada Ltd.
- Can. General Elec. Co. Ltd.
- Can. Westinghouse Co. Ltd.
- Crompton Parkinson (Canada) Ltd.
- Harland Eng. Co. of Can. Ltd.
- Northern Electric Co. Ltd.

### T

**Tanks:**
- Babcock-Wilcox & Goldie-McCulloch Ltd.
- Braithwaite & Co. Engineers Ltd.
- Canada Cement Co. Ltd.
- Canadian Vickers Ldt.
- Dominion Bridge Co. Ltd.
- Foster Wheeler Ltd.
- E. Leonard & Sons Ltd.
- Vulcan Iron Wks. Ltd.

**Tanks, Wood:**
- Canadian Wood Pipe & Tanks Ltd.

**Tees:**
- Dart Union Co. Ltd.

**Telegraph Line Material:**
- Northern Electric Co. Ltd.

**Testing Sets:**
- Moloney Electric Co. of Can., Ltd.

**Thermometers, Recording:**
- Bailey Meter Co. Ltd
- Bristol Co. of Can. Ltd.

**Tiles:**
- Canada Cement Co. Ltd.

**Tinplate:**
- Bethlehem Steel Export Corp.

**Towers, Cooling, Fractionating:**
- Foster Wheeler Limited.

**Track Tools:**
- B. J. Coghlin Co. Ltd.

**Transformers, Instrument, Testing, Distribution:**
- Bepco Canada Ltd.
- Ferranti Electric Ltd.
- Moloney Electric Co. of Can., Ltd.

**Transformers, Lighting and Power:**
- Bepco Canada Ltd.
- Can. General Elec. Co. Ltd.
- Can. Westinghouse Co. Ltd.
- Crompton Parkinson (Canada) Ltd.
- Ferranti Electric Ltd.
- Moloney Electric Co. of Can., Ltd.
- Northern Electric Co. Ltd.
- Bruce Peebles (Canada) Ltd.

**Transmission Poles and Towers:**
- Dominion Bridge Co. Ltd.

**Trolley Materials:**
- Can. Ohio Brass Co. Ltd.

**Tubes, Boiler, Lapwelded Steel, and Iron:**
- Babcock-Wilcox & Goldie-McCulloch Ltd.
- Canadian Vickers Ltd.
- E. Leonard & Sons Ltd.

**Turbines, Hydraulic:**
- Dominion Engineering Works Limited.
- Wm. Hamilton Div. Canadian Vickers Ltd.
- Wm. Kennedy & Sons Ltd.

**Turbines, Steam:**
- Babcock-Wilcox & Goldie-McCulloch Ltd.
- Harland Eng. Co. of Can. Ltd.

**Turbo Generators:**
- Bepco Canada Ltd.
- Can. General Elec. Co. Ltd.
- Can. Westinghouse Co. Ltd.
- Lancashire Dynamo & Crypto Co. of Can. Ltd.

**Turntables:**
- Dominion Bridge Co. Ltd.

### U

**Unions:**
- Dart Union Co. Ltd.

### V

**Valve Controls:**
- Northern Electric Co. Ltd.

**Valve Discs, Rubber:**
- The Garlock Packing Co. of Can. Ltd.
- Jenkins Bros. Ltd.

**Valves:**
- Can. Ohio Brass Co. Ltd.
- Dominion Engineering Works Limited.
- Jenkins Bros. Ltd.

**Valves, Relief:**
- Neptune-National Meters Ltd.

**Varnishes:**
- Canadian Industries Limited.

**Ventube:**
- Canadian Industries Limited.

### W

**Washers, Air:**
- Canadian Ingersoll-Rand Company Limited.

**Water Cooled Furnaces:**
- Babcock-Wilcox & Goldie-McCulloch Ltd.
- Combustion Engineering Corp. Ltd.
- Foster Wheeler Limited.

**Waterproofing:**
- The Barrett Co. Ltd.

**Welding Machines, Electric and Accessories:**
- Can. General Elec. Co. Ltd.
- Can. Ohio Brass Co. Ltd.
- Can. Westinghouse Co. Ltd.
- Northern Electric Co. Ltd.

**Wheels, Fly and Gear:**
- Hamilton Gear & Machine Co.

**Winches, Stop-log and Headgate**
- Canadian Vickers Ltd.

**Wire:**
- Bethlehem Steel Export Corp.

**Wire, Electric, Bare and Insulated:**
- Can. General Elec. Co. Ltd.
- Northern Electric Co. Ltd.

**Wire Rope:**
- Dom. Wire Rope Co. Ltd

**Wire Springs:**
- B. J. Coghlin Co. Ltd.

**Worm Gears:**
- Hamilton Gear & Machine Co.

# PROFESSIONAL CARDS



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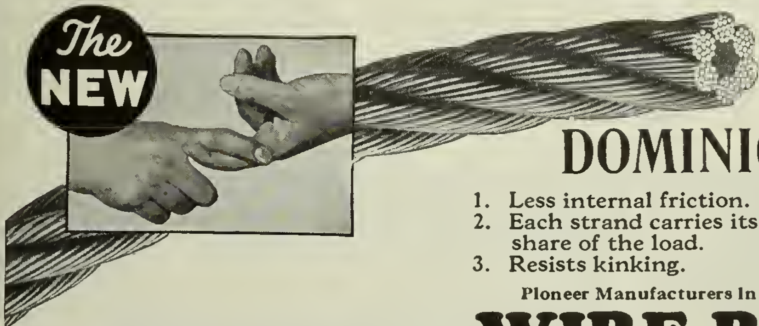
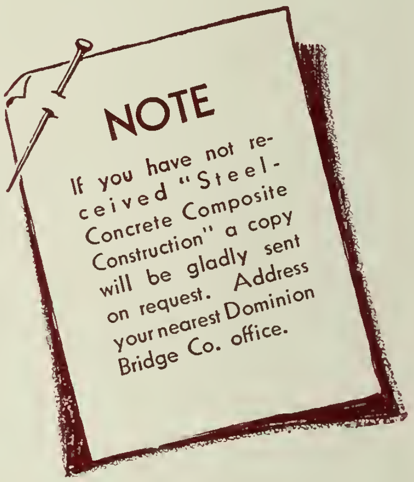


## INDEX TO ADVERTISERS

# STEEL-CONCRETE

## COMPOSITE CONSTRUCTION


## Fully Described and Illustrated in this New Booklet.




Steel-Concrete Composite Construction enables architects, engineers and contractors to build, not only well but with greater speed and economy. It gives the owner a better structure and yet one that can be easily altered at minimum cost. It assures security to the architect and engineer because of its accuracy and reliability.

This booklet is issued in response to the many requests for information regarding this important development in the construction industry.

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1934

## *In this issue*



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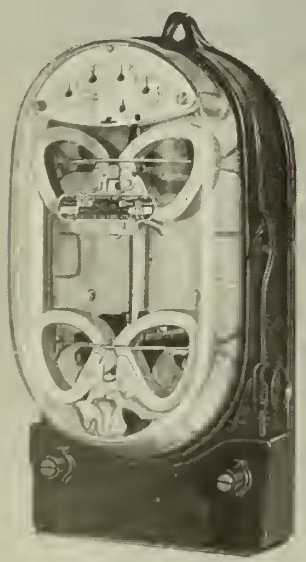
THE ENGINEERING INSTITUTE *of* CANADA

# DISTRIBUTION EQUIPMENT

DISTRIBUTION TRANSFORMERS
PORCELAIN-HOUSED CUTOUTS
PELLET LIGHTNING ARRESTERS



D-14 POLYPHASE
WATTHOUR METERS

I-16 SINGLE-PHASE
WATTHOUR METERS

## DISTRIBUTION TRANSFORMERS

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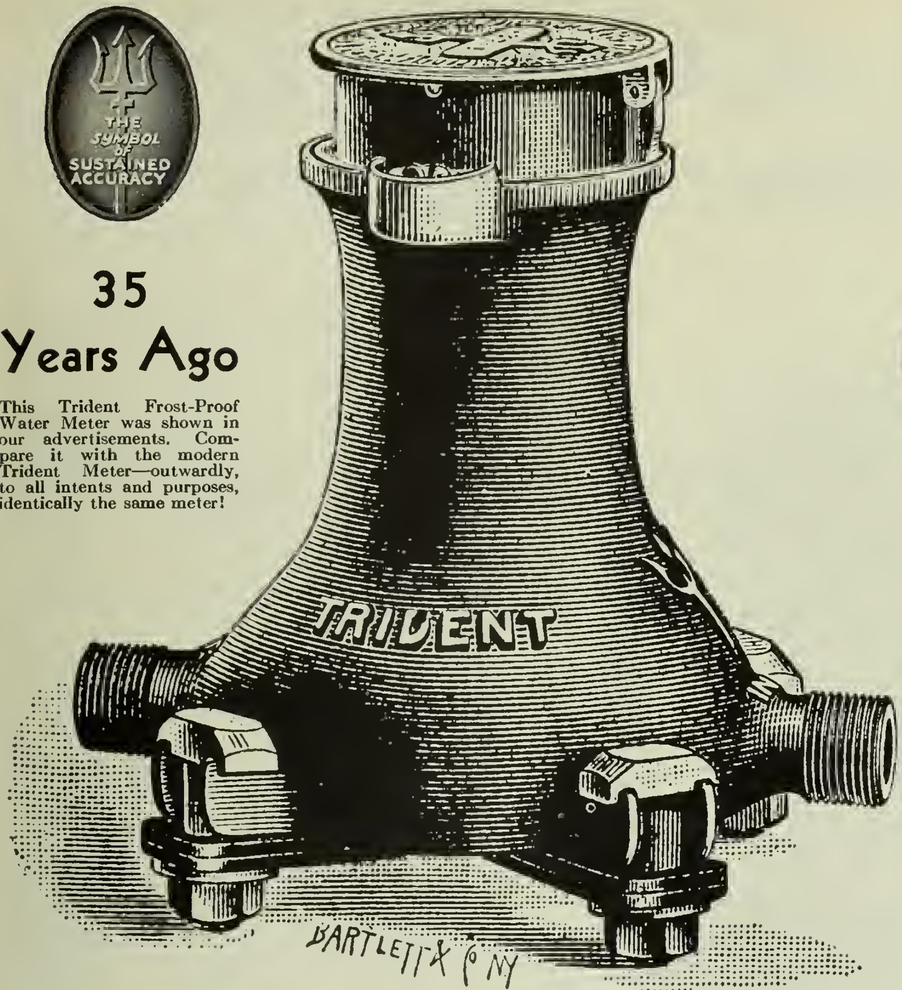


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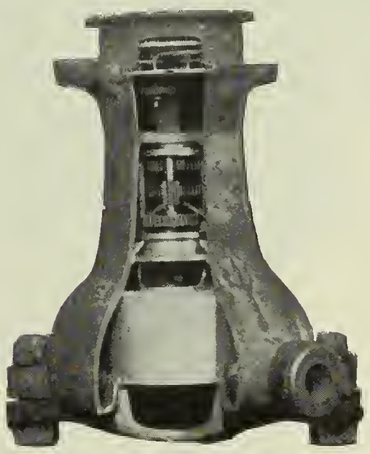

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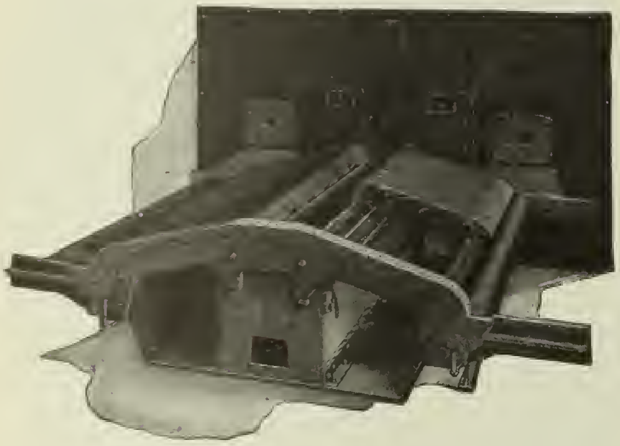
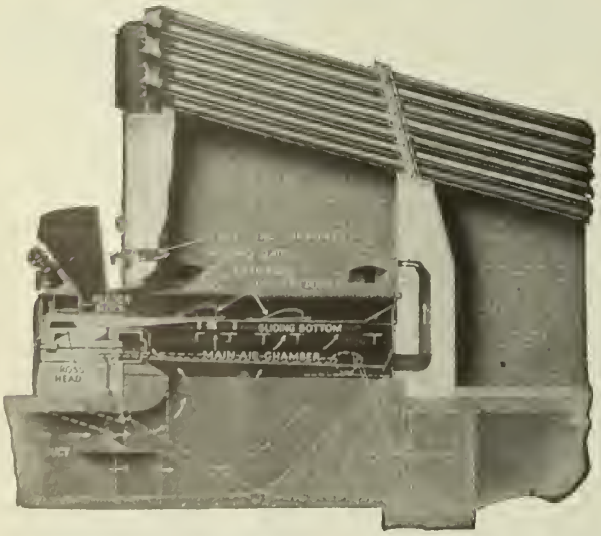
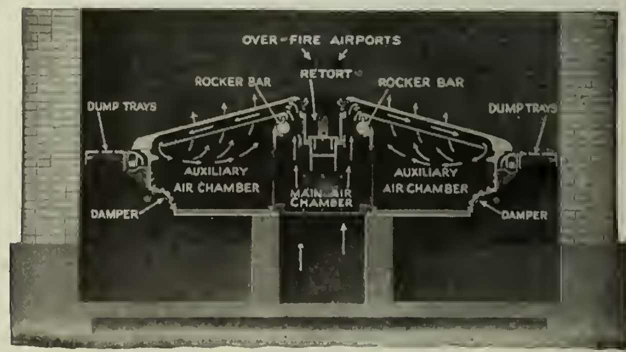


*Rear view showing retort, grate bars, dump grates and auxiliary windbox.*




*Longitudinal section showing air distribution. Air duct may enter from front or rear.*




*Cross-section showing air distribution. Air may be admitted to dump grates as required.*

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# Highways and Highway Transportation in British Columbia

*Patrick Philip, M.E.I.C.,*
*Chief Engineer and Deputy Minister, Provincial Department of Public Works, Victoria, B.C.*

**Paper presented at the Western Professional Meeting of The Engineering Institute of Canada, Vancouver, B.C., July 11th to 14th, 1934.**

**SUMMARY.—Outlining the history and development of the highway system in British Columbia, the author gives particulars as to its administration, organization and operation, with figures as to costs of construction and maintenance. He discusses the experience obtained with various types of road surface and the materials and equipment found suitable for conditions in the province, and describes the practice adopted as regards bridges of various types.**

The administration of highways throughout Canada today is an important function of all the provincial governments and presents many major problems. It is safe to say that there is not one province in Canada in which the programme of highway building and improvement is yet abreast of the needs of modern motor-vehicle transportation. The motor-vehicle industry in Canada, as elsewhere, has become one on which a very great number of persons are directly dependent for a livelihood; the use of motor-vehicles is now general and has revolutionized our social habits, particularly in country districts. This condition has resulted in demands for road extensions and improvements to an extent beyond the resources of the average provincial government.

The general public is financially interested in the efficient administration of each provincial highway system: the costs of highway transportation are governed, to a large extent, by the condition of maintenance and type of construction of the highways and it is the vehicle owners themselves who pay the major portion of the bill and who, therefore, are entitled to the first consideration.

The problems of financing and administration are, broadly speaking, very similar in each province; they differ, however, in detail and, as the title of this paper indicates, it is the intention of the author to present some of the problems and points of interest in the administration of British Columbia's highways.

British Columbia covers a vast territory. In actual land area it is 20 per cent larger than the combined land areas of the provinces of Alberta, New Brunswick, Nova Scotia and Prince Edward Island, but is the least densely populated of all provinces in Canada, having an average density of only 1.92 persons per square mile of land area.

As may be seen from the map (Fig. 1), only approximately one-half of the province is at present served by the existing highway system. The remainder of the province, with the exception of the Peace River district and the settlements at Telegraph Creek, Dease Lake and Atlin, is, to all intents and purposes, uninhabited.

The map only shows the main highways and some of the local roads of the province, representing less than 25 per cent of the entire provincial highway system, a system which has been built entirely within the last seventy-five years and which now consists of 19,522 miles of all classes of highways under provincial jurisdiction.

### EARLY HISTORY

Before dealing with the conditions now existing, it may be of interest briefly to relate the story of the first major highway project in British Columbia.

In the year 1857, except for a few trails, there were no means of land transportation on the mainland of British Columbia and there was practically no settlement. In the year 1858, with dramatic suddenness, following the discovery of rich deposits of gold on the Fraser river, the town of Victoria, on Vancouver Island, became, almost overnight, the jumping-off point for thousands of fortune seekers filled with determination to reach the gold fields by some route or other. The infant Crown Colony was thus faced with a sudden crisis: not only was a road to the interior a necessity for the purpose of transporting supplies and gold, it was also needed for the preservation of law and order in a vast and almost inaccessible region which, until that time, had been practically uninhabited. The building of the famous Cariboo road, nearly 400 miles in length, from Yale to Barkerville within the incredibly short time of four years at a cost of approximately $2,000,000 is a story with which many are familiar; over this road there was transported, mostly in stage coaches, some $30,000,000 worth of gold. Much of the original road is still in use today and, although the building of the two trans-continental railroads later destroyed the sections through the Thompson and Fraser river canyons, the present modern highway through these canyons still follows generally the route first chosen by the pioneers.

*Rapid Development*

The events described in the foregoing paragraph were mainly responsible for the early and rapid development of the province before and after Confederation. It is doubtful whether any factor other than the discovery of gold could have provided the impetus for the phenomenal effort of building a wagon road of such length through mountainous country under the difficult circumstances which existed at that time.

With a road to the interior available, settlement and development were rapid, and the years which followed Confederation were marked with great activity in road building; by the year 1900, when the first measurement of roads was attempted by men with bicycles fitted with cyclometers, 5,615 miles of road had been built, mostly for the purpose of local settlement.

This early road building, necessary as it was for immediate development, was not on scientific lines and it has cost, and will for some time continue to cost, the province large sums to correct the mistakes of those earlier days, for it appears often to have been the custom in laying out the route of a new road to follow the line of least resistance without much consideration for gradient or alignment and without any reference to a general plan for a main highway system, the need for which does not appear to have been fully recognized until about the year 1910, when the automobile was becoming a factor in highway transportation in the western province.

The Highway System

During the past twenty-five years, however, good progress has been made with the development and improvement of the main highway system, although such progress was necessarily somewhat retarded by the war.

As will be seen from the map (Fig. 1), the southerly part of the province is entered from the east by three routes, which pass through the Kicking Horse Pass, Vermilion Pass and Crow's Nest Pass respectively. The first-named pass is the gateway to British Columbia's section of the trans-Canada highway; the last-named connects the southern trans-provincial highway to the Alberta highway system; the two routes are of equal importance and converge at Hope, 99 miles east of Vancouver.

In neither case is the construction of these two routes completed. On the trans-Canada route some 63 miles remain to be constructed at the northerly end of the Big Bend of the Columbia river and, until this work has been completed, vehicles entering the province via Kicking Horse Pass or Vermilion Pass must travel south before they can proceed further in a westerly direction.

On the southern trans-provincial route the new 88-mile link between Princeton and Hope, via Allison Pass (elevation 4,450 feet) is not yet finished, but work on this section is now proceeding as a relief measure under the Department of National Defence; for the time being, it is necessary for vehicles en route from the southern interior to the coast to detour from Princeton to Spence's


Fig. 1—Main Highways, British Columbia.

Bridge, to join the trans-Canada route which, from this point, passes through the canyons of the Thompson and Fraser rivers. The total distance from Crow's Nest to Vancouver via the southern route is 687 miles, including 12 miles by ferry on Kootenay lake. By the trans-Canada route, from the Alberta boundary to Vancouver the distance is 668 miles. These distances include the two uncompleted links referred to.

At some future date a road may be built from Alberta to Prince George and Kamloops via the Yellowhead Pass. A connection with the province of Alberta exists to the north between Grand Prairie, Alberta and Pouce Coupé, B.C., in the famous Peace River district.

A feature of British Columbia's highway system is the number of connections made with the highway system of the United States. As many as 185,418 automobiles have visited the province from the south in one year and the international boundary line is crossed at no less than eighteen places, the more important ones only being shown on the map. The most popular of these routes is the Pacific highway which crosses the boundary at Blaine, 33 miles from Vancouver.

Traffic to and from Vancouver is served by two main highways on the north and south sides of the Fraser river respectively. Both of these well travelled routes have been in use for a long time and 67 miles of these roads have been entirely reconstructed to modern highway standards, with rights-of-way generally 100 feet wide and with easy curvature and gradients. Connection between these two routes across the Fraser river is provided at Agassiz by power-ferry and at Mission by the Canadian Pacific Railway bridge which has been planked for the use of vehicles. The southern route and the Pacific highway cross the Fraser river by a bridge at New Westminster which was built between the years 1902 and 1904 and which, in addition to vehicular traffic, carries the tracks of the Canadian National, Great Northern and British Columbia Electric Railways. As many as 15,016 vehicles have crossed this bridge in one day; two lanes of traffic are available and at times there is a congestion of traffic.

Next in relative importance is the road to Prince George and Hazelton, part of which, from Clinton to Quesnel, follows the old Cariboo road for most of its distance. The total distance from Prince George to Vancouver is 521 miles, but it is not unusual to drive the whole distance in two days, although the road is not paved. Westerly, from Prince George, the road generally parallels the Canadian National Railway to Hazelton, a distance of 823 miles from Vancouver.

A few years ago the road from Quesnel to Barkerville was perhaps considered as one of the least important roads in the province; today the reverse is the case, for the only other means of access to this now thriving town from the Pacific Great Eastern railhead at Quesnel is by aeroplane. The government of British Columbia is fully cognizant of the immense wealth which the present mining activity may be the means of developing in this region, whose resources have remained dormant since the early placer mining days. In order to give every assistance possible to this development, special efforts are being made to keep this road open under all conditions.

An important highway is the road from Kamloops to Penticton in the Okanagan Valley. This route provides a direct connection between the southern trans-provincial highway and the trans-Canada highway and carries a relatively large traffic.

Our description would not be complete without mention of the famous Island highway on Vancouver Island, which road follows the east shore of the island from Victoria to Menzies Bay, a total distance of 185 miles, of which 155 miles are bituminous surfaced or paved. This highway carries a heavy traffic, which has amounted to as many as 3,900 cars in one day and 13,500 cars in a week at some points and it attracts numerous tourists.

In addition to the main highways which have been described, together with the others shown on the map, there is an extensive net-work of local roads, together with many thousands of miles of farm and mining roads, the total being 19,522 miles of highway under provincial control as follows:—

Table I

Mileage of Provincial Highway System and Type of Surface

| *Type of Surface* | *Mileage* |
|---|---|
| Unimproved or cleared only | 2,598 |
| Earth or sand-clay | 10,007 |
| Gravelled | 6,254 |
| Bituminous surfaced | 441 |
| Paved | 165 |
| Other types and mileage under construction | 57 |
| Total | 19,522 miles |

In addition, there are 9,418 miles of trails maintained by the provincial government, of which some 55 per cent are mining trails.

Prior to the year 1919, the cost of all highway work, including new construction, was met from current revenue. Since that time, various loans have been issued for highway purposes, the total amount outstanding for this purpose at March 31st, 1933, being about $40,000,000; the estimated valuation of roads, bridges, wharves and ferries is now placed at $76,430,378.

Throughout the past decade there has been a great deal of activity in highway construction and improvement; during this period the total mileage of highways has increased by 3,377 miles; in addition, a policy of major improvement has been vigorously carried out and, as far as the main highways are concerned, the time is approaching when many of the worst stretches will have been eliminated or greatly improved. Much, however, remains to be done; north of Revelstoke, for instance, on the trans-Canada highway, many miles will require to be widened or reconstructed; portions of the trans-Canada highway between Hope and Chilliwack will also require attention and elsewhere it has been necessary to postpone some much needed diversions and improvements; eventually it is hoped that the trans-provincial highways at least will be hard-surfaced throughout.

### Legislation and Administration

The administration of the Motor Vehicle Act is under the jurisdiction of the Attorney General and the details of administration are carried out by the provincial police, including the licensing of motor vehicles and the enforcement of the various speed and other laws in connection therewith.

The Highway Act is administered by the Minister of Public Works who is the head of the Department of Public Works. Under this Act the Minister has very wide powers in the establishment of highways. The usual method of establishing a highway, other than in closely settled or semi-urban districts, is by the publication of a notice by the Minister in the *British Columbia Gazette* setting out the direction and extent of the lands taken; a description of the centre line and of the initial and terminal points is usually given. Highways are usually established 66 feet in width. In some cases highways are established by depositing a British Columbia Land Surveyor's plan in the Land Registry Office. Compensation is only paid for land when the area taken for highways exceeds one-twentieth of the total area of the parcel; compensation is paid for any improvements acquired in the construction of highways.

The Highway Act also gives the Minister powers to regulate traffic, particularly the gross weights, tire equipment and dimensions of vehicles, for the purpose of protecting the highway from damage; it provides for the control, either in whole or in part, of certain important highways within municipalities. Under the Highway Act, the Minister of Public Works is also responsible for the licensing of public carriers.

In connection with the provincial highway system, a large number of ferries are operated by the government;

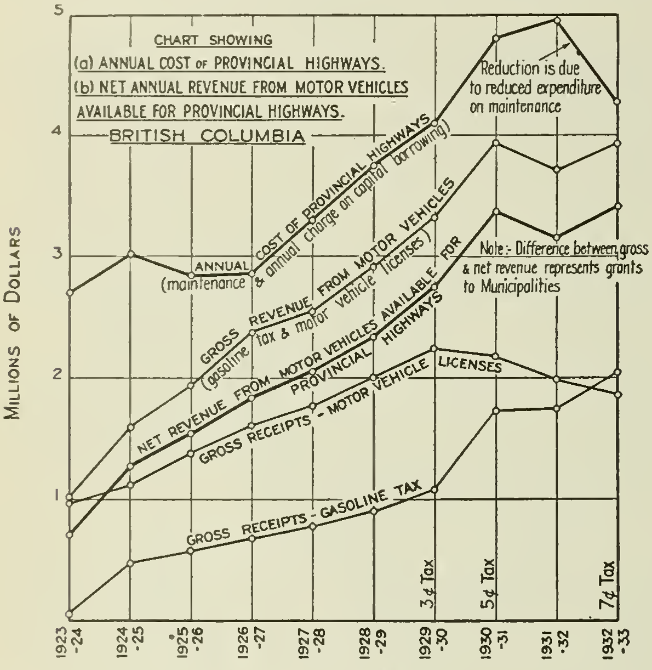


**Fig. 2**

in addition, several ferries are operated by private parties licensed under the Ferries Act, a subsidy being paid by the government in most cases.

### Organization

The province of British Columbia is not divided into counties, townships or other subdivisions for administration purposes and, apart from the municipalities, there is no form of local government. The incorporated municipalities, consisting of thirty-three cities, twenty-eight districts and seventeen villages, although containing about 75 per cent of the provincial population, only contain 0.5 per cent of the entire area of the province, and all highways in the remaining 99.5 per cent of this vast area are under the direct jurisdiction of the Minister of Public Works, in addition to some 520 miles of main municipal highways, most of which lie in the lower valley of the Fraser river. Thus it follows that, in addition to the important work of administering the main highway system of the province, much of the activity of the Department is necessarily devoted to the administration of local highways, requiring careful organization and the division of the entire area of the province, consisting of 359,279 square miles (land area), into districts.

The unit of subdivision for highway administration is the electoral district in charge of an Assistant District Engineer or General Foreman; these officials are either competent engineers or general foremen of long experience in the class of work and have an average of about 670 miles of road under their supervision. Several such districts are formed into an engineering district in charge of a District Engineer, there now being eight such districts and one sub-district.

In addition to the district offices, the Department maintains at Vancouver a small traffic branch for the regulation of Common Carriers, and a Right-of-Way and Claims Agent, while at Victoria there is a clerical staff, accounting staff, bridge department and equipment branch. There is also an architectural branch responsible for the construction and maintenance of all public buildings.

### Highway Transportation

The chief basic industries in British Columbia are mining, lumbering, fishing and agriculture. The topography is generally but by no means entirely of a mountainous nature. The climate varies from moist and equable at the coast, to dry with extremes of temperature in the interior; the average density of population is very low, with 53 per cent of the entire population concentrated in the lower valley and delta of the Fraser river within a distance of about 50 miles from Vancouver.

As a general result of these circumstances, in this province, where automobiles are a necessity rather than a luxury, it is necessary to provide and maintain an extensive mileage of roads for a relatively low volume of traffic of moderate weight. The tourist industry is a valuable one and the maintenance of a reasonably smooth and safe surface on our main highways is a necessity.

Figure 2 illustrates the relation between the annual cost of highways and the net and gross annual revenue received from motor-vehicles, for each year since 1923. By the "annual cost of highways" is meant the maintenance charges plus the interest and sinking fund on capital borrowings. The gross revenue is the amount received from motor-vehicle license fees and registration fees, chauffeurs' and drivers' licenses, and from the gasoline tax; net revenue is the amount available for provincial highways, the difference being the proportion of license fees annually payable by the province to the municipalities, who have no licensing powers. The gasoline tax was first imposed in 1924 and was set at 3 cents per gallon; this was raised to 5 cents per gallon in 1930 and again increased

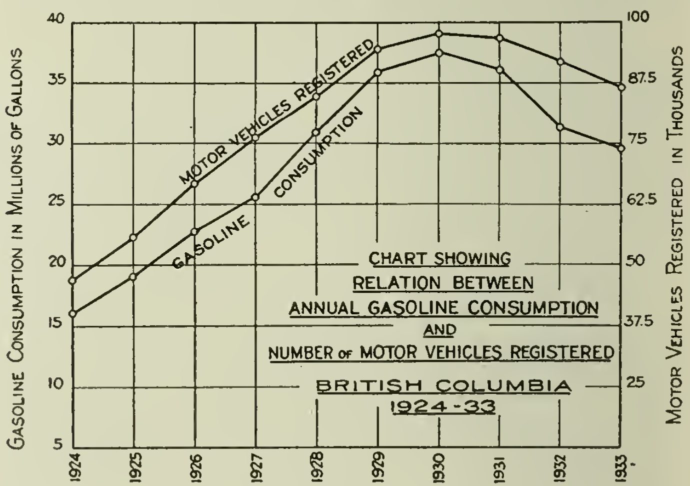


**Fig. 3**

to 7 cents per gallon in 1932. It will be noted that the annual cost of highways is in excess of the total revenue from motor-vehicles.

The growth and recent decline of the use of the motor-vehicle according to annual gasoline consumption is shown by Fig. 3, which also shows the annual motor-vehicle registration; the marked decline for the years 1931 and 1932 is probably in keeping with conditions in other provinces; from the trend of the curves there is justification for expecting a slight improvement in 1934. The gasoline consumption per car in 1933, namely 339 gallons, is very nearly the same as it was in 1924; in 1930 the amount was 388 gallons per car.

Motor-vehicle license fees are now assessed on the basis of net weight of vehicle; the annual fees so payable are shown in the following table; in cases where a license is only taken out for a portion of the year, there is a pro-rata reduction of one-twelfth of the total fees in respect of each month.

Table II
Motor Vehicle License Fees

| Net Weight of Vehicle in Pounds | Annual Fee | Net Weight of Vehicle in Pounds | Annual Fee |
|---|---|---|---|
| 1,500 or less. | $ 12.00 | 16,001 to 17,000 | $250.00 |
| 1,501 to 2,000 | 16.00 | 17,001 to 18,000 | 270.00 |
| 2,001 to 3,000 | 20.00 | 18,001 to 19,000 | 290.00 |
| 3,001 to 4,000 | 25.00 | 19,001 to 20,000 | 310.00 |
| 4,001 to 5,000 | 35.00 | 20,001 to 21,000 | 330.00 |
| 5,001 to 6,000 | 50.00 | 21,001 to 22,000 | 350.00 |
| 6,001 to 7,000 | 65.00 | 22,001 to 23,000 | 370.00 |
| 7,001 to 8,000 | 80.00 | 23,001 to 24,000 | 390.00 |
| 8,001 to 9,000 | 95.00 | 24,001 to 25,000 | 410.00 |
| 9,001 to 10,000 | 110.00 | 25,001 to 26,000 | 430.00 |
| 10,001 to 11,000 | 130.00 | 26,001 to 27,000 | 450.00 |
| 11,001 to 12,000 | 150.00 | 27,001 to 28,000 | 470.00 |
| 12,001 to 13,000 | 170.00 | 28,001 to 29,000 | 490.00 |
| 13,001 to 14,000 | 190.00 | 29,001 to 30,000 | 510.00 |
| 14,001 to 15,000 | 210.00 | 30,001 to 31,000 | 530.00 |
| 15,001 to 16,000 | 230.00 | | |

Owing to the outdoor nature of the industries, the percentage of commercial vehicles is relatively high, averaging 17½ per cent of the total number of vehicles registered. An analysis of these registrations, however, indicates that the proportion of heavy trucks is still comparatively small, it being estimated that not more than 10 per cent of trucks in British Columbia have a potential maximum gross weight of over 6 tons and that it is unlikely that more than 2 per cent exceed 10 tons gross weight.

Permissible gross weights and dimensions of vehicles are set by regulation made by order-in-council. The weights vary with the type or class of construction of the highway and with the season of the year and are as follows:—

Table III
Maximum Gross Weight and Maximum Weight on any One Axle

| Class of Highway | Summer Period | | | Winter Period | | |
|---|---|---|---|---|---|---|
| | Maximum Gross Weight | Maximum Weight on any One Axle | | Maximum Gross Weight | Maximum Weight on any One Axle | |
| | | Vehicles with not more than Two Axles | Vehicles with more than Two Axles | | Vehicles with not more than Two Axles | Vehicles with more than Two Axles |
| | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds |
| I | 24,000 | 14,400 | 12,000 | 24,000 | 14,400 | 12,000 |
| II | 20,000 | 12,000 | 10,000 | 14,000 | 8,400 | 7,000 |
| III | 14,000 | 8,400 | 7,000 | 10,000 | 6,000 | 5,000 |
| IV | 10,000 | 6,000 | 5,000 | 7,000 | 4,200 | 3,500 |

Class I includes all highways constructed entirely of Portland cement or bituminous concrete, or with a granite block, wood block, brick, or bituminous top laid on a Portland cement or bituminous concrete base.

Class II includes all highways constructed of bituminous-bound stone or gravel not laid on a Portland cement or bituminous concrete base.

Class III includes all highways constructed of water-bound macadam or surfaced with gravel, whether surface-treated or not surface-treated with asphalt or with oil.

Class IV includes all highways constructed of earth, without the addition of a gravel or other improved surface.

Permissible dimensions for vehicles are:—

Width.............................. 8 feet
Height.............................. 12 feet 6 inches
Length.............................. 30 feet

Experience has shown that, for all ordinary cases, these weights are generally reasonable and little difficulty


**Fig. 4—Special Permit Plate.**

has been experienced in their enforcement; they are based primarily on the capacity of the bridges, which are the controlling factor as far as gross weight of vehicles is concerned. The distribution of the weights is also set by regulation according to the tire equipment of the vehicle.

Provision is made in the regulations whereby the operation of certain vehicles which exceed the permissible weights is authorized by special permit; the conditions of the permit are such that the operation is entirely under the control of the Department; a cash security deposit is usually required before the permit is issued and the vehicles carry two special permit plates (Fig. 4). The permit system is especially useful as a means of controlling the operations of logging contractors; if such operations were uncontrolled there is probably no reasonable limit to the loads which might be carried on the highways, as is instanced by the following weights of one vehicle found to be operating on a public highway:—

Table IV
Example of Heavy Logging Outfit

| | Gross weight on each wheel Pounds | Tires | Gross weight on each axle Pounds |
|---|---|---|---|
| Right front | 3,000 | 7-inch solid | |
| Left front | 2,300 | 7-inch solid | 5,300 front axle |
| Right rear | 12,800 | 16-inch solid | |
| Left rear | 10,400 | 16-inch solid | 23,200 rear axle |
| Right trailer | 12,800 | 14-inch solid | |
| Left trailer | 14,850 | 14-inch solid | 27,650 trailer axle |
| Total gross weight | 56,150 | | 56,150 |

(Weights as measured by loadometers.)

In general, we find that heavy equipment is improving each year; loads which a few years ago were supported by six solid tires are now carried on ten or fourteen pneumatic tires and the operators have realized that it is against their own interests to damage the highways. Figure 5 is a photograph of a well-equipped vehicle engaged in hauling Douglas fir on Vancouver Island; the gross weight of truck, trailer and load in this case is not less than 14 tons.

In the case of licensed common carriers, special permits for the operation of over-weight vehicles are not necessary; each case is carefully investigated before the license is issued and the license is, *ipso facto*, a special permit for the operation of the vehicle in accordance with the weights stated in the license.

The erection of advertising signs on highways within the right-of-way is not allowed except under permit. The policy of the Department is opposed to the erection of the ordinary advertising sign but signs which may be of use to the motorist indicating the location of beaches, camps, hotels, picnic grounds, etc., are allowed. In the matter of warning signs, the standard yellow and black colour has been adopted and a large number of wooden signs have been erected; wooden signs have not been found sufficiently durable except as a temporary measure.

Fig. 5—Logging Operations on Vancouver Island.

### Construction and Maintenance

For many years it has been the policy of the Department of Public Works to require that all highway improvement or new highway work of any importance be properly surveyed, a policy which results in uniformity and, in the long run, a saving in the cost of the work. While it is true that several major road construction projects remain to be completed, the present need in British Columbia is not so much the construction of new roads as the improvement of the existing roads; such improvement, which has been going forward steadily for years, includes the construction of major diversions, widening, grade revision, improved vision, drainage, replacement of the smaller bridges with culverts and fills, super-elevation of curves, elimination of railway crossings and the like. Work of this nature is usually carried out by "day labour" and, during the last few years, as a relief measure.

The general policy of the provincial government with regard to highway construction in the past has been to carry out such work by contract; during recent years it has been necessary to modify this policy, due, in part, to the change in the economic situation and the resulting need for classing nearly all highway work as "relief undertakings." When contracts are let, they are almost invariably let on a unit price basis with the usual four classifications of solid and loose rock, hardpan and earth. The statute requires that all tenders advertised in the press for public works be opened in public.

The most important highway construction project undertaken in British Columbia in recent years was the reconstruction of the Cariboo road through the Fraser river and Thompson river canyons from Hope to Spence's Bridge, a total distance of 96 miles, at a cost of approximately $2,600,000, during the years 1925 to 1928. Figure 6 shows the Fraser Canyon section of the Cariboo highway with the Canadian Pacific Railway retaining wall on the right and drystone masonry retaining wall 18 feet high on the left.

Space does not permit of describing this project in detail but it was fully dealt with in the author's paper* presented at the Western General Professional Meeting of The Engineering Institute of Canada at Vancouver, B.C., in June, 1928.

With the exception of the portions 22 miles in length between Boothroyd and Lytton and 15 miles between Hope and Yale, the work was carried out by contract in three sections which involved a total of 1,265,000 cubic yards of excavation, of which 28 per cent was in solid rock. This highway forms the main artery from the coast to the interior, and follows, generally, the original route of its predecessor built in the years 1862-65 and later destroyed by the construction of the two trans-continental railways. Prior to the opening of this highway, through travel from the coast to the interior was not possible except by a detour of considerable length through the state of Washington, U.S.A., and the opening of the new highway entirely altered highway transportation conditions in British Columbia. A toll gate is maintained on this highway at Spuzzum, between Yale and Lytton, during the period from April to November, the charges for an ordinary passenger vehicle being $1.00, although local residents are exempted from paying this toll. In the year 1927, the first year of opening of the toll section, 7,659 vehicles passed through the toll gate. This number has gradually increased and, in the year 1931, the number of vehicles was 20,495.

In British Columbia a specialty has been made of low-cost surfaces such as bituminous spray coat and bituminous mulch and it is the practice to carry out part of the work by contract and part by the Department's forces, or the work is occasionally done by the combination of both, the contractor doing the spraying, the Department attending to the gravel aggregate.

Fig. 6—Cariboo Highway, Fraser River Section.

Owing to the topography and geological features of British Columbia, the cost of main road construction per mile is, no doubt, high as compared with many other parts of Canada. It recently became necessary to know the average cost of highway construction in this province and representative contracts for a total of 115 miles of main

*See The Engineering Journal, July 1928, pp. 399-409.

road constructed during the past ten years were analyzed; this gave the following figures which may be of interest for the purpose of comparison:—

Table V

Analysis of 13 Road Construction Contracts Covering Construction of 115 Miles of Main Highway

| Average Cost per Mile (excluding large bridges and gravelling) | | Average Quantities per Mile | |
|---|---|---|---|
| Excavation | $16,640 | *Excavation*, 16,900 cubic yards. | |
| Clearing | 630 | Solid rock | 32.5 per cent |
| Grubbing | 378 | Loose rock and hardpan | 45.5 per cent |
| Culverts | 700 | Earth | 22.0 per cent |
| Trestle bridges | 816 | | |
| Cribs, etc | 2,722 | | |
| Miscellaneous | 1,142 | | 100.0 per cent |
| Total | $23,028 | *Clearing* | 5.75 acres |
| | | *Grubbing* | 1.88 acres |
| | | *Average Cost of Excavation.* $0.98 per cubic yard. | |

Some by no means exhaustive inquiries have also been made into the distribution of the highway dollar, a subject which may be of interest, if it only serves to promote a discussion on a matter which is of vital importance.

Table VI

Estimated Distribution of $100.00 Expended on Highway Construction—Day Labour Work

*Distribution*

| Class of Work | Wages | Materials | Plant rentals | Tools | Gasoline, oil and repairs | Total |
|---|---|---|---|---|---|---|
| Highway construction involving heavy excavation, including clearing and grubbing | $66 | $15 | $ 8 | $6 | $ 5 | $100 |
| Highway construction involving only light excavation, including clearing and grubbing | 76 | 6 | 7 | 6 | 5 | 100 |
| Gravelling | 70 | 2 | 15 | 3 | 10 | 100 |

### Mining Roads

One of the most important activities in British Columbia is mining, and a large proportion of the roads and trails in the interior of the province were originally constructed for the purpose of obtaining access to mineral areas. Nature has so ordered that, just as the finest fruit is often at the top of the tree, the most valuable ore deposits are frequently located in inaccessible regions.

While it is not the policy of the government to construct roads or trails for the benefit of privately owned mining corporations, legislation exists under the Mines Development Act providing for government assistance to be given for the purpose of encouraging bona-fide prospects and, on the recommendation and authority of the Mines Department, the Public Works Department carries out or supervises the construction of a certain mileage of roads and trails annually; the amount so expended during the last ten years has been approximately $100,000 per annum.

### Maintenance of Highways

The average annual cost of maintenance of highways in British Columbia, including maintenance of bridges, is $117 per mile of road. This expenditure is inclusive of snow removal and all incidental expenditures and includes the cost of supervision but not of administration. On main highways the average expenditure for maintenance is about $250 per mile and, where traffic is heavy, reaches as high as $600 per mile.

Although the maintenance of highways may be considered to be a simple matter, past experience teaches that the cost of maintenance can only be kept within reasonable bounds by the adoption of the most modern methods under the direction of experienced officials. A good gravelled or well-kept earth road makes an excellent highway for motor traffic at ordinary speeds, but such surfaces, far from being attained by haphazard methods, are the result of long experience, careful planning and team work on the part of the engineer, foreman and operators.

**Fig. 7—Diversion of New Denver-Rosebery Road.**

Owing to the varied climatic conditions, maintenance problems differ greatly throughout the province. In the interior, generally, there is sufficient moisture and winter frost to cause heaving in the spring while the summer rainfall is usually light; the limited funds available for maintenance do not permit of continuous grading, except on main highways; therefore, to insure that the maximum benefit shall result from the expenditure made, it is usual to concentrate on spring and fall grading.

The best time for spring-time grading is the period between the last severe frost and the time when the road begins to set under the influence of sun and wind, a period which is often a matter of only a few days; grading carried out too soon will have to be done again and, if the critical period is missed and if the grading is done when the road is set, an unstable surface will result.

The majority of the roads in the interior of the province are of earth or gravel; in every district where gravel surfaced roads are maintained, power graders are used. Wherever possible, crushed rock or crushed gravel is used for surfacing. The natural deposits of suitable gravel are widely separated and in many parts of the province the only gravel available is too coarse to make suitable surfacing material and, when crushed or screened down to ¾ inches at the pit, a large volume of over-size material has to be hauled away, an expense which cannot well be avoided.

In filling large holes or depressions the old-time practice of placing coarse material at the bottom with a covering of finer material at the top has been changed, as from experience it has been found that such coarse material, even if deeply buried invariably comes to the surface, necessitating the extraction of any large stones before the road can be successfully graded. Heavy material close to the surface also impedes the light scarifying which is so beneficial in the spring or when the road is damp.

Much of the success or otherwise of grading operations is dependent on the skill of the operator who can improve the vertical alignment of the road by scarifying humps or by filling depressions each time the road is graded. A skilful operator can also gradually improve the shoulders by preventing the encroachment of vegetation and also by mixing in the gravel which has been thrown to the sides of the road with the soil on the shoulders.

HIGHWAY BRIDGES

The economic, physical and climatic features of British Columbia have an important bearing on bridge problems. In order to provide the necessary highway facilities to serve the immense though sparsely populated area, many bridges are required; the streams for the most

Fig. 8—Bridge over Slocan River at Vallican.

part are swift running and some are mountain torrents which periodically get out of control, with devastating consequences.

For the size of the areas they drain, the streams have a very high discharge at high-water periods, a condition which is due, in many districts, to the coincidence of the rainy season with the period of warm winds from the Pacific, which melt the snow in the mountains, a fact which explains why the late autumn is often the period of the most damaging floods. Not only are great quantities of timber drift carried down, but, both in midwinter and in the spring, ice jams are formed which, at times, almost completely dam some of the rivers.

Apart from the natural difficulties which affect it, a bridge policy is necessarily influenced by economic considerations. In British Columbia there are large reserves of fine structural timber suitable for building spans up to 180 feet in length with 16-foot wide roadways sufficient for the needs of moderate traffic; within fairly wide limits, it is therefore possible to build such bridges and renew them every fifteen years at less than the cost of financing permanent structures, if interest, sinking fund and maintenance costs are all taken into consideration. In building bridges of timber, use is being made of the natural resources of the province, as there are no iron mines, blast furnaces or rolling mills; furthermore, the province is only in the course of its development, and therefore the probability of structures becoming obsolete has to be considered.

These and other considerations have resulted in the adoption of the following general policy with regard to highway bridges: firstly, to substitute culverts and fills for minor bridges as far as that is practicable; second, to build in concrete and steel all the major bridges over the main rivers and on main highways where substructures are costly and span lengths are necessarily long; and third, to build of timber the bridges intermediate between these two extremes. Adherence to this policy meets all the real needs of traffic without overstraining our financial resources. It is a "wait and see" policy, it is true; but since it is impossible to foresee the trend of development in many districts, it would be unwise to adopt standards of construction beyond the real needs of the traffic that are reasonably certain to develop in the near future. In other words when the ultimate economy of alternative proposals is being considered, initial cost and probable obsolescence are more important factors than they would appear to be in older, more settled and wealthier communities.

Of the many interesting and historical bridges of British Columbia's earliest days, three may be named: the Hagwilget bridge over the Bulkley river at Hazelton, built by the Indians in the year 1856, has the distinction of having received honourable mention in Mr. Waddell's monumental work; the Alexandra suspension bridge over the Fraser river at Spuzzum, built in the year 1863, was a worthy forerunner to the modern bridge on the same site and an important link in the famous Cariboo highway already referred to; the old bridge at Lytton, which was destroyed by flood in the year 1894, is worthy of mention as one of the few good examples of Burr trusses in existence at that time.

*Types of Bridges*

There are now in British Columbia over four thousand highway bridges, both large and small, the total length of which is about 60 miles. Included in this number are trestles, trusses of all kinds, suspension spans, arches, swing bridges, vertical lift spans, bascules and, in fact, every type of bridge with the exception of the cantilever. Substructures vary from the simplest pile piers to massive concrete piers sunk to a great depth below the stream-beds. The designs as to loadings and widths also vary considerably; the latter range from 10 feet 6 inches to 22 feet and these bridges have been designed for uniform loads ranging from 40 pounds to 100 pounds per square foot and from 8 tons to 20 tons gross per vehicle.

Such is the variety of conditions throughout the province that it would, from an economical standpoint, be unwise to adopt standard specifications with respect to loadings and widths; each bridge is considered with respect to the traffic existing or likely to be developed in the near future and also with respect to such features as alignment, gradient and visibility; if no standard plan is available to suit any particular site, special designs are prepared, bearing in mind that bridges are the most expensive single item in highway costs and that savings may often be made by a careful study in particular cases.

The trend of designs is, of necessity, towards heavier structures of a more permanent nature: this is due not only to the increasing volume and weight of traffic but, as far as

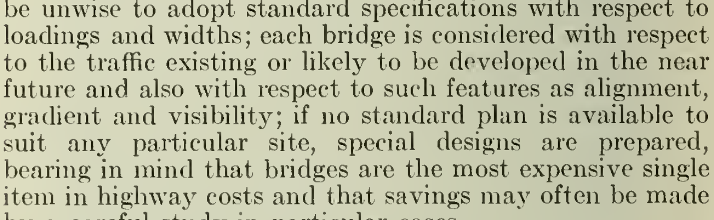

Fig. 9—Fraser Avenue Bridge over North Arm of Fraser River.

substructures are concerned, to the gradual denuding of the forests by logging and fire which results in a more rapid run-off, higher flood levels and large accumulations of timber drift.

In designing, standard practice is generally followed; Canadian Engineering Standards Association specifications are applied consistently to all work; on the whole the Department's practice is perhaps even more conservative than the strict letter of those specifications would demand, especially in steel construction.

*Untreated Timber Bridges*

While great improvements have been made in the design of timber bridges, and in construction methods, the greatest saving has been in the increased life of such structures; it is estimated that $145,000 per year would be saved by extending the average life of timber bridges in the province by only five years. This thought raises the question as to why timber bridges, generally, last so short a time. To this there is practically only one answer: failure of timber bridges is almost entirely due to ordinary "rot."

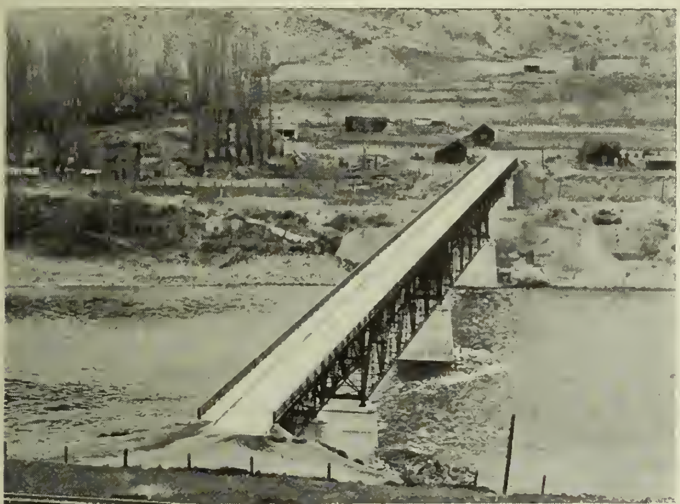

**Fig. 10—Spences Bridge over Thompson River.**

Among timber species in British Columbia available for structural purposes there are only three which are considered satisfactory, namely cedar, tamarac and fir. Cedar is very durable but is low in strength, particularly in impact bending. Tamarac is quite durable and is high in strength. Fir is also quite durable and is the finest structural timber with respect to strength, size, workability and freedom from defects. All of the species named are inherently durable as opposed to decay and will give good service if reasonably protected.

In combating "rot" and in thus lengthening the life of timber structures, the pre-seasoning of the timber is considered important and it is not expensive. Moisture collects and remains wherever timber in a structure is in contact, wherever there are dead air-pockets and at all connections and bearings, and, in so doing, it establishes favourable conditions for decay; connections have accordingly been designed to allow of free circulation of air, while areas in contact are covered with sheet metal, the purpose being, primarily, to permit the timber to dry off quickly and to keep the moisture content down to low limits.

Surfaces in contact are treated before erection with brush coats of hot creosote. It is not advisable to use paint, tar or pitch unless the timber is thoroughly seasoned. It is better practice to permit the timber to "breathe."

Other important points are to avoid bruised and punctured areas in the timber, bad checks on upper faces, closed pockets, collections of dirt and all other conditions which tend to collect and hold moisture. Figure 8 illustrates a typical untreated timber structure consisting of two 130-foot span Howe trusses.

*Treated Timber Structures.*

Prior to 1930 the costs of construction tended steadily upwards, hence the urge to still greater economy by prolonging the life of timber structures. However, with all the improvements made, it did not seem possible to get more than twenty years average life out of exposed untreated timber. Attention was therefore turned to preservative treatments. Encouragement was received in this first by the profound improvement in the art of treatment; second by the tendency towards lower prices for treatment; and third by the well-directed interest in and effort towards the expansion of the use of timber on the part of the timber preserving industry in general and of our own operating companies in British Columbia in particular.

Figure 9 shows an example of an all-creosoted timber structure, that is, with the exception of two concrete piers. The span consists of a 150-foot Howe truss. The roadway width is 20 feet clear and one 5-foot sidewalk.

It was at first assumed that the standard designs, in which the open chord assembly is used, would be satisfactory for treated timber structures, but it was soon realized that, when using properly treated timber, this standard design could be changed to advantage. In proper pressure treatment the timber is seasoned and sterilized prior to its penetration with preservative; during this process, the moisture content is reduced to a relatively low percentage, the timber is rendered free from incipient rot and the outer fibres are rendered immune. Under these conditions it was no longer necessary to provide free circulation of air around the leaves of built-up chords or around connections in contact and thus the expense of machined blocks and keys could be eliminated.

In place of the open chord assembly laminated chords were substituted. Instead of using chord leaves made up of large-sized, long sticks, relatively small sizes and short lengths were used, packed and bolted solidly together. To transfer direct stresses across splices, it was at first thought that it would be necessary to introduce packing keys, dowels or connector rings between the laminations. Such arrangements are quite practicable, but involve the use of both vertical keys and horizontal bolts, the framing for both of which reduces the sectional areas. By a series of tests and calculations it was determined that, provided the bolts were large and numerous enough, keys would be unnecessary. Pipe-bolts were accordingly adopted. This arrangement reduces framing to a minimum, eliminates all clamps and keys and gives a solid compact member with full bearing for angle blocks and with other desirable features.

By this means the construction of such a truss span has been greatly simplified; the framing has been reduced to a minimum and the only machining necessary on the ironwork is the threading of tension rods and bolts and a little finishing on the ribs of the angle blocks.

In constructing bridges of this type the timber is entirely framed prior to treatment, this being a very important feature. To get a deep, uniform penetration, all timber is incised; power-driven machines are used in all these operations. Chord members are completely assembled, clamped and bored for pipe-bolts. Each stick is match-marked in accordance with diagrams. No difficulty has been encountered in erection, mainly on account of the fact that the longitudinal shrinkage of timber in seasoning is practically nil.

On the average, the treatment increases the cost of spans erected by about 12 to 15 per cent. This percentage varies a little depending largely upon transportation charges. The farther the bridge is from the treating plant the less the percentage increase will be. The cost of maintenance is a little less on treated than on untreated spans for the reason that a larger part of the shrinkage takes place in the treating process and hence the adjustment of tension rods and tightening of bolts is much reduced.

It is believed that structures of this type will last over thirty years and probably thirty-five to forty years. That being the case, substructures must of necessity last as long or longer. For this reason concrete substructures for such spans have been generally adopted.

*Steel and Concrete Bridges.*

With respect to steel and concrete structures, Figs. 10, 11 and 12 will give an idea of the characteristics of some of the more modern bridges.

Figure 10 illustrates a modern steel and concrete structure consisting of two 215-foot spans, two 90-foot spans, one 67-foot span and two 40-foot spans. The bridge has a concrete roadway and sidewalk.

The bridge shown in Fig. 11 consists of three 164-foot steel spans on concrete piers and abutments with concrete roadway. An old timber structure, replaced by the steel bridge, is also shown.

The reinforced concrete bridge shown in Fig. 12 has a total length of 280 feet with a main span of 68.5 feet and is built on a 10-degree curve.

**Fig. 11—New Steel and Old Timber Bridges over Kootenay River at Wardner.**

**Fig. 12—Parsons Bridge on Island Highway, Victoria, B.C.**

It is perhaps surprising that, even in this mountainous country, very few bridge substructures are founded on solid rock. This is explained by the fact that the creeks and rivers lie in eroded faults and shear zones where the rock formations dip sharply to great depths. Borings have been taken at major bridge sites where rock outcropped on both banks but was not encountered in the stream-bed anywhere within 150 feet of low water level. Pile foundations, therefore, assume an important place in the substructure work.

The stability of piers naturally has to be given special consideration. Broad based piers with low centre of gravity and batters 1 in 12 and side batters 1 in 18 or 24 are considered the most satisfactory. Reinforcing (bonding) rods extend from bottom to top. The semi-circular cutwaters have also proved the most satisfactory as far as scour is concerned and are found the best for deflecting drift and anchor ice.

Owing to the fact that piers are subjected to very severe conditions, the durability of the concrete is a prime requisite and it is necessary to ensure that great density is secured; a quality of concrete indicated by a twenty-eight-day strength of less than 3,000 pounds per square inch is not sufficiently durable for requirements.

*Paints.*

The best success has been obtained with standard paints which are as follows: one priming coat of red lead, one undercoat of red oxide of iron, and one or two finishing coats of black graphite. These are all linseed oil paints of first class quality. In recent years aluminum paints have been substituted for graphite where it was desired to obtain a light colour, but in no case is the red lead priming coat omitted. Experience in this matter confirms the opinion that the best results are obtained only by adopting a priming coat with inhibitive qualities.

### Ferries

A description of British Columbia's highways would be incomplete without mention of the fifty-five ferries which are operated as part of the system and which carried, in the year 1932-33, 370,000 vehicles and over 1,000,000 passengers, as well as freight and cattle.

Eight of these ferries are privately owned and are operated under license and, in most cases, under a subsidy from the government; three of these boats on which tolls are charged give connection between Vancouver Island and adjacent islands.

With the exception of the S.S. *Nasookin* on Kootenay lake and the M.S. *Kelowna-Westbank* on Okanagan lake (see Fig. 13), the provincially-owned boats are operated free of charge to the travelling public except after normal hours; included in this fleet of ferries are six steam, Diesel or gasoline powered boats, thirty-one ferries operated by current, four ferries operated by engine and cable and two scows with gas boats attached.

Although ferries are a poor substitute for a bridge, they are greatly appreciated by the settlers in districts where the traffic needs would not warrant the cost of a bridge. Under certain conditions, particularly when ice is running or the river is frozen over, they cannot be operated, but at all other times they furnish a more or less satisfactory means of crossing.

The large number of ferries operated by the river current will be noted. In the early days, current-reaction ferries were considered to be simple, primitive craft, but if attention is given to refinements in construction and operation they operate safely and efficiently. The old flat-bottom scows have, in most cases, been superseded by the twin-pontoon type which have a greater capacity, are more easily controlled and are lighter, safer and faster. The real test of whether a reaction-ferry is properly designed and equipped is its performance during high water and it is found that the twin-pontoon type actually performs better at high water than at any other period.

Each ferry requires at least two landings or wharves and the installation and maintenance of these facilities, together with the operation and maintenance of the boats, is a relatively expensive item in the annual highway bill, amounting to an average annual expenditure of $155,000 during the past five years.

### Surfacing

Although there are now a total of 606 miles of surfaced highways in the province, it has not been possible to keep abreast of the progress made in the United States; the main highways on Vancouver Island and in the vicinity of Greater Vancouver and easterly along the Fraser valley are now either paved with concrete or bitumen; with a few isolated exceptions, however, none of the highways in the interior of the province have been paved.

Although it would naturally have been preferred to lay the higher types of pavement, finances have only permitted and traffic justified the construction of 112.46 miles of Portland cement or asphaltic concrete, and 53.23 miles of bituminous macadam pavement, inclusive of municipal highways in the provincial system. These pavements are entirely satisfactory, the maintenance being very reasonable. So many thousands of miles of such pavements have been constructed within recent years on this continent that it is not necessary to enter into any discussion with regard to this class of work.

With a large mileage of roads waiting to be surfaced and with a relatively small population, the chief objective has, of necessity, been the extension of the surfaced mileage, and, having regard to funds available, the choice has been mainly restricted to the less expensive or "low cost" types, of which there are now 441 miles, including 111 miles of bituminous mulch and 330 miles bituminous carpet coat. The field of such low cost surfacing has not yet been fully explored or developed and so many questions remain to be decided that perhaps a few notes on methods and experiences in British Columbia during the past twelve years may be of interest.

The low cost surfacing work ranges from oil or tar spray-coats costing a few hundred dollars a mile to premix mulch 2½ inches thick, costing around $5,000 a mile. This type of work is considered as essentially "stage construction," the idea being that, by subsequent retreatments, a stable asphaltic surface is finally built up of sufficient thickness to withstand all traffic. It is therefore the aim to obtain the best results possible at each stage of construction, with a view to economical maintenance and a saving in the cost of subsequent treatments.

It has been found that, for this class of work, the most important and primary requirement is that the road shall be in proper condition to take the surface; that is to say, the grading of the existing gravel or stone top and the drainage must be the best that can be obtained. A flush or carpet coat will not iron out any surface irregularities due to poor construction, nor will it bridge over any soft spots, neither is it possible satisfactorily to lay a road-mix or premix mulch on an irregular grade, and it follows that, no matter how good the spray or mix may be, if the road is in poor condition prior to treatment, the ultimate repair and maintenance costs are liable to be excessive.

Given a good surface as a base for a bituminous carpet coat treatment, a priming coat is considered to be essential and the best results are obtained with the use of coal tar. In new work, this is followed by an application at the rate of one-third gallon per square yard of either a heavy liquid asphalt or tar product, on which is placed a blinding of ½ inch or ¾ inch clean stone or gravel. By this method satisfactory non-skid surfaces 16 feet wide are obtained at a cost of from $1,000 to $1,600 per mile. Maintenance costs of such surfaces vary from $20 to $250 per mile per year, depending on the volume and weight of traffic, climatic conditions and other circumstances, but on no occasion is the maintenance found to be more than the cost of maintaining a gravel road in the same situation, and of course a dustless surface is provided which is greatly appreciated by the travelling public.

It was previously the practice to lay mulch by the road-mix method, but latterly the premix method has been adopted and this is found to be more economical and satisfactory in every way, although the road-mix method has its value under certain conditions. The cost of 9.31 miles of road-mix, 20 feet wide, averaged $5,536.54 per mile in 1930 as compared with $4,706.67 per mile for 22.85 miles of premix mulch laid in 1931. On the total mileage of the foregoing the maintenance charges have averaged $57.42 per annum per mile.

For many years the renewal and repair work on all types of low-cost surfacing was by means of hot flush coating at the rate of ⅙ to ¼ gallon of bitumen per square yard, followed by the application of a suitable aggregate covering; for filling pot holes, materials were hand-mixed. Such has been the advance made in recent years, that, for similar work and for new mulch work, a premix bitumen combined cold with suitable aggregates in an ordinary cement mixer is being used, and by this method a mixture is produced suitable for almost all repair and resurfacing requirements. It is now no longer necessary, in preparing patching mixtures, to heat the aggregates, which do not even have to be completely dry; pot holes can be repaired with this material, even in wet weather, and it is possible to blade a thin "cap" over an old surface at no greater cost than the cost of respraying by the old method and the resulting surface is superior and is "non-skid" and without "fatty spots."

The cost of all premix material used in 1931 for new surfacing was $3.27 per cubic yard in place, and each cubic yard contained an average of 9.3 gallons of asphalt. For resurfacing by this method about 11 gallons of asphalt per cubic yard of material is used, as it is found advantageous to have an excess of asphalt to assist in adherence to the old surface and for other reasons; the cost per cubic yard of material for the latter averages $3.52 exclusive of placing, the cost of which varies with the nature of the repair or resurfacing work to be done.

For many years it was the practice of the Department to let contracts for supplying, handling, and spraying bitumens at a cost of around 22 cents per gallon. In the year 1930 equipment was purchased to handle this work in Engineering District No. 1 and, apart from the considerable saving in cost, the arrangement is far more satisfactory and has resulted in improvement in all stages of the work, as the contractor's convenience and anxiety to get on with the work of spraying is no longer a factor.

Departmentally-owned equipment for bituminous work now includes the following:—

1 — 680 Imperial gallon distributor.
1 — Tandem (gas) roller.
1 — Power grader, 12-25 dual drive.
1 — Vertical boiler, mounted on a 2½-ton trailer.
1 — Trailer sweeper with 9-foot broom, and tractor connection.
Several portable hand spray tanks.
1 — 500 gallon transport tank.


**Fig. 13—Provincial Government Ferry on Okanagan Lake.**

There are also, at two places, seven and eight thousand gallon storage tanks from which the local repair crews can obtain their supplies instead of purchasing bitumen by the barrel. It is thus possible to avoid the demurrage charges on railway tank cars, which in the past have amounted to quite an item, and also in this way 5 cents per gallon can be saved by buying in bulk.

### Municipal Roads

In addition to the streets in city or urban areas, there are some 2,790 miles of rural municipal roads open to traffic, the control of which is a responsibility of the municipalities and, in addition, there are 520 miles of main municipal highways, the control of which is either partly or wholly a government responsibility.

Prior to the year 1920, the municipalities were entirely responsible for all highways within their areas. In the earlier days of horse-drawn traffic, this arrangement was equitable, as traffic was then of a purely local nature; with the increasing use of the motor vehicle, however, the average distance of normal travel has been greatly extended, and today the major portion of the traffic using main municipal highways is through traffic and is provincial in character; naturally the cost of maintaining these through or arterial highways gradually increased to a point where the municipalities found themselves unable to maintain or improve these roads to the requisite standard.

To correct this situation, special legislation was enacted under the Highway Act, authorizing the classification of important municipal highways affording main channels of communication connecting important centres of population or important terminal points, as deemed necessary from time to time, and providing for the payment by the government of the entire cost or a proportion of the cost of the maintenance and construction of such highways; the control of those highways classified as arterial or primary is in the hands of the Department of Public Works, such highways becoming to all intents and purposes provincial highways. No highways may be classified in cities having a population of over two thousand; thus it is the district municipalities and the smaller cities which benefit from this legislation.

The following tabulation shows the three classifications permitted, the proportion of cost paid in each case by the government, the controlling agency and the present mileage of such municipal highways now classified. The cost to the provincial government in the year 1932-33 for the maintenance for these highways was $150,219; the average cost for maintenance of arterial highways was $398 per mile.

Table VII

Classification of Municipal Highways

| How Classified | Proportion of Cost paid by Government | | Highway Controlled by | Miles so Classified |
|---|---|---|---|---|
| | Construction | Maintenance | | |
| Arterial | 100 per cent | 100 per cent | Government | 311.61 |
| Primary | 75 per cent | 75 per cent | Government | 60.87 |
| Secondary | 50 per cent | 40 per cent | Municipality | 148.50 |
| | | | Total, miles | 520.98 |

Common Carriers

In recent years the question of regulating and licensing motor buses and trucks using the highways as common carriers has become one of relative importance; it is now admitted on all sides that some measure of control of such vehicles is absolutely necessary, not only for the protection of the general public but also for the protection of the carriers from unfair competition by "wildcat" operators who are a menace to the travelling public.

In British Columbia the control of such carriers within incorporated areas is in the hands of the municipalities, except where such carriers operate on a municipal highway classified as arterial or primary; in other words, only those common carriers operating on provincial highways are under provincial control as regards special licensing, and the provincial government has no control over such vehicles when they are operated exclusively within the cities of Vancouver, Victoria or any other city of over two thousand population.

The main highway routes of the province are now well covered by common-carrier passenger and freight services; it is not the policy of the department to issue licenses to all applicants, and the number of licenses granted on any route is generally restricted, as it is considered against the public interest to allow the intensive competition which would result from the opposite policy. Naturally, the restriction of licensing causes some contention, but the public now appears to realize the importance and responsibility which attaches to a common carrier's license and, year by year, there is less difficulty in administering the act and regulations.

Numerically, the whole problem of licensing common carriers in British Columbia is a minor one; the number of common carrier vehicles only represents less than one-half of one per cent of the total number of vehicles registered. Licenses issued during the calendar year 1933 were as follows:—

Table VIII

Number of Common Carriers Licensed, 1933

| *Carrying Capacity* | *No. of vehicles licensed* |
|---|---|
| *Passenger Vehicles* | |
| 1 to 5 passengers | 33 |
| 6 to 10 passengers | 78 |
| 11 to 20 passengers | 37 |
| 21 to 30 passengers | 68 |
| over 30 passengers | 12 |
| Total | 228* |
| *Freight Vehicles* | |
| Up to 1½ tons | 75 |
| Over 1½ tons and up to 2½ tons | 94 |
| Over 2½ tons | 32 |
| Motor cycles | 1 |
| Total | 202* |

*42 of the above passenger licenses and 36 of the above freight licenses were cancelled during the year.

With the exception of a few large firms, the operation of the common carrier vehicle in British Columbia is still very much of an individual or local matter. Out of one hundred and seventy-eight operators, about 65 per cent are the holders of a license to operate one vehicle only and 20 per cent are the holders of licenses to operate two vehicles only.

Additional fees payable by common carriers are based on the carrying capacity of the vehicle and may not exceed one per cent of the licensee's gross receipts.

**Fig. 14—V-Type Plough propelled by Two-Ton Truck.**

At the present time there is no legislation in British Columbia requiring special licensing of the so-called "contract carrier"; it is admitted that in some cases it is very difficult to differentiate between this class of vehicle and the common carrier, and there is no doubt that much of the business done by contract carriers is of a nature that that should be under some control. It is reasonable to expect that, within the next few years, an agreement will be reached by the various provinces with a view to uniformity in dealing with this difficult and contentious problem.

USE OF MACHINERY AND PLANT

It was not until the year 1910 that the provincial government purchased the first mechanical power-operated road machinery. In that year four steam-driven traction engines were acquired, together with four 4-yard hopper-bottom trailers, three steam-rollers and two crushing outfits. About this time two steam-wagons with steam-operated dump boxes of 3-yard capacity were also purchased, having a speed of about 10 miles per hour and capable of carrying water and coal sufficient for a 12-mile run. The first internal-combustion engined vehicles purchased were two 3-yard chain-driven hand-dump trucks capable of a speed of from 15 to 20 miles per hour.

Today the department has equipment in use for construction and maintenance work valued at nearly $2,000,000 including the following major units:—

45 power shovels
366 trucks
170 tractors
84 power graders
77 snow ploughs
45 road drags
13 power road rollers
281 pull graders
24 rock crushers
14 mechanical loaders
30 air compressors
11 concrete mixers
22 stationary engines, gas and Diesel.

It is outside the scope of this paper to discuss the relative merits of any particular make of road machinery. Generally speaking, it may be said a 35-h.p. tractor has been found a very suitable unit for construction work, while the heavy duty leaning-wheel grader, the 40 cubic foot capacity rotary scraper and the 5 point road ripper are the most popular types of machinery in the field for this type of work. For gravelling or general haulage purposes, the 1½-cubic yard capacity steel dump truck is found to be the most satisfactory unit.

For ordinary construction work of a class undertaken by the department's forces, the ½-yard gasoline driven shovel has proved to be very economical in operation and maintenance and most suitable for road construction, while the lighter and more mobile type of ⅜-yard capacity is very popular for clearing small slides, loading gravel, widening and other light operations.

Due to its better traction and lack of vibration and ability to negotiate soft stretches of road, the pneumatic-tire-equipped grader with dual or tandem rear wheel drive has been found most satisfactory; the ability of such machines to travel long distances at a fairly high rate of speed is in their favour. Multi-blade maintainers have proved highly efficient and satisfactory on long stretches of gravel highway but are found to be of little use on a narrow, rocky or uneven road. A 20-h.p. tractor or a heavy-type truck has been found a satisfactory power unit for these maintainers.

With one or two exceptions, all rock or gravel crushers in use by the department are designed for a semi-permanent set-up; the problems in rock crushing are varied and numerous owing to the diversified nature of the rock and gravel encountered, its location and its suitability or otherwise for road material.

In one district there is a double-reduction Diesel-operated plant capable of producing 125 cubic yards of ¾-inch material per day. This type of plant is not economical unless it is possible to keep it in more or less constant operation. The most satisfactory and economical machinery is the type which is mounted on a steel truck with folding elevator and which can be backed into a small pit and be put into operation within two or three hours; such an outfit operated by a tractor is capable of producing 50 or 60 yards of ¾-inch material per day, the material being delivered by chute to truck or stock pile.

With regard to the financing of equipment, the larger units are purchased from a special equipment fund and are rented by the department to the various jobs, the rentals charged being fixed at a rate sufficient to pay for all maintenance costs, repairs and depreciation. By this means it is possible to move units from one part of the province to another as may be required, an arrangement far more satisfactory than the previous one under which units were bought from the district road appropriation and were therefore apt to be looked upon as the property of the district. A very careful record of the exact cost of operating and maintaining each unit is kept and it is thus possible for the department to check any cases of rough usage or uneconomical operation and, in particular, to judge as to the relative merits or demerits of the various makes of equipment. Equipment is subject to constant and careful inspection and proper care and maintenance of all machinery is insisted on.

SNOW PLOUGHING

It is only during recent years that snow-ploughing service, which was begun in a small way, has become a regular feature of winter maintenance work on main and other important roads. During the year of 1932-33, snow removal was carried out on 4,236 miles of highway at an average cost of $13.37 per mile. During the previous year 5,547 miles were kept clear at an average cost of $15.25 per mile. Snowfall in British Columbia varies from light at the coast to exceptionally heavy in the interior, particularly west of Revelstoke and in the south-eastern part of the province. In some cases ploughing has been necessary almost continuously in order to keep the roads clear.

For light snowfalls and on narrow sidehill roads, of which there is a large mileage in this province, the flat blade reversible type of plough has given satisfaction, although lack of sufficient speed is its drawback. The most efficient type of equipment now in use in British Columbia by the Department of Public Works is the "V" type plough with hydraulic operated side wings and propelled by a tractor; this machine is capable of negotiating heavy grades and can deal with snowfalls from three to four feet in depth with ease and can successfully clear all types of road. The cost of operation, however, is somewhat high and the maximum speed obtainable is not over 3½ miles per hour.

CONCLUSION

It is hoped that the foregoing gives a clear outline of the highway system without unnecessary detail.

Queen Victoria was in the twenty-first year of her reign when her Colonial Secretary despatched a company of Royal Engineers to British Columbia for the purpose of laying out townsites, planning and constructing roads and the like. Since that time there has been a continued demand for road building; hardly a year passes when the government is not inundated with requests for public works to an extent far in excess of available resources. Who can foresee what developments will occur within the next decade? The great mining regions of Bridge River, Cariboo, Omineca and the Kootenays are all dependent on adequate highways and no one but the engineer can successfully meet the problems that will arise in the development of our natural resources. In a comparatively young province there must, of necessity, be great tasks ahead.

It will be the part of wisdom to plan carefully, and build wisely and well, so that highway development will take its due part in the march of progress.

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**SUMMARY.—This intercepting sewer was designed to deal with the sanitary sewage from four outfalls serving some 7,500 acres having an ultimate population of 270,000 Extensive experiments were made to determine the best location of the interceptor outfall, having regard to tidal currents and the proximity of bathing beaches. The methods of construction and equipment used are described, also the arrangements for diverting storm water and avoiding the deposition of grit. The paper also deals with the construction of the submerged outfall, of concrete pipe supported by pile bents; information is given as to progress and costs.**

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Twenty-three years ago the city of Vancouver and the surrounding municipalities were faced with a serious drainage problem. It was the period of expansion just before the war. Population was increasing rapidly, lands were being cleared for settlement and building activity was general. In the midst of all this development, sewerage and drainage facilities lagged. So far, in fact, that by 1911 it was realized some form of united action was necessary to remedy the situation. In order to obtain this action, the several municipalities joined together to form the Burrard Peninsula Joint Sewerage Committee.

The committee met and decided to secure expert advice. An eminent consulting engineer was retained and under his direction extensive surveys and investigations were carried out over the whole peninsula. His report submitted in 1912 outlined a plan for sewerage and drainage to take care of the estimated population and development for the year 1950. The object of the plan was to give the most efficient service to the whole district, unhampered by municipal boundaries and to insure that each construction unit as undertaken would fit into the general scheme.

The provincial government gave effect to these recommendations by passing the Sewerage Board Act, which set up an administrative body, the Vancouver and Districts Joint Sewerage and Drainage Board, whose duty it is to administer the Act in the Sewerage District.

The Board as now constituted has jurisdiction over an area of 90 square miles, on which the average annual rainfall is 56 inches. It differs from most metropolitan sewerage boards in that it is responsible for surface drainage, as well as the disposal of sanitary sewage. The present municipal members of the board are: the city of Vancouver, the city of New Westminster, the municipality of Burnaby, and the University Endowment Lands.

About half of the whole district has now been divided into separate drainage areas, in each of which the Board maintains a trunk sewer or drainage channel, or both, up to the 400-acre point, and an outfall discharging into one of the tidal waters on the north, west and south.

Some years ago four of these outfalls on the south shore of English bay were discharging an ever-increasing volume of sewage into waters adjacent to bathing beaches. The growing nuisance of the sewage and the rapid development of these beaches led to the demand for the construction of the English bay interceptor, the largest single piece of construction work which the Board had undertaken up to that time.

It should be noted that the original scheme called for the construction of this interceptor before any outfalls were laid into the bay. However, the cost of the work prohibited the undertaking in the early days of the Board.

The function of the interceptor is to pick up the sanitary sewage from each of these four trunk sewers and discharge it into the sea at some point where it will either be carried out into the Gulf of Georgia or be so broken up that it will never reach the foreshore. The first important consideration, then, was the location of the outlet.

Two years were spent in a search for the best position. A careful study was made of the currents existing in English bay at all stages of the tide and during periods of both high and low water on the Fraser river. The water from the north arm of this river, sweeping around the Spanish Banks, exerts a powerful influence on the currents in the bay, especially during flood periods. It was desirable to locate the outfall somewhere in English bay, if possible, so that the length of the interceptor could be kept at a minimum. However, observations were also made at the mouth of the Fraser river and in the gulf, in case it was necessary to extend the interceptor beyond the Spanish Banks.

Several methods were employed to trace the varying current courses. The most successful was the employment of different types of floats.

The surface floats were simply weighted blocks of wood designed to expose as little surface as possible to the wind. The sub-surface floats could be adjusted to test the current at any depth. Their four large fins made them responsive to the slightest movement in any direction. A relatively light surface attachment floating flush with the water offered little resistance. Both types carried a light flag for spotting. (Fig. 3.)

These floats were released in groups from different selected points in the bay and gulf. A group would consist of two surface and five or six sub-surface floats at different depths. They were allowed to drift for eight or ten hours, during which time they went through a complete tide cycle. At regular time intervals, usually every hour, the position of each float was located by sextant angles to prominent points tied in to a shore traverse. The paths followed by the floats were later plotted in the office on a plan which also showed the velocity and direction of the wind, the flow in the Fraser river, and the tide curve for the day.

A study of these results revealed some very interesting facts. For instance, not only did the surface floats follow quite different courses from their under-water fellows, but sub-surface floats of different depths released from the same point frequently drifted in different directions. This made the work of the observer very difficult, as the diverging flags were often several miles apart at the end of the day. Some floats were lost at first and it seemed hopeless to look after eight floats with one boat. Gradually, however, as the currents were understood, it was possible to anticipate the action of the floats under different conditions. Floats of the same depth, released from the same point and under similar tide conditions, would follow the same course time after time.

In general, floats released anywhere in the gulf within half a mile off shore, swept around Point Grey to the Spanish Banks on a rising tide and up the north arm of the Fraser river on a falling tide. Those released anywhere off Spanish Banks swept in towards Kitsilano beach on a flood tide. If the run-in were long enough or strong enough they either went ashore there or crossed the mouth of False creek and went ashore below English bay beach. No matter what their position a turn from flood to ebb would start them drifting out to the open gulf.

This was the general condition and it did not look too promising. A strong flood tide threatened to carry the sewage en masse to the beaches. There were, however, points where the movement inward was not so pronounced and where cross currents were especially active. One such point was located five thousand feet off shore on the line of Imperial street. This was a likely place and many groups of floats were released here and their actions closely studied.

Another type of experiment was also tried at this point to verify the presence of cross currents. Uranine dye was mixed with a light fish oil and the mixture placed in glass containers. These containers were exploded at different depths below the water surface and under different tide conditions. The oil held the dye well together and even from a depth of 80 feet there was no mistaking the appearance of the mixture on the surface of the sea. The various positions at which it appeared promised excellent diffusion conditions at this 5,000-foot point.

While the float observations were in progress, and before an outlet position had been definitely selected, test piles were driven at different points in the bay. On the Spanish Banks hard packed sand was encountered at any depth. Further east the bottom was very soft—so soft that a pile driven 30 feet could be pulled out again with ease. From Point Grey south to the north arm of the Fraser river the material on the sea bed was much the same as that on the Banks, although the actual foreshore was quite rocky.

Temperature tests showed a variation of only 4 degrees F. between winter and summer at a depth of 80 feet, although at the same time the surface water varied from 64 degrees F. to 42 degrees F., and the atmospheres from 72 degrees F. to 44 degrees F. The temperature of the sewage carried in trunk sewers varies somewhat at different times during the day but at periods of maximum flow it is approximately 65 degrees F.

On testing for salinity it was found that during flood periods in the Fraser river as much as 25 per cent of the water over the surface of English bay was fresh. This fresh water layer extended about 10 feet below the surface. For both the salinity and temperature tests, which were taken together, a large round flask with a very narrow neck was used. The cork was suspended on a separate line from the flask. Both lines were lowered to the depth at which it was desired to sample the water, the cork was pulled and after sufficient time had elapsed to fill the flask, it was drawn swiftly to the surface. The sample of water was then transferred to a jar in which a thermometer and a salinometer were inserted.

In analyzing the data obtained, it was apparent that the best location for an outfall was along the line of Imperial street. It was not an ideal location because of the soft bottom, but it had certain definite advantages, viz. there was deep water quite close to shore; active cross currents were in evidence at the 5,000-foot point; an outfall located here gave the shortest possible land line. A much better foundation could be obtained by laying the outfall across the hard packed Spanish Banks. However, this would mean a much longer interceptor, and a longer outfall too, since it would be necessary to traverse about half a mile of sand bar before reaching deep water. The same conditions applied to any location at the mouth of the Fraser river.

Further tests along the Imperial street line gave more encouraging results. A trial trench was excavated and its length, depth, and general shape noted by divers. Three weeks later when the trench was examined it was found that although some silting had occurred, the general shape and dimensions were as before. Twelve piles were driven in four three-pile dolphins forming a square, penetration being about 30 feet. The piles went down with the usual ease and without much driving with the three-ton hammer. In fact, the weight of the hammer itself was sufficient. Twenty-four hours later it was found the piles had stiffened

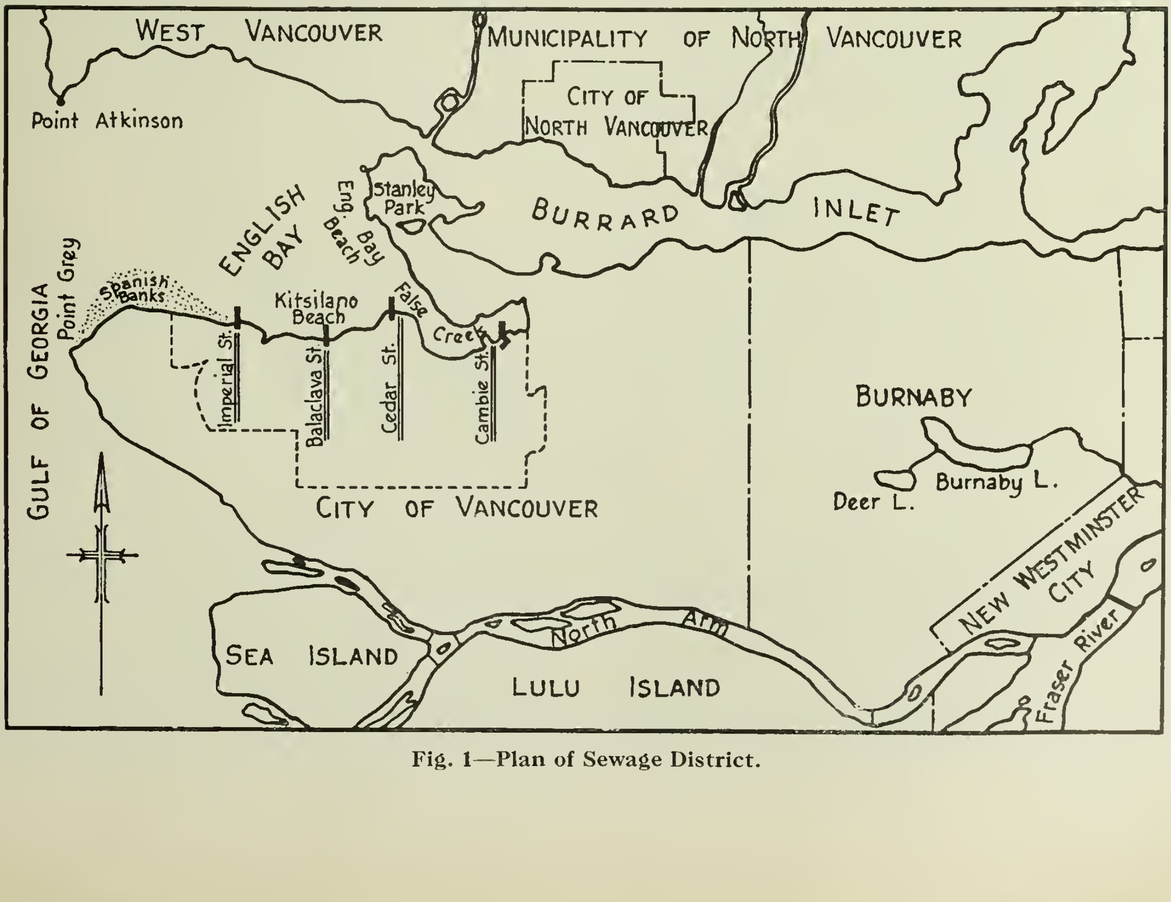


Fig. 1—Plan of Sewage District.

considerably. No longer was it possible to pull them out and it required real driving to get them down further. A platform was laid between the dolphins, and after the exact elevation was recorded it was loaded with 40 tons of short rails and scrap iron. Under this weight the platform sank approximately three inches (the four corners sank different amounts). Next day the rails were taken off and the elevation again observed. No change had taken place. These experiments showed that it was possible to drive a

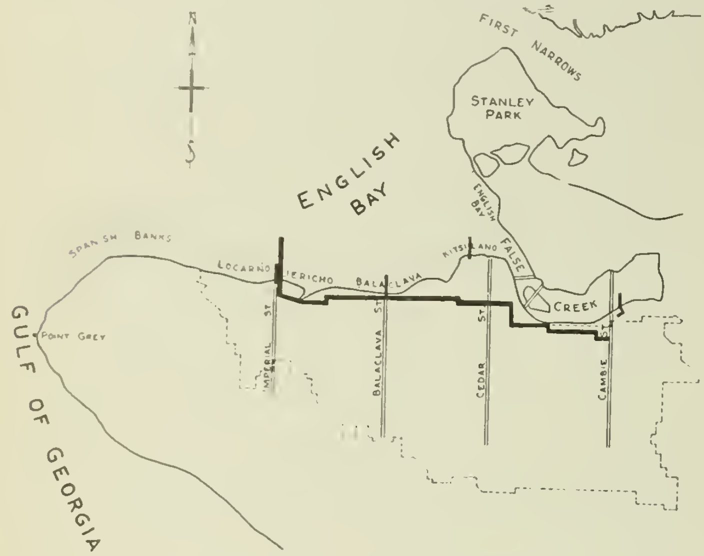


Fig. 2—General Location of Interceptor.

pile foundation in an excavated trench in the kind of material which would be encountered during construction. During these preliminary submarine investigations one fact was noted whose full significance was not realized until construction had begun—it was always pitch dark at the bottom of English bay.

Having selected the position of the outfall, the next consideration was the location of the line of the interceptor. Cambie street was its eastern terminus and its western limit was now fixed at Imperial street. Between these two points several routes were examined. It was thought that a sewer along the foreshore might be built as part of a sea wall. Such a line had the advantage of being at the lowest possible elevation and consequently all territory could be drained by gravity. For economic reasons, however, this proposed location had to be abandoned.

Two other possible lines known as tunnel line No. 1 and tunnel line No. 2 were also investigated. Borings were taken at frequent intervals and showed without exception excellent material for tunnelling. Sandstone and shale alternated with thin seams of coal, a narrow dyke of basalt at one place being the only exception to the regular sandstone-shale strata. The line finally selected began at high water level on Imperial street, and, after traversing the grounds of Jericho Golf Club at shallow depths, entered the Kitsilano hillside at Alma road and from there to Oak street was mostly in tunnel. The total length of the line was 5 miles. (Fig. 2.)

The English bay interceptor was designed to serve an area of 7,500 acres, estimated to contain by 1950 a population of two hundred and seventy thousand. The basis of design was ninety imperial gallons of water per person per day reaching the sewers; plus infiltration of two thousand gallons per acre per day; plus an allowance for light summer rains of 0.03 inches per hour.

There were four main concentration points, one of which was at the foot of Balaclava street. The area contributing here was roughly 2,500 acres, and the town planning map gave the ultimate population density as forty persons per acre, corresponding to an estimated population of one hundred thousand.

To determine the size of pipe required it was necessary first to translate the estimated flow into cubic feet per second. On an average day it would be necessary to provide for 100,000 by 90 or 9,000,000 imperial gallons. But the maximum day was taken as being 150 per cent of the average day, and the maximum hour of the maximum day 175 per cent of that, so at that point provision was made for $1.5 \times 1.75 \times 9,000,000$, or

| | | |
|---|---|---|
| 24,625,000 imperial gallons per 24 hours | =45 | cubic feet per second |
| plus infiltration at 2,000 gallons per acre | = 9 | cubic feet per second |
| plus 0.03 inches per hour of rainfall | =18.75 | cubic feet per second |

(0.25 was selected as the run-off factor suitable for the Balaclava area.) Thus there was a total of 72.75 cubic feet per second tributary at Balaclava street.

Treating the other concentration points in a similar way, it was found that the total estimated flow arriving at the outfall would be 200 cubic feet per second.

Having determined the quantity of flow, it was then necessary to fix the grades. One chief factor governed the grades on which the sewer was laid. This was the desire to include as much territory as possible within the area draining naturally to the interceptor. All lower ground would be pumping areas entailing perpetual expense. In other words, the grades were kept as low as possible consistent with a minimum velocity of three feet per second when the sewer was running half full.

For the interceptor proper and for all its sizes, it was decided to use the "Boston Horse Shoe Section," which is the standard section used on all the Board's trunk sewers. The diameter of pipe required at different stages along the line was estimated by applying a recognized formula to the conditions of flow and velocity which controlled the design at each stage. The result was then checked by the application of other formulae. The coefficient of roughness for the proposed concrete sewer was taken as 0.013, recom-

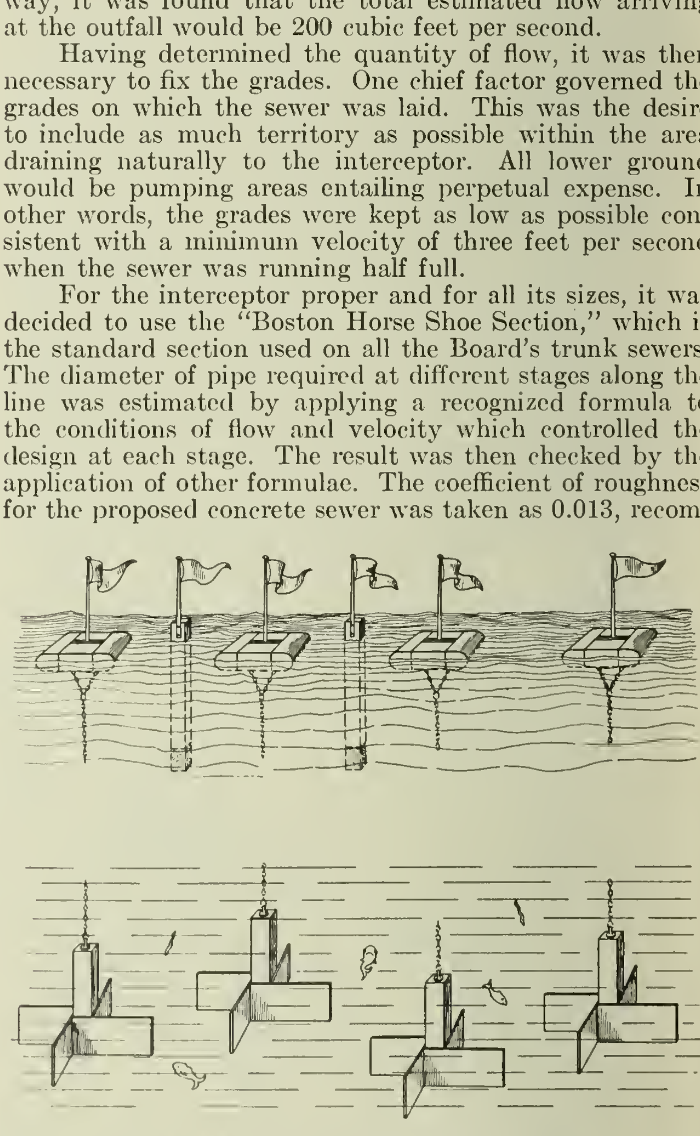

Fig. 3—Surface and Sub-surface Floats.

mended by Metcalf and Eddy. The value of the coefficient $C$ in general was taken as 120, a value which was slightly low by most formulae and consequently gave a conservative estimate of velocity and capacity.

From the foreshore to the first concentration point it was proposed to use a sewer 8 feet in diameter with a fall of 6 inches per thousand feet and under pressure throughout its entire length. The hydraulic radius of such a sewer is 2, and the velocity 3.70 feet per second when passing approximately the required 200 cubic feet per second. (Fig. 4.) Actually an increase in the hydraulic gradient was obtained by a change in design at the lower end of the 8-foot section.

The interceptor had been located down the west side of Imperial street and on the north side of the existing trunk sewer through the grounds of the Jericho Country Club. This necessitated a crossing at the entrance to these grounds and for this purpose a syphon was designed at First avenue, with twin channels each of which would take half of the estimated flow. Each channel was 8 feet wide at the top, 3 feet 6 inches deep at the centre, and 3 feet deep at the sides, the hydraulic radius being 1.2 and the estimated velocity 4.0 feet per second.

This scheme was rejected and it was decided to use the existing trunk sewer already constructed down the east side of Imperial street, which was also 8 feet in diameter with a fall of 1.8 feet per thousand. Although this steeper slope used up more than one foot of elevation, it was considered preferable to use that part of the Alma-Imperial trunk sewer for the interceptor rather than install a syphon at First avenue as mentioned. A new storm sewer was designed, and later built, along the west side of Imperial street to take the place of the section thus appropriated for the interceptor.

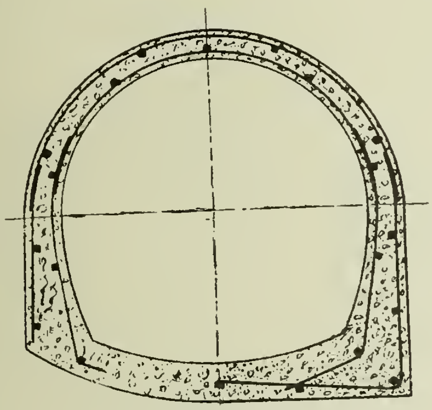

**Fig. 4—Pressure Section, 8-foot Diameter Pipe.**

The interceptor as finally designed and built varied in diameter from 8 feet at the foreshore to 4 feet 6 inches at the upper end. The changes in diameter take place at the various concentration points where the sanitary sewage is diverted into the interceptor.

At these places it was decided to construct in each trunk sewer a curving weir, whose height was just sufficient, under normal conditions, to divert the desired quantity. Using Balaclava again as an example, the height of the weir was calculated as follows:—The trunk sewer down Balaclava street was 8 feet in diameter on a grade of 0.0072 and had a capacity of approximately 800 cubic feet per second; but as only 72 cubic feet per second or 9 per cent of this was to be carried to the interceptor, the height of the flow in the Balaclava sewer under these conditions would be 0.022 of the diameter, or 21 inches. Thus the height of the weir required was estimated as 21 inches.

During heavy rains, however, when a considerable head may be built up, more sewage would be forced into the interceptor from the trunks than the permissible amounts and so a regulating device was designed whose function was to control the flow under those conditions. The regulating machinery, installed in a chamber adjoining the intercepted trunk, consists of a movable gate suspended from a lever arm which is balanced on the other end by a hollow casting or float set in a small separate chamber. The float chamber receives the first water over the weir through a pipe connected to the trunk sewer. The consequent loss in weight of the float upsets the balance and starts the gate closing. A slight grade in the entering pipe drains the float chamber as the flow subsides. (Fig. 5.) It was necessary to design everything in such balance that the operation of closing the gate would be slow and regular.

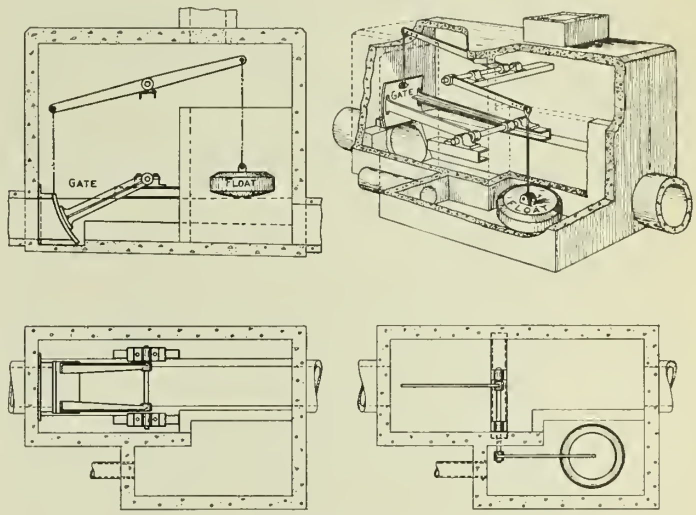


**Fig. 5—Regulating Chamber.**

In addition to controlling the flow it was deemed necessary to control the sand and grit which would be swept into the interceptor. In general the problem of grit in the storm sewers is a very serious one in Vancouver, especially where long flat stretches succeed steep grades, as they do in many cases. It was regarded as essential that no grit should get into the submarine outfall, for once in it would be extremely difficult to remove.

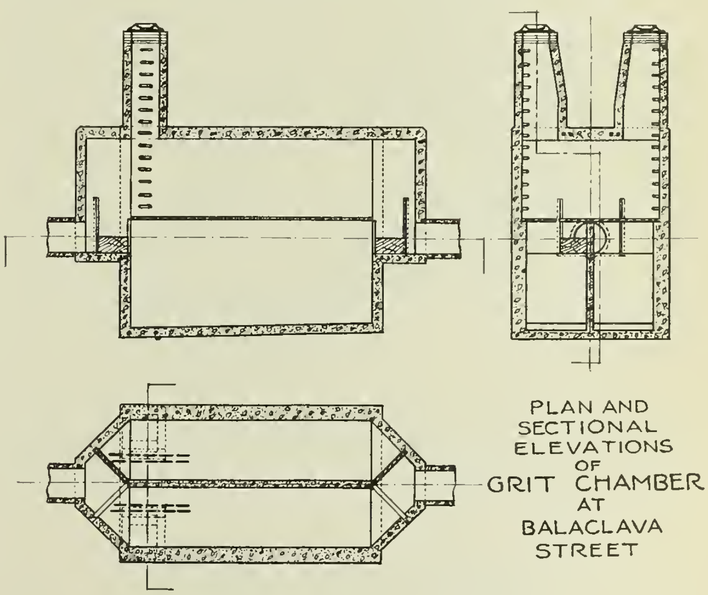


**Fig. 6.**

Two methods of grit control were considered. The first, a large settling chamber on the foreshore just in front of the outfall, or alternatively a series of smaller chambers at each of the intercepted trunks. There were several definite objections to the use of one large chamber. The interceptor was laid on minimum grades and consequently there would be danger of it silting up along the whole length if grit were allowed in. The danger of erosion was an added reason for keeping it out altogether.

The problem of grit interception, while simple in theory, is quite difficult in practice because of the fluctuating flow. If the chamber is narrow, the stream velocity is high during a storm and grit is swept through. If the channel is kept wide, during periods of minimum flow the velocity drops to a point where sewage is deposited along with the grit, causing offensive odours. The only way to meet the situation is by a series of channels, each taking a limited amount of the flow, the more channels the greater control of fluctuation. In this case lack of space limited the design to two.

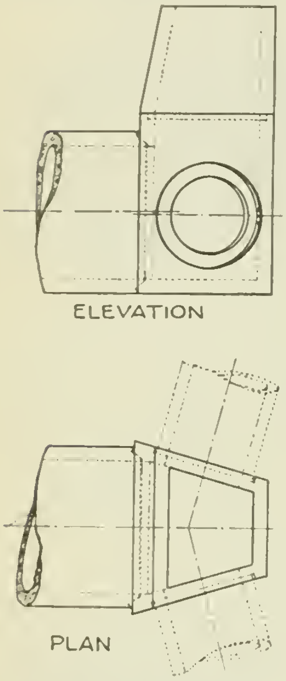


Fig. 7—Outlet at End of Outfall Showing Branch Pipes.

One foot per second is recognized as the velocity at which grit will be deposited without letting down too much sewage. In this case 1.2 feet per second was selected, and at Balaclava with 36 cubic feet per second passing through each channel, the velocity was calculated on a stream area somewhat less than that of the channel to allow for silting up. (Fig. 6.) In each case the grit chamber was designed to lie just below the regulating chamber and connected to it by a pipe of sufficient diameter and grade to take the flow. From the grit chamber another pipe carried the flow to the connecting chamber where it entered the interceptor.

Elevation 105.7 on Vancouver City Datum was chosen as the maximum elevation at which the hydraulic gradient could be fixed at the foreshore, while still keeping the interceptor working properly, and the diameters down to a reasonable limit. The possible extension of the interceptor westward to Point Grey had to be considered. This extra length is about 15,000 feet, most of which would be in deep tunnel. It is altogether likely that the Imperial street outfall will be permanently in operation, but as the University Endowment Lands develop, part of the flow from the interceptor may be diverted westward to join the flow from this area, with an outfall into the gulf south of Point Grey.

In the design of the outfall off Imperial street the problem was to carry a flow of 200 cubic feet per second through a 5,000-foot outfall during a high tide. Zero tide equals elevation 83.5 Vancouver City Datum. Designing to meet the conditions created by a 14-foot tide when the water over the outlet would be 85 feet deep we have:

$$105.7 - 97.5 = 8.2 \text{ feet}$$

but

$$\frac{\text{weight of sea water}}{\text{weight of sewage}} = \frac{64.14}{62.45} = 1.027$$

hence a column of sewage to balance a column of sea water needs 0.32 inches extra for every foot of depth over the outlet.

$$85 \times 0.32 \text{ inches} = 27 \text{ inches.}$$

Now in summer or during periods of flood in the Fraser river there is approximately 25 per cent fresh water over the outlet, and the allowance for the difference in specific gravity then becomes 1.7 feet. There was thus available 8.2 feet − 1.7 feet = 6.5 feet to drive the sewage through a 5,000-foot outfall at high tide. To give a velocity of 5 feet per second this would require a pipe nearly 7 feet in diameter. But this was making provision for the maximum hour's demand, the maximum rainfall and a high tide all occurring simultaneously, a combination whose probability was figured as once in two thousand times. (Using a probable concurrence of the maximum hour's flow with a rainfall of 0.03 inches as three times in a year, together with twenty tides of 14 feet or over.)

Under more usual conditions, to keep the velocity up and to keep the cost of construction down, it seemed desirable to limit the diameter by providing for the maximum amount of sanitary sewage only. This amounted to 140 cubic feet per second. About this time it was also decided to provide a temporary outlet 3,000 feet offshore and to extend the outfall to the 5,000-foot point when the area was more densely settled. Calculating on this newly accepted basis, it was found that using a 5-foot 6-inch diameter pipe on a grade of 1.6 per 1,000 feet for 3,000 feet required 4.8 feet. Branching at the 3,000-foot point into two 4-foot 6-inch diameter pipes on a grade of 1.1 per 1,000 feet for 2,000 feet required 2.2 feet, a total of 7.0 feet.

This was rather more than the available 6.5 feet but was considered close enough. To take any flow in excess of 140 cubic feet per second during the short period that a 14-foot tide would control, there was designed an overflow pipe 3 feet in diameter discharging a little beyond low water mark.

It is to be noted that this overflow would come into action only when rain coincided with exceptional high tides and any sewage thus dealt with would go out on a falling tide. Except in a very wet summer it will seldom operate during the bathing season.

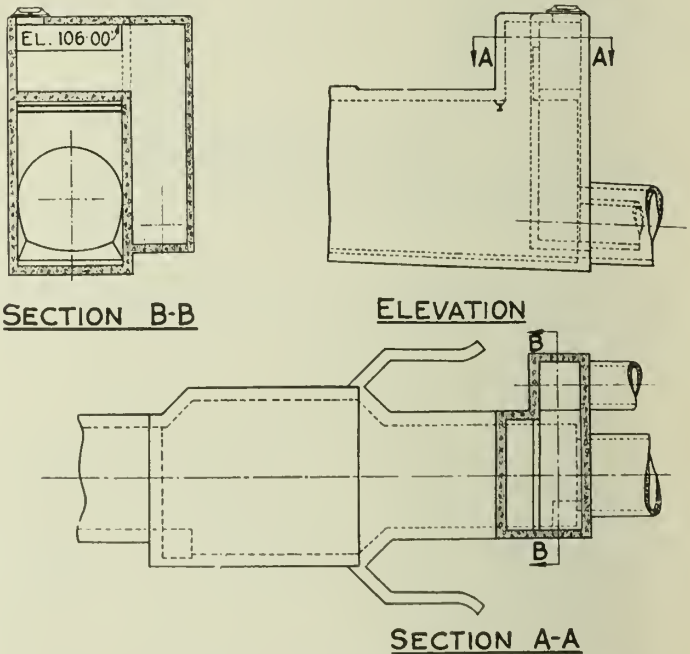


Fig. 8—Overflow Chamber at Foreshore, Imperial Street.

The soft nature of the sea bed off Imperial street precluded any idea of laying the sewer along the bottom and it was decided to use a pile foundation set in an excavated trench and using two steel rails as a cradle for the pipe. Experiments had shown that a ditch would probably stay open long enough to permit piles to be driven.

Reinforced concrete was the material selected for the outfall pipe. The pipes were pre-cast and had two layers of wire mesh reinforcing as well as longitudinal rods. The walls were 7½ inches thick, making a weight of 1,755 pounds per lineal foot. The joint as designed was a combination of the tongue and groove and butt joints. It was open enough to permit caulking as an added safeguard against leakage, although if properly laid the butt joint itself made it watertight. It was decided that 8 feet was the economical length of pipe to use.

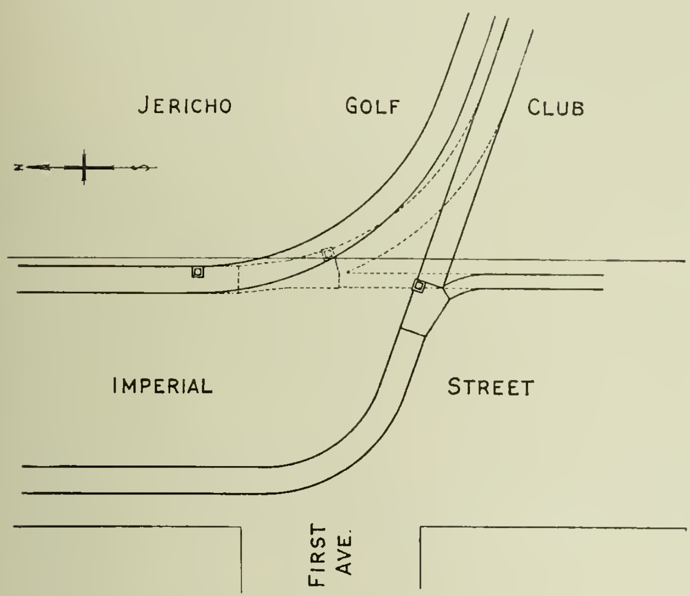


**Fig. 9—Imperial Street Connection After Construction of Interceptor.**

In designing the substructure it was decided to use two-pile bents at 6-foot centres. Numerous experiments had indicated the depth to which the piles should be driven. Applying the "Engineering News" formula $P = \frac{2\,wh}{S+1}$ to the observations recorded during the tests it was found:—

Total weight of pipe and cradle per lineal foot = 1,855 pounds. Assuming two piles every 6 feet and neglecting buoyancy, load on each pile is 5,565 pounds. Using a 5,800 pound hammer, a fall of 7 feet, and penetration per blow of 12 inches the result was:—

$$\frac{2 \times 5{,}800 \times 7}{12 + 1} = 6{,}246 \text{ pounds}$$

Hence piles should be driven until the penetration was about 12 inches under 5,800 pounds falling 7 feet.

Skin friction in silt, according to Fowler's "Practical Treatise on Subaqueous Foundations," may be taken as 120 pounds per square feet of pile surface as safe. Figuring on 9 inches diameter piles with a circumference of 28.27 inches and where $L$ is the required penetration:

$$L \times \frac{28.27}{12} \times 120 = 5{,}565 \text{ or } L = 20 \text{ feet}$$

The bent intervals were increased to 8-foot centres as the ground became firmer farther out. Even at that spacing there was a large factor of safety.

Total weight of pipe and cradle 1,855 pounds per lineal foot. Assuming 2 piles every 8 feet, weight on cap = 1,855 × 8 = 14,840 pounds. Allowing for buoyancy this becomes

$$14{,}840 \times \frac{150 - 62.5}{150} = 8{,}607 \text{ pounds.}$$

The safe concentrated load on a 10 by 12-inch cap with a 9-foot span would be 8,900 pounds; in this case the load was not concentrated and clear span is nearer 8 feet.

The last stages of design were carried on in the midst of an insistent public demand that the interceptor should be built without delay. The local press led a campaign to clean up the bathing beaches and keep them free from pollution.

The spring of 1929 saw the final preparation for construction, including the approval of the plans by the Dominion government and by the engineer originally retained by the Board, whose services as a consultant were fortunately still available. It was decided that the Board would undertake the entire construction itself, rather than let contracts for all or any part of the work.

Ground was broken on May 27th at the foreshore on the west side of Imperial street. Work was commenced with a small crew which was increased as the open trench lengthened. All the way up Imperial street fine running sand was encountered, making it necessary to close-lag the sides of the ditch.

Since the bottom of the excavation was 10 or 12 feet below high tide, water was present at all times, and to keep the trench dry a 5-inch centrifugal pump was installed at the foreshore. This pump, belt-driven by a 20-h.p. gas engine, ran day and night. A subdrain of agricultural tile was laid in gravel below the invert and carried the water to a sump at the lower end of the ditch just beside the pump. The concrete was run in place, in three operations, using movable wooden forms which were greased with a light fish oil for easy and clean removal.

This Imperial street section, 8 feet in diameter, was designed as a storm sewer to take the place of the Alma-Imperial trunk converted into the interceptor. (Fig. 9.)

At the turn into the Jericho Club grounds the storm sewer joined the old combined trunk, and new construction from there was part of the interceptor proper. All parts of the old structure not needed as part of the new scheme were broken up and removed. Through the golf links the

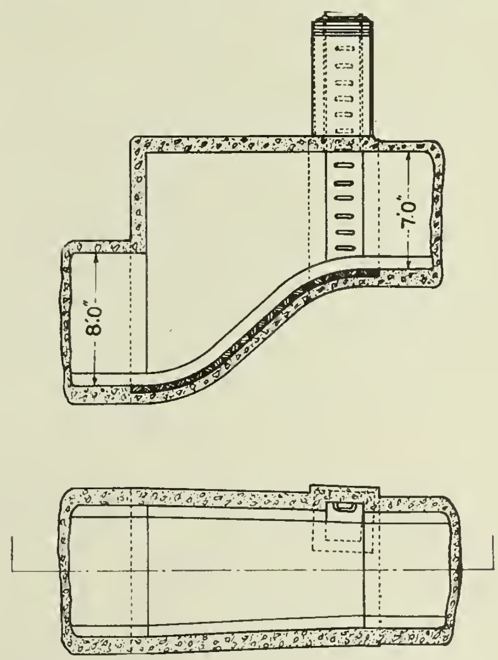


**Fig. 10—Combined Ramp and Transformer.**

material encountered was much the same as below but with less water, although close sheathing was still necessary.

On the Imperial street storm sewer the rough concrete invert was 8 inches thick, on which a thin cushion of sand made a bed for fire-clay brick laid on edge. Reinforcing steel consisted of ½-inch square deformed bars. In the interceptor proper the construction was similar except that instead of the brick invert, a paving finish two inches thick, half pump-sand and half cement, was laid on in sections before the rough concrete had set.

Open cut was the method of construction through the golf links and on to the point where the sewer turned north. The ground was rising rapidly here and the depth of the trench increased, until at 24 feet tunnel construction became more economical and the first portal was established. Very little blasting was necessary to open the ground up to the first portal, but in the subsequent stretches of open cut, sandstone and shale were encountered and constant blasting was required.

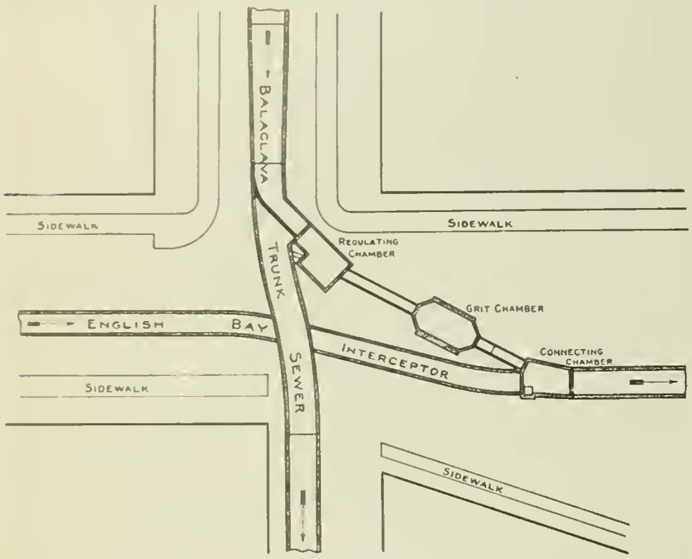

Fig. 11—Balaclava Street Layout.

A combined ramp and transformer just west of portal No. 1 reduced the diameter of the sewer to 7 feet and raised the invert about 6 feet. (Fig. 10.) From this point the sewer was no longer under pressure and consequently less reinforcing steel had to be installed.

The series of connecting structures at each of the intercepting trunks were installed as the open cut reached the different points. No particular difficulty was encountered at any place except at Balaclava street, where the top of the interceptor was designed to cut through the bottom of the existing trunk sewer. To take care of the flow during construction a false bottom was laid at the springing line in the old sewer, and the water was flumed across the point where the work was in progress. The interceptor here took the shape of a flat deformed section so as to cut a minimum of space out of the Balaclava trunk, whose invert was then built up to the top of the interceptor crown. The structures were built practically as designed, only minor changes in dimensions being made to meet underground conditions. (Fig. 11.)

Costs on the open trench sections varied greatly between the large section laid in shallow depths, and the smaller section further up the line which were much deeper and in harder material. For the lower part the average cost of excavation was $2.40 per cubic yard, which included laying of the subdrain, and half the cost of pumping, as well as labour and materials used in digging the ditch. Rock excavation in the upper stretches cost about $6 per cubic yard. Concrete costs over the whole open cut varied from $12 to $15 per cubic yard. This concrete was poured by hand and the price included setting up and removing the forms as well as placing the reinforcing steel. Backfilling costs throughout were fairly constant at 55 cents per cubic yard. Invert bricks cost 10 cents each in place, a price which makes the use of a substitute material very desirable.

The part of the interceptor constructed in tunnel amounted in length to 12,500 feet, and the tunnel was driven throughout grey sandstones and shale. Numerous seams of coal were observed varying in depth from an inch or two to a seam of 2 feet under Granville street. During the winter months some of this coal was used to heat the workmen's shacks, burning freely to a fine ash although rather hard to ignite. A narrow dyke of basalt was encountered under Balaclava street; otherwise the strata were very uniform, dipping about 15 degrees to the south.

Twelve shafts were sunk at various places along the line. The openings were 10 feet by 16 feet giving a 10-foot by 10-foot square shaft and a 6-foot staircase. Elevated bunkers received the dirt from a bucket running on an Alaska trolley. An A-frame on one side of the bunker supported by two deadmen in line on either side provided a cable way for the trolley. The hoist house beside the shaft contained a compact single drum hoist complete with 15-h.p. motor, and having a line speed of 150 feet per minute. An automatic trip discharged the dirt from the bucket into the bunkers. (Fig. 12.)

Headings were driven both ways and a sump at the bottom of the shaft was set low enough to drain both ends. An electric pumping unit installed part way down the shaft kept the sump clear.

To fix the centre line two reels of fine wire were mounted on either side of the shaft on planks. Weights with fins were suspended from the end of the wires and lowered into two buckets of water. When all movement had stopped the wires were centred on top and line was produced below. The transfer of the line from the surface above to the tunnel was repeated many times to obviate error.

The ground varied in hardness but throughout the entire job the drilling was good. However, owing to the tendency of the rock to air-slack, timber sets were placed at 6-foot intervals and a large portion of the roof of the tunnel was close-lagged. The sets were put in square and the sills centred with a transit, the object being to reduce the amount of overbreak to a minimum. Before placing the timber a light pneumatic pick and spader was used to good advantage in trimming the rock.

Not more than two shafts were opened at one time. The headings were advanced with Leyner type drills mounted on horizontal bars, and supplied with air by large compressors centrally located. Thirty per cent polar-

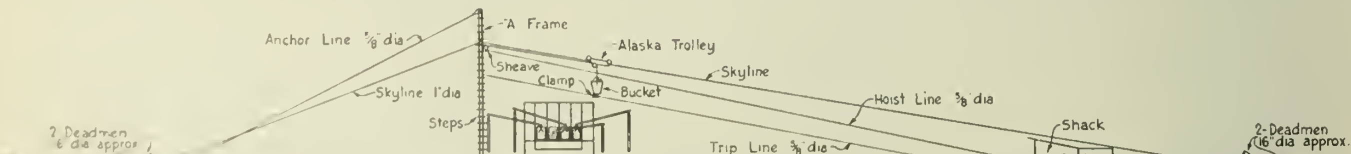

Fig. 12 Diagram of Equipment on Top of Shaft.

forcite was used to dislodge the rock, and charges were exploded by battery from the top of the shaft.

It was necessary to limit the amount of powder used in each round on account of the thickly populated residential district under which the tunnel was driven. For this reason also no blasting was done on the night shift, although mucking and loading went on twenty-four hours a day, six days a week.

The usual powder load was three sticks of 1⅛-inch by 8-inch polar-forcite in the cut holes and lifters, and from 2 to 2½ sticks per hole in the balance of the round. Both forty per cent and thirty per cent polar-forcite were used, but thirty per cent seemed to give better results in this type of ground. Powder consumption worked out at two pounds per cubic yard of rock removed. All holes were tamped with sand in 1¼-inch by 8-inch shells. The shells were empty powder cartridges crimped on one end only and made especially for stemming purposes.

Delay action caps Nos. 0 to 8-inch were used throughout. The use of so many different delays in a round which averaged only twelve holes, arose from the necessity of shooting not more than two holes on one delay to reduce vibration. (Strict control over the blasting materially reduced complaints from residents in the neighbourhood.) The caps were wired up in parallel and fired from a 220-volt power line. Shift bosses were in charge of the loading and firing and the wiring was supervised by the electrician. About 3 feet of rock was pulled in each round from a 5-foot hole, and the average daily advance per tunnel heading was 6 feet.

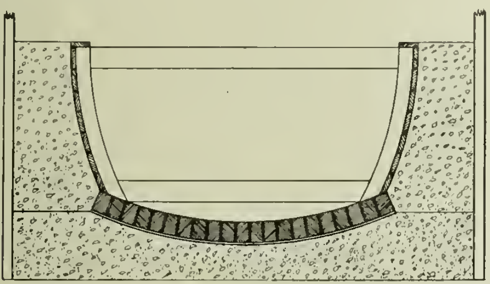

Fig. 13—Formwork for Concrete Invert and Sidewalls.

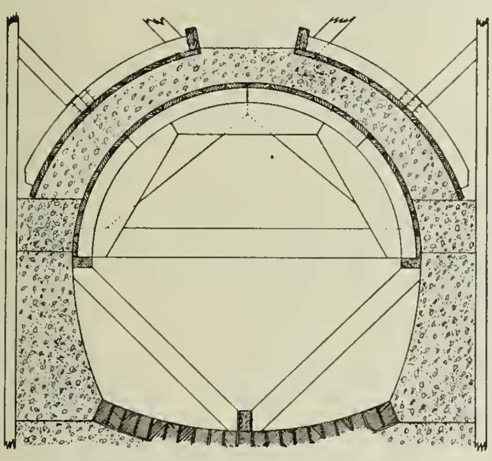

Fig. 14—Formwork for Pouring Crowns.

The tunnel was electrically lighted and a narrow gauge railway, single track with a siding half way to the heading, provided trackage for the small dirt trucks. Mucking was done by hand, 60,000 cubic yards of rock being removed in all. After a few hours in the open, the rock disintegrated into fine sand which was easily handled. Motor trucks removed the material from the bunkers, and disposed of it in nearby fills.

Ventilation was obtained by fans mounted at the top of each shaft. The fans were powered with a 7½-h.p. motor and supplied air through a 10-inch metal pipe which was carried down the shaft and along the tunnel to a point near the heading. The air current could be reversed by an arrangement of slide valves.

The first bore was 10 feet square to give a 7-foot diameter finished sewer inside, and the smallest bore was 7 feet square for the 4-foot 6-inch sewer. Ninety-degree

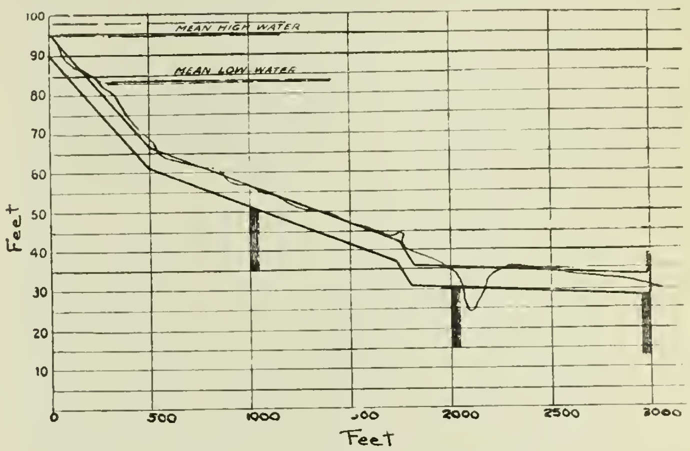


Fig. 15—Profile of Sea Bottom off Imperial Street.

curves were encountered in three of the tunnel lengths, but by using short chords carefully set no difficulty was experienced in getting a good break through when the headings met.

After two headings had been pushed to a junction, the tunnel was trimmed and cleared ready to receive the concrete lining. Concrete was mixed at the top of the shaft and sent to the bottom in chutes. For the invert it was loaded into buggies and sent along the tunnel to be spread. The invert was started midway between two headings and worked back towards the shafts; grout for the paving finish being sent down the other shaft so as not to interfere with the invert concrete, and yet be laid on while it was still soft.

On completion of the invert wooden forms were set up in sections to shape the top part of the sewer. (Fig. 14.) The concrete was placed behind the forms by a Ransome concrete placer, horizontal type, set up at the bottom of the shaft. A 6-inch steel pipe line laid along the top of the drift carried the concrete under pressure of one hundred pounds per square inch to the face. Air was supplied by a five hundred and seventy cubic foot compressor with two storage tanks in line, to keep the pressure up during a blow. The longest placement was 2,040 feet from the source of supply.

Lean concrete was poured in the shafts to bring them down to standard manhole dimensions, and the tunnel was complete. In all, the underground work consisted of two hundred and fifty thousand man shifts, and only one accident resulting in loss of working time occurred. One crew had a narrow escape when a heading broke into an accumulation of water from a leaking main. The water rushed into the tunnel with such force that men were thrown to the ground, but fortunately all were able to make the shaft in safety.

Using the 5-foot 6-inch diameter sewer as an example to illustrate the tunnel costs, it is found that the cost of driving (exclusive of shafts) was $8.50 per cubic yard, the cost of timbering (including lumber) was $2.15 per lineal foot, the cost of concrete invert varied from $12.50 to $13.50 per cubic yard, and that of concrete sidewalls and crown varied from $9 to $10.50 per cubic yard.

Work on the outfall began August 1st, 1929, with the construction of two wharves, each 350 feet long by 20 feet wide. These wharves were adjacent to the line of the interceptor outfall and the line of the storm sewer outfall respectively. They were of standard construction: three-pile bents at 6-foot intervals with diagonal bracing and designed to carry a moving load of 25 tons. These structures were to serve a double purpose. Materials and supplies for the floating equipment could be loaded at any stage of the tide and in addition all of the storm outfall, and the first section of the interceptor outfall, could be laid by a steam crane working off the wharves.

After the completion of these structures about 200 piles were driven in line to form a breakwater. This gave a mooring ground for the scows at night, sheltered from the prevailing west winds. The floating equipment consisted of a pile driver, derrick, dredge, tugboat, two diving scows, and two pipe barges.

Two rows of five-pile dolphins were driven at 100-foot intervals and 40 feet on either side of the proposed centre line. These piles were all driven to a penetration of 50 feet below the sea bed and provided secure mooring for the working scows. Light cable was strung taut along both lines of dolphins (which were in exact line) and painted marks on the cable gave the spacing for the pile bents.

It had been decided to excavate a trench deep enough to keep the top of the pipe below sea bottom. Fortunately the profile of the bottom was fairly regular and only four changes in grade were necessary throughout the whole length to keep the depth of trench within the limits, 10 to 15 feet. The bottom width was 15 feet to give sufficient working space. (Fig. 15.)

The dredge started working about 350 feet from shore, just off the end of the east wharf, using a one and one-half yard bucket, easily filled at every dip in the soft bottom. Large sights with painted cross arms were erected on shore, marking the limits of the ditch, and the depth at first was checked by soundings. A man would ride the bucket, sounding line in hand, testing the bottom every couple of feet. This proved too slow, however, and an automatic depth check was evolved. This consisted of a weight moving in a slot up or down the "A" of the derrick. A light cable ran from the end of the weight over the headblock, out to the end of the boom and down to the bucket. The A-frame was marked off in equal spaces each of which corresponded to a vertical drop of one foot of the bucket. A tide gauge, marked with actual elevations, was nailed to each dolphin. In this way the dredge foreman was able to keep a close check on his depths, and a remarkably smooth ditch was the result.

When the dredge had completed a length of trench sufficient to permit the pile driver to operate, the next stage in the construction was begun. The driver was equipped with extension leads which let down 30 feet below the surface and the same 5,800-pound hammer which had been used on the test piles. Each pile was carefully lined in with the transit, operated first from shore, and later from central platforms erected as the work was carried seaward. Bents were spaced by numbered clamps set on the two taut cables, along the line of the mooring dolphins. A light rope was suspended between corresponding clamps and the piles were brought up against the rope before being centred with the transit.

Piles were let down gently until they just felt the bottom, and then driven carefully to the water surface. A follower pile completed the driving to the required depth. This was several feet above the cut-off level, as no chances were taken in driving too deep. Eight piles, or four bents, completed a set, and the pile driver then moved out of the way while readings were taken.

It was during these first readings that the total darkness on the sea bottom was recognized as a permanent condition. Submarine lights were tried but the slightest movement of the water gave such distorted vision that it was considered more dangerous than no light at all. However, it was a distinct handicap to work without being able to see anything and for that reason no pains were spared to make sure by mechanical checks that the work was correctly carried on below.

A long maple rod 2 inches by 3 inches, spliced and reinforced with metal straps, was let down to a diver who waited on top of the pile. The amount of cut-off having been figured, a metal rod with movable shoe was used. The cut-off length was set as the distance between the shoe and the end of the rod. It was then lowered to the diver who placed the shoe on top of the pile and drove a nail, lightly, opposite the bottom. When all the piles had been read and marked in regular order on both sides, shiplap was lowered and nailed along the piles to form a bearing surface for the saw.

The first cut-offs were made by two divers working with an ordinary cross cut saw, but this proved very slow and also very exhausting to the men. A chain saw driven with compressed air was then tried and proved very successful, although it had never before been used at such depths. The operation of the machine was improved by piping the exhaust air to the surface, and thus reducing the back pressure. With this saw, piles which required twenty minutes to cut by hand, now were off in less than five, and the divers were able to cut eight without a rest.

Considerable care was taken in using the power saw in the darkness at the sea bottom, especially when the cut was nearly through. Once free the piles shot upward with great force, a 20-foot piece frequently leaping clear of the surface as it came to the top. The two-way telephone used on all divers' equipment was a big factor in preventing accidents. As soon as a cut had been made air was shut off from the saw, and not turned on again until the divers had moved to their next position and were ready to start a new cut.

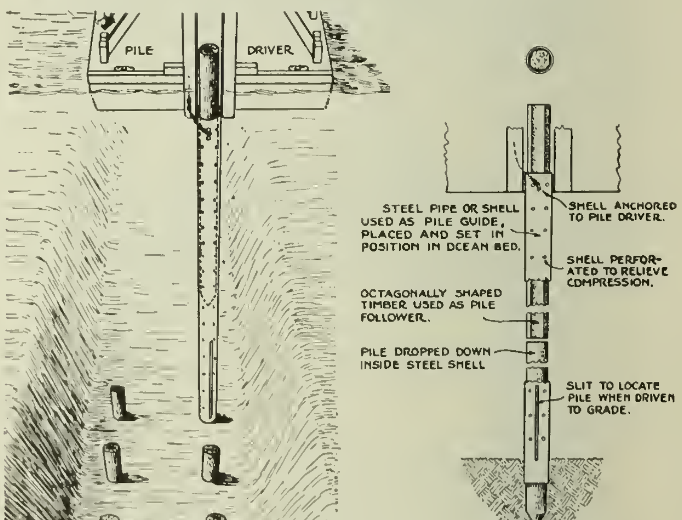


**Fig. 16—Steel Shell used in Driving Short Piles on Outfall.**

When a set of piles had been cut, the elevation of their new tops was checked again with the transit and rod. The sea was seldom perfectly calm and the instrument platforms, although well braced, were always subject to a certain amount of heaving and swaying. Final readings, as often as possible, were taken during periods of slack tide and little wind.

To cap the pile bents straight grained fir was used, each piece 10 inches by 14 inches by 12 feet long. The design had called for 10 inches by 12 inches but because it was impossible to secure exact readings at all times, it was sometimes necessary to notch the ends of the cap where they fitted over the pile.

A problem was to lower the caps so that they would arrive on the bents in a horizontal position and require a minimum of handling by the divers. For this purpose a pair of weighted tongs were devised and used. The caps were set centrally in the tongs on the deck of the pile driver and then lowered with the pile line. The divers manœuvred the timber into position by directions given to the pile driver foreman through the telephone. When in position drift bolts were driven through the cap and into the pile below.

**Fig. 17—Pile Driver ready to lower Bent Cap.**

Instrument readings were again taken to check the final elevation of the top of the caps. In all, four different sets of readings were taken from the time the piles were driven until the bents were capped.

When a pile foundation was completed the next operation was to lay the cradle on which the pipe itself would be placed. 85-pound rails formed the cradle and the gauge was fixed so that there would be a clearance of one inch between the bottom of the pipe and the top of any cap. The rails were assembled in pairs on the deck of the derrick scow and were spiked to light ties. These ties kept the rails at a uniform gauge and were spaced so that they would not coincide with any cap. Measurements obtained by divers before each pair of rails was slung indicated the correct allowance to make. It was essential that the underwater track should be laid in as perfect a line as possible so as to get good joints in the pipe.

A long wooden rod stiffened with metal plates was first used to line in the track but did not prove satisfactory. A heavy all-metal rod was no better. In both cases the movement of the water bellied the rod to such an extent that no true plumb line could be obtained. After pulling up and relaying several sets of rails due to the poor results obtained with the rods, it was found necessary to design something so thin that the movement of the water would have no effect.

To obtain this result a heavy plumb bob (50 pounds) was hung from the end of a very fine wire. The wire hung from a carriage which moved in and out along a swinging arm. This arm was three feet long and swung about a standard which was bolted to the deck of the derrick scow. The wire was reeled at the standard on a ratchet which controlled the drop.

To set the track in position, the derrick scow was brought to the scene of operations, the arm swung over the side and the plumb bob lowered to the diver waiting beside a cap. The diver directed the movement of this scow until the plumb bob was a foot above the cap. The instrument man on top, sighting on the wire then moved the carriage into position. The moment it was directly on line (line being the west flange of the west rail) the bob was released, dropping on to the timber. The diver felt for the resulting dent and marked the place with a nail. Three readings were taken, and if they coincided, the nail was driven in and the same operation repeated on the next cap.

The track was slung from the derrick scow with four chains, spaced so as to give a horizontal set, and lowered on to the caps where the divers placed the flange of the west rail along the series of nails. When it was in place the sling was released, track plates were bolted on at the joints and the rails were spiked to the timber caps.

The pile foundation and cradle were now ready to receive the pipe. This pipe, delivered to the job on scows, was in 8-foot lengths, each length weighing about 7½ tons out of the water. The pipes were lowered into place on a "banjo": a casting weighing 1,200 pounds and having a long lower arm. It was set into the pipe on the deck of the derrick scow and suspended from the boom by a cable which was shackled to one of the holes in the short upper arm of the "banjo." From the deck of the scow the pipe was lowered slowly to the sea bottom. Two divers, waiting on either side of the track below, received it and guided it into place between the rails, giving direction by telephone to the foreman on the scow above. When it was pressed home against the preceding pipe, the cable was slacked off and the "banjo" itself dropped loose and was withdrawn by a rope fastened to its heel and passing to a scow moored north of the scene of operations. Due to the care taken with the pile foundation and the cradle, no trouble was experienced in laying the pipe sections. Each one slipped home and gave a good tight joint. (Fig. 18.)

These joints were specially designed and gave a butt joint effect, yet were accessible for caulking. (Fig. 19.) Several materials were considered for this, lead wool being the material commonly used on work of this type. At the start of construction no caulking material had been selected, but it was decided to try Sika, a British preparation with great powers of adhesion and a very quick set.

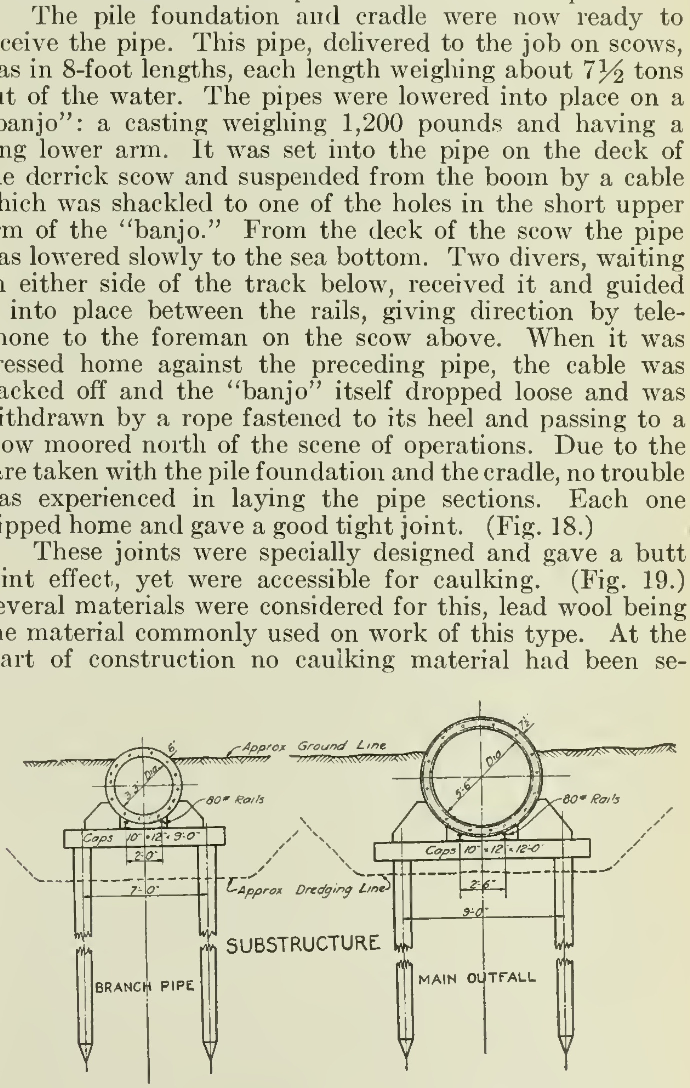


**Fig. 18—Cross Section of Submarine Structure.**

Sika and water were mixed together in the ratio of one to three, and cement was added to the mixture until it had a consistency like putty. This putty was placed in tin pails, covered and lowered to the diver on the pipe below. He removed the lid and quickly inserted the paste into the joint. The first set was almost instantaneous, that is, there was no tendency to dissolve in the water, and the final set took place within fifteen minutes, leaving a material harder than concrete. The pipes were caulked on the inside around the bottom and half way up, and on the outside from one rail over the top to the other, thus assuring a safe overlap in the joint.

This caulking material proved very satisfactory on this submarine work. It was pliable and easy to handle and could be packed into the joint without using tools. It was much cheaper than lead wool, which seems to have a tendency to rot and disintegrate after a short time in salt water. Examination of the first Sika joints made two years after they were put in showed them to be in good condition with no sign of cracking or breaking. However, lead wool would be preferable in any structure that was not absolutely rigid.

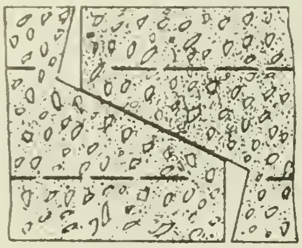

Fig. 19—Special Joint of Outfall Pipe.

Timber chocks cut to the shape of the pipe were placed on either side, and drift bolted through to the cap. Each joint was thoroughly inspected and final rod readings were taken on top of the pipe as a final check. When everything was in order the whole structure was covered over with fill to the level of the original sea bed.

At the 1,500-foot point there was a change in grade as the profile of the sea bed flattened out. Although no submarine manholes had been designed, it was decided to install one here to permit access at a point where grit might settle. The manhole was made on the job by breaking a hole in the 5-foot 6-inch diameter pipe big enough to take a 30-inch diameter pipe with 4-inch walls. Reinforcing wire from both pipes was twisted together and the saddle was filled inside and out with a thick layer of Sika, the inside layer being flush with the surface of the pipe. This T-pipe was lowered on a piece of 12-inch by 12-inch timber set along the arms of the T; no cover was put on at that time. Manholes were installed at 500-foot intervals from the half-way point to the end of the outfall as well as at the 350-foot point where work started and where the first change in grade occurred. (Fig. 20.)

From the 1,500 to the 2,000-foot point the sea bed seemed to be a little firmer and aided by summer weather good progress was made. At the 2,000-foot point, the sea bed, which had been flat and regular, was broken by a channel some 200 feet wide and 14 feet deep at the centre. This channel lay at an angle across the line of the outfall and was thought to be the scene of former dredging operations. Sand has frequently been dredged from the vicinity of the Spanish Banks and taken in scows to fill at some other place.

The outfall was laid across this channel in the usual way and a manhole was put in near the south side. Fill was placed right across and to a point about half-way up the pipe. Back-filling had always followed the pipe laying as soon as possible to prevent teredos getting into the timber substructure. Replacement of piles in the breakwater and to a lesser extent in the wharves had indicated what rapid destruction these teredos could cause. Sewage discharging on the foreshore gave protection to the wharf piles; but the breakwater, close to shore yet out of the sewage field, was vulnerable to attacks of these white worms. Authorities seemed to agree that the teredo did not operate in deep water. They were wrong.

Stormy winter weather forced the floating equipment to leave the outer end at the 2,200-foot point, and it was decided to take advantage of the high winter tides to complete the inshore portion of the outfall and also the storm sewer outfall.

The old outfall pipe had been lifted by the steam crane working off the wharf. Although carrying a hardened mixture of grit and sewage about one-third up the diameter, the pipes when cleaned were found to be in sufficiently good shape to relay on the west side for the new storm sewer outfall. These pipe sections were 5 feet inside diameter in about 5-foot lengths and weighed 4 tons per section. The interceptor outfall proper was completed from the starting point back to the outfall chamber, the joint being made a few feet out from the chamber at low tide.

Some months had elapsed in finishing this inshore work and it was the spring of 1931 when equipment was moved out to complete the last 800 feet of the interceptor outfall. A diver was sent down to mark the end of the completed ditch. He came up with startling news. A strong tide was running and for once the bottom was fairly clear. The old channel was washed clear of the fill, exposing the piles and caps, teredos had been at work, the substructure had collapsed in places and the pipe, vaguely visible, had sunk or was suspended on rails which had no support.

A more detailed examination with instrument readings revealed the extent of the damage. Nineteen lengths or 152 feet of pipe were off the correct grade, varying from half an inch to 3 feet. The pipe was wedged tight even in its deformed position and no large opening was found. Pieces of timber cut off and brought to the surface showed the caps and piles in the exposed channel to be riddled with teredos. The channel was explored and found to run on line with the edge of Spanish Banks and to have a distinct and active current. This current did not seem to follow any regular tidal condition but there was no doubt it was sometimes very strong. In fact since then, this same current closer to Spanish Banks is reported to have been the cause of several drowning accidents.

Fig. 20 T-Pipe with Manhole.

To repair the damage two lengths of pipe were blasted out to form an opening; sixty sticks of dynamite laid around the circumference were used to shatter each pipe.

The other seventeen lengths were then removed as well as the rails and the remainder of the caps, the piles were left in. It was decided to leave the channel open and use creosoted lumber and piling where there was no fill.

It was essential that no crack or split should occur in the creosoted material to allow the teredos to enter. Also it was desirable to limit the length of piles, a difficult problem in 75 feet of water. Various ways of splicing two piles were considered, and were discarded as impractical. Finally a scheme which gave good results was devised. Three steel pipes 18 inches in diameter of ⅜-inch plate were welded together to form a straight steel shell 75 feet long, perforated in several places and with a long slit near the bottom. This pipe was suspended in the leads and dropped slowly to sea bed, keeping a constant strain to prevent it sinking into the soft mud. Then a short straight creosoted pile, 16 inches in diameter or less, was dropped into the pipe and as it floated the follower was placed and driven down. This follower was a straight piece of square timber 16 inches by 16 inches and 70 feet long, with the corners adzed off smooth and with a thick rubber mat nailed to the bottom.

No cut-offs were made on the creosoted piles. As the top approached the required grade a diver kept inserting a rod with a long shoe into the slot near the bottom of the pipe. The height of the hammer drop was shortened and the pile was just tapped into place. Any slight variation was made up on the caps before they were creosoted. All creosoting was done under pressure sufficient to give a penetration of one inch.

After the channel section was restored, no further delays occurred. The long steel shell was retained and short straight piles were used to the end of the job. Although slower, this method paid by its economical use of timber. The sea bed to the outlet was very flat and level and somewhat firmer than close to shore.

For better diffusion it was decided to branch into three outlets at the end of the outfall. Two 36-inch steel pipes were laid north-east and north-west from the main outfall chamber for a distance of 50 feet. Two smaller chambers formed the terminus of the steel pipes. All the outlets turned upward and were provided with manhole covers big enough for a diver to enter. These chambers were cast on the wharf, taken out on a scow and lowered on to prepared pile platforms.

The last work done on the interceptor on land or sea was placing the manhole covers on the T-pipes. These covers were specially designed and had bronze fittings. The last cover set was at the 1,500-foot point. After a struggle it was forced into place and the information was telephoned to the tug. Three minutes later the smooth surface over the outlet was broken by three churning circles as the English bay interceptor went into operation.

The total cost of laying the outfall figured out at \$80 per lineal foot; of which the pipe cost about \$15 per foot, the lumber and piling \$12, and other material, rails, cement, Sika, etc., about \$3 per foot; so that the actual laying cost was about \$50 per foot for the 3,040 feet laid.

Regular inspection of the outfall has been made every spring and fall since the construction was completed. A fill of coarse gravel now extends almost the whole length on both sides of the pipe. It was found that submarine currents tended to shift the light fill and expose the timber. Last year even the channel was filled with gravel as a precaution against dragging anchors. No other improvements or adjustments have been made in any part of the interceptor. It has continued to work in a satisfactory manner and to fulfil the object for which it was constructed —freedom of the foreshore from pollution, and clean and sanitary bathing beaches.

The entire project was carried out by the Vancouver and Districts Joint Sewerage and Drainage Board. Mr. E. A. Cleveland, M.E.I.C., was chairman of the Board, Mr. J. M. Begg, M.E.I.C., was chief engineer of the Board, and Mr. R. S. Lea, M.E.I.C., acted as consultant. The total construction cost was \$1,575,000.

# Electric Soil Heating

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**Paper presented before the Winnipeg Branch of The Engineering Institute of Canada, March 1st, 1934**

SUMMARY.—The paper discusses the utility of soil heating, describes the equipment needed, gives figures as to the cost of installation and operation, and states some actual results, both in hotbeds and greenhouses.

Everyone is familiar with the comforts and conveniences afforded by electricity in the home. The economies and higher efficiency made possible by the application of electricity to our industries are also generally known. The extension of electric service into rural districts has made possible the application of electricity to yet another field, namely horticulture. All market gardeners, florists and similar growers find that for early plant growth, extra heat other than that provided by nature is a necessity. In the past this has been supplied in the form of steam heated greenhouses and manure heated hotbeds. During the last few years it has been proved that electricity can replace these as a source of heat for growing more than fifty kinds of crops. Electric hotbeds are gradually replacing manure hotbeds. Directly heating the soil on propagating benches for the starting of all kinds of cuttings and for forcing various greenhouse crops can be more than paid for by the saving in fuel, to say nothing of improved growing conditions. Also, heating the soil for outdoor crops has proved very satisfactory in growing intensive high priced crops.

It is of interest to know that the feasibility of supplying heat directly to the soil by electricity was first realized by a Norwegian engineer, more or less by accident. While examining a network of overloaded underground cables he noticed that the vegetation over them was greener and more advanced than elsewhere. From this he conceived that the deliberate conversion of electricity into heat by means of a buried resistance would result in an efficient and easily controllable means of promoting plant growth. During 1922 his experiments were successful, in fact so successful that inside of five years over 12 per cent of all the hotbed sash in Norway was electrically heated. This development was almost paralleled in Sweden, where we find 5,900 square yards of electric hotbeds by 1927 and 24,000 square yards in use by 1929. Denmark, Holland, France, Germany and England have adopted the idea more or less in inverse proportion to the cost of electric power in the different countries. About 1926 saw the introduction of electric soil heating in the United States. By 1929 the power companies became interested in its possibilities with the result that by 1932 over one million kilowatt hours were known to have been used in this way, and in spite of low price levels and other disturbing features the consumption for 1933 is already four times that for 1932. The records show that 2,000 thermostats and 330,000 feet of cable were sold between May 1932 and May 1933. This increasing use everywhere must mean that the heating of soil electrically is economical as well as more efficient.

It was not long before the Canadian power companies undertook to introduce electric soil heating to the Canadian grower. In doing this they have a fortunate advantage in the fact that power rates are on the average much lower than in other countries where electric soil heating has already proved a commercial success.

In 1932 numerous installations were put in in the market gardening districts around Montreal where the Shawinigan Power Company has been the chief sponsor. In Ontario the Hydro-Electric Power Commission has taken an active interest in several installations. In Manitoba the Winnipeg Electric Company is sponsoring experimental installations, and in British Columbia the B.C. Electric Company has already proved its practical value.

### Advantages

The fact that the power companies have been behind most of the experimental installations would indicate that electric soil heating must constitute a desirable load. It is true that the transforming of kilowatt hours into vegetables and flowers can be made profitable both to the producer of kilowatt hours and to the producer of vegetables and flowers. From the power companies' standpoint:—

(*a*) The electric hotbed or propagating bench consumes annually an average of 1,000 kilowatt hours per kilowatt of connected load, which compares favourably with most other electric appliances.

(*b*) The greatest consumption is during the early spring months when water power is most plentiful.

(*c*) Experiments show that it is at least 70 per cent night load and therefore to a large extent an off peak load.

(*d*) For the most part it is connected to underloaded rural distribution feeders, helping them to stand on their own feet with little or no new capital expenditure for extra line equipment.

From the grower's standpoint there are many proved advantages, such as:—

(*a*) The soil temperature best suited to any particular crop can be maintained by thermostatic control, thereby improving growing conditions as well as insuring against sudden change or extreme weather conditions.

(*b*) Crops may be advanced or retarded at will. Often bringing a crop on the market on a certain fixed date, such as flowers at Easter or Christmas, means a great deal to the grower. With other crops, being able to place them on the market ahead of their competitors means much higher prices.

(*c*) The electric hotbed can be used in the fall of the year as well as the spring, since constant temperatures can be maintained as the weather grows colder, whereas this is impossible with manure heat since it loses its heat when most needed.

(*d*) Several successive crops can be raised in the hotbed in one season without removing the soil. With manure heat the bed has to be emptied every six weeks or so and left a considerable time to allow the new manure to start heating.

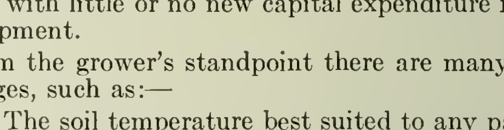


**Fig. 1—Cross Section of Typical Electric Hotbed.**

(*e*) The electric hotbed is clean and free from ammonia fumes. This eliminates many forms of insect life and plant rot.

(*f*) A uniform temperature is maintained throughout the entire bed, a big improvement over the concentrated heat of a manure hotbed.

(*g*) The hotbed temperature can be readily lowered as desired and finally made into a virtual cold frame by merely adjusting the thermostat, yet the heat is always available and will automatically look after unexpected cold weather.

### General Layout

In its experimental stages the use of electricity to heat propagating benches and hotbeds was accompanied by a vast amount of detail regarding special construction features, mostly aiming to eliminate heat losses and thereby conserve electric power. For example, early experimenters claimed that in dull wet seasons as much as 22 per cent could be saved in kilowatt hours by totally insulating the hotbed from the ground by means of air spaces or cinders. This of course involved digging a pit to allow 6 to 8 inches of cinders under the entire bed and a one-foot embank-

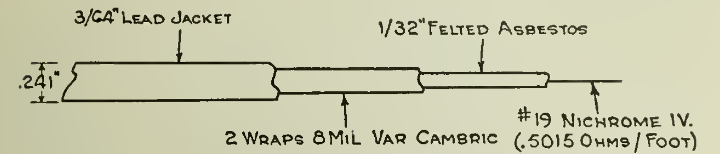


**Fig. 2—Lead Covered Cable used in Soil Heating.**

ment on all sides. While this no doubt prevented considerable heat losses it made construction more difficult and expensive and tended to make the job too complicated to appeal to the average grower. Also this bottom insulation was found to have a detrimental effect on the growth in the bed; this was especially noticeable in longer season crops such as cucumbers, celery, etc. However, 22 per cent power saving could not be overlooked and therefore total insulation was recommended by early authorities.

More recent development indicates that these heat losses can be eliminated by changing the location of the cables instead of bottom insulation. Numerous other examples could be cited showing where construction has been simplified without sacrificing efficiency. However, consideration as to layout is still very important for hotbeds, such as southern exposure to get the maximum benefit of the sun, shelter from prevailing winds and good natural under-drainage. Having chosen a site with these things in mind the usual construction that applies to manure hotbeds has proved quite satisfactory.

### Heating Elements—Types Available

The most important feature of electric soil heating is, of course, the heating elements. There are two main types

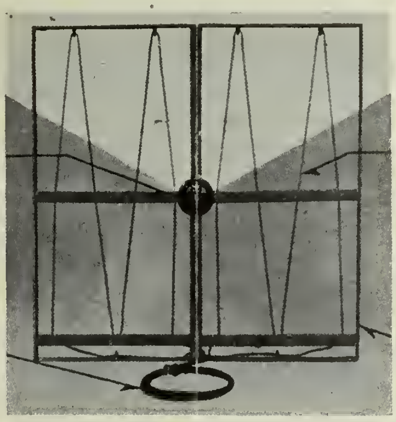

**Fig. 3—Plug-in Unit Open Element Type with Built-in Thermostat.**

of elements offered at present and both have their good points. The most popular type consists of a single nichrome wire, insulated and lead covered, which is designed to be buried in the soil 4 to 6 inches below the surface. The conductor used has a resistance of 0.5 ohms per foot and when 60 feet is connected across 110 volts it gives a 400-watt element. This amounts to 6.7 watts per foot which is not a hot wire element and when buried in moist soil the heat is gradually dissipated throughout the soil. The 60 feet of lead-covered cable gives a very flexible element, which can be laid out with any desired spacing without causing "hot spots" in the soil.

The other type of element consists of an open, low temperature resistance coil, strung on a light frame. The whole unit is slid into a special air compartment immediately below the growing soil. This type of heater has the advantage of supplying the heat directly to the air, not being hindered by the lead covering; also the whole element can readily be removed and used elsewhere. However, the necessity for special air space under the bed tends towards higher heat losses and has the aforementioned bad effects of bottom insulation.

### Capacity Required

The size of heating elements required of course varies according to the size of the hotbed and can best be dealt with in terms of heating capacity or heat flux required per square yard of bed. The installed capacity generally recom-

**Fig. 4—Fitting Element into Air Compartment.**

mended to safely cover Canadian weather conditions is 100 watts per square yard. The capacity actually necessary depends upon the average difference in temperature inside and outside the frame and a factor of safety to allow for weather conditions such as high winds or sudden frosts. Data obtained from experiments using 100 watts per square yard shows that in the greenhouse the heaters were only in use 30 per cent of the time. From this it is obvious the same heating elements could have been spread over double the area and still leave an ample factor of safety for greenhouse work.

Similarly for a fairly well constructed hotbed, while the factor of safety has to be larger because the bed is exposed to outdoor temperature, the whole unit is more enclosed and therefore holds its heat longer. In one test it was found that with an outdoor temperature ranging from 26 to 32 degrees F. during the night with a fairly strong wind, 100 watts per square yard maintained a temperature of 70 degrees in the hotbed without any difficulty, the heat being on only 60 per cent of the time, leaving 40 per cent unused capacity. Opinions would no doubt differ as to whether to leave this unused capacity as a factor of safety for temperatures below 28 degrees F. or to cut down the capacity and allow the temperature in the frame to fall below the thermostat setting if the outside temperature falls below 26 degrees. From the author's experience it is preferable to spread the element over more area and use more nearly its full capacity. The larger crop raised would more than offset any setback there might be on account of temperature dropping say from 70 to as low as 40 degrees for a few hours during an exceptionally cold night. This method is sure to meet with the approval of the grower because he will not require as much equipment to heat his frames, the power company will be benefited by less peak load but the same or more kilowatt hours, and the manufacturers of the equipment will also benefit in the long run, if not at first, because the biggest obstacle in selling electric soil heating is the initial outlay for equipment.

An argument against reducing the capacity per square yard of bed would be that the season when the bed can be used safely is immediately shortened. In Manitoba, at

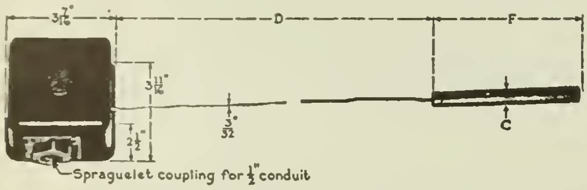


Fig. 5—Soil Heating Thermostat.

least, the electric hotbed is not practical during the period when below zero weather may be expected. The variety of crops which can be grown do not command high enough prices to warrant heating frames if the average night temperature is below 20 degrees F. With the manure hotbed the season does not start until the average temperature is above freezing so that the use of the electric hotbed lengthens the season considerably if it is started when the temperature averages 20 degrees F. The mean temperature curve for Winnipeg for the last four years crosses the 20 degree F. line about March 15th, which gives two and a half to three months during which extra heat is required for spring crops. A similar period in the fall of the year makes a total of five months during which low priced crops can be grown profitably in Manitoba. In the Maritime provinces hotbeds can be used all winter. Soil heating in the greenhouse can be used all year and is most useful during severe weather.

The general opinion of a meeting of representatives of several power companies and government engineers recently held in Hamilton was that the recommended heat flux could safely be reduced to 60 to 75 watts per square yard for spring and fall use, rather than 100 watts as was originally recommended.

### Thermostatic Control

Large variations in temperature from day to day and between night and day necessitate regulation of the amount of heat supplied at different times. This checking and regulating can be done manually by means of a four-way switch, and the electric heat will still be ahead of the manure heat, but the fact that it can readily be done automatically by means of a thermostat is where electric heating shows its real superiority. The electric thermostat is on the job twenty-four hours a day to give the soil just as much heat as it requires and no more.

Thermostats especially designed for soil heating are equipped with a soil bulb which is connected to the thermostat by means of a capillary tube. This bulb is quite sensitive and will actuate the thermostat when the temperature varies about 3 degrees above or below the thermostat setting, making an operating range of 6 degrees at the soil bulb which is hardly noticeable at the surface of the soil.

These thermostats are reliable and at their present price are not too expensive if their full capacity, 2,800 watts, can be utilized. However, for smaller installations, which must be sold first to introduce the larger ones, a smaller and cheaper thermostat would help. A thermostat large enough to control 1,000 watts would suit small installations or smaller units of a big installation. Even large installations are better controlled in smaller units as this gives a factor of safety to allow for failure of any one thermostat. Also different temperatures in different parts of the same bed may be desired to force or retard that portion of the crop.

### Initial Cost

It would be difficult to compare the initial cost of the two types of elements and also rather unnecessary, since more recent improvements have caused the lead-covered cable to be almost universally adopted as the most efficient and adaptable means of supplying the heat to the soil.

The cost of equipment in this district, including thermostatic control, ranges from \$2.60 per square yard in small beds to as low as \$1 per square yard in larger installations. For example, a hotbed of 10 square yards area at the new rating of 75 watts per square yard would require two 400-watt elements costing \$5 each, a joint box and thermostat, making a total of say \$26, depending on the type of thermostat used. This amounts to \$2.60 per square yard of bed. A larger bed, say 80 square yards, would require eight times as much heating cable costing \$80 but only one thermostat, making a total cost of say \$96, or \$1.20 per square yard of bed.

This equipment should give service for several years without further cost.

### Results

In all types of crops, both vegetable and flower, faster growth without sacrificing sturdiness of plant or strength of roots is the aim of electric soil heating. By maintaining the soil temperature higher than the air temperature the effect is first shown in more vigorous root growth which soon results in stronger foliage and finally choicer fruit. Some types of crops will not stand quick forcing to full maturity but can be given a flying start and then encouraged at a slower rate to allow proper maturity. As much as 50 per cent of the time can be saved in germinating practically all seed, but after germination the temperature must be lowered somewhat to conform with the former habits of the plant. When this is done as high as 33 per cent saving in time between germinating and transplanting into the field or garden is effected. Short season crops such as radish, lettuce, cucumbers, etc., which can normally be matured in six to twelve weeks, can be forced to maturity with soil heat in from four to nine weeks. As an example, in Vancouver cucumbers were matured one month earlier, thereby collecting \$1 per dozen more by being on the market before the normal crop. In California 1/10 acre of cucumbers in the field were heated electrically and maintained 25 degrees higher than a similar unheated plot. The heated plot matured in forty-one days, a month earlier than the check plot, and yielded twice as many cucumbers with an additional \$150 revenue from the plot, against which was charged 2,400 kw.h. at 1 cent per kilowatt hour or \$24.

In the propagation of cuttings, much time can be saved because here the primary concern is the forcing root growth. For this reason the heated bench is not boxed in, only the soil being heated, the air temperature being more or less governed by the greenhouse temperature. But more important than the saving in time is that a very much higher percentage of the cuttings will take hold. This is to a large extent due to the fact that the soil, being warmer than the air, evaporates moisture at the surface rather than condenses it, as takes place when the air is losing heat to the soil. This automatically prevents black leg and stem rot, diseases very common to the propagating bench. The lower air temperature also discourages the development of aphis and other forms of insect life which menace the foliage of many plants.

Many of these improvements cannot be evaluated accurately in dollars and cents but will not be ignored by growers who are looking for ways of meeting keen competition and of outwitting backward or unfavourable seasons.

To what extent these results can be applied to local conditions can only be answered by trying them out locally. Sponsored by the Winnipeg Electric Company, first hand experience with electric soil heating was obtained at the Tomlinson greenhouses, Bird's Hill road, where a

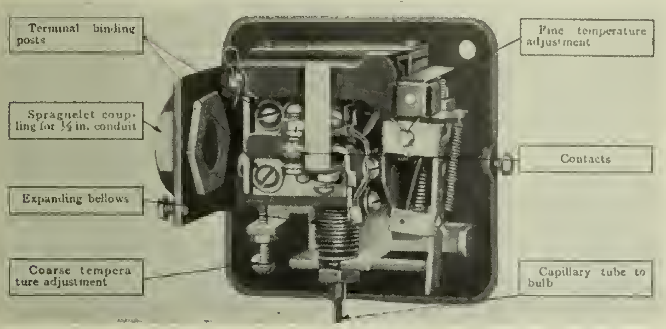


**Fig. 6—Interior of Thermostat.**

400-watt, lead covered heating cable was installed on the greenhouse bench. The temperature was controlled by means of a small water heater type thermostat. At list prices, the total cost of equipment was approximately $13. The bench was used for the germination of expensive varieties of flower seeds, the aim being to improve the percentage germinated. The power was turned on February 18th and was operated along with a check bench exactly similar but without electric soil heat. By March 10th, twenty-two days, several batches of seed were germinated. The bench was kept at a minimum of 70 degrees F. The average temperature of the check bench was 55 degrees F. The power used was 45.3 kw.h. in twenty-one days, or 2.1 kw. per day.

Germination Test Results

| Variety | Time germ. htd. bed | Time germ. chk. bed | Percentages: Germ. htd. bed | Germ. chk. bed | Damp off htd. | Damp off chk. |
|---|---|---|---|---|---|---|
| Lobelia | 4 days | 7 days | 90 | 75 | 0 | 20 |
| Pansies | 6 days | 6 days | 75 | 75 | 0 | 0 |
| Balsam | 4 days | 6 days | 100 | 80 | 0 | 30 |
| Verbena | 5 days | 7 days | 90 | 65 | 0 | 10 |
| Coleus | 7 days | 12 days | 80 | 40 | 5 | 30 |

Electric Soil Heating in the Cold Frame

When the propagating season was over, about March 30th, the same equipment, heating cable and thermostat, was utilized as a prevention against sudden frosts in the cold frame. In this instance the object was to supply just sufficient heat to keep the temperature a few degrees above freezing; thus the 60 feet of cable of 400 watts heating capacity could be spread over a larger area. In this case it was strung around the perimeter of a cold frame 7½ feet wide and 22 feet long. The thermostat was set to go on at 36 degrees and off at approximately 46 degrees F. While no autographic record was kept of the number of times the apparatus was in service, there were at least three nights within two weeks that the electric heat came on and prevented damage by frost; which is proved by the fact that frost was evident in other cold frames even though they were covered with heavy carpeting.

By stringing the heating cable around the sides of the cold frame, close to the glass, heat was supplied close to the source of most of the cold draughts, thereby pre-heating the air entering the frame before it spread or did any damage. At the same time this allows the cable to service more area, keeping down the cost per square yard for equipment.

Electric Soil Heating in the Greenhouse

The soil heating equipment used in the cold frame, and previously on the propagating bench, was now moved back into the greenhouse to be used in the forcing of cucumbers.

The 60 feet of cable was buried along each side of a row of cucumber plants, when they were transplanted from boxes to the greenhouse bench. The cable was laid three inches below the surface of the soil, and approximately five inches from the row on each side. The 60-foot length serviced twelve plants; as a check the row of plants continued further but without any soil heat.

The thermostat was set to turn the heat on when the soil temperature dropped to 56 degrees, turning off again at about 67 degrees, thus maintaining an average of approximately 62 degrees F.

Power Used

| Date | Hours on (Approx.) | Kw.h. Used | Kw. per Day | Remarks |
|---|---|---|---|---|
| May 18th to 25th | 32 | 13 | 1.85 | Heat on 3.5 to 5.0 hours per day. |
| May 25th to June 1st | 28 | 11.2 | 1.60 | Marked difference in size htd. plants in bud. |
| June 1st to 14th | 40 | 16.0 | 1.23 | Small fruit in htd. plants. Chk. plants in bud. |
| June 14th to 24th | 24 | 9.7 | 0.97 | Htd. plants clipped to stop growth, force fruit. |
| Total 37 days | 124 hours (3.4 hr/dy) | 49.9 Kw.h. | 1.35 Kw./day | Weather exceptionally hot for June. |

Although quite warm weather prevailed throughout the test, the heat came on almost every night from May 18th to June 15th and occasionally up to June 24th.

Further tests are needed to see if a higher temperature could safely be used for faster forcing, which would be applied during the day as well. However, it would probably be necessary to supply artificial lighting to lengthen the day, so that the plants would mature earlier, rather than grow too large instead of bearing fruit.

The spring of 1933 will be recorded as an exceptionally good growing season, weather conditions being about a month advanced compared to other years. For this reason the check plants with natural conditions showed quick growth and the artificially heated plants did remarkably

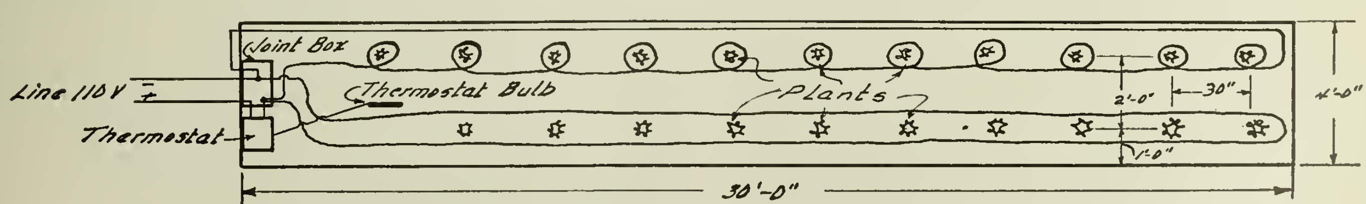


**Fig. 7—Two Methods of Applying Heat to Plants on Greenhouse Bench.**

**By encircling each plant the soil temperature was raised 17 degrees F. near the plant, whereas the lower method raised the soil temperature 10 degrees F. using the same amount of power.**

well to show superiority in size and quality. With average June weather the difference would be more noticeable, and the equipment would have been used for more hours each day.

### Hotbeds

The principal use of soil heating, however, is the electric hotbed. Here electricity replaces manure as a source of heat. In order to give it a fair trial both an experimental installation and a practical farm installation were started last spring. The experimental installation was operated by the Agricultural College, the main object

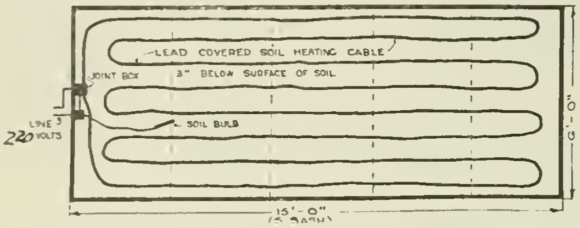


**Fig. 8—Five Sash Hotbed, 120-foot heating cable.**

being to test out a standard electric hotbed under local conditions. The bed was laid out with the recommended heat flux of 100 watts per square yard, which was supplied by 120 feet of lead-covered cable buried 6 inches below the surface of the soil. The temperature was controlled by a soil heating thermostat with the soil bulb also buried in the soil. With the thermostat set at 70 degrees F. no difficulty was experienced in maintaining this temperature in the soil, but it was found that the air temperature fell to as low as 36 degrees even though the lower soil was above 70 degrees. This was mostly due to too heavy a layer of soil above the heating cables, preventing the heat from rising to surface fast enough to replace heat lost through the glass.

Benefiting by this experience an installation of 16 square yards area was installed at the Tomlinson greenhouses. This bed was laid out with a heat flux of 75 watts per square yard supplied by lead-covered cable buried only 3 inches below the surface. In order to further insure against too great variation between soil and air temperatures another 25 watts per square yard heat flux was supplied in the form of 50-watt tungsten lamps suspended from the ribs which supported the sash. It was found that with the heating cables nearer the surface the auxiliary air heating was not necessary, the largest variation between soil and air temperature being 10 degrees. This small difference is not of any consequence and would not warrant

Comparison of Heated Bed and Check Bed Temperatures

| Date | Outside Temp. Degrees Fahr. | Thermostat Setting Degrees Fahr. | Soil Temp. Degrees Fahr. | Air Temp. Degrees Fahr. | Check bed Temp. Degrees Fahr. | Notes |
|---|---|---|---|---|---|---|
| April 12 | | | | | | |
| a.m. | 19 | 70 | 67 | 62 | 24 | Radish showing |
| p.m. | 25 | 70 | 68 | 68 | 37 | (2 days). |
| April 15 | | | | | | |
| a.m. | 27 | 70 | 55 | 62 | 30 | Thermostat not on. |
| p.m. | 45 | 70 | 70 | 72 | 55 | Lights on full time. |
| April 19 | | | | | | |
| a.m. | 30 | 70 | 68 | 67 | 36 | New thermostat put in |
| p.m. | 42 | 70 | 71 | 76 | 50 | service |
| April 23 | | | | | | |
| a.m. | 40 | 65 | 63 | 62 | 46 | Radish showing in check |
| p.m. | 65 | 65 | 70 | 78 | 75 | bed (1½ days). |
| May 1 | | | | | | |
| a.m. | 46 | 65 | 66 | 62 | 60 | Pulled sample of radish, |
| p.m. | 60 | 65 | 75 | 80 | 75 | elec. bed (19 days). |
| May 8 | | | | | | |

Thermostat only on about three hours each night.

special air heating equipment and could be further reduced by placing the heating cables still closer to the surface.

The first crop grown in this bed consisted of radish, spinach and leaf lettuce, which were seeded on April 10th. The radish were fully germinated in three days, thinned out on the seventh day and were harvested between May 9th and May 12th. The manure hotbed, operated as a check bed, took five days to germinate, needed no thinning out, and the first radishes were pulled May 18th.

Between April 15th and April 19th, thermostat trouble caused temperatures in soil to drop too low at night; the lights were switched to a separate circuit so that they could be left on regardless of the thermostat. This supplied sufficient heat to keep out frost while obtaining a new thermostat.

Power Consumption and Cost Data

| | Outside Temp. Degrees Fahr. | Hotbed Temp. Degrees Fahr. | Kw. per day | Kw. per sq. yd. | Hours on (average) |
|---|---|---|---|---|---|
| April 10th to 15th | 27 to 45 | 70 | 20.1 | 1.25 | 12 |
| April 15th to 19th | 26 to 50 | 60 | 5.2 | 0.33 | 24 (lights only) |
| April 19th to 24th | 30 to 60 | 68 | 15.7 | 0.98 | 9.3 |
| April 24th to May 1st | 46 to 65 | 66 | 14.3 | 0.89 | 8.4 |
| May 1st to 8th | 40 to 64 | 64 | 13.1 | 0.85 | 7.7 |
| Average—25 days | 26 to 65 | 66 | 14.85 | 0.93 | 8.7 hours |

In figuring the average, the period from April 15th to 19th was not considered, since the thermostat was out of order.

The total energy used to grow a crop of radish and spinach in twenty-nine days was 392 kw.h. or about 14 kw.h. per day for 16 square yards of bed.

### Improvements from Experience

Every year has seen improvements in the construction of beds, types of elements and their location in the soil, thermostats, and also in the price of power supplied. All have helped to build up an increasing margin of superiority for electric soil heating.

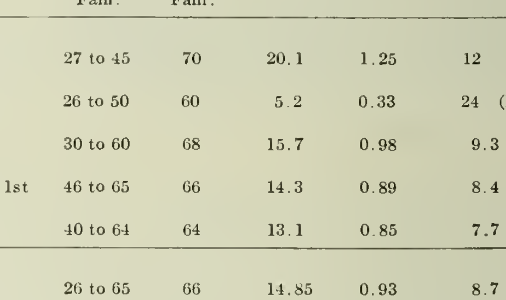


**Fig. 9—Comparison of Temperatures in Unheated Greenhouse Bench, February 10th, 1933.**

There is still considerable argument as to where the element should be placed—deep in the soil, just below the surface, or at the surface.

Repeated tests by the National Project and co-operating growers during the past winter and spring have shown that surface heating is entirely practical in hotbeds and coldframes. By applying the heat directly at the point where it is most needed, power consumption has been reduced and the need for special insulation and laborious or expensive construction obviated. Any hotbed which is well drained, protected from winds, and free from cracks and openings may be made into a satisfactory electric hotbed by laying electric soil heating cable on the soil surface at the time the seeds are planted.

Plants grew in contact with the heating cables without injury. Germination was quicker, plants grew faster, and in the tests reported the plants were sturdy and had larger root systems. Power consumption was considerably reduced during mild weather, and because of the quicker response to falling temperatures there was better protection from frosts and higher night temperatures during periods of cold.

The lead-covered element seems to be reliable, flexible and durable, and its heat flux of 5.7 watts per lineal foot

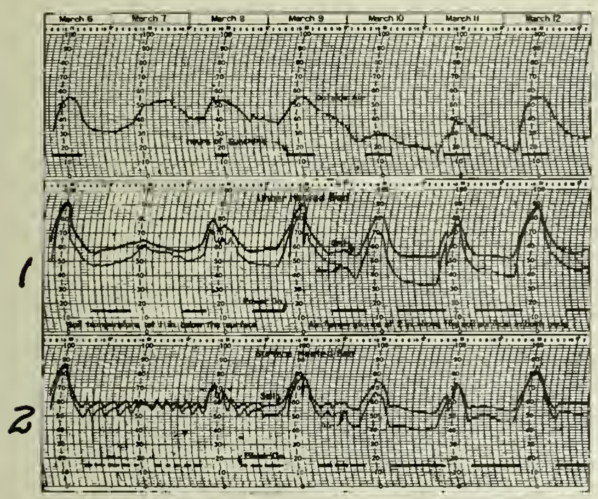


**Fig. 10—Outdoor Soil and Air Temperatures.**
**(1) Underheated Hotbed.**
**(2) Surface Heated Hotbed.**

is ideal where 100 watts per square yard is used. However, with a reduction to 60 to 70 watts per square yard an element of 5 watts per lineal foot would spread the heat better.

One of the methods of saving power in any type of electrically heated hotbed is to cover the beds with mats at night. In an eight day cold weather test burlap bags filled to a thickness of 4 inches with straw resulted in a saving of 33 per cent in the power used in an identical bed without mats. Double glazing of the sash proved to be almost as effective for conserving the heat of the beds. The double glass was effective for twenty-four hours each day whereas the mats could only be used at night.

Persistent inquiry into the matter of thermostats has failed to produce a soil heating thermostat at a price suitable to smaller installations. Capacity and sensitivity could well be sacrificed to keep the thermostat cost down to not more than equal the cost of the equipment it is to control.

Many European installations still use manual control, generally a four-way stove switch giving three different heats on any installation of over 800 watts capacity. While this system has all the inherent disadvantages of manual control, it lends itself admirably to special night rates for power. Power companies in many cases find that they can more profitably supply off peak load at half price rather than install new distribution equipment to supply twenty-four-hour demand. For example, in Norway power can be used between 6 p.m. and 7 a.m. at from 0.4 cents to 0.6 cents per kilowatt hour. A study of our own charts from the newer type of hotbed indicates that 90 per cent of the time the soil heating load automatically confines itself to these hours.

In conclusion it is suggested that the following points require further study, namely:

(1) The proper soil and air temperatures required for various plants and for various stages of plant growth.

(2) The proper electrical capacity to maintain good growing conditions under different weather conditions.

(3) A comparison of manual and thermostatic control under local conditions.

(4) The use of electric light to vary the length of day, in conjunction with electric soil heating.

(5) The best method of selling electric soil heating to the grower.

The electric hotbed is not a luxury—it is an agricultural tool designed to make the work of the grower more pleasant, more efficient and more profitable.

Generally speaking a large installation can be made at a lower cost per bed than a small one, and if one bed can justify itself economically it follows that several should be even more profitable.

There is undoubtedly a splendid field for electric soil heating in Canada. This is evidenced by a summary of operation of electric hotbeds by the Shawinigan Power Company for 1933, which shows twenty-two installations totalling over 2,000 square yards of beds which used 50,000 kw.h. during the early spring season. It is to be hoped that there will be a continuation of the splendid co-operation and interchange of experience amongst all who are engaged in its development.

Note: The author desires to acknowledge the co-operation of Professor F. W. Broderick, Professor of Horticulture at the University of Manitoba, and of Mr. L. M. Cochrane, of the Cochrane-Stephenson Company. Also information and data taken from the following publications:

"Promoting Plant Growth by Electrically Heated Soil" by O. W. Titus of the Canada Wire and Cable Co.

"Profitably Turning Kilowatts into Cucumbers" by W. F. Mainguy, Power Sales Engineer, Shawinigan Water and Power Co., Montreal.

"The Electric Hotbed; Its Construction and Operation" by S. Bowman of the British Columbia Electric Railway Co.

"Electric Hotbeds and Propagating Benches" (Report No. 6-1932) and "Electric Soil Heating" (Report No. 8-1933) by the National Rural Elec. Project of U.S.A. College Park, Maryland.

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## Engineers in the Public Service

Ever since Confederation, Canadians have justly taken pride in the quality of the engineering work carried out by their government departments, and in the professional competence and personal character of the members of the departmental engineering staffs.

Engineering work in the public service, whether Federal or provincial, is necessarily performed under conditions differing materially from those obtaining in the case of private enterprises. The government service presents (or used to present) a greater degree of security of tenure, and there was the prospect of a modest pension or retiring allowance at the end of one's active career. Accordingly, the majority of engineers in government employ have in the past been content with salaries somewhat less than they could have obtained from private employment, and have regarded the stability of their employment as some compensation for their lower pay.

Conditions such as these appeal particularly to the type of man who appreciates freedom from financial uncertainty as enabling him to centre his entire interest on the technical or administrative problems of his special line of engineering work. The government services have, in fact, secured on this basis men of outstanding merit, who have rendered disinterested service to the country, and whose work has won general approval from their professional brethren outside the service.

When a change of government occurs, retrenchment in the civil service is always one of the war cries, and the newly elected legislators are apt to hasten to apply the pruning knife. On these occasions the statement is often made that the civil servant is overpaid and underworked. This is certainly not correct in regard to those holding responsible engineering positions in the professional branches. Persons who have had the most intimate contact with the officials of the engineering branches of government departments and are best able to judge, will be the first to admit this. On the other hand, the layman, who has only the vaguest idea of an engineer's actual duties and responsibilities, is apt to take such a statement as gospel without troubling to make enquiries as to its truth or falsehood, and does not realize the necessity of effective engineering work if public funds are to be used economically.

The engineering departments of our public services are responsible for the economical and efficient expenditures of very large sums of money, and deal with new construction as well as the maintenance of our public works. It is regrettable that their advice as to the economic feasibility of these various projects is seldom asked, and if asked, is even more rarely heeded. The government engineer is too often required merely to carry out instructions from his executive chiefs and proceed with the design and supervision of a given piece of work without being asked to make the necessary preliminary studies as to whether it is economically justifiable. Should the project prove unremunerative or ineffective after completion, the engineer is sometimes blamed for this fact, even although he has had no voice whatever in the decision as to the advisability of the work. In any case, when instructed to proceed with an undertaking, its design and construction receives the same careful and competent attention, whether it involves a hundred millions for a Welland canal, or more modest sums for topographical mapping, or the construction of roads in our national parks. The high reputation borne by Canadian engineers in countries outside Canada is in no small degree due to the achievements of the engineers in the Dominion and provincial government services.

In any organization which carries out engineering work the best results can only be obtained if the staff operates on a basis of harmonious co-operation between the different departments, if its members feel that their positions are reasonably secure, if they are adequately paid, and if their work is appreciated by those to whom they are responsible. Events which tend to break down the morale of the staff and cause apprehension on such points as the above, cannot fail to affect the quality of the work performed.

To deal effectively with his technical problems, which are sufficiently worrying in themselves, the engineer, whether in private work or in government employ, must be able to give his mind entirely to the engineering questions involved, so that he may decide correctly as to the best and most economical methods of doing the work which has been placed in his charge.

Even in times of stress, when the necessity for retrenchment makes changes in staff or reduction in pay unavoidable, he should feel that such measures will not be taken arbitrarily, or without due consideration of his interests. The nature of engineering work is such that in many instances the money saved by dispensing with the services of the more experienced men, is only a fraction of the amount which may be wasted by a single major error in judgment, or wrong decision on a question of construction or maintenance.

The recent course of events in Ontario affecting engineers in the employ of the provincial government, has led to some doubt as to whether such points as those just discussed have received due consideration from the authorities concerned. Recognizing this possibility, the Council of The Institute proposes to bring it to the attention of the Premier of the province, in the hope that such measures will be taken as will reassure the engineers concerned, ensure the continuance of efficiency in the engineering work of the province and promote real economy in the provincial technical departments.

# The President's Visits in the West

It would be ungracious to allow this issue of The Journal to be published without an expression of my appreciation of the hospitality extended to me during my visit to the Western Branches of The Institute.

It is not only the entertainment which these Branches gave to me as your President, that I wish to acknowledge gratefully, but what is even more significant, the sympathetic hearing accorded to my remarks and addresses on the affairs of The Institute.

In Victoria and Vancouver local committees had arranged beforehand for the meetings and the entertainment of those attending the joint convention of the American Society of Civil Engineers and The Engineering Institute of Canada. The successful issue of these arrangements has been recorded elsewhere, but it was gratifying to find that in a crowded programme, these Branches, at informal lunches and in personal conversations, made time for, and gave close attention to, the discussion of the problems facing The Institute.

Reluctantly leaving Vancouver, where Mr. Cleveland and his able committees, both social and technical, had made the meetings so enjoyable, I proceeded to Lethbridge, where the members of that Branch listened to my address at a dinner meeting held at the Marquis hotel on July 20th. The following day the Branch, under the chairmanship of Mr. C. S. Donaldson, invited me to join the members on a motor trip through the Glacier National Park and the Waterton Park. This afforded a unique opportunity of seeing a very beautiful part of the Rocky Mountains of which I find it difficult to adequately express my appreciation and admiration.

Arriving at Calgary on the 22nd, the secretary of that Branch met me, and early next morning the chairman, Mr. G. P. F. Boese, drove me through the principal parts of Calgary. A luncheon meeting was held at which our General Secretary, Mr. Durley, gave an account of The Institute's business affairs. That evening a banquet took place at which I was invited to give an address on Institute problems. The members gave me close and courteous attention and discussed these questions in a way that evidenced the active interest of the Branch in the future wellbeing of The Institute and of the engineering profession. The next day Mr. Patrick took me to see the C.P.R. irrigation works, and other members kindly assisted me in obtaining a view of structural works which were of particular interest.

The next stop was at Regina, where again the Branch officers met my train, drove me around the city, and met me at lunch with several other members, at Colonel Linton's charming home. This afforded a welcome opportunity of discussing Institute affairs and of learning the views of the members of the Branch. After a drive to the Qu'Appelle Valley, a dinner was held in the Saskatchewan hotel, where my address concerning The Institute was most satisfactorily discussed. The next morning I was joined by Mrs. Shearwood who arrived from Vancouver, and the cordial hospitality of Regina was doubled by Mr. L. A. Thornton, who drove us across the prairie to his summer home on Lost Mountain lake. The main points of my address were constantly referred to before I left Regina, and in spite of the intense heat, Colonel Linton and his wife were good enough to take us to our train for Winnipeg, in this way giving me another opportunity of explaining the affairs of The Institute in which he was deeply concerned.

Branch officials also met me on arrival in Winnipeg, where a luncheon meeting of the Branch members had been arranged, and again I sensed the warmth of western hospitality together with keen interest in the progress of The Engineering Institute. A private dinner and informal meeting at the home of the Branch chairman, Major A. J. S. Taunton, also helped to bring about a genial discussion of methods of meeting problems before The Institute, and the result was eminently satisfactory. These affairs were again the topic of conversation when the vice-chairman, Mr. H. M. White, and his wife entertained us on Sunday evening.

On Monday, July 29th, the members of the Winnipeg Executive Committee were good enough to lunch with me at the Hudson Bay Rooms when there was a very evident desire on the part of all members to assure me of their loyalty and of their willingness to further the best interests of the engineering profession. All this seemed a vast amount of time and trouble for our Winnipeg Branch to have given, but their hospitality reached its climax that evening when they entertained Mrs. Shearwood and myself at "The Lower Fort," where the picturesque buildings of the old Hudson Bay Fur Trading Post, surrounded by charming gardens, made a fitting setting for the dinner and entertainment given to us by the friendly members of The Engineering Institute and of the Winnipeg Motor Club.

Reaching Port Arthur at a very early hour on the first of August, I was met and entertained by Mr. J. Antonisen, city engineer. After showing us features of engineering interest in Port Arthur, he took Mrs. Shearwood and myself to view the famous Kakabeka Falls thirty miles away. In the evening I gave the story of The Institute affairs at the Armoury, and also spoke on "Bridge Erection." The problems of The Institute evoked an interesting discussion which lasted until after midnight, and some pointed questions were put to me as to our future policies and ways and means of furthering the interests of The Institute.

Arriving at Sault Ste. Marie by steamer, we were met by several members and their wives, who took charge of Mrs. Shearwood and gave her much enjoyment in a drive along the shores of the lake where dinner was served at sunset. Meantime, I was able to visit the Algoma Steel plant, speaking afterwards at a banquet which the Branch had arranged and at which the members gave me the same close attention which it was my privilege to experience in all the Branches visited. On the next day, the last of my western visits was brought to a close by a long country drive with Mr. and Mrs. J. W. LeB. Ross, and lunch at their home on the Sault canal point, followed by a visit to the hospitable camp of the vice-chairman, Mr. and Mrs. F. Smallwood.

As we waved good-bye to the members of the Sault Ste. Marie Branch who came to the boat to see the last of us, I could not help reflecting that The Engineering Institute has a host of friends in the west who are working actively for its welfare. Each Branch has asked for a copy of my address and suggestions on the present state of Institute affairs, which is a gratifying sign of their interest, since they wish to consider my remarks in detail and send in the result of such consideration to the Council meeting in October. In all the meetings I was impressed with the ready response and the many helpful suggestions made for our future progress.

Every opportunity was given me to appreciate western methods of dealing with important problems, and I feel confident that when these views are placed before Council they will be found of great assistance in framing a procedure which will benefit not only the engineering profession, but all its allied undertakings throughout Canada. Experience leads me to feel that Canada is fortunate in the soundness of its Engineering Institute, and especially in the loyalty, friendship and wish for co-operation of its western members.

F. P. SHEARWOOD,
President.

## OBITUARIES

### James Milne, M.E.I.C.

We regret to record the death at Toronto, Ont., on May 21st, 1934, of James Milne, M.E.I.C., chief mechanical and electrical engineer, Works Department, City of Toronto.

Mr. Milne was born at Aberdeen, Scotland, on January 29th, 1864, and received his early education in that city, serving his apprenticeship in mechanical engineering for five years.

Coming to Canada in 1886, Mr. Milne was for a year draughtsman with R. Gardner and Sons, Montreal, and in 1887-1888 he was with M. D. Barr and Company, the general agents in Canada for the Edison Electric Company, as construction engineer. In 1888-1890 he was a member of the Keegans-Milne Company, electrical engineers and contractors, and was later for a time manager of the Windsor Salt Company. From 1892-1895 Mr. Milne was general superintendent of the Incandescent Light Company at Toronto. He later entered the service of the Department of Works of the City of Toronto, and was associated with several important waterworks extension projects, the latest being the duplicate waterworks system.

Mr. Milne joined The Institute (then the Canadian Society of Civil Engineers) as an Associate Member on December 19th, 1895, and transferred to the class of Member on December 9th, 1897.

### Alexander Milne, A.M.E.I.C.

The membership of The Institute will learn with regret of the death at St. Catharines, Ontario, on August 10th, 1934, of Alexander Milne, A.M.E.I.C.

Mr. Milne was born at Aberdeen, Scotland, on February 19th, 1859, and came to Canada at an early age. For a time he was on the staff of the railway under construction from Toronto to St. Thomas, and later in 1884-1886 was assistant to Mr. J. D. Blaikie, C.E., of St. Thomas, being engaged on surveys and general municipal work. In 1886-1887 Mr. Milne was engaged on the construction of the Aylmer waterworks, and in 1887 was appointed engineer for the town of Aylmer and adjoining townships. In 1900 Mr. Milne became engineer and superintendent of the St. Catharines Waterworks, and in addition to this in 1903-1905 he was engineer to the Waterworks Commission on matters affecting the interests of the city of St. Catharines in relation to the hydraulic works of the Hamilton Cataract Power Light and Traction Company.

During his tenure of office Mr. Milne was responsible for many marked improvements in the waterworks system of St. Catharines, and the betterment of the supply, which is now conceded to be among the best in Canada. Among these improvements was the design, location and construction of a 24-inch main from the reservoir in 1911-1912, the installation of the automatic liquid-chlorine control plant in 1914, and in 1925-1926, the design and construction of the modern filtration plant.

Mr. Milne was a member of the American Waterworks Association, of which he was elected president in 1911, being the first Canadian to hold that office.

Mr. Milne joined The Institute as an Associate Member on October 11th, 1906, and took an active interest in its affairs, being chairman of the Niagara Peninsula Branch in 1927.

## PERSONALS

J. E. Craster, S.E.I.C., is now connected with the Consolidated Mining and Smelting Company in the Warfield plant at Trail, B.C. Mr. Craster graduated from the University of British Columbia in 1930 with the degree of B.A.Sc., and was later for a time on the staff of the Canadian General Electric Company Limited at Peterborough, Ont.

G. E. Humphries, Jr.E.I.C., who was formerly with the Edwards Mine at Lochalsh, Ontario, is now in charge of the Milmac Mines Limited property at Michipicoten River, Ontario.

L. K. Sillcox, M.E.I.C., vice-president of the New York Air Brake Company, New York, N.Y., is chairman of a Mechanical Advisory Committee recently appointed by the Federal Co-ordinator of Transportation, to co-operate with the Section of Transportation Service, Washington, D.C.

Dr. A. Frigon, M.E.I.C., Director General of Technical Education for the Province of Quebec, and Dean of the Ecole Polytechnique, Montreal, is a member of a commission appointed by the Quebec government to enquire into the electricity situation from every angle.

W. M. Murray, S.E.I.C., who graduated from McGill University in 1932 with the degree of B.Eng., has been awarded a scholarship at the Massachusetts Institute of Technology entitling him to a further year's postgraduate study at that institution. Mr. Murray is specializing in mechanical engineering.

J. C. H. Jette, A.M.E.I.C., has joined the staff of the Consolidated Paper Corporation Limited, at Port Alfred, Que. Mr. Jette was at one time field engineer for the Canada Power and Paper Company at Cap de la Madeleine, Que., and was latterly with the Page Equipment and Construction Company at Three Rivers, Que.

A. U. Sanderson, A.M.E.I.C., has been appointed engineer of the Water Supply Section, Department of Works of the City of Toronto. Mr. Sanderson graduated from the University of Toronto in 1909 with the degree of B.A.Sc. and following this he became assistant engineer with the Canadian Pacific Railway Company. In 1910 he joined the staff of the Toronto slow sand filtration plant as assistant engineer, and from 1911 to 1913 Mr. Sanderson was assistant and resident engineer on design and construction for the Department of Works, Toronto. From 1914 to 1917 he was resident engineer on the construction of a drifting sand filtration plant for the Department of Works, Toronto, and in 1918 he became superintendent of the filtration plant. In 1929 Mr. Sanderson was appointed assistant mechanical and electrical engineer with the Water Supply Section, Department of Works, Toronto.

H. E. Mott, A.M.E.I.C., is president and general manager of the newly-formed company of H. E. Mott Company Limited, of Brantford, Ontario, which has purchased the assets of the Goold, Shapley and Muir Company Limited pertaining to the tower, wood tank and textile machinery part of their business.

Mr. Mott graduated from McGill University in 1922, with the degree of B.Sc., and following graduation joined the staff of the Canadian Marconi Company as test engineer. Later, he became engineer in charge of the test room and in May, 1923, he was appointed superintendent of works. In October, 1923, Mr. Mott became works engineer which position he retained until 1927, when he joined the De-Forest Radio Corporation Limited at Toronto as chief engineer. In 1928 Mr. Mott was chief engineer of the Standard Radio Manufacturing Corporation Limited, and in 1929 he became manager, engineering and production, and chief engineer of the Rogers Majestic Corporation, Toronto, successors to Standard Radio Manufacturing Corporation. More recently Mr. Mott has been engaged on consulting work in England and the United States for an American group.

During the War, Mr. Mott served in the Royal Air Force from 1916 until 1919, being retired with the rank of Captain.

# RECENT ADDITIONS TO THE LIBRARY

### Proceedings, Transactions, etc.

Institution of Civil Engineers: Proceedings 1932-1933.
New Zealand Society of Civil Engineers: Proceedings 1933-1934, Vol. 20.
Cleveland Institution of Engineers: Proceedings 1933-1934.

### Reports, etc.

*Canada, Department of Mines, Geological Survey:*
Economic Geology Series No. 13—Platinum and allied metal deposits of Canada.
Memoir 172—Geology and Mineral Deposits of Salmo Map Area, British Columbia.
Summary Report 1933—Parts B and D.
*Financial Federation:*
Welfare Work in Montreal in 1933.
*Hydro-Electric Power Commission of Ontario:*
Annual Report 1933.
*International Tin Research and Development Council:*
The Corrosion of Tin and its Alloys, Part 1, by T. P. Hoar.
The Electrochemical Behaviour of the Tin-Iron Couple in Dilute Acid Media, by T. P. Hoar.
*Institution of Civil Engineers:*
List of Members 1934.
*Institution of Municipal and County Engineers:*
Handbook 1934-1935.

### Technical Books, etc., Received

Air Conditioning Planned and Proved, by Clyde R. Place, New York.
Federal Emergency Relief Administration: Engineering Manual for Traffic Surveys.

# BOOK REVIEW

## Tables of Integrals and Other Mathematical Data

*By Herbert Bristol Dwight, The MacMillan Company, New York, 1934. 5¾ by 8¾ inches, 220 pages, $1.65, cloth.*

Reviewed by PROFESSOR N. B. MACLEAN*

The author has presented herein a very complete collection of mathematical formulae supplemented by the addition of sets of tables of numerical values and of useful references. As a result, the book should be of great service as a ready reference, not only to the practical engineer, but also to the mathematician.

The major portion of the book (pages 1 to 182 inclusive) is devoted to the presentation of the main formulae connected with series, integrals and trigonometric, exponential, logarithmic, hyperbolic, elliptic and Bessel functions and surface zonal harmonics. This section concludes with a brief summary of the more simple standard forms of ordinary differential equations. The few diagrams, tables, and explanatory notes are well-chosen, and, while not extensive, add to the value of the whole.

The Appendix contains tables of numerical values and references. The tables include numerical values of $\sqrt{(a^2+b^2)}/a$, trigonometric data, brief sets of common and natural logarithms, exponential and hyperbolic functions, elliptic integrals of the first and second kind, and Bessel functions, and concludes with a brief set of the more common mathematical constants and the Greek alphabet. In many respects this section comprises a great portion of the value of the whole book.

The references are sufficiently extensive to satisfy at least the practical engineer.

The author and publishers are to be congratulated upon the form and convenience of the book, and upon the clarity of the type.

* *Professor of Applied Mathematics, McGill University.*

# BULLETINS

*Diesel Engines*—The Worthington Pump and Machinery Corporation, Harrison, N.J., have issued an 8-page bulletin containing particulars regarding their vertical four-cycle, direct injection Diesel engines, describing types B, C, D and E. The full line covers power requirements from 25 to 600 h.p. The field for these engines includes those of the prime mover, stationary, marine, semi-portable or portable types.

*Stainless Clad Steel*—A 20-page booklet received from the Ingersoll Steel and Disc Company, Chicago, Ill., contains particulars of the fabrication of stainless clad steel. It is entitled "Manual of Welding and Fabricating Procedures for IngAclad Stainless Clad Steel" and contains diagrams to guide the fabricator in working with the material.

*Centrifugal Pumps*—A 6-page bulletin issued by the Worthington Pump and Machinery Corporation, Harrison, N.J., contains particulars of Types C, CA and CB centrifugal pumps. The bulletin contains tables of capacities, speeds and horsepower motor driven and belt driven types of pumps with heads varying from 10 to 80 feet.

# The Value of Engineering Supervision of Oxy-Acetylene Welding and Cutting

*D. S. Lloyd, A.M.E.I.C.,*
*Service Engineer, Dominion Oxygen Company Limited, Toronto, Ont.*

**Paper presented before the Sault Ste. Marie Branch of The Engineering Institute of Canada, May 25th, 1834.**

Engineers who have anything to do with metals know that the oxy-acetylene flame can be used for joining metals and for severing most of the ferrous alloys. The principles involved are fairly simple and have been generally quite well understood by technically trained men. The actual practice of doing the work, however, was looked on by the engineer as a craft somewhat similar to blacksmithing, and he took it for granted that a good workman could be relied upon to indicate the practicability of doing any particular job where these processes might be employed. There are several major factors which make it desirable for the modern engineer to inquire more particularly into his responsibility on work of this kind.

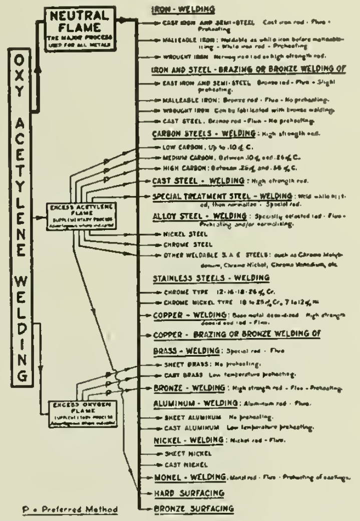


**Fig. 1 Chart of Weldability of Metals by Oxy-Acetylene Process.**

(*a*) The almost innumerable metals and alloys which can be satisfactorily joined by welding—an understanding of the characteristics of all of these being entirely beyond the average workman.

(*b*) The increasing use of corrosion and wear-resisting metals and alloys and the obvious impracticability of expecting the welder to have any accurate knowledge of corrosion problems.

(*c*) The influence of welding and cutting practices on the limits in design.

(*d*) The possibilities of effecting economies in labour and materials through the use of equipment and procedures which will speed up the work.

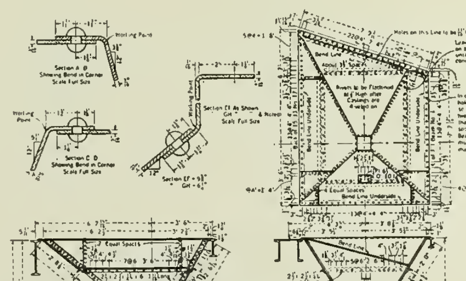

**Fig. 2—Drawing for Riveted Skew Hopper.**

### AVAILABILITY OF TECHNICAL DATA

Ten or fifteen years ago little published data on welding and cutting was available except instruction manuals and sales literature of companies selling the materials. The work of technical societies and the very widespread adoption of these processes for fabricating metals in many industries, has considerably changed this picture.

References are given in this paper to some of the more recent publications which are available to the engineer for detailed study of the various applications of the process.

### Weldability of Various Metals by the Oxy-acetylene Process

The 1933 report of the Oxy-Acetylene Committee(1) of the International Acetylene Association contains a chart of welding applications which should be very interesting to the engineer. It will be noted that a list of metals and alloys is given together with reference to basic information about the procedures for welding, such as the type of flame, whether or not preheating is necessary, the type of welding rod to be used, and whether flux should be used. (Fig. 1.)

The study of such data by the engineer is essential for the most efficient use of the process in any plant, to supplement the knowledge of the practical man. For example, consider the welding of copper. Welds made in good commercial copper using an ordinary copper welding rod of the same composition have low tensile strength and poor ductility due to the impairment of strength in the base metal by the separation of cuprous oxide. Bronze welding may be used and is the most practical way to make a satisfactory joint in commercial copper where good strength and ductility are desired. However, deoxidized copper is available and it is possible by its use to secure strength in the joint of 30,000 to 35,000 pounds per square inch.

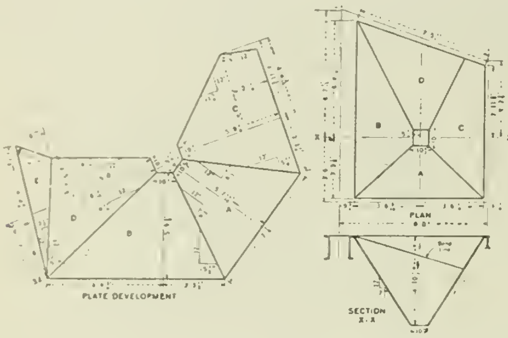

Fig. 3—Drawing for Riveted Skew Hopper Welded.

The average welder is totally incapable of working out the economies of using the more expensive material or judging the practicability of designing so that bronze welding can be used. A study of such factors by the engineer on either repair or production work will in almost every instance result in satisfactory procedures for welding this metal on the particular work at hand.

To ask a welder to work on stainless steel without the engineer having made a study of the weldability of the material is inviting trouble.(2) The chromium steels may be divided generally into several classes from a weldability standpoint. Some are easy to weld, others more difficult. Some need heat treatment after welding, while in other cases this is not required. Not only does the composition have an effect on the weldability but the procedure will affect the qualities of the finished joint. The place of the engineer in analyzing the use of such materials and methods of fabrication is obvious, if, as is usually the case, the most highly efficient joint is required. A careful study of the new nickel alloys and other corrosion resisting metals is required if satisfactory joints are to be obtained. Welding is accepted as the preferred method for jointing these materials but again the engineer must assist the practical man if the finished work is to give satisfactory service under unusual conditions.

Fig. 4—Fuel Regulator Header and Assembly of Separator and Drip.

### Influence of Welding on Design

Designing is naturally the field of the engineer. Whether it be the designing of a complicated chassis for a radio set—where space is at a premium and electrical conductivity problems are all important—or the laying out of a stand for a steel rolling mill—where strength and durability are important—a knowledge of welding is essential today if the lowest production costs and best products are to be obtained. Such design problems are of a specialized nature and do not come within the province of the plant engineer of the average industrial organization.

However, every engineer, whether he be in a textile or paper mill, oil refinery or box factory, has occasion from time to time to lay out rough designs for auxiliary equipment for special work in his particular plant. Perhaps it may be a special pedestal for a motor, or a short pipe line. Again it may be a hopper similar to the one illustrated. Such a piece of equipment is almost always special both in shape and dimensions. The economies in using welded construction start at the draughting board and the finished cost is almost invariably lower if the engineer who plans the use of this equipment has a good general knowledge of the use of welding and cutting.

Layouts for special headers in piping systems(3) as in Fig. 4 again show the simplicity of welded construction. It might be said that the use of welding in design leads invariably towards simplicity. Imagine how much more complicated this construction would be if cast fittings and flanges were used.

The assistance of the engineer is also demanded in the making of templates for pipe cutting preparatory to welding. Although tables(4) for marking out the pattern for making the most common joints are usually available to the pipe welder, complicated specials require engineering assistance in the laying out. Figure 5 shows(5) the template for cutting pipe to make a swage and is a simple piece of descriptive geometry to the engineer. A workman can spend much valuable time trying to lay out such work alone by his own methods where the help and guidance of the engineer in providing proper patterns will greatly speed up the work to say nothing of making the finished job more accurate.

### New Equipment and Procedures

The continuous advances which are being made in the procedures for using the oxy-acetylene flame for both welding and cutting, make it difficult for the practical man to keep up with progress in these processes. A welder who received his preliminary training a dozen years ago, for instance, was probably told that the way to repair a crack in the back of a large cast iron press frame as shown in the illustration, would be by welding with a cast iron filler rod after preheating very carefully. It is doubtful if such a method of repair would be practical on this frame due to the difficulties in maintaining alignment, cost of keeping the whole joint at a red heat during welding and the extra labour required because of the tremendous heat given off. The bronze welding of cast iron has changed the economics of such a repair considerably.(6) Many old time welders do not realize the progress which has been made in the development of new alloy rods for bronze welding. These are also satisfactory for making joints in steel with strengths as high as 55,000 pounds per square inch. Welders not familiar with the progress in this field do not realize that the use of oxidizing flames in this type of work gives greater strength in the bond between the bronze and base metal. It is the place of the engineer to see that the practical man is aware of these changes and that he knows about these new materials and procedures, if the best work is to be done and greatest economies effected.

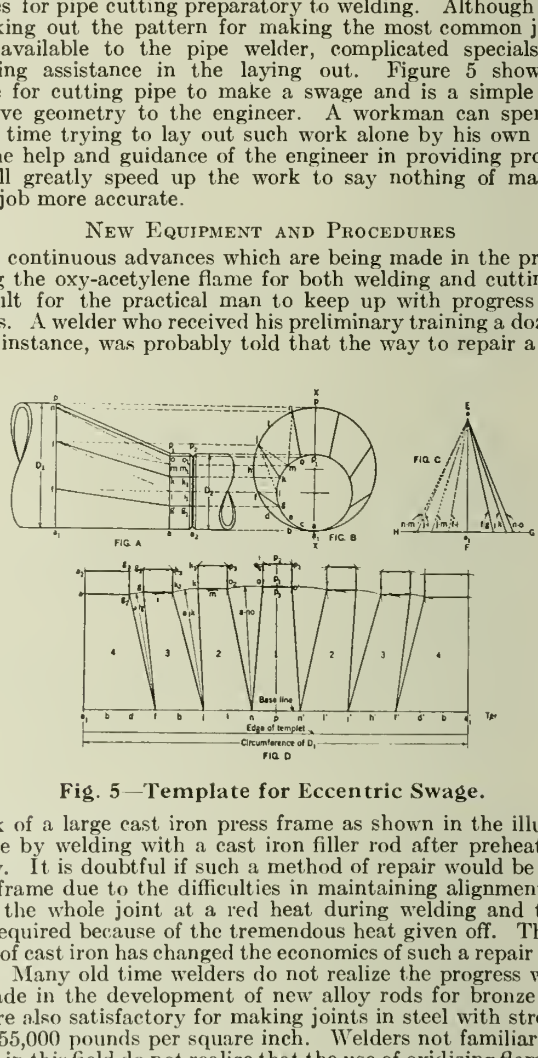

Fig. 5—Template for Eccentric Swage.

Again, the development of a new and faster method of welding steel and the use of semi-automatic blowpipes is of great interest to the engineer. The use of a special technique and new type of welding rod must be explained to the welder if the greatest economy is to be obtained.

The interest and attention of the engineer as well as the practical man is also desirable and necessary in the application of the process to the hard-surfacing of metal parts.(7) Non-ferrous metal coatings may be applied as welding rods for wear resistance but these require in many instances special methods of application if the most satisfactory results are to be obtained.

The development of machines for guiding and controlling blowpipes for oxy-acetylene cutting has progressed rapidly in the past few years and warrants the careful study of engineers in any plant where steel plate or structural steel work is done. Some of these machines are capable of making flame cuts with a flexibility equivalent to woodworking with a jig-saw and of such high quality and accuracy that for many purposes no finishing is required.

The cutability of various steels is another subject of interest to the engineer. Modified procedures(1) have been developed for the severing of cast iron and most alloy steels which in some cases differ radically

(1) etc.—See references page 423

from the technique usually used by an operator. To secure proper results the workmen must be trained in these new methods and it devolves upon the engineer to interpret this information for them.

Until the past few years, the oxy-acetylene cutting process has been used primarily as a severing tool. Ordinary cutting is done with the blowpipe, usually in a plane at 90 degrees to the surface of the part cut. If the blowpipe is held almost tangential to the surface of the metal, and special nozzles are used, grooves up to 2 inches in width and ⅜ inch or more in depth can be cut from the surface at speeds from 15 to 30 feet per minute. The rate of tangential cutting varies but in some cases can be as high as 1,000 pounds per hour with a single jet.

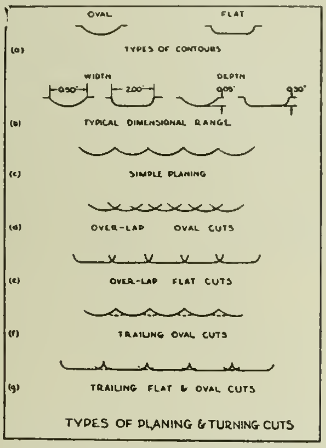


**Fig. 6—Types of Planing and Turning Cuts Produced by Flame Machining.**

This is usually called flame machining and the possibilities of this process for the preparation and shaping of carbon steels in place of using tools seems to be limited only by the degree of precision obtainable commercially by the flame machining nozzle. Figure 6 shows some of the types of planing and turning cuts which can be made by flame machining.

This principle has been in use for deseaming steel billets and cleaning up cracks and sand holes in castings for some time, and is now being used for veeing thick plates preparatory to welding.

This new process naturally interests the engineer in view of the considerable economies which may be possible in the shaping of metal parts.

### Testing Welds and Welders

No paper on this subject would be complete without reference to the place of the engineer in the testing and qualification of welders. The experience of the users of welding has indicated that by proper procedure control, the human element can be readily controlled in welding practice and at the same time economies in the use of the process can be effected.

### TYPES OF TEST FOR WELDS

Qualification—
*Quantitative:* Tensile test.
Reduced-section weld metal test.
All-weld metal tensile test.
Specific gravity test.
Free bend test.
*Qualitative:* Forward bend test.
Reverse bend and fracture test.
Nick-break test.
Leak-proof (bomb) test.
Observation test.
Non-Destructive—Hydrostatic pressure tests.
Air pressure tests.
Reheating welds.
Stethoscope tests.
X-ray test.
Gamma ray test.
Magnetic test.
Electrical resistance.
Special— Fatigue test.
Izod test.
Hardness tests—
Brinnell.
Soleroscope.
Rockwell.
Lay-out test.
Compression and drift tests.

Fusion welding has now reached such a stage of development that the most complicated and important vessels may be fabricated by this process when proper methods of qualification and testing are employed. The American Society of Mechanical Engineers Code(8) allows the welding of practically any type of pressure vessel and specifies the procedures by which the quality of the work will be definitely assured. The accompanying chart shows some of the various tests which are used to insure the highest quality of joints and the greatest economy in the use of welding. The application of such tests is necessarily an engineering function in the production of metal parts and equipment.

The modern engineer, whether he be a designer, fabricator or user of metal products, will do well to study the wide applications of welding and cutting processes and to know, by testing the ability of his workmen, their qualifications for applying the process, so that he can render the proper engineering assistance in the using of these processes most effectively.

### REFERENCES

(1) Annual Report (1933) of The Oxy-Acetylene Committee, International Acetylene Association, 30 E. 42nd St., New York.
(2) "Gas Welding of High-Chromium Corrosion Resistant Alloys," by W. B. Miller. Proc. A.S.T.M., Vol. 28, Part II 1928 (reprinted).
(3) "Design Standards for Oxwelded Steel and Wrought Iron Piping." Dominion Oxygen Company Limited Limited, 92 Adelaide St. W., Toronto.
(4) "Standard Manual on Pipe Welding" of the Heating and Piping Contractors National Association, New York.
(5) "Fabrication of Welded Piping Designs." Dominion Oxygen Co. Ltd., Toronto.
(6) "Progress of Bronze Welding" and "Principles of Bronze Welding," Dominion Oxygen Co. Ltd., Toronto.
(7) Chart "Rebuilding Worn Parts," May-June 1934 issue of Dominion Oxwelding Tips. Dominion Oxygen Co. Ltd., Toronto.
(8) "Rules for Construction of Unfired Pressure Vessels—A.S.M.E. Boiler Construction Code." American Society Mechanical Engineers, 29 W. 39th St., New York.
(9) "Destructive and Non-Destructive Tests," by J. R. Dawson and A. B. Kinzel—Nov. 13, 1929, 30th Annual Convention, International Acetylene Association, 30 E. 42nd St., New York (reprinted).
Supplemental—"The Oxwelder's Manual," Dominion Oxygen Company Limited, Toronto. "Journal of the American Welding Society," 33 W. 39th St., New York. "The Welding Engineer," 608 S. Dearborn St., Chicago. "Welding," Steel Publications Inc., 108 Smithfield St., Pittsburgh, Pa.

## The Electrochemical Behaviour of Tinplate and the Corrosion of Tin and its Alloys

With the aim of overcoming the corrosion of tinplate the importance of investigating the electrochemical relations of tin and iron in different liquid media has long been recognized, but interpretation of the work done in the past has been rendered difficult by the peculiar reversal of potential which occurs under certain conditions. Thus, tin is sometimes anodic and sometimes cathodic to iron.

The mechanism of these changes is more clearly understood as a result of recently published research carried out on behalf of the International Tin Research and Development Council by Dr. T. P. Hoar at Cambridge University. The work described has a direct bearing on the corrosion of tinplate cans by fruit juices, etc., and indicates promising lines for future work aiming at reducing the corrosion of tinplate.

The corrosion of tin and pewter has also been studied by the same investigator and his results are described in a paper recently presented to the Institute of Metals.

Samples of tin and of various pewter alloys have been tested by two different methods. The ability of the materials to produce a protective surface film, and thus to resist the commencement of attack has been determined by means of time-potential measurements. The loss of weight of specimens immersed in various tap waters and dilute acids has also been determined.

The results of these tests give useful information regarding the effect of the composition of the alloy on resistance to corrosion, and also illustrate the different types of attack produced by the several liquids investigated.

Copies of the above papers may be obtained from the International Tin Research and Development Council, 378 Strand, London, W.C. 2, England, or from L. J. Tavener, United States representative, 149 Broadway, New York, N.Y.

## Analysis of Continuous Frames

A revised edition of a 73-page booklet entitled "Analysis of Continuous Frames," by Earle B. Russell, has been published at a price of $1.25 by Ellison and Russell, consulting structural engineers, Pacific Building, San Francisco, Calif. The method employed is stated to be original with the author and to be a practical method which can be used in an engineering office.

The book treats frames for both vertical and transverse loads, and for members with uniform or variable moments of inertia. Tables are presented for members with variable moments of inertia which appear quite complete. These tables may be used directly in the Hardy Cross method. Various types of problems are worked out in detail.

There is also included a well prepared set of tables for continuous beams of variable spans with different combinations of loaded spans.

## Canadian Institute of Mining and Metallurgy

The Annual Western Meeting of the Canadian Institute of Mining and Metallurgy will be held in Calgary, Alta., on September 13th, 14th and 15th, 1934, with headquarters at the Paliser Hotel.

# BRANCH NEWS

## Calgary Branch

*J. Dow, M.E.I.C., Secretary-Treasurer.*
*H. W. Tooker, A.M.E.I.C., Branch News Editor.*

Forty-five members of the Calgary Branch of The Institute met at dinner at the Renfrew Club on July 22nd, 1934, to honour President F. P. Shearwood, M.E.I.C.

In introducing Mr. Shearwood, G. P. F. Boese, A.M.E.I.C., the Branch chairman, referred to the President's achievements as a bridge engineer in Canada, mentioning that he had been actively engaged in bridge construction with the Dominion Bridge Company, of which he is now chief engineer, for many years. During this period he had designed and supervised the building of bridges from coast to coast. In addition to his bridge building activities, Mr. Shearwood is an enthusiastic yachtsman and yacht designer.

### Institute Affairs

In addressing the Branch on the affairs of The Institute, Mr. Shearwood discussed many topics of interest to the engineers, touching on the subjects of membership, finance, unemployment and other problems which face the organization at this time.

### Bridge Building

Later in the evening Mr. Shearwood gave an illustrated lecture on bridge building which was followed with deep interest by those present. He pointed out through the medium of lantern slides the difficulties under which bridge construction is done, emphasizing the need of care in the erection of steelwork.

R. S. Trowsdale, A.M.E.I.C., expressed the appreciation of the Branch at having had the privilege of meeting the President and of hearing him, and went on to ask that men who had firms of their own give due consideration to the graduate just out of university, stating that he thought it was the responsibility of every company to take an interest in the young men who would soon guide the engineering destinies of the country.

## Halifax Branch

*R. R. Murray, A.M.E.I.C., Secretary-Treasurer.*
*C. Scrymgeour, A.M.E.I.C., Branch News Editor.*

The August meeting of the Halifax Branch took the form of a picnic, which was held at "Green Acres," Waverley, some sixty couples attending.

Unfortunately weather conditions were not favourable for the carrying out of a complete programme, which had been arranged by R. L. Dunsmore, A.M.E.I.C., chairman, and R. R. Murray, A.M.E.I.C., secretary. However, in spite of the weather the attendance was very gratifying to the sponsors and showed keen interest in the affairs of the local Branch, particularly when an effort had been made to provide a meeting in which the ladies could take part.

After dinner the evening was spent in the playing of cards and dancing.

## Lethbridge Branch

*E. A. Lawrence, S.E.I.C., Secretary-Treasurer.*
*A. Meldrum, A.M.E.I.C., Branch News Editor.*

F. P. Shearwood, M.E.I.C., President, The Engineering Institute of Canada, and chief engineer, Dominion Bridge Company, Ltd., Montreal, was the speaker at a special meeting of the Lethbridge Branch of the Institute on Friday evening held in the Marquis hotel, with C. S. Donaldson, A.M.E.I.C., in the chair.

### Bridge Erection

The speaker was introduced by the local councillor, C. S. Clendening, A.M.E.I.C. Mr. Shearwood spoke first on "Bridge Erection," which subject was illustrated with lantern slides, the projector being operated through the courtesy of C. M. Watson. Following this address, he enlightened the members present on matters which were being discussed at Headquarters and invited suggestions for discussion by the Council.

Bridge designing, said Mr. Shearwood, is a most interesting occupation, the most fascinating part of bridge work being the erection and structures. It is fascinating on account of the dangers and unforeseen conditions which may arise. The meeting of these conditions and their surmounting is what requires the long experience of the bridge builders. In the early days of bridge engineering, erection of bridges was what one might call more of a skilled art and science on the part of an old erection foreman.

In present day bridge building, complete plans are made showing the method of erection, and strains and stresses are worked out in minute detail. Forty years ago, practically all steel bridge erection was done on falsework. Nowadays, spans are frequently run out on top of previous spans and lowered into position by derricks.

Slides of more recent bridges, such as the new bridge over the St. Lawrence river, showed that engineers were combining æsthetics with utility, thus beautifying the country.

Following the slides, several questions on bridge construction were ably answered by Mr. Shearwood, after which he proceeded with his address on "Institute Affairs."

### Institute Affairs

Mr. Shearwood pointed out in his talk on this subject that he was trying to discover the views of the members rather than impress his ideas upon them. In regard to work at Headquarters, the speaker said it was hard to realize what has to be done until one comes in contact with it. The preparation of The Journal and other publications, keeping track of technical conditions, as well as ordinary business, takes up the full time of a steady staff. Mr. Shearwood made the suggestion that the numerous branches in The Institute might be provided with provincial headquarters with competent office staffs in charge so that these could work in closer contact with the branches and relay any suggestions and desires on to Headquarters.

In connection with The Engineering Journal, the speaker thought that discussions would add to the interest of any engineering subjects. The qualifications for membership was another point brought up and in connection with this the speaker remarked that the objective of The Institute should not be forgotten. The first objective is to protect the public from incompetent services, the second, the advancement of the profession by the interchange of knowledge and experience.

This outlines some of the questions that are being discussed, and others, no doubt, will come up as time goes on. Local members gave Mr. Shearwood some suggestions which they considered would be to the betterment of The Institute, particularly those relating to Institute membership and an improved basis of financing The Institute branches.

At the close of the evening, G. N. Houston, M.E.I.C., moved a vote of thanks to the speaker, and arrangements were made by a party of the local members to take Mr. Shearwood on a tour through Glacier and Waterton National Parks on Saturday and Sunday.

## Quebec Branch

*Jules Joyal, A.M.E.I.C., Secretary-Treasurer.*

### Assemblee Annuelle

L'Assemblée Annuelle de la Section de Québec fut tenue au Palais Montcalm le 14 mai dernier, à 8 heures du soir.

Le fauteuil présidentiel était occupé par M. Alex. Larivière, M.E.I.C., vice-président de la Section, qui s'est acquitté de cette fonction avec toute la dignité et la maîtrise d'un Commissaire.

Dès l'ouverture de la séance, MM. W. R. Caron, A.M.E.I.C., et P. W. Doddridge, S.E.I.C., furent choisis comme scrutateurs et se mirent immédiatement à dépouiller les bulletins de votation: les minutes de l'assemblée annuelle précédente furent lues puis les rapports du Conseil et du Trésorier pour l'année 1933-34 furent présentés à l'auditoire. Le tout fut approuvé sur motion.

M. Larivière, président du Comité local de Chômage, donne ensuite un rapport verbal des activités de ce comité et communique à l'assemblée une résolution de la Section de Winnipeg et deux lettres adressées à l'Honorable Premier Ministre du Canada, l'une pour la Section de Winnipeg, l'autre par le président de l'Institut, le tout demandant au Gouvernement Fédéral d'employer immédiatement des ingénieurs pour étudier les aspects techniques des projets de travaux publics que l'on propose d'entreprendre pour remédier au chômage; l'Assemblée approuve l'action prise par le Président de l'Institut en l'occurrence.

Les scrutateurs soumettent leur rapport et le président proclame les officiers élus pour 1934-35.

L'on procéda ensuite au choix des membres des divers comités: Législation, Nomination, Excursions, Chômage et Bibliothèque; puis M. Ivan Vallée, A.M.E.I.C., propose un vote de remerciements aux officiers sortant de charge et un vote de félicitations aux nouveaux élus; M. W. S. Buchanan, A.M.E.I.C., seconde cette proposition qui est adoptée.

Comme le président sortant de charge, M. Hector Cimon, avait été forcé de s'absenter pour des motifs urgents, il avait prévu le cas d'une réélection possible et dans une lettre qu'il avait adressée à M. Larivière il disait que si le résultat du scrutin confirmait la décision du Comité de Nomination et qu'il était de nouveau élu président, il remerciait bien sincèrement tous les membres de la section pour la confiance qu'ils mettent en lui, il remerciait aussi ses collaborateurs de l'année écoulée et assurait tous les membres de son entier dévouement pour le plus grand bien de chacun de nos membres, de notre section et de l'Institut en général.

## U.S. Consulting Engineers Oppose Code

In a resolution transmitted to Hugh S. Johnson, Administrator, National Recovery Administration, The Institute of Consulting Engineers has gone on record as being opposed to a code for the proposed engineers' division of the construction industry and as favouring amending Chapter I of the Code of Fair Competition for the Construction Industry, so as to exclude designing from the work covered by the code's definition of the construction industry.

A large majority of the members of the Institute of Consulting Engineers are also members of the American Society of Civil Engineers, the organization submitting the code for the professional engineers' division of the construction industry now before the NRA, and The Institute has been represented on the A.S.C.E. code work and approved the draft of a code submitted in revised form. Its present change of view is the result of a questionnaire recently submitted to its members.

The council believes that the American Institute of Consulting Engineers is more fairly representative of the engineers who are intended to be bound by the code under consideration than is the American Society of Civil Engineers, and feels that the purposes of the NRA would not be furthered in any way by the coding of engineers but that this coding might on the contrary have an adverse effect on general recovery.

# Preliminary Notice

## of Applications for Admission and for Transfer

August 28th, 1934

The By-laws provide that the Council of The Institute shall approve, classify and elect candidates to membership and transfer from one grade of membership to a higher.

It is also provided that there shall be issued to all corporate members a list of the new applicants for admission and for transfer, containing a concise statement of the record of each applicant and the names of his references.

In order that the Council may determine justly the eligibility of each candidate, every member is asked to read carefully the list submitted herewith and to report promptly to the Secretary any facts which may affect the classification and selection of any of the candidates. In cases where the professional career of an applicant is known to any member, such member is specially invited to make a definite recommendation as to the proper classification of the candidate.*

If to your knowledge facts exist which are derogatory to the personal reputation of any applicant, they should be promptly communicated.

**Communications relating to applicants are considered by the Council as strictly confidential.**

The Council will consider the applications herein described in October, 1934.

R. J. Durley, Secretary.

* The professional requirements are as follows:—

**A Member** shall be at least thirty-five years of age, and shall have been engaged in some branch of engineering for at least twelve years, which period may include apprenticeship or pupilage in a qualified engineer's office, or a term of instruction in a school of engineering recognized by the Council. The term of twelve years may, at the discretion of the Council, be reduced to ten years in the case of a candidate for election who has graduated from a school of engineering recognized by the Council. In every case the candidate shall have held a position in which he had responsible charge for at least five years as an engineer qualified to design, direct or report on engineering projects. The occupancy of a chair as a professor in a faculty of applied science of engineering, after the candidate has attained the age of thirty years, shal be considered as responsible charge.

**An Associate Member** shall be at least twenty-seven years of age, and shall have been engaged in some branch of engineering for at least six years, which period may include apprenticeship or pupilage in a qualified engineer's office or a term of instruction in a school of engineering recognized by the Council. In every case a candidate for election shall have held a position of professional responsibility, in charge of work as principal or assistant, for at least two years. The occupancy of a chair as an assistant professor or associate professor in a faculty of applied science of engineering, after the candidate has attained the age of twenty-seven years, shall be considered as professional responsibility.

Every candidate who has not graduated from a school of engineering recognized by the Council shall be required to pass an examination before a board of examiners appointed by the Council. The candidate shall be examined on the theory and practice of engineering, with special reference to the branch of engineering in which he has been engaged, as set forth in Schedule C of the Rules and Regulations relating to Examinations for Admission. He must also pass the examinations specified in Sections 9 and 10, if not already passed, or else present evidence satisfactory to the examiners that he has attained an equivalent standard. Any or all of these examinations may be waived at the discretion of the Council if the candidate has held a position of professional responsibility for five or more years.

**A Junior** shall be at least twenty-one years of age, and shall have been engaged in some branch of engineering for at least four years. This period may be reduced to one year at the discretion of the Council if the candidate for election has graduated from a school of engineering recognized by the Council. He shall not remain in the class of Junior after he has attained the age of thirty-three years, unless in the opinion of Council special circumstances warrant the extension of this age limit.

Every candidate who has not graduated from a school of engineering recognized by the Council, or has not passed the examinations of the third year in such a course, shall be required to pass an examination in engineering science as set forth in Schedule B of the Rules and Regulations relating to Examinations for Admission. He must also pass the examinations specified in Section 10, if not already passed, or else present evidence satisfactory to the examiners that he has attained an equivalent standard.

**A Student** shall be at least seventeen years of age, and shall present a certificate of having passed an examination equivalent to the final examination of a high school, or the matriculation of an arts or science course in a school of engineering recognized by the Council.

He shall either be pursuing a course of instruction in a school of engineering recognized by the Council, in which case he shall not remain in the class of Student for more than two years after graduation; or he shall be receiving a practical training in the profession, in which case he shall pass an examination in such of the subjects set forth in Schedule A of the Rules and Regulations relating to Examinations for Admission as were not included in the high school or matriculation examination which he has already passed; he shall not remain in the class of Student after he has attained the age of twenty-seven years, unless in the opinion of Council special circumstances warrant the extension of this age limit.

**An Affiliate** shall be one who is not an engineer by profession but whose pursuits, scientific attainments or practical experience qualify him to co-operate with engineers in the advancement of professional knowledge.

The fact that candidates give the names of certain members as reference does not necessarily mean that their applications are endorsed by such members.

### FOR ADMISSION

BLAIR—DONALD, of 173 Daly Ave., Ottawa, Ont., Born at Fredericton, N.B., Oct. 14th, 1887; Educ., 1908-10, McGill Univ.; 1910-11, asst. engr., city engrg. dept., Moose Jaw, Sask.; 1912, dftsman and transitman, land survey, Peace River District, B.C.; 1917-18, field engr., smokeless powder plant, Trenton, Ont., for Fraser Brace Co.; 1918-22, sanitary engr., Dept. of Public Works, Ottawa; 1923-25, office engr. and clerk, constrn. dept., Temiskaming & Northern Ont. Rly.; 1926, res. engr., Rouyn Branch Lines Co., C.N.R.; 1927-32, engr., Federal District Commission, Ottawa; 1933 to date, struct'l. designing engr., Dept. National Defence, Ottawa. (Structural steel, concrete and heating.)

References: E. J. C. Schmidlin, A. K. Hay, G. G. Gale, W. F. M. Bryce, C. M. Pitts, A. E. Dubuc, W. L. L. Cassels.

CASTLEDEN—GEOFFREY PERCY, of Duparquet, Que., Born at Gosport, Portsmouth, England, April 1st, 1893; Educ., B.Sc. (Mech.), Univ. of Sask., 1927. One year's study toward Civil Engrg. degree, 1932-33; Summer work: 1910-13, survey parties; 1922, Geodetic Survey; 1923-25, instr'man., secondary observations, Geodetic Survey; 1926, dftsman in architect's office; 1917-19, instr'man., Can. Rly Troops; 1927, dftsman., Manitoba Bridge and Iron Works; 1928 (Jan.-June), instr'man., Underwood & McLellan, Saskatoon; 1928-30, asst. engr., 1930-32, asst. mechanic, Sherritt Gordon Mines; Nov. 1933 to date, asst. mechanic, Beattie Gold Mines, Duparquet, Que.

References: J. J. White, R. A. Spencer, H. B. Brehaut, A. R Greig, Y. R. Anderson.

DICKSON—ARCHIBALD, of Calgary, Alta., Born at Motherwell, Scotland, Mar. 21st, 1886; Educ., Public and High School, Motherwell; 1903-08, ap'ticeship, and 1908-11, junior dftsman, Lanarkshire Steel Co., Motherwell; 1911-13, dftsman., Manitoba Bridge and Iron Works, Winnipeg; 1913 to date, with Dominion Bridge Co. as follows: (Winnipeg) 1913-20, dftsman., 1920-26, checker, 1926-30, squad leader, and 1930 to date, chief dftsman. at Calgary, Alta.

References: H. M. White, A. Campbell, C. T. Barnes, R. Barnecut, J. R. Wood, H. B. LeBourveau.

STEWART—FREDERICK CHOATE, of 2748 Dundas St., Vancouver, B.C., Born at Mission, B.C., March 2nd, 1898; Educ., B.A.Sc., C.E., Univ. of B.C., 1923; Member, Assn. Prof. Engrs. B.C.; 1916, chainman, Great Northern Rly.; 1917-19, overseas, Can. Engrs.; 1919-21, instr'man., City of Vancouver; 1922-23-24 (summers) with C.P.R., asst. to divn. engr. at Cranbrook and Vancouver; 1924-26, with City of Vancouver, design and layout of pipe lines, also res. engr. in charge of pipe line constrn.; 1926 to date, asst. engr. with Greater Vancouver Water District. Design and layout of pipe lines; res. engr. in charge of constrn. of pipe lines (riveted and welded); concrete dam and intake, Seymour Falls; concrete reservoir at Vancouver Heights; pressure tunnel under the First Narrows; Surveys and investigations (hydraulic and geological) of Capilana Canyon, also prelim. design and estimate for a 300 ft. dam; field engr. in charge of surveys and gen. investigation for hydro-electric development on Cheakamus River, also prelim. designs and estimate of power cost for report on same.

References: E. A. Cleveland, W. H. Powell, C. Brakenridge, C. E. Webb, A. S. Wootton, T. E. Price.

### FOR TRANSFER FROM THE CLASS OF ASSOCIATE MEMBER TO THAT OF MEMBER

LOVE—ALEXANDER, of 40 Paisley Ave. So., Hamilton, Ont., Born at Saltcoats, Ayrshire, Scotland, Dec. 6th, 1890; Educ., B.Sc. (Engrg.), Glasgow Univ., 1912; Summer work: 1909-10, mech. dftsman., W. Young & Sons, Ardrossan; 1911, mech. fitter, Ardeer Iron Works; 1912, tracer, Hamilton Bridge Co.; 1912-13, dftsman., C.P.R., divn. engr's. office, Toronto; 1913-14, instr'man., Ont. Divn., C.P.R.; 1917-19, Lieut., Can. Engrs., C.E.F.; 1919 to date, with the Hamilton Bridge Company as follows: 1919-23, detailer, checker; 1923-27, designer; 1927 to date, plant engr. (*A.M. 1920.*)

References: R. K. Palmer, J. A. McFarlane, H. B. Stuart, F. W. Paulin, W. F. McLaren, H. A. Lumsden.

### FOR TRANSFER FROM THE CLASS OF JUNIOR

FRY—JOHN DAWSON, of Westmount, Que., Born at Montreal, March 17th, 1901; Educ., B.Sc., McGill Univ., 1923; (Summers) 1919, mach. shop, Thos. Davidson & Co.; 1920, Price Bros. & Co., Kenogami; 1921, with McDougall & Friedman; Aug. 1923 to date, with McDougall & Friedman, Consltg. Engrs., as assistant, work consisting principally of the preparation of plans and specifications, together with supervision in connection with the mech'l. equipment of bldgs. (*St. 1919, Jr. 1924.*)

References: G. K. McDougall, F. J. Friedman, C. P. Creighton, J. H. Larmonth, M. V. Ross.

GOODALL—ERNEST LORNE, of 18 Winnipeg Ave., Port Arthur, Ont., Born at Ottawa, Ont., Apr. 10th, 1901; Educ.: B.Sc., McGill Univ., 1924; 1921-24, road survey, Ottawa Suburban Roads Commn.; 1924-27, paper mill engrg., Abitibi Power and Paper Co., Iroquois Falls, Ont.; 1927-28, field engr. for same company at Smooth Rock Falls, Ont., and 1929-30, central engrg. office of same company in Toronto; 1930 to date, res. engr. in charge of constrn., mtce., repairs and engrg., Provincial Paper Ltd., Port Arthur, Ont. (*St. 1924, Jr. 1929.*)

References: G. H. Burbidge, R. B. Chandler, J. Antonisen, J. A. Dickinson, H. J. Buncke, G. R. Duncan.

LAZENBY—THOMAS WILLIAM, of 17 Colborne St., Kingston, Ont., Born at York, England, Feb. 13th, 1900; Educ., 1915-22, York Technical School (evenings), Cert. of Merit, 1922; One year, Leeds Univ. (evenings); 1915-21, 7 years ap'ticeship as mech. dftsman., with H. Leetham & Sons, York, England. 3 years, drawing office on design and detail of flour milling machy., and 4 years engrg. shops, building and testing machines; 1923-31, chief dftsman., E. Leonard & Sons, London, Ont., in charge of all designs, details, bill of materials, etc., on steam boilers, boiler settings, pressure vessels of all kinds, sheet iron work and struct'l. steel; 1931-32, shop supt., in charge of tank shop, for McKelvey & Birch, Kingston. Pressure vessels, storage tanks, sheet iron and light steel work. Riveted and welded constrn. Preparation of shop drawings and misc. details; at present, sub-foreman on constrn., Relief Project 37, Kingston, Ont. (*Jr. 1928.*)

References: I. Leonard, A. H. Morgan, L. F. Grant, H. H. Lawson, J. K. Ashworth.

### FOR TRANSFER FROM THE CLASS OF STUDENT

ACHESON—HARRY ROSS MACDOUGALL, of Edmonton, Alta., Born at Toronto, Ont., June 26th, 1907; Educ., B.Sc. (E.E.), Univ. of Alta., 1929; R.P.E. Alta.; Summer work: 1926, rodman, and 1927-28-29, instr'man., C.P.R.; 1930 (Nov.-Dec.), transitman, C.P.R., Kamloops, B.C.; 1931 to date, dftsman., tech. divn., Dept. Lands and Mines, Prov. of Alberta, Edmonton. Responsible for charge of records and preparation of legal descriptions in connection with grazing leases. Also math. computations and misc. dfting., corres., statistics, etc. (*St. 1926.*)

References: F. K. Beach, D. A. Hansen, H. J. MacLeod, R. S. L. Wilson, H. R. Webb, J. A. McCoubrey, G. H. N. Monkman, J. A. Henderson.

ADAMS—ERIC G., of Montreal, Que., Born at Hull, Que., May 3rd, 1907; Educ., B.Sc. (E.E.), McGill Univ., 1929. 1929-31, at Harvard Graduate School of Business Administration. M.B.A. degree. (Specialized in transportation); 1928 summer), insulation dept., Can. Gen. Elec. Co.; 1930 (summer), business research dept., Westinghouse Elec. and Mfg. Co.; 1931-33, engr. and economist, Cockfield Brown & Company, Montreal, research divn. (preparing reports on various business problems for clients); 1933 to date, account executive for same firm, planning and preparing advertising for clients such as Northern Electric Co., etc.) (*St. 1928.*)

References: G. D. MacKinnon, C. V. Christie, G. A. Wallace, L. R. Thomson, R. E. Jamieson, J. G. Notman, R. J. Durley.

BLACK—JOHN ALFRED, of Amos, Que., Born at Chicago, Ill., Aug. 6th, 1905; Educ., B.Sc. (Civil), N.S. Tech. Coll., 1930; 1927 (2 mos.), tester in carbon lab., Aluminum Co. of Canada; 1928-29 and 1931 (12 mos.), recorder and plane table topog'r., Geol. Survey of Canada; 1930 (4 mos.), locating and field engr., power line constrn., International Power & Paper Co., of Nfld.; 1931 (3 mos.), instr'man., Beauharnois Constrn. Co. Ltd.; 1932 (5 mos), field engr. on hydro-plant constrn., Treadwell Yukon Constrn. Co. Ltd.; 1932-33, amalgamator, 1933-34, surveyor and dftsman., 1934, mill supt., with Bussieres Mining Co. Ltd.; at present, mill supt., Perron Gold Mines Ltd., Amos, Que. (*St. 1929.*)

References: F. R. Faulkner, P. G. Gauthier, D. Hutchison, M. G. Saunders, E. V. Gilbert, S. Ball.

DOULL—ROBERT MORSE, of Montreal, Que., Born at Halifax, N.S., June 11th, 1907; Educ., B.Sc. (Mech.), McGill Univ., 1929; 1926-27, timekpr., highway constrn., Dept. Highways Nova Scotia; 1928-29, junior estimator, and 1929-31, estimator, Dominion Engineering Works; 1931-34, purchasing agent, Construction Equipment Co. Ltd., in complete charge of all engrg. purchases and misc. special work, and at present asst. manager of company. Also purchasing, estimating and engrg. for associated company, Gunite and Waterproofing Ltd., and from 1933 to date, manager of company. (*St 1927.*)

References: A. R. Chadwick, C. M. McKergow, H. Crombie, R. E. Chadwick, F G. Rutley.

LITTLE—HARRY, of Ste. Anne de Bellevue, Que., Born at Darlington, England, March 15th, 1907; Educ., 1922-28, Darlington Technical College (Night Classes). Also two full time periods of 3 months each at same college, taking heat engines, maths., strength of materials and machine design; 1922-29, engrg. ap'tice and junior dftsman., with the Darlington Railway Plant and Foundry Co. Ltd. Training in machine shop, tool room, foundry, pattern shop and drawing office; 1929-31, mech. dftsman., Aluminum Co. of Canada Ltd., Arvida, Que. Plant mtce., work on conveyers, crushers, rod mills and electric furnaces. Struct'l. steel detailing of plant extensions; 1932 (March-Nov.), mech. design and experimental research, Canada Oil Floating Corpn. Ltd., Montreal; 1933 (Jan.-Dec.), mech. design, E. T. Fairbanks Ltd., Sherbrooke, Que. On domestic fuel oil burners, full automatic type, electrically controlled; 1934 (Jan.-May), teacher, mech. drawing, Social Service Cte., Maisonneuve Centre; at present, sales engr., Ransome & Marles Bearing Co. of Canada Ltd., Montreal. (*St. 1931.*)

References: J. K. Ashworth, O. A. Fogarty, A. W. Whitaker, Jr., J. W. Ward, J. F. Plow, E. Baty.

ORANGE—FRANK A., of 188 Station St., Sudbury, Ont., Born at Salt Lake City, Utah, U.S.A., Sept. 26th, 1904; Educ., B.Sc., Queen's Univ., 1927; 1924-25, machinist, British American Nickel Co., Sudbury; 1925 (summer), mechanic, Mond Nickel Co., Coniston; 1926 (summer), concrete inspr., Fraser-Brace, Farmer's Rapids, Que.; 1927 (May-July), mech. dftsman., Bickle Fire Engine Co., Woodstock, Ont.; 1927-28, mech. foreman, Lawson & Jones, Ltd., London, Ont.; 1928-29, efficiency engr., Swift Canadian Co., Toronto; 1929-(Aug. Dec.), constrn. dftsman., Carborundum Co., Niagara Falls, N.Y.; 1930 (Jan.-Sept.), mech. dftsman., Ontario Refining Co., Copper Cliff, Ont.; 1933 (Jan.-Sept.), struct'l. dftsman., Noranda Mines Ltd., Noranda, Que.; Sept. 1933 to date, mech. engr., International Nickel Co., Copper Cliff, Ont. (*St. 1927.*)

References: L. M. Arkley, C. S. Millard, C. O. Maddock, J. R. Bradfield, H. G. Acres.

SAUER—GEORGE DOUGLAS, of Beauharnois, Que., Born at Ogdensburg, N.Y., July 18th, 1907; Educ., B.Sc., McGill Univ., 1931; Grad. R.M.C., 1930; Summers: 1927-29, dftsman., Wm. Hamilton Co., Peterborough, Ont.; 1930, dftsman., Beauharnois Constrn. Co.; 1932 (Oct. and Nov.), Dept. Rlys. and Canals, asst. hydrographic surveyor; 1931-32, designer, 1932 (July-Sept.), inspr. on dyke constrn., and 1933, rodman and instr'man., Beauharnois Constrn. Co.; April 1934 to date, designer, river control works, misc. structures, Beauharnois Light Heat & Power Co., Beauharnois, Que. (*St. 1930.*)

References: M. V. Sauer, R. H. Reid, L. H. Burpee, J. A. Knight, L. F. Grant, R. C. Flitton, E. Brown, R. DeL. French.

SVARICH—JOHN PAUL, of Edmonton, Alta., Born at Vegreville, Alta., Dec. 2nd, 1904; Educ., B.Sc., Univ. of Alta., 1929; 1928 (3 mos.), and 1929 (2 mos.), timekpt. on bldg. constrn.; 1929-30, dftsman., Edmonton town planning; 1930, dftsman., Driscoll & Knight; 1930-32, dftsman., engrg. dept., City of Edmonton; at present, not employed in engr. work. (*St. 1927.*)

References: R. S. L. Wilson, R. J. Gibb, H. L. Seymour, W. R. Mount, H. R. Webb.

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# The Growth and Work of the Association of Professional Engineers of the Province of British Columbia

*Dr. E. E. Brydone-Jack, M.E.I.C.*

**Abstract of an address given at a luncheon of the American Society of Civil Engineers and The Engineering Institute of Canada at the Hotel Vancouver, July 11th, 1934.**

In Canada the first real step toward Dominion-wide legislation in regard to the registration of professional engineers was made by The Engineering Institute of Canada in February 1919, when a committee was appointed to draft a model act as a basis for procuring such legislation in the different provinces of the Dominion. Under the British North America Act such enactments are a provincial, not a Federal, responsibility.

Engineering acts had been in existence in Quebec and Manitoba previously, these were revised, and in 1920 acts were passed in Nova Scotia, New Brunswick, Alberta and British Columbia. Later, in 1924, Ontario, and in 1930, Saskatchewan, also obtained acts.

In the British Columbia Act, all registered professional engineers constitute the Association of Professional Engineers of British Columbia, and a professional engineer is defined as any person engaged in the practice of professional engineering. Further, professional engineering is defined as the carrying on for hire, gain or hope of reward of any branch of civil, mining, mechanical, electrical, chemical or structural engineering, including report on, designing, or directing the construction of any works which require for their design or the supervision of their construction, or the supervision of their maintenance, such experience and technical knowledge as are required by or under the act for the admission by examination to membership in the Association.

This definition of the professional engineer was further amplified by an amending act of 1930.

The act is administered by the executive council of the Association, consisting of eleven members, the president, vice-president and four councillors, being elected annually by the Association, the past-president is a councillor *ex officio*, and four councillors, who must be registered professional engineers, including one from the faculty of the University of British Columbia are appointed by the Lieutenant-Governor-in-council. Thus the control of the profession rests in the hands of the profession itself, and only those registered in the Association or licensed by the council of the Association are allowed to engage in the practice of professional engineering. Temporary licenses are available to non-residents on providing satisfactory proof of their qualifications.

Registration is granted largely by examination, which may be an oral thesis or a written examination, as the council may require. A board of examiners for each branch of engineering is appointed by the council.

An important feature of the Association's work is the system which has been devised to care for the growth and development of the student whether he is of the university or non-university class. In the case of the university student, registration as an engineering pupil is granted under the authority of an applied science course, as an engineer-in-training on graduation, and as a professional engineer when he has completed four years of practical experience after graduation and upon presentation of a satisfactory thesis or engineering report.

In the case of a non-university student, junior or high school matriculation or the equivalent is required before formal listing as a prospective student. After this a preliminary examination will admit him as an engineering pupil, an intermediate examination as an engineer-in-training, and later a final examination admits to registration as a professional engineer.

The proper administration of any registration act makes it necessary to prescribe a definite system of training for all who would become members of the profession and to let established engineers know exactly the qualifications required. Further, the public must be advised of the wide difference which exists between the skilled mechanic or the stationary engineer and the scientifically trained professional engineer.

Such a student system replaces the earlier haphazard methods of entering the profession and gives an orderly approach to registration. The university student is taught to think professionally and among other things this creates a higher regard for the profession he is about to enter. Ninety-five per cent of the undergraduates in engineering in the University of British Columbia are enrolled as engineering pupils to-day and the Association keeps in constant touch with these younger men.

The engineering profession should have just as high standards as any other profession. This is due to the profession and to the general public.

There is a certain amount of educational work to be done constantly with the public and with the engineers. Public bodies such as cities must be made aware that registered engineers must be employed in their engineering work, and senior engineers must be urged to give recognition to the enrolled or registered engineer for positions under their control.

The Association to-day has an enrollment of about eight hundred registered engineers, two hundred and fifty engineers-in-training and two hundred and fifty engineering pupils.

This progress has been made by steady striving for the ideal year by year, and there is still much to be done. In this connection, the highest tribute should be paid to the registrar and secretary of the Association, Mr. E. A. Wheatley, A.M.E.I.C., for his efforts and unflagging zeal.

## EMPLOYMENT SERVICE BUREAU

**The Service is operated for the benefit of members of The Engineering Institute of Canada, and for industrial and other organizations employing technically trained men—without charge to either party.**

*All correspondence should be addressed to*

**The Employment Service Bureau, The Engineering Institute of Canada**
**2050 Mansfield Street, Montreal**

## Situations Vacant

SALES ENGINEER wanted by a large pulp and paper machinery manufacturer. Applicants should be young men and experienced in modern pulp and paper mill practise. Apply to Box No. 1056-V.

METALLURGIST. Recent graduate wanted for junior position in manufacturing plant near Montreal. Please reply giving particulars of education, experience, and salary expected to Box No. 1062-V.

SALES ENGINEER. A company established fifteen years specializing in the heating, ventilating, air conditioning and power plant field is seeking the services of an engineer familiar with such equipment, preferably one with sales experience. To the right individual this position holds out excellent prospects. Send complete experience record to Box No. 1064-V.

INDUSTRIAL SALESMAN. A natural gas company in the Canadian West desires to receive applications for the position of industrial engineering salesman. Applicants must have received engineering training specializing in heating and combustion problems, and must have had wide experience in the practical application of this specialized training. Apply to Box No. 1066-V.

## Situations Wanted

ESTABLISHED SALES ENGINEER. Univ. of Toronto '24, with plant and manufacturing experience, wishes to represent manufacturers of technical equipment. Connections with automobile and electrical equipment dealers, throughout Canada. Will make small investment if necessary. Apply to Box No. 1-W.

MECHANICAL ENGINEER, A.M.E.I.C. Married. Experience in machine shops, erection and maintenance of industrial plant mechanical and structural design. Reads German, French, Dutch and Spanish. Seeks any suitable position. Apply to Box No. 84-W.

INDUSTRIAL ENGINEER, B.Sc., McGill Univ. Age 29. Married. Mechanical and electrical engineering experience with four large Canadian companies; including supervision of manufacture of various products, reduction of manufacturing costs, factory planning and investigation of piece work systems. Available on short notice. Apply to Box No. 132-W.

MECHANICAL ENGINEER, graduate McGill Univ. Experience on hydro-electric power construction and design and installation of equipment of pulp and paper mills. Desires position as mechanical engineer in an industrial plant or pulp and paper mill, or as representative on the sale of heavy machinery. Apply to Box No. 142-W.

PURCHASING ENGINEER, graduate mechanical engineer, Canadian, married, 34 years of age, with 13 years' experience in the industrial field, including design, construction and operation, 8 years of which had to do with the development of specifications and ordering of equipment and materials for plant extensions and maintenance; one year engaged on sale of surplus construction equipment. Full details upon request. Apply to Box No. 161-W.

REINFORCED CONCRETE ENGINEER, B.Sc., P.E.Q., eight years experience in construction design of industrial buildings, office buildings, apartment houses, etc. Age 30. Married. Apply to Box No. 257 W.

MECHANICAL ENGINEER, age 28, nine years all round experience, Grad. Inst. of Mech. Engs. England, S.E.I.C. Technical and practical training with first class English firm of general engineers; shop, foundry and drawing office experience in steam and Diesel engines, asphalt, concrete machinery, boilers, power plants, road rollers, etc. Experience in heating and ventilation design and equipment; 18 months designing draughtsman with Montreal consulting engineers. 2½ years sales experience, steam and hot water heating systems, power plant equipment, machinery, oil-burning apparatus. Canadian 4th class Marine Engineers Certificate; C.N.S. experience. Available at short notice. Apply to Box No. 270-W.

DESIGNING DRAUGHTSMAN, experience in layout of steam power house equipment and piping. Wide experience in mechanical drive and details of machinery, gearing, and hoists. Accustomed to layout of small mill buildings of steel and timber, structural design and details. Good references. Present location Montreal. Apply to Box No. 329-W.

ELECTRICAL ENGINEER, B.Sc., A.M.E.I.C., Am.A.I.E.E., age 30, single. Eight years experience H.E. and steam power plants, substations, etc., shop layouts, steel and concrete design. Location immaterial. Available immediately. Apply to Box No. 435-W.

## Situations Wanted

CIVIL ENGINEER, B.A.Sc., and C.E., A.M.E.I.C., age 30, married. Experience over the last ten years covers construction on hydro-electric and railway work as instrumentman and resident engineer. Also office work on teaching and design, investigations and hydraulic works, reinforced concrete, bridge foundations and caissons. Location immaterial. Available at once. Apply to Box No. 447-W.

SALES ENGINEER, M A.Sc. Univ. of Toronto, wishes to represent firm selling building products or other engineering commodities, as their representative in Western Canada. Located in Winnipeg. Apply to Box No 467-W.

MECHANICAL ENGINEER, B.Sc. Age 28, married. Four and a half years on industrial plant maintenance and construction, including shop production work and pulp and paper mill control. Also two and a half years on structural steel and reinforced concrete design. Available at once. Apply to Box No. 521-W.

CIVIL ENGINEER, Canadian, married, twenty-five years' technical and executive experience, specialized knowledge of industrial housing problems and the administration of industrial towns, also town planning and municipal engineering, desires new connection. Available on reasonable notice. Personal interview sought. Apply to Box No. 544-W.

ELECTRICAL AND MECHANICAL ENGINEER, B.Sc., A.M.E.I.C. Experience includes C.G.E. Students' Test Course and six years in engineering dept. of same company on design of electrical equipment. Four summers as instrumentman on surveying and highway construction. Several years experience in accounting previous to attending university. Desires position with industrial concern where the combination of technical and business experience will be of value. Apply to Box No. 564-W.

### Employment Service Bureau

This bureau is maintained by The Engineering Institute of Canada for the benefit of members and organizations employing technically trained men.

An enquiry addressed to 2050 Mansfield Street, Montreal, will bring full information concerning the services offered Details can also be obtained from Branch secretaries who are located in the larger centres throughout Canada.

Brief announcements of men available and positions vacant will be published without charge in The Engineering Journal and the Bulletin. Replies addressed in care of the required box number will be forwarded to the advertiser without delay.

An additional service also offered those who are unemployed or wish to change their positions, is the opportunity of placing their names and records on file at 2050 Mansfield Street for consideration by employers wishing to employ engineers. This is of great assistance as many employers will not advertise or wish to locate a suitable man on short notice. If desired the information contained in these records can be kept confidential.

Forms for registration purposes may be obtained from The Institute Headquarters or Branch secretaries.

MECHANICAL ENGINEER, A.M.E.I.C., with twenty years experience on mechanical and structural design, desires connection. Available at once. Apply to Box No. 571-W.

DOMINION LAND SURVEYOR, and graduate engineer with extensive experience on legal, topographic and plane-table surveys and field and office use of aero-photographs, desires employment either in Canada or abroad. Available at once. Apply to Box No. 589-W.

CHEMICAL ENGINEER, S.E.I.C., B.Sc., University of Alberta, '30. Age 31. Single. Six seasons' practical laboratory experience, three as chief chemist and three as assistant chemist in cement plant; one year's p.g. work in physical chemistry; three years' experience teaching. Desires position in any industry with chemical control. Available immediately. Apply to Box No. 609-W.

DESIGNING ENGINEER AND ESTIMATOR, grad. Univ. of Toronto in C.E., A.M.E.I.C., twenty years experience in structural steel, construction and municipal work. Available at once. Apply to Box No. 613-W.

## Situations Wanted

CIVIL ENGINEER, A.M.E.I.C., R.P.E., Ontario; three years construction engineer on industrial plants; fourteen years in charge of construction of hydraulic power developments, tower lines, sub-stations, etc.; four years as executive in charge of construction and development of harbours, including railways, docks, warehouses, hydraulic dredging, land reclamation, etc. Apply to Box No. 647-W.

ELECTRICAL ENGINEER, B.Sc. in E.E. (Univ. of Man., '30). Age 25. Two year Can. Westinghouse Apprentics Course. Depts.—Switchboard assembly, general draughting office, switchboard engineering, test office. One year's experience since then designing and rewinding small motors and transformers. Location immaterial. Apply to Box No. 651-W.

MECHANICAL ENGINEER, A.M.E.I.C., Canadian, technically trained; six years drawing offices. Office experience, including general design and plant layout. Also two years general shop work, including machine, pattern and foundry experience, desires position with industrial firm in capacity of production engineer or estimator. Available on short notice. Apply to Box No. 676-W.

DIESEL ENGINEER. Erection and industrial engineer, A.M.E.I.C., technically trained mechanical engineer with English and Canadian experience in erection and operation of steam and Diesel equipment in power house and mines, pumping, rock drilling, air compressors. Experienced in industrial and steel works operations including rolling mills, quarries, sales. Open for position on maintenance, operation or sales engineer. Location immaterial. Apply to Box No. 682-W.

MECHANICAL AND STRUCTURAL ENGINEER. Six years experience with prominent manufacturer, designing, heating and power boilers, boiler installations, coal and ash handling equipment. Good practical knowledge of steel plate work welding. Also wide experience in designing, estimating and detailing structural steel for buildings and bridges. Good education. Have held position of responsibility. Above can be verified by best of references. Available at once. Apply to Box No. 692-W.

ELECTRICAL AND CIVIL ENGINEER, B.Sc., Elec., 29, B.Sc., Civil '33. Age 27. Jr.E.I.C. Undergraduate experience in surveying and concrete foundations; also four months with Canadian General Electric Co. Thirty-three months in engineering office of a large electrical manufacturing company since graduation. Good experience in layouts, switching diagrams, specifications and pricing. Best of references. Available immediately. Apply to Box No. 693-W.

MECHANICAL ENGINEER, B.Sc., '27, Jr.E.I.C. Four years maintenance of high speed Diesel engines units, 200 to 1,300 h.p. Also maintenance of D.C. and A.C. electrical systems and machinery. Draughting experience. Westinghouse apprenticeship course. Practical mechanical and electrical engineer with a special study of high speed Diesel engine design, application and operation. Location in western or eastern Canada immaterial. Apply to Box No. 703-W.

COMBUSTION ENGINEER, R.P.E., Manitoba, A.M.E.I.C. Wide experience with all classes of fuels. Expert designer and draughtsman on modern steam power plants. Experienced in publicity work. Well known throughout the west. Location, Winnipeg or the west. Available at once. Apply to Box No. 713-W.

ELECTRICAL ENGINEER, B.Sc., University of N.B., '31. Experience includes three months field work with Saint John Harbour Reconstruction. Apply to Box No. 722-W.

MECHANICAL ENGINEER, age 41, married. Eleven years designing experience with project of outstanding magnitude. Machinery layouts, checking, estimating and inspecting. Twelve years previous engineering, including draughting, machine shop and two years chemical laboratory. Highest references. Apply to Box No. 723-W.

CIVIL ENGINEER, B.Sc. (Alta. '31), S.E.I.C. Experience includes three seasons in charge of survey party. Transitman on railway maintenance, and concrete bridge designing Nature of work and location immaterial. Apply to Box No. 724-W.

YOUNG CIVIL ENGINEER, B.Sc. (Univ. of N.B. '31), with experience as rodman and checker on railroad construction, is open for a position. Apply to Box No. 728-W.

DESIGNING ENGINEER, M.Sc. (McGill Univ.), D.L.S., A.M.E.I.C., P.E.Q. Experience in design and construction of water power plants, transmission lines, field investigations of storage, hydraulic calculations and reports. Also paper mill construction, railways, highways, and in design and construction of bridges and buildings. Available at once. Apply to Box No. 729-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.Sc., Univ. of B.C. '30. Single, age 24. Sixteen months with the Allis-Chalmers Mfg. Co. as student engineer. Experience includes foundry production, erection and operation of steam turbines, erection of hydraulic machinery, and testing texropes and centrifugal pumps. Location immaterial. Available at once. Apply to Box No. 735-W.

CIVIL ENGINEER, M.Sc., A.M.E.I.C., R.P.E. (Ont.), ten years experience in municipal and highway engineering Read, write and talk French. Married. Served in France. Will go anywhere at any time. Experienced journalist. Apply to Box No. 737-W.

## Situations Wanted

RADIO AND ELECTRICAL ENGINEER, B.Sc. '31, S.E.I.C. Age 27. Experience in installation of power and lighting equipment. Temporary operstor in radio station; studio experience with part time announcing. Two summers in switchboard and installation department of telephone company, eight months on extensive survey layouts. Interested in sales work of electrical or radio equipment. Available on short notice. Locstion immsterial. Apply to Box No. 740-W.

CIVIL ENGINEER, graduate '29. Married. One year building construction, one year hydro-electric construction in South America, fourteen months resident engineer on road construction. Working knowledge of Spanish. Apply to Box No. 744-W.

SALES ENGINEER, B.Sc., McGill, 1923, A.M.E.I.C. Age 33. Married. Extensive experience in building construction. Thoroughly familisr with steel building products; last five years in charge of structural and reinforcing steel sales for company in New York state. Available st once. Located in Canada. Apply to Box No. 749-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. Queen's Univ. '29. Age 25. Married. Three years experience as construction supt. and estimstor for contracting firm. Experience includes general building, bridges, sewer work, concrete, boiler settings, sand blasting of bridges and spray painting. Available at once. Apply to Box No. 776-W.

CIVIL ENGINEER, B.Sc., '25, Jr.E.I.C., P.E.Q., married. Desires position, preferably with construction firm. Experience includes railway, monument and mill building construction. Available immediately. Apply to Box No. 780-W.

DRAUGHTSMAN, experience in civil engineering, forestry engineering, land surveying and house construction. Good rsferences. Apply to Box No. 781-W.

ELECTRICAL AND SALES ENGINEER, S.E.I.C., grad. '28. Experience includes ons year test course, one year switchboard design and two yesrs switchboard and switching squipment sales with large electrical manufacturing company. Thres summers Pilot Officer with R.C.A.F. Available at once. Apply to Box No. 788-W.

ELECTRICAL ENGINEER desires position as engineer or manager for industrial plant or factory. Over ten years diversified electrical and mechanical experience in the industrial field. Apply to Box No. 795-W.

CIVIL ENGINEER, S.E.I.C., graduate '30, age 23, singls. Experience includes mining surveys, assistant on highwsy location and construction, and assistant on large construction work. Steel and concrete lsyout and design. Apply to Box No. 809-W.

CIVIL ENGINEER, college graduate, age 27, singls. Exoerience includes surveying, draughting concrete construction and design, street paving both asphalt and concrete. Available at once; will consider anything and go anywhere. Apply to Box No. 816-W.

CIVIL ENGINEER, B.E. (Sask. Univ. '32), S.E.I.C. Single. Experiencs in city street improvement; sewer and water extensions. Good draughtsman. References. Available at once. Location immaterial. Apply to Box No. 818-W.

CIVIL ENGINEER, B.Sc., A.M.E.I.C., with fifteen ysara experience mostly in pulp and paper millwork, reinforced concrete and atructurs1 steel design, field surveys, layout of mechanicsl equipment, piping. Availsbls at oncs. Apply to Box No. 825-W.

ELECTRICAL ENGINEER, S.E.I.C., grad. '29, age 24, married; experiencs includes cne year Students Test Course, sixteen months in distribution transformer design and eight months as assistant foreman in chargs of industrisl control and switchgear tests. Location immaterial. Availabls at once. Apply to Box No. 828-W.

CIVIL ENGINEER, B.A.Sc., D.L.S., O.L.S., A.M.E.I.C., age 46, married. Twelve years experisnce in charge of legal field surveys. Owns own surveying squipmsnt. Eight years on technical, administrative, and editorial office work. Expsrienced in writing. Desires position on survey work, assisting in or in charge of prsparation of house organ, on staff of technical or ssmi-technical magazine, or on publicity, editorial or administrative office work. Available at once. Will consider any salary, and any location. Apply to Box No. 831-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. '32 (Univ. of N.B). Age 25. married. Two years experience in power line construction and maintenance; one year of highway construction; one summer surveying for power plant site, location and spur railway line construction. Available at once. Location immaterial. Apply to Box No 840-W.

CIVIL ENGINEER, B.Sc. '15, A.M.E.I.C., married, extensive experience in responsible position on railway construction, also highways, bridges and water supplies. Position desired as engineer or superintendent. Available at once. Apply to Box No. 841-W.

CIVIL ENGINEER, B.Sc. (Alta. '31), S.E.I.C., age 24. Experience, three summers on railroad maintenance, and seven months on highway location as instrumentman. Willing to do anything, anywhere, but would prefer connection with designing or construction firm on structural works. Available immediately. Apply to Box No. 846-W.

## Situations Wanted

BRIDGE AND STRUCTURAL ENGINEER, A.M.E.I.C., McGill. Twenty-five years' experience on bridge and structural staffs. Until recently employed. Familiar with all late designs, construction, and practices in all Canadian fabricating plants. Desirous of employment in any responsible position, sales, fabrication or construction. Apply to Box No. 851-W.

STRUCTURAL ENGINEER, B.A.Sc., A.M.E.I.C. Twenty-two years experience in design of bridges and all types of buildings in structural steel and reinforced concrete. Three years experience in railway construction and land surveying. Apply to Box No. 856-W.

MECHANICAL ENGINEER, B.Sc. '32, S.E.I.C. Good draughtsman. Undergraduate experience:—One year moulding shop practice; two years pipe fitting and sheet metal work; one yesr draughting and tracing on paper mill layout; six months machine shop practice; and eight months fuel investigation and power heating plant testing. Desires position offering experisnce in steam power plants or heating and vsntilating design. Will go anywhere. Apply to Box No. 858-W.

MECHANICAL ENGINEER, age 31, graduats Sheffield (England) 1921; apprenticeship with firm manufacturing steam turbine generators and auxiliaries and subsequent experience in design, erection, operation and inspection of sams. Marine experience B.O.T. certificate thoroughly conversant with Canadian plants and equipment. Available on short notice. Any location. Box No. 860-W.

CHEMICAL ENGINEER, B.Sc. (McGill '21), A.M.E.I.C., age 36, married; three years since graduation with pulp and paper mills; sight years in shops, estimating and sales divisions of wsll-known gas engineering and construction companies in the United States. Excellent referencss. Available on short notice. Apply to Box No. 866-W.

CONSTRUCTION ENGINEER (Toronto Univ. of '07). Experiencs includes hydro-electric, municipal and railroad work. Available immediately. Location immaterial. Apply to Box No. 886-W.

ELECTRICAL ENGINEER, graduats 1929, S.E.I.C. Single. Experience includes two years with slectrical manufacturing concern and ons on highway construction work. Available at oncs. Will go anywhere. Apply to Box No. 887-W.

AGENCIES WANTED, Young engineer, B.A.Sc. in C.E., with business and sales experience, speaking fluent French, would consider representing a firm as agent for Montreal or the province of Quebec. Apply to Box No. 891-W.

ELECTRICAL ENGINEER, grad. Univ. of N.B. '31. Experienced in surveying and draughting, rsquires position. Available at once. Will go anywhere. Apply to Box No. 893-W.

CIVIL ENGINEER, B.A.Sc., Jr.E.I.C., age 29, single. Experience includes two years in pulp mill as draughtsman and designer on additions, maintenance and plant layout. Three and a half ysars in the Toronto Buildings Department checking steel, reinforced concrete, and architsctural plans. Available at oncs. Location immaterial. At present in Toronto. Apply to Box No. 899-W.

DESIGNING ENGINEER, A.M.E.I.C. Permanent and executive position prefsrred but not essantial. Fiftesn ysars expsriencs in designing power plants, engins and fan rooms, kitchens and laundries. Thoroughly familiar with plumbing and ventilating work, pnsumatic tubes, and refrigeration, alao heating, elsctrical work, and specifications. Apply to Box No. 913-W.

ELECTRICAL ENGINEER, Dipl. of Eng., B.Sc. (Dalhousie Univ.), S.B. and S.M. in E.E. (Mass. Inst. of Tech.), Canadian. Married. Seven and a half years' experience in design, construction and operation of hydro, steam and industrial plants. For past sixteen months field office electrical enginser on 510,000 h.p. hydro-electric project. Available at oncs. Apply to Box No. 936-W.

CIVIL ENGINEER, B.Sc., O.P.E. Experience includes ssveral years on municipal work-design and construction of sewers, steel and concrete bridges, watermains and pavements. Available at once. Apply to Box No. 950-W.

CIVIL ENGINEER, B.Sc. (Univ. of Sask. '33), S.E.I.C., age 28, single. Expsrience in testing hydro-electric equipment, draughting, surveying, city street, improvements, technical photography. Available at once. Location immaterial. Apply to Box No. 986-W.

ELECTRICAL ENGINEER, S.E.I.C., B.Sc., (N.S. Tech. Coll., '33), desires work. Experience in transmission line construction. Location or class of work immaterial. Apply to Box No. 1010-W.

## Situations Wanted

ENGINEER SUPERINTENDENT, age 44. Engineering and business training, executive ability, tactful, energetic. Had charge of several large projects. Intimate knowledge of costs and prices, reports and estimates. Available immediately. Any location. Apply to Box No. 1021-W.

CIVIL ENGINEER, B.Sc. (Queen's 14), A.M.E.I.C., Dominion Land Surveyor, 5 months' special courss at ths University of London, England, in municipal hygiens and reinforced concrete construction. Experience covers legal and topographic surveys, plane tabling and stadia surveying, railway and highway construction, drainage and excavation work. Available at oncs. Apply Box No. 1035-W.

ELECTRICAL ENGINEER AND GEOPHYSICIST. Age 36. Married. Seven years experience in geophysical exploration using seismic, magnetic and electrical methods. Two ysars experience with the Western Electric Company of Chicago, working on equipment and magnetic materials research. Experienced in radio and telephone work, also specializing in precise electrical msasurements, resistance dsterminations, ground potentials and similar problems of ground current distribution. Apply to Box No. 1063-W.

ELECTRICAL ENGINEER, B.A.Sc. Univ. Toronto '28. Expsriencs includes Can. Gen. Elec. Co. Test Course. Also more than two years in the engineering dept. of the same company. Available on short notice. Preferred location central or eastern Canada. Apply to Box No. 1075-W.

ELECTRICAL ENGINEER, B.Sc. Married. Eight years electrical experience, including operation, maintenance and construction work, electrical design work on large power development, mechanical ability, sxpsrienced photographer, employed in electrical capacity at present. Available on reasonable notice. Apply to Box No. 1076-W.

GRADUATE IN MECHANICAL ENGINEERING, 1927, desires opportunity in Diesel engine field, preferably in design and development work. Skilled draughtsman and clever in design. Familiar with basic theories of the Diesel engine and in touch with recent developments and applications. Anxious to obtain a foothold with up-to-date company. No objection to shopwork or other duties as a start but would prefer shopwork and assembly if possible. Apply to Box No. 1081-W.

CIVIL ENGINEER, age 27, graduate 1930, single. Experience includes detailing, designing and estimating structural stesl, plate work and pressure vessels; also hydrographic surveying. Available at once. Apply to Box No. 1111-W.

ELECTRICAL ENGINEER, B.Sc., in E.E. (Univ. of N.B. '34), S.E.I.C. Experience in bridge and road construction and auto repairing, desires position in industrial or power plant. Any locality. References on request. Apply to Box No. 1114-W.

CIVIL ENGINEER, B.Sc. Sask. '30. S.E.I.C. Age 24 years. Experiencs in municipal engineering, including sewer and watsr construction, sidewalk construction, paving, storm sewer design, draughting, precise levelling, and reinforced concrete bridge construction. Unmarried. Available at once. Will go anywhers. Apply to Box No. 1115-W.

ELECTRICAL ENGINEER, B.Sc.E.E. (Univ. of N.B. '31). C.G.E. Test Course included industrial control, induction motors and transformers; the transformer test included desk work for two months on computing losses, efficiencies, etc. Availabls at oncs. Apply to Box No. 1119-W.

MECHANICAL ENGINEER, B.A.Sc. (Univ. of B.C.), M.S. (Univ. of Pittsburgh). Canadian. Age 26. Single. One year graduate student course, W.E. and M. Co., East Pittsburgh. Three and a half years engineering research in mechanics with the same company. Location immaterial. Available at oncs. Apply to Box No. 1123-W.

GEODETIC AND TOPOGRAPHICAL ENGINEER, D.L.S., M.E.I.C. Experience in all kinds of geodstic and topographical survsys, especially photo-topography, well versed in all kinds of air photo surveys; Canadian and U.S. patent mathod of determining position and elevations of points from air photographs. Available at once anywhere in Canada or the United States. Apply to Box No. 1127-W.

PETROLEUM CHEMIST, B.Sc. in Chem. Eng. Age 25. Single. One and a half years experience as assistant chemist. Capable of taking charge in small refinery. Wishes position anywhere in Canada Apply to Box No. 1130-W.

ELECTRICAL ENGINEER. B.Sc., Queen's '33. Single, age 23. Anxious to gain experience. Present experience installing small private hydro-electric plant. Location immaterial. Available at once. Apply to Box No. 1137-W.

CIVIL ENGINEER, A.M.E.I.C., with over twenty years experience in field and office on construction, maintenance, surveying, location, etc., desires position preferably of a permanent nature. At present near Montreal, but willing to locate anywhere. Apply to Box No. 1168-W.

# Purchasers' Classified Directory

*A Selected List of Equipment, Apparatus and Supplies*

**For Alphabetical List of Advertisers see page 22.**

A

**Acids:**
Canadian Industries Limited.

**Aerial Survey:**
Canadian Airways Ltd.

**Ammeters and Voltmeters:**
Bepco Canada Ltd.
Crompton Parkinson (Canada) Ltd.

**Angles, Steel:**
Bethlehem Steel Export Corp.

**Ash Handling Equipment:**
Babcock-Wilcox & Goldie McCulloch Ltd.
Combustion Engineering Corp. Ltd.

**Asphalt:**
Barrett Co. Ltd.

**Axles, Steel, Forged:**
Dominion Foundries & Steel Ltd.
Dominion Steel & Coal Corpn. Ltd.

B

**Ball Mills:**
Dominion Engineering Works Limited.
Wm. Kennedy & Sons Ltd.
Foster Wheeler Ltd.
Wm. Hamilton Div. Canadian Vickers Ltd.

**Balls, Steel and Bronze:**
Can. S.K.F. Co. Ltd.
Wm. Kennedy & Sons Ltd.

**Barking Drums:**
Canadian Ingersoll-Rand Company, Limited.

**Bars, Steel and Iron:**
Bethlehem Steel Export Corp.
Dominion Foundries & Steel Ltd.
Dominion Steel & Coal Corpn. Ltd.

**Bearings, Ball and Roller:**
Can. S.K.F. Co. Ltd.

**Billets, Blooms, Slabs:**
Bethlehem Steel Export Corp.
Dominion Foundries & Steel Ltd.

**Bins:**
Canada Cement Co. Ltd.

**Blasting Materials:**
Canadian Industries Limited.

**Blowers, Centrifugal:**
Can. Ingersoll-Rand Co. Ltd.
B. F. Sturtevant Co. of Can. Ltd.

**Blue Print Machinery:**
Montreal Blue Print Co.

**Boilers:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Canadian Vickers Ltd.
Combustion Engineering Corp. Ltd.
Foster Wheeler Limited.
E. Leonard & Sons Ltd.
Vulcan Iron Wks. Ltd.

**Boilers, Electric:**
Can. General Electric Co. Ltd.
Dominion Engineering Works Limited.
Northern Electric Co. Ltd.

**Boilers, Portable:**
Foster Wheeler Ltd.
E. Leonard & Sons Ltd.

**Boxes, Cable Junction:**
Northern Electric Co. Ltd.

**Braces, Cross Arm, Steel, Plain or Galvanized:**
Northern Electric Co. Ltd.

**Brackets, Ball Bearing:**
Can. S.K.F. Co. Ltd.

**Brakes, Air:**
Can. General Elec. Co. Ltd.

**Brakes, Magnetic Clutch:**
Northern Electric Co. Ltd.

**Bridge-Meggers:**
Northern Electric Co. Ltd.

**Bridges:**
Canada Cement Co. Ltd.
Canadian Vickers Ltd.
Dominion Bridge Co. Ltd.

**Bucket Elevators:**
Jeffrey Mfg. Co. Ltd.

**Buildings, Steel:**
Dominion Bridge Co. Ltd.

C

**Cables, Copper and Galvanized:**
Northern Electric Co. Ltd.

**Cables, Electric, Bare and Insulated:**
Can. Westinghouse Co. Ltd.
Can. General Electric Co. Ltd.
Northern Electric Co. Ltd.

**Caissons, Barges:**
Dominion Bridge Co. Ltd.

**Cameras:**
Associated Screen News Ltd.

**Capacitors:**
Bepco Canada Ltd.
Can. Westinghouse Co. Ltd.
Lancashire Dynamo & Crypto Co. of Can. Ltd.

**Castings, Brass:**
The Superheater Co. Ltd.

**Castings, Iron:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Dominion Engineering Works.
Foster Wheeler Ltd.
Wm. Kennedy & Sons Ltd.
E. Leonard & Sons Ltd.
The Superheater Co. Ltd.
Vulcan Iron Wks. Ltd.

**Castings, Alloy Steel:**
Dominion Foundries & Steel, Ltd.

**Castings, Steel:**
Dominion Foundries & Steel Ltd
Wm. Kennedy & Sons Ltd.
Vulcan Iron Wks. Ltd.

**Catenary Materials:**
Can. Ohio Brass Co. Ltd.

**Cement Manufacturers:**
Canada Cement Co. Ltd.

**Chains, Silent and Roller:**
Hamilton Gear & Machine Co.
Jeffrey Mfg. Co. Ltd

**Channels:**
Bethlehem Steel Export Corp.

**Chemicals:**
Canadian Industries Limited.

**Chemists:**
Milton Hersey Co. Ltd.
Roast Laboratories Reg'd.

**Chippers, Pneumatic:**
Canadian Ingersoll-Rand Company, Limited.

**Choke Coils:**
Ferranti Electric Co.

**Circuit Breakers:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.

**Clarifiers, Filter:**
Bepco Canada Ltd.
Crompton Parkinson (Canada) Ltd.

**Clutches, Ball Bearing Friction:**
Can. S.K.F. Co. Ltd.

**Clutches, Magnetic**
Northern Electric Co. Ltd.

**Coal Handling Equipment:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Combustion Engineering Corp. Ltd.

**Combustion Control Equipment:**
Bailey Meter Co. Ltd.

**Compressors, Air and Gas:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Canadian Ingersoll-Rand Company, Limited.

**Concrete:**
Canada Cement Co. Ltd.

**Condensers, Steam:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Canadian Ingersoll-Rand Company, Limited.
Foster Wheeler Limited.

**Condensers, Synchronous and Static:**
Bepco Canada Ltd.
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Crompton Parkinson (Canada) Ltd.
Harland Eng. Co. of Can. Ltd.
Lancashire Dynamo & Crypto Co. of Can. Ltd.
Northern Electric Co. Ltd.
Bruce Peebles (Canada) Ltd.

**Conditioning Systems, Air:**
B. F. Sturtevant Co. of Can. Ltd.

**Conduit:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co Ltd.

**Conduit, Underground Fibre, and Underfloor Duct:**
Northern Electric Co. Ltd.

**Controllers, Electric:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.

**Couplings:**
Dart Union Co. Ltd.
Dresser Mfg. Co. Ltd.

**Couplings, Flexible:**
Dominion Engineering Works Limited
Dresser Mfg. Co. Ltd.

**Couplings, Flexible:**
Wm. Hamilton Div. Canadian Vickers Ltd.
Hamilton Gear & Machine Co.
Wm. Kennedy & Sons Ltd.

**Cranes, Hand and Power:**
Dominion Bridge Co.

**Cranes, Locomotive:**
Dominion Hoist & Shovel Co. Ltd.

**Cranes, Shovel, Gasoline Crawler, Pillar:**
Canadian Vickers Ltd.
Dominion Hoist & Shovel Co. Ltd.

**Crowbars:**
B. J. Coghlin Co. Ltd.

**Crushers, Coal and Stone:**
Canadian Ingersoll-Rand Company, Limited.
Jeffrey Mfg. Co. Ltd.
Wm. Kennedy & Sons Ltd.

D

**Dimmers:**
Northern Electric Co. Ltd.

**Disposal Plants, Sewage:**
W. J. Westaway Co. Ltd.

**Ditchers:**
Dominion Hoist & Shovel Co. Ltd.

**Drills, Pneumatic:**
Canadian Ingersoll-Rand Company, Limited.

**Dynamite:**
Canadian Industries Limited.

E

**Economizers, Fuel:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Combustion Engineering Corp. Ltd.
Foster Wheeler Limited.
B. F. Sturtevant Co. of Can. Ltd.

**Elbows:**
Dart Union Co. Ltd.

**Electric Blasting Caps:**
Canadian Industries Limited.

**Electric Railway Car Couplers:**
Can. Ohio Brass Co. Ltd.

**Electrical Repair Work:**
Montreal Armature Works.

**Electrical Supplies:**
Can. General Elec. Co. Ltd.
Can. Ohio Brass Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.

**Electrification Materials, Steam Road:**
Can. Ohio Brass Co. Ltd.

**Engines, Diesel and Semi-Diesel:**
Canadian Ingersoll-Rand Company, Limited.
Harland Eng. Co. of Can. Ltd.

**Engines, Gas and Oil:**
Canadian Ingersoll-Rand Company, Limited.

**Engines, Steam:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Canadian Vickers Ltd.
Harland Eng. Co. of Can. Ltd.
E. Leonard & Sons Ltd.

**Evaporators:**
Foster Wheeler Limited.

**Expansion Joints:**
Foster Wheeler Limited.

**Explosives:**
Canadian Industries Limited.

F

**Feed Water Heaters, Locomotive:**
The Superheater Co. Ltd.

**Filtration Plants, Water:**
W. J. Westaway Co. Ltd.

**Finishes:**
Canadian Industries Limited.

**Fire Alarm Apparatus:**
Northern Electric Co. Ltd.

**Floodlights:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.

**Floor Stands:**
Jenkins Bros. Ltd.

**Floors:**
Canada Cement Co. Ltd.

**Forcite:**
Canadian Industries Limited

**Forgings:**
Bethlehem Steel Export Corp.
Dominion Steel & Coal Corpn Ltd.

**Foundations:**
Canada Cement Co. Ltd.

G

**Gaskets, Asbestos, Fibrous, Metallic, Rubber:**
The Garlock Packing Co. of Can. Ltd.

**Gasoline Recovery Systems:**
Foster Wheeler Limited.

**Gates, Hydraulic Regulating:**
Canadian Vickers Ltd.
Dominion Bridge Co. Ltd.

**Gauges, Draft:**
Bailey Meter Co. Ltd.
Bristol Co. of Can. Ltd.

**Gear Reductions:**
Hamilton Gear & Machine Co.

**Gears:**
Dominion Bridge Co. Ltd.
Dominion Engineering Works Limited.
Hamilton Gear & Machine Co.
Wm. Kennedy & Sons Ltd.

**Generators:**
Bepco Canada Ltd.
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Crompton Parkinson (Canada) Ltd.
Harland Eng. Co. of Can. Ltd.
Lancashire Dynamo & Crypto Co. of Can. Ltd.
Northern Electric Co. Ltd.
Bruce Peebles (Canada) Ltd.

**Governors, Pump:**
Bailey Meter Co. Ltd.

**Governors, Turbine:**
Dominion Engineering Works Limited.

**Gratings, M. & M. Safety:**
Dominion Bridge Co. Ltd.

H

**Hangers, Ball and Roller Bearing:**
Can. S.K.F. Co. Ltd.

**Headlights, Electric Railway:**
Can. General Elec. Co. Ltd.
Can. Ohio Brass Co. Ltd.
Can. Westinghouse Co. Ltd.

**Heat Exchange Equipment:**
Foster Wheeler Limited.

**Heating Systems:**
C. A. Dunham Co. Ltd.

**Hoists, Air, Steam and Electric:**
Canadian Ingersoll-Rand Company, Limited.
Dominion Hoist & Shovel Co. Ltd.
Wm. Hamilton Div. Canadian Vickers Ltd.

**Humidifying Equipment:**
W. J. Westaway Co. Ltd.

I

**Indicator Posts:**
Jenkins Bros. Ltd.

**Industrial Electric Control:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.

**Injectors, Locomotive, Exhaust Steam:**
The Superheater Co. Ltd.

**Inspection of Materials:**
J. T. Donald & Co. Ltd.
Milton Hersey Co. Ltd.

**Instruments, Electric:**
Bepco Canada Ltd.
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Crompton Parkinson (Canada) Ltd.
Ferranti Electric Ltd.
Moloney Electric Co. of Canada, Ltd.
Northern Electric Co. Ltd.

**Insulating Materials:**
Canadian Industries Limited.

**Insulators, Porcelain:**
Can. Ohio Brass Co. Ltd.
Northern Electric Co. Ltd.

**Intercoolers:**
Foster Wheeler Limited.

J

**Journal Bearings and Boxes, Railway:**
Can. S.K.F. Co. Ltd.

L

**Lacquers:**
Canadian Industries Limited.

**Lantern Slides:**
Associated Screen News Ltd.

**Leading Wire:**
Canadian Industries Limited.

*The advertiser is ready to give full information.*

# Purchasers' Classified Directory

**Library Films:**
Associated Screen News Ltd

**Lighting Equipment, Industrial and Street:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.

**Lightning Arresters:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Ferranti Electric Ltd.
Northern Electric Co. Ltd.

**Line Materials:**
Can. Ohio Brass Co. Ltd.
Northern Electric Co. Ltd.

**Locomotives, Electric:**
Can. General Elec. Co. Ltd.
Can Westinghouse Co. Ltd.

M

**Machinery, Hydraulic:**
Dominion Engineering Works Limited.

**Machinery, Metal and Wood-Working:**
Dominion Engineering Works Limited.

**Magnetic Separators:**
Northern Electric Co Ltd

**Material Handling Equipment:**
Jeffrey Mfg. Co. Ltd.

**Metallurgists:**
Roast Laboratories Reg'd.

**Meters, Boiler, and Coal:**
Bailey Meter Co. Ltd.

**Meters, Electric:**
Bristol Co. of Can. Ltd.
Can General Elec. Co. Ltd.
Can Westinghouse Co. Ltd.
Ferranti Electric Ltd.
Northern Electric Co. Ltd.

**Meters, Flow:**
Bailey Meter Co Ltd.
Neptune-National Meters Ltd.

**Meters, Liquid (Hot or Cold):**
Bailey Meter Co. Ltd
Neptune-National Meters Ltd.

**Mine Cars:**
Canadian Vickers Ltd

**Mining Machinery:**
Canadian Ingersoll-Rand Company, Limited.
Canadian Vickers Ltd.
Dominion Engineering Works Limited.

**Motion Pictures:**
Associated Screen News Ltd

**Motors, Electric:**
Bepco Canada Ltd.
The Can. Fairbanks-Morse Co. Ltd.
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Crompton Parkinson (Canada) Ltd.
Harland Eng. Co. of Can. Ltd.
Lancashire Dynamo & Crypto Co. of Can. Ltd.
Northern Electric Co. Ltd.
Bruce Peebles (Canada) Ltd.

**Moulded Goods, Rubber and Asbestos:**
The Garlock Packing Co. of Can. Ltd.

O

**Oil Burning Equipment:**
Bethlehem Steel Export Corp.

**Oil Refining Equipment:**
Foster Wheeler Limited.

**Ornamental Iron:**
Vulcan Iron Wks. Ltd.

P

**Packings, Asbestos, Cotton and Flax, Metal, Rubber:**
The Garlock Packing Co. of Can. Ltd.

**Paints, all purposes:**
Canadian Industries Limited.

**Paving Materials:**
Barrett Co. Ltd.

**Penstocks:**
Canadian Vickers Ltd

**Phase Rotation Indicators:**
Ferranti Electric Ltd.

**Photographs, Commercial and Portrait:**
Associated Screen News Ltd.

**Piling, Steel Sheet:**
Bethlehem Steel Export Corp.

**Pillow Blocks, Plain, Ball and Roller Bearing:**
Can. S.K.F. Co. Ltd.

**Pinions:**
Hamilton Gear & Machine Co.

**Pipe, Wood Stave:**
Canadian Wood Pipe & Tanks Ltd.

**Pipe Coils:**
The Superheater Co. Ltd.

**Pipe Couplings and Nipples:**
Dart Union Co. Ltd.

**Plates, Steel:**
Bethlehem Steel Export Corp
Dominion Foundries & Steel Ltd.

**Pneumatic Tools:**
Canadian Ingersoll-Rand Company Ltd.

**Pole Line Hardware:**
Can. Ohio Brass Co. Ltd.
Northern Electric Co. Ltd.

**Polishes:**
Canadian Industries Limited.

**Powder, Black and Sporting:**
Canadian Industries Limited.

**Power Switchboards:**
Bepco Canada Ltd.
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Crompton Parkinson (Canada) Ltd.
Harland Eng. Co. of Can. Ltd.
Northern Electric Co. Ltd

**Preheaters, Air:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Combustion Engineering Corp
Foster Wheeler Limited

**Projectors:**
Associated Screen News Ltd.

**Pulleys:**
Plessisville Foundry.

**Pulleys, Ball Bearings, Loose:**
Can S.K.F. Co. Ltd.

**Pulp and Paper Mill Machinery:**
Can. General Elec. Co. Ltd.
Canadian Ingersoll-Rand Company, Limited
Can. Westinghouse Co. Ltd
Dominion Engineering Works Limited.
Wm. Hamilton Div. Canadian Vickers Ltd
Harland Eng. Co. of Can. Ltd.

**Pulverized Fuel Systems:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Bethlehem Steel Export Corpn.
Combustion Engineering Corp. Ltd.
Foster Wheeler Limited.
Wm. Kennedy & Sons Ltd.

**Pump Valves, Rubber:**
The Garlock Packing Co. of Can. Ltd.

**Pumps:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Canadian Ingersoll-Rand Company, Limited.
Foster Wheeler Limited.
Wm. Hamilton Div. Canadian Vickers Ltd.
Harland Eng. Co. of Can. Ltd.

**Purifiers, Water:**
W. J. Westaway Co. Ltd

R

**Radiator Air Vents and Traps:**
Jenkins Bros. Ltd.

**Radiator Valves:**
Can. Ohio Brass Co. Ltd.
Jenkins Bros. Ltd.

**Radio Receiving Sets:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.

**Radio Transformers:**
Ferranti Electric Ltd.

**Rail Bonds:**
Can. Ohio Brass Co. Ltd
U.S. Steel Products Co.

**Rail Braces and Joints:**
B. J. Coghlin Co.

**Railway Equipment:**
Can. General Elec. Co. Ltd.
Canadian Ingersoll-Rand Company, Limited.
Can Ohio Brass Co. Ltd.

**Receivers, Air:**
Canadian Ingersoll-Rand Company Limited.
E. Leonard & Sons Ltd.

**Recorders**
Bailey Meter Co. Ltd.
Bristol Co of Can. Ltd.

**Refrigerating Machinery:**
Canadian Ingersoll-Rand Company, Limited.

**Regulators, Feed Water:**
Bailey Meter Co. Ltd

**Reservoirs:**
Canada Cement Co Ltd.

# Purchasers' Classified Directory

**Riveted Pipe:**
Dominion Bridge Co. Ltd.
**Roads:**
Canada Cement Co. Ltd.
**Road Machinery:**
Plessisville Foundry.
**Rods:**
Bethlehem Steel Export Corp.
**Rolls, Paper Machine:**
Dominion Engineering Works Limited.
**Roofing, Prepared:**
The Barrett Co. Ltd.
**Roofs, Built-up:**
The Barrett Co. Ltd.
**Rope, Wire:**
Dom. Wire Rope Co. Ltd.

S

**Screening Equipment:**
Canadian, Ingersoll-Rand Company, Limited.
Foster Wheeler Ltd.
**Separators, Electric:**
Northern Electric Co. Ltd.
**Sewers:**
Canada Cement Co. Ltd.
**Shingles, Prepared Asphalt:**
The Barrett Co. Ltd.
**Shovels — Powered Electric or Gasoline:**
Canadian Vickers Ltd.
**Smokestacks:**
Canada Cement Co. Ltd.
Canadian Vickers Ltd.
Foster Wheeler Ltd.
E. Leonard & Sons Ltd.
**Softeners, Water:**
W. J. Westaway Co. Ltd.
**Sporting Powder:**
Canadian Industries Limited.
**Springs — Automobile, Railway, Wire:**
B. J. Coghlin Co. Ltd.
**Stains:**
Canadian Industries Limited.
**Steam Plant Equipment:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Combustion Engineering Corp. Ltd.
Foster Wheeler Limited.
Harland Eng. Co. of Can. Ltd.
**Steel Plate Construction:**
Canadian Vickers Ltd.
Dominion Bridge Co. Ltd.
Foster Wheeler Ltd.
E. Leonard & Sons Ltd.
**Stokers:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Combustion Engineering Corp. Ltd.
**Structural Iron and Steel:**
Canadian Vickers Ltd
Dominion Bridge Co. Ltd
Vulcan Iron Works Ltd.
**Superheaters:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Foster Wheeler Limited.
The Superheater Co. Ltd.
**Surge Absorbers:**
Ferranti Electric Ltd.
**Switchboards, Power Lighting:**
Bepco Canada Ltd.
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Crompton Parkinson (Canada) Ltd.
Harland Eng. Co. of Can. Ltd.
Northern Electric Co. Ltd.

T

**Tanks:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Braithwaite & Co. Engineers Ltd
Canada Cement Co. Ltd.
Canadian Vickers Ldt.
Dominion Bridge Co. Ltd.
Foster Wheeler Ltd.
E. Leonard & Sons Ltd.
Vulcan Iron Wks. Ltd.
**Tanks, Wood:**
Canadian Wood Pipe & Tanks Ltd
**Tees:**
Dart Union Co. Ltd.
**Telegraph Line Material:**
Northern Electric Co. Ltd.
**Testing Sets:**
Moloney Electric Co. of Can., Ltd.
**Thermometers, Recording:**
Bailey Meter Co. Ltd.
Bristol Co. of Can. Ltd.
**Tiles:**
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No. 10

OCTOBER
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## *In this issue*



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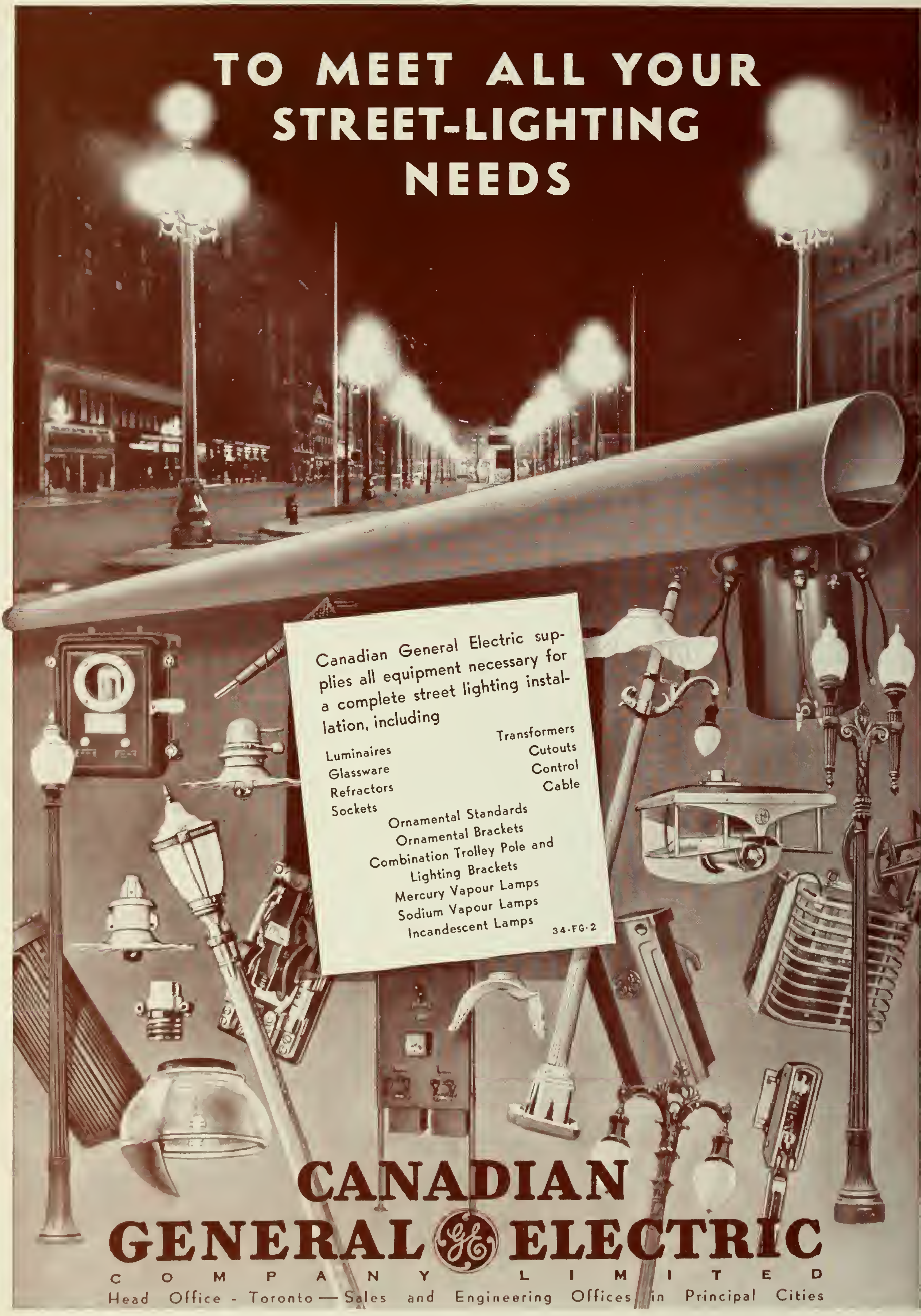

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# The Romance of the Construction Industry in Canada

Toronto skyline from the waterfront

Sept. 17, 1930—East Heading Shaft No. 6

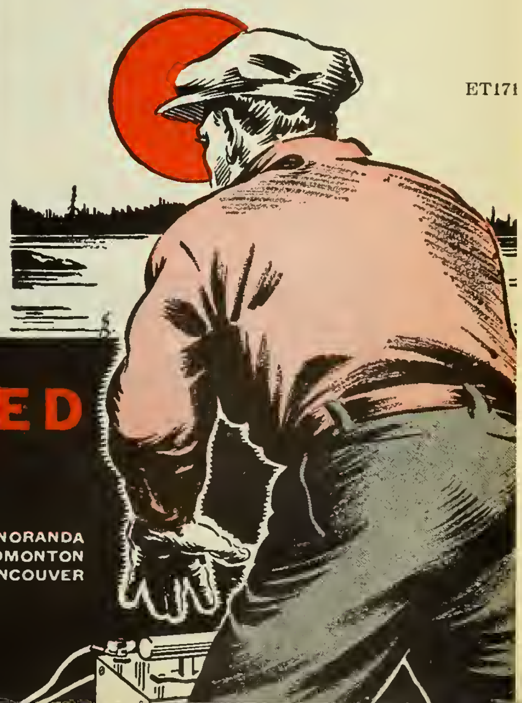
## FILTERED WATER TUNNEL *for the* City *of* Toronto

FROM early times, water has been conveyed in aqueducts formed by tunnelling. These tunnels were of small cross-sections, and many of them were of great length. They generally followed the grade of the flowing water and where valleys were encountered they were crossed by aqueducts of stone arches, many of which still exist.

The new filtered water tunnel completed last year by the Water Works Department of the City provides for the future water supply of Toronto. The tunnel extends from Keele Street on the West to the city limits on the East, covering a distance of some 9½ miles, at a depth varying from 100 to nearly 200 feet below the water level. The construction of the tunnel was carried on through shale rock formation. The diameter of the tunnel varies from six to ten feet and has a capacity of 140,000,000 gallons per day.

In projects such as this, explosives played a large part, doing the work quickly and economically; in fact, without the use of explosives, the completion of the Toronto filtered water tunnel would be far off.

Dec. 21, 1931—Intake from Shaft South



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# New Leakproof Butt Joint for


THE new CANADIAN BUTT JOINT for continuous-stave wood pipe has proven absolutely leak-proof under severe tests of blistering heat, sub-zero frosts and pressures, after a year's service at the famous Pioneer Mine, Bridge River District, B. C. The International Paper Co. Ltd., Timiskaming, Que., also selected the Canadian Butt Joint for its new 5-foot mill-supply line, 6,250 feet long.

An integral part of the pipe, this new joint withstands more pressure than the pipe itself. There are no extra fittings to become lost, no metal to rust or corrode, and no delays in setting up. The Canadian Butt Joint surpasses all types of metal tongues or fittings and is, in our opinion, the greatest single improvement in wood-pipe history.

It can be obtained only with Canadian Continuous-Stave Wood Pipe and is supplied at no extra cost. To get the many advantages of the new CANADIAN BUTT JOINT, make certain you order Canadian Wood Pipe.

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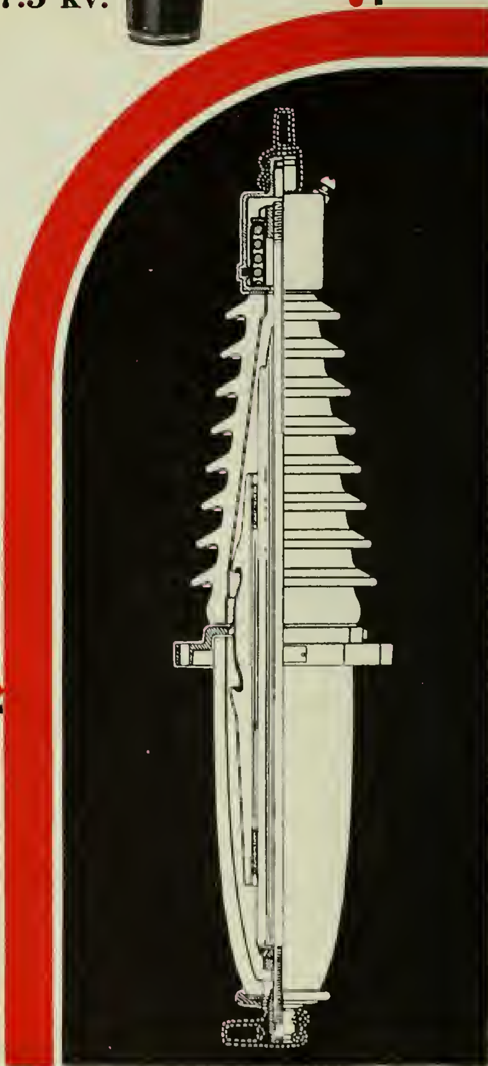
69 kv.

34.5 kv.

7.5 kv.



*Line drawing showing the compression-assembly used in O-B Class L Bushings. Note the absence of cemented joints. All external porcelain parts are under compression, insuring great mechanical strength and making the bushing absolutely leak-proof.*

# NOW-Ⓑ OIL-FILLED BUSHINGS *for Voltages as Low as 7.5 kv.*

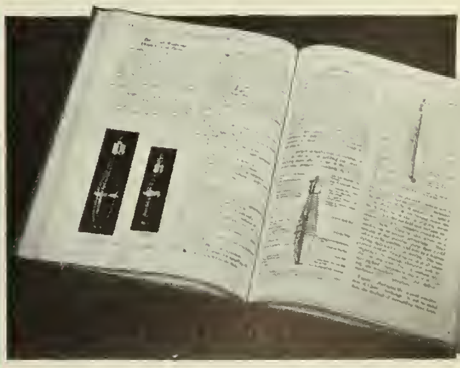
For years, oil-filled bushings have played an important part in the proper functioning of transformers and circuit-breakers in high-voltage service. Now, the same desirable characteristics of these higher-voltage, oil-filled bushings are incorporated in a new line of O-B bushings for voltages ranging from 69 kv. to 7.5 kv.

The new lower-voltage, oil-filled bushings, known as the O-B Class L, have internal porcelain baffle systems and internal grading shields. Many features, unusual to lower-voltage bushings, are found in this new O-B design.

1. Porcelain is used to maximum extent for internal insulating core.
2. Bushings are free from radio interference.
3. Internal electrical grading is used.
4. The bushings will flashover without puncture.
5. Provision is made for installing co-ordinating gap at any time.
6. All external joints are self-tightening.
7. There are no external cement joints.
8. The bushings are oil-and-weather tight.
9. Ample room is provided for oil expansion.
10. The bushings have convenient means for sampling oil.
11. The bushings can be repaired readily in the field.

If sub-station design and maintenance is your interest, we believe you will find much of value in these new bushings that warrants giving them full consideration, perhaps with the view toward incorporating their advantages in your scheme of operation.

These new bushings are completely described on pages 118 to 150 of your New C-O-B Catalog No. 21.

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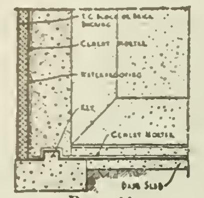
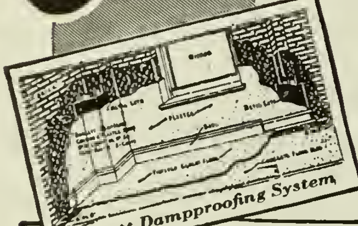
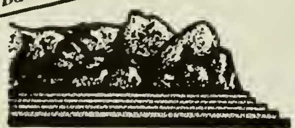
# From Foundation to Roof with Barrett Quality Products



Barrett Waterproofing System


Barrett Dampproofing System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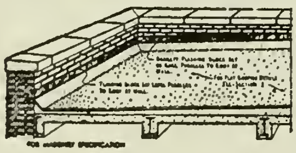
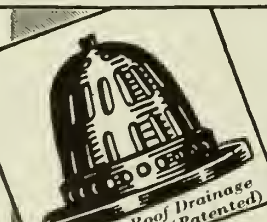
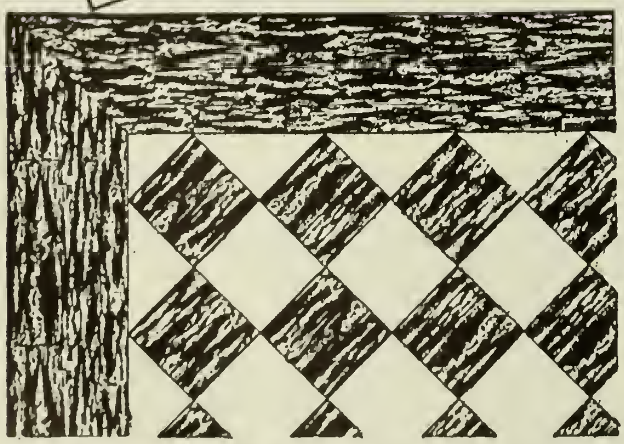

Barrett Roof Flashing System


Barrett Roof Drainage Connections (Patented)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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"*

**October 1934** **Volume XVII, No. 10**

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# Geology and Civil Engineering

## Their Relationship, with reference to Canada

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Paper presented before the Montreal Branch of The Engineering Institute of Canada, January 18th, 1934.

SUMMARY.—The paper surveys the applications of geological principles and methods to the practice of civil engineering. Although the "Father of British Geology," William Smith, was a civil engineer, the importance of geology to civil engineers was for long neglected: probable causes of this neglect are indicated. A broad outline of the science of geology is presented to provide a background for a discussion of the application of the science to a number of general divisions of civil engineering work, illustrated by examples taken from actual practice. In conclusion, a summary of the principal means of contact of the science and the art are suggested. An appendix provides a guide to references to civil engineering geology in the records of The Institute, and in general literature.

William Smith, world renowned as the "Father of British Geology," was a civil engineer. Born in 1769 of humble origin, he spent an appreciable part of his life of fifty years as a canal engineer in Somerset, England, becoming later a land agent near Scarborough. He was one of the first to introduce into what was then a purely descriptive science the concept of quantitative study and regular stratigraphical succession, and so helped to establish the science on the basis on which it is founded today. The work for which he will ever be remembered was the preparation of the first real geological map of England and Wales. He practised extensively as a consultant on geological matters, often with special reference to their application to engineering work.[1]

Other early engineers were vitally interested in geology and applied its principles to their work, their direct approach to the many problems encountered naturally leading them to considerations of the structure and constituents of the earth's crust. Robert Stephenson stands out from amongst them: to him must be accredited the first scientific investigation of the movement of water in sand, his observations on the underground water encountered during the construction of the Kilsby tunnel completed in 1838 being classical, although contained only in reports to directors.[2]

These early days offer a strange contrast to the divorce of the science from engineering which has persisted through many of the intervening years. The divergence is the more strange when it is considered that in every branch of civil engineering some contact with geological conditions is inevitable. For geology is essentially the study of the nature of the earth's crust, whilst the civil engineer, in seeking to control the forces of nature for the use and convenience of man, constructs something on, in, or through the earth's crust, using a variety of materials, amongst which some natural product of the earth is almost always included. The contact is so intimate that to stress it unduly would be out of place, and yet it may be that its very intimacy has been a potent cause for its neglect.

Brief consideration of some of the more indirect causes is instructive. It is suggested that one such reason has been the prevalent misconception as to what the science of geology actually is, its scope, what it can do, and on the other hand the limits of present day geological knowledge. A further cause has been undoubtedly the natural antipathy of the practically minded engineer to the popular idea of a geologist as one whose preoccupation was an unceasing hunt for fossils.

In recent years there may have been a reaction on the part of engineers who have had unfortunate contacts with pseudo-geologists, of whom there have been some in the mining field. Others may have found it difficult to envisage applied geology in any other field but that of mining. The most potent factor of all, perhaps, is the question of expense. To employ a geologist in consultation means the expenditure of additional money; civil engineering works have been carried out in the past without the aid of geologists; so why employ one now? So runs a familiar argument which, superficially, is difficult to refute. Fundamentally, however, the argument is fallacious, as it is the intent of this paper to show. Finally, amongst younger men there is often an unfortunate distaste for geology, due to injudicious choice of textbooks and to the method of presentation of the subject to them, as students.

The state of affairs indicated by the foregoing is unfortunate, and demands attention. It is not common practice to publish details of, and to discuss failures of civil engineering works, and even public discussion of difficulties encountered during construction is infrequent. This tendency is to be regretted since it is only by the analytical consideration of failures that some discoveries are made. If failures of civil engineering works could be analysed, there can be no doubt but that the majority would be found to be due to defective foundation conditions or to defects in geological structure.

In the course of the discussion of a paper[3] giving details of remarkable difficulties encountered in founding piers for a bridge in New South Wales, presented before the Institution of Civil Engineers, Dr. W. L. Lowe Brown, M.Inst.C.E., stated:—

"If a small fraction of the time spent on refined calculations and very accurate designing were spent on watch-

*Canadian Sheet Piling Company Limited, Montreal.

ing the preliminary boring operations and in examining the foundations when work was in progress, the benefit would probably be many times greater than any advantage from the greatest attention to refinement of calculation of design."

The adequate performance of the duties just mentioned necessitates some geological knowledge. Similar statements can be made with respect to tunnel work and open excavation and prove to be even more applicable.

The experience obtained in a tunnel but a few feet from The Institute headquarters need be no more than mentioned as a case in which the neglect of geology prior

Fig. 1—Gaillard Cut, Culebra, Panama Canal.

to construction is said to have led to difficulties and extra expense, all of which might have been avoided.* In any publication on geology and civil engineering, mention of the troubles encountered in the excavation of the Panama canal has become almost proverbial. Yet the "classical" nature of the upheavals caused by the failure of argillaceous sandstone renders an apology for mention of the case scarcely necessary.

The accompanying illustration, Fig. 1, shows the Gaillard Cut, Culebra, after the disastrous slide of September 1915, when the island seen in the centre came up overnight out of 30 feet of water. One third of the material excavated from this cut has been due solely to slides.[4, 5, 6]

The "preventative" work, indicated in the foregoing paragraphs, which geology can effect when applied to civil engineering, is but one phase of their relationship. Definitely, constructive information is equally as important an outcome of contacts of the science and the art. Excavation and tunnelling methods may often be aided materially both as regards cost and speed by adequate study of geological conditions. New building stones can only be fully investigated if subjected to microscopical examination and tested in relation to their position in the geological structure. Underground water supply is a matter founded almost solely on geological investigations. Other examples will be cited in the course of this paper.

The selection of the data to be submitted in order to bear out what has already been indicated in general terms has been difficult owing to the wide scope of the subject and to the mass of information available. In this paper a brief review of the science, its methods of investigation, etc., is first given in order to provide a background for the adequate appreciation of its application to civil engineering. Points of contact of the two are then considered, illustrated by examples from practice.

*In this connection see reference by Dr. Ries on page 6 of The Engineering Journal for January 1929.

### *Geology*

#### An Outline of the Science

Geology is perhaps best defined as the branch of natural science devoted to the study of the physical features of the earth, the composition and structure of the rocks composing it, and the evolution of animals and plants from their unknown beginnings. Intimately associated with it is the twin science of mineralogy which describes and classifies the various kinds of minerals constituting the earth's crust, and meteoric bodies which reach the surface of the earth.

The pioneers of geological investigation are all men of the last two centuries, and of many nationalities, from amongst whom Sir William Logan (1798-1875) will long be remembered for his pioneer work in Canada.

The science may to-day be conveniently divided into five main sections:—

(*a*) *Cosmogony:*
The study of the relation of the earth to the solar system, and to the universe, and of the origin and early stages of the terrestrial sphere.

(*b*) *Physical Geology:*
The study of the form of the earth's surface, its structure, manner of origin, and the nature of the modifying processes at work upon it.

(*c*) *Petrology:*
The comparative study of rocks and the constituent minerals, found in the accessible crust of the earth (part of this field being covered jointly with mineralogy).

(*d*) *Palaeontology:*
The study of the biology of fossil life.

(*e*) *Stratigraphical Geology* (or Stratigraphy):
The study of the history of the earth and its geography in past ages by means of present structural relationships of the component materials in the earth's crust and of their fossil contents.

Field geology covers part of the work of all sections, as the science has been built up by patient observation of, and consequent speculation upon, the nature and details of the earth's crust. Results of investigations in stratigraphy are recorded by means of geological maps, sections and tables of succession, the other divisions utilizing standard methods of record. Detailed study of specimens by means of chemical tests, the microscope, the use of polarized light, the comparative study of fossil forms, and more recently the adoption of mechanical methods of analysis have enabled many aspects of the science to be studied in the laboratory as well as in the field. Within recent years, the development of geophysical methods of prospecting have put into the hands of the geologist a new and invaluable tool, the full significance of which is not yet generally realized.

Economic geology is the general term that has been given to the applications of the findings and methods of the pure science to utilitarian purposes. It may be divided conveniently into four main groups:—

(*a*) Mining geology concerned with the discovery and working of metallic ores;
(*b*) Mining geology concerned with the discovery and working of useful "earths";
(*c*) Mining geology concerned with the discovery and working of natural fuels;
(*d*) Civil engineering geology.

With the first three sections this paper is not directly concerned, but the work achieved in each case by the application of geology has been of inestimable benefit to mankind.

It is hoped that the above outline is reasonably clear, since although each individual contact of the science and civil engineering may be limited to one branch of geology, the proper application of that branch can only be made if the particular problem can be considered in relation to the science as a whole. Before passing on, some further notes on those divisions of the science directly concerned with such contacts may well be made. These are physical geology, petrology and stratigraphy. Between them, they cover the investigation of the form and structure of the earth's crust at the present time, and its general composition, a field which can be seen to be exactly that which the civil engineer must enter in order to conduct his operations.

Physical geology is based on direct and indirect field observations of what may perhaps be termed the "mechanical" aspects of the earth's surface, considered in relation to the well known geological cycle of denudation, deposition and earth uplift. The analytical study of topographical maps is one basis for such work. Coupled with the study of surface waters goes the investigation of underground water, as revealed in wells, by springs and general indications of water tables. Erosion and silting form important lines of study. Finally, the study of volcanic action, seismology and all associated work on active earth movement occupies an important part of the field of physical geology.

Stratigraphy, and associated with it, structural geology, may justly be regarded as the logical development of physical geology, field observations again forming a foundation on which the whole fabric of stratigraphical knowledge has been built. The study finds its main expression in geological maps and sections, as distinct from topographic maps. The nature of these maps will be generally known —how that by means of colouring or shading the varying nature of the rock outcropping over the mapped area is indicated. Notations of dip and strike (i.e. of the angle made by the beds of rock with the horizontal, and the direction of a line running horizontally along the beds) result in the map being more than a record of surface conditions, and geological sections frequently accompany each map sheet in order to show the structural relation of the various types of rock encountered. Folding, faulting, unconformities and erosion of rock strata can readily be discerned from such maps. After a careful examination of an area in which a sufficient number of rock outcrops occur an accurate prediction of conditions far below the surface becomes possible. The presence of superficial, drift or glacial deposits often complicates the preparation of such "solid" maps and leads (in some districts) to the necessity for two sets of geological maps. The other directions of stratigraphical enquiry do not affect directly the civil engineer or his work.

Petrology, the study of rocks, is more the field of the expert than either of the divisions previously considered, being based on observations of hand specimens and microscopic sections which often require mature experience for their interpretation. The elements of the study can however easily be mastered and on these experience is built up. The appearance, weight, texture, structure, hardness and feel of hand specimens enables the investigator to classify them broadly. Simple chemical tests and examination of thin sections through a microscope will enable a more detailed classification to be made, and this is generally sufficient for all engineering purposes.

### *Geology: Applications in Civil Engineering*

#### General Preliminary Work

The first essentials in any civil engineering project are a reasonably definite idea of the work to be built and knowledge of the topography of the location selected. Requisite foundation depths and rock levels underground are usually assumed. If the project proves to be a favourable one, the next steps taken will be the collection of such physical data as need to be utilized, the preparation of a detailed plan of the site and in some cases the drilling of test holes and the digging of test pits in locations dictated by considerations of topography. Utilizing information so obtained, final designs are prepared, arrangements for construction made (when finance permits) and active building starts.

Such is the general case and no alternative is suggested to this logical procedure but in almost every case it should be extended to include geological investigation. When the preliminary surveying is carried out, geological survey work of a corresponding degree should also be done. The two branches of work can be carried out at the same time and possibly by the same engineers. Such geological survey work would include the recording of all solid rock outcrops in the area to be mapped, details of their dip and strike, the nature of the rocks exposed, signs of earth movement, nature of overburden, etc. This last item is of special significance in Canada in view of the wide distribution of glacial drift and similar surface deposits. Field observations of such strata may seem trivial, but they can often be of great value. From this information a general idea of conditions obtaining below ground level can be derived. If the area in question has been mapped by the Geological Survey, the published map will often suffice for this part of the work.

It is, however, in the final planning of projects that geology should be of most avail. Concurrently with the preparation of the final topographic maps, geological surveys should be carried out of such a nature as is called for by the type of work in hand. In the case of a tunnel, an accurate geological survey along all possible routes of the tunnel is the main requirement; for a reservoir, a map and section showing the relation of the strata in the adjoining valleys; for a bridge, a section along the centre line of the pier foundations. To be fully effective, the two surveys should be carried out either simultaneously or in the closest co-operation. Another section of geological field work of general application to civil engineering work is a reconnaissance of the district around the site, chosen with a view to the location of suitable sand and gravel for concrete work, and possibly of building stones or road metal. In the case of surveys of small areas in populated parts, the work will often involve an examination of available geological records of adjacent properties. At the same time a diligent search through all available geological literature which may have any bearing on the area under consideration should be made—a task that can only properly be done by a geologist.

Finally, drill holes and test pits call for special mention. These exploratory aids are widely employed. The observation cannot be withheld, however, that if the money that has been wasted in the past by the injudicious location of drill holes and test pits—even in Canada—could be calculated, the total would be surprising. For to put down test pits and borings without relation to the geological structure of the ground, as is generally the case, is surely the most illogical of all practices in civil engineering. Figure 2 illustrates how deceptive drill holes can be. It is based on an actual section and is but one of many ways in which a trial boring can lead to incorrect conceptions of the underlying strata. The incorrect nature of the deductions as to foundation conditions which would be drawn (normally) from the drill holes marked is clear. The only comment to be made is that the presence of the fault and the porous sandstone would be undetected unless the structure of the surrounding ground had been carefully studied and especially in relation to the results obtained from the borings.

Test borings are however an essential in all but exceptional cases: the foregoing remarks point only to the fact that to be effective the location of such holes must be carefully selected with reference to the geological information available. All such exploratory work must be carried out with the greatest care, constantly under the supervision of an engineer and/or geologist who can record accurately the results obtained and interpret them correctly. The information revealed by cores should always be plotted on the geological sections available while work proceeds. Trial pits may be necessary in certain isolated cases and when the depth to be explored is small. A careful boring will, however, generally give the same information at a fraction of the cost of such a shaft. Test pits involve some

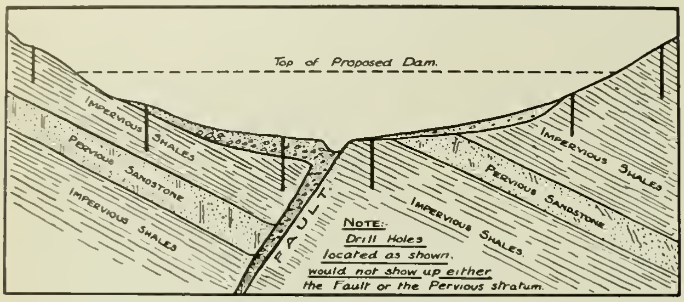


Fig. 2—Sketch of Section of River Valley.

hazard in construction, can only be constructed slowly, and if boulders are encountered either drilling will have to be resorted to, or else a definite result can not be obtained. Details of drilling work need not be given here but it is suggested that work of this nature should be paid for on a day-labour basis in order to obviate the slightest possibility of the work being improperly executed. Drilling should not be stopped until it can be stated with certainty that the result obtained is definite, i.e. that rock has been reached and not merely a boulder.

The almost insuperable difficulties met with during the construction of the Silent Valley dam for the Belfast City and District Water Commissioners were due, very probably, to the assumption that granite boulders encountered by the original test boreholes were solid rock. Actually, instead of a rock foundation being found at a depth of about 50 feet below ground level, the cut off trench had to be carried to a depth of 180 feet, through running sand of such a nature that the use of the maximum working pressure of compressed air only served to reduce the water level a few feet. The final solution of the problems thus encountered provides a fascinating study.[7]

There are available to-day alternatives to the exploratory methods just considered in cases where the surface of rock is concealed by overburden. These can be classed generally as geophysical methods and include gravitational, electrical and seismic prospecting. Methods of this kind depend on theoretical considerations which permit of no succinct explanation and so no more than this passing reference can be made to them here. Informative literature on these prospecting methods is generally available.[8, 9] Again, however, records of depth to rock so obtained can only be of real avail if considered in conjunction with the results of general geological investigations, and when confirmed by drilling.

The information obtained by methods outlined above will often influence design to some degree, as will presently be explained: facts will also be available which may influence construction methods. These data, although reasonably accurate, lack the precision attainable only by actual measurement. They must therefore be constantly checked as construction proceeds and actual sections are revealed. Work of this nature is just as important as the initial investigation and should be as carefully attended to, for if troubles unforeseen at the start of construction are to be encountered, some indication will be given, almost invariably, which will act as a warning if interpreted aright. The nature of such "check" geological work will vary according to the nature of the civil engineering project, but the importance of careful observation and recording of all new sections opened up on every undertaking cannot be over-emphasized.

A paper by Dr. J. A. Allan published in The Engineering Journal[10] in 1927 is an admirable example of such preliminary geological studies as have been described. Numerous references to preliminary geological investigations carried out for the Shawinigan Water and Power Company in the Upper St. Maurice Valley have appeared in the press and were mentioned in a paper describing the survey work in this area recently printed in The Journal of The Institute.[11] The publications of the United States Geological Survey include several papers devoted to investigations of this kind.[12, 13] As further examples of such exploratory work, two notable civil engineering works in Great Britain will be cited, as each was in its way unique at the time the work was undertaken. Both are instances of useful co-operation between geology and civil engineering in preliminary investigations.

The Vyrnwy dam, impounding water for the supply of the City of Liverpool, was the first "great" dam to be built in Great Britain, construction occupying the years 1880 to 1890.[14] Mr. Thomas Hawksley and Dr. G. F. Deacon, MM.Inst.C.E., were the engineers responsible for this project. In the preliminary surveys of the Vyrnwy valley, the engineers deduced from surface indication that the valley was the site of an old glacial lake, held up at one time by a rock bar. They placed the centre line of the dam, for the Parliamentary plans, along the deduced position of this rock bar. Subsequent detailed investigation by trial drill holes and shafts proved the inference to be practically correct, and the dam was built as originally located. Dr. Deacon afterwards estimated that between $1,500,000 and $2,000,000 were saved on what the dam would have cost had it been located only 220 yards either upstream or downstream of the location selected.

The River Mersey provides a natural barrier between the City of Liverpool and the Wirral Peninsula. Two tunnels now penetrate the bed of the river, at Liverpool,

Fig. 3—Vyrnwy Dam showing Exposed Foundation Bed of Glaciated Rock.

and the construction of each one was materially assisted by the application of geology. The first, that in which runs the Mersey Railway, was constructed between 1881 and 1886.[15] The tunnel was driven through the local Bunter sandstone, and its level was modified in view of the prediction by a local amateur geologist, Mr. T. Mellard Reade, some years previously[16] of a buried channel in the present bed of the river. This prediction and also that of a sub-Mersey fault by another geologist, Mr. G. H. Morton, were verified during the tunnel construction.

The Mersey vehicular tunnel, which has just been opened, is the greatest subaqueous tunnel in existence. The experience mentioned above and subsequent records compiled by other local geologists have been utilized by Professor P. G. H. Boswell, F.R.S., in connection with his notable work as geological advisor on this project and a full description of this application of geology is shortly to be published.

TUNNELS

The examples just given might well be regarded as an introduction to the consideration of geology as applied to tunnelling, than which there is no more vital application of the science. The best route to be followed, the minimum allowance of rock cover (in the case of pressure tunnels), the necessity for and design of reinforced linings, construction methods to be adopted, and the possibility of encountering underground water during construction—all these major issues in tunnel work depend essentially, and in some cases wholly on the geological features to be encountered.

Preliminary work having been discussed, it will suffice to state here that there are few tunnel locations which cannot be mapped geologically prior to construction, with a fair degree of accuracy. The rocks liable to be met with will generally outcrop locally and so can often be examined and compared with similar rock encountered on other tunnel work. These comparisons will, in certain cases, lead to useful information. With such data available before construction starts, the civil engineer is enabled to base his designs on a rational basis rather than on empirical assumptions. He will also be able to draw up specifications which will apply fitly to the work to be done, thereby aiding the contractor and leaving few if any loopholes for dispute due to constructional difficulties. The question of overbreak is probably that which causes more trouble and litigation after tunnel driving than any other. Although no final statements can be made about it until construction is under way, yet adequate preliminary geological investigation will permit of the inclusion of clauses in the specification and terms of contract which will admit of little questioning when construction is over.

Throughout the construction of a tunnel it is essential to keep a continuous and accurate geological record of the section of the earth's crust that is pierced. This should be regularly checked with that prepared beforehand and with general surface details both topographical and geological. In this way it is probable that any unusual difficulties will be foreseen. The actual work of excavation depends primarily on the nature of the rocks encountered, but also on the dip and strike of their strata. While the latter can be foretold with some degree of accuracy, structural displacements may cause unexpected changes. Again close observation and a carefully compiled record of the dip and strike encountered as driving proceeds will aid in forecasting such changes thus enabling the requisite adjustments in drilling and blasting arrangements to be made. Should there be serious trouble with overbreak, a geological section obtained during construction will always be the determining factor in deciding any case that may come into a court of law.

The preceding remarks apply generally to tunnels through solid rock, but some apply also to excavation work through clay and other softer material. In such cases, and in certain cases of tunnels in rock, underground water will often prove to be one of the main difficulties encountered. Geology can here be of avail in providing the means for a study of underground water table conditions, the methods of grouting which can be most advantageously adopted, and in indicating what means of drainage exist. As an interesting example, the drainage of one of the "tube" railways in London, England, may be mentioned. Driven through the well known London clay, all drainage water leaves it *down* a drain pipe leading to the underlying chalk. This unusual expedient was adopted on geological advice and has proved entirely satisfactory. The Kilsby tunnel has already been mentioned[2]: probably no better example could be given of a tunnel, the construction of which was so hindered by water troubles that work on occasion had to stop.

As an example of tunnel work illustrating close co-operation between geology and civil engineering, the Lochaber water power tunnel will be cited. Located in the north of Scotland, this work is described because of its size and of the fact that the author had the privilege of being intimately associated with the work, on the staff of the consulting engineers, Messrs. C. S. Meik and Halcrow. The Lochaber development will generate ultimately 120,000 h.p. under a head of 800 feet, at a power house adjacent to Fort William, Inverness-shire. All this power will be utilized for the manufacture of aluminium by the British Aluminium Company for whom the project is being carried out. References are given to complete descriptions of the works.[17, 18]

**Fig. 4—Tunnel Running at Right Angles to Strike.**

Loch Treig is the main reservoir for the scheme, located more than 15 miles from the power house site, and joined to it by means of a pressure conduit consisting of a pressure tunnel and a steel pipe line. The tunnel is just over 15 miles long and has an average effective diameter of about 15 feet so that it constituted, when constructed, the largest of its kind in the world. Prior to construction a geological survey of the route selected for topographical reasons was made by Professor E. B. Bailey, as a result of which this route was confirmed. The tunnel passes under Ben Nevis and through rock strata constituting one of the most geologically complicated parts of Great Britain, the rocks encountered varying from shattered mica schist to granite and baked schist so hard that three sets of drill steel were required for each hole in each round.

Most of the staff of the resident engineer had a working knowledge of geology and so a close check was kept on all rock features encountered during construction. Professor Bailey made a complete geological survey of the tunnel during construction and in this way the public records were enriched. Few unusual features were encountered, deductions from surface exposures being generally confirmed. Figures 4 and 5 show clearly the effect of drilling into and at right angles to the strike and along it, in the mica schist, features which affected the excavation programme of the contractors. At the Loch Treig end of the tunnel some bad slips in soft mica schist occurred, but caused no serious trouble as all but two were located accurately from surface indications. The excavation of the tunnel was completed in 1929, its successful completion and the absence of serious troubles being undoubtedly due, in great part, to the constant assistance rendered by geology.

### Earthworks

This division is intended to cover excavation in open ground for purposes other than confined foundations. Again, the success and stability of such works is dependent

Fig. 5—Tunnel Running along Strike.

ultimately on geological features. A study of these conditions can often avail much in aiding and expediting excavation work in ways already indicated.

A special feature of all earthwork problems is the general question of the angle of slope or repose to be adopted for the material excavated or embanked. Too often this important factor is chosen either arbitrarily or by the use of empirical rules. Yet the change in volume of material effected by even a small change in the angle of repose assumed is large and is generally realized. The fact that almost an infinite variation of the type of material forming either the sides of excavation or an embankment is possible, explains the initial adoption of empirical rules for slope angles, and is at the same time the strongest of reasons for the individual consideration of each case of such work. For this reason alone, in practically all major work involving earth slopes, the angle of internal friction of the materials being worked should be determined as carefully as possible before work commences and checked periodically as work proceeds. Experimental methods are available for giving the information desired and experimental results can be utilized with confidence so long as the drainage of the slopes is watched and due consideration given to the possibilities of the slopes becoming waterlogged, as in the case of the banks of a reservoir.

Mention of drainage suggests the general matter of landslides. So many factors enter into these oft-time disastrous earth movements that to generalize about them in such a paper as this is difficult. It can be stated definitely, however, that whenever remedial works have to be carried out after either indications of an impending slip or an initial earth movement, the principles of geology should always be utilized by the civil engineer responsible. In all cases they can be of some avail; in some they will suggest remedial measures; in others they will prevent further damage being done by injudicious operations. Failure or erosion of the weakest bed in certain strata is one potent natural cause of slips, particularly of rock slips and rock falls (utilizing Professor Heim's classification). Interference with natural drainage conditions is probably the most general cause of soil slips and earth slides, the interference being either natural or caused by adjacent works. There are on record several notable instances of the stopping of earth movement by suitable drainage, including the saving of a pier of a large steel bridge of the Chicago and North Western Railway in the Des Moines river, but space does not permit of detailed reference to them. It is, however, instructive to note that William Smith employed this same method in order to prevent serious damage due to a possible land slide at Coombegrove, near Bath, in the year 1800. For a similar reason the composition and construction of earth dams, now an extensive and involved subject, can be but noted. The effect of earth movements, generally known as faulting, must however be mentioned, for as much trouble is caused in earthwork due to this as occurs in rock excavation. Major faults can generally be mapped from surface indications, but minor faults are often obscured by vegetation and so are difficult to ascertain until excavation is in progress. Careful observation is the first essential in all localities, and, coupled with some knowledge of the local geology, will often be the means of preventing serious trouble.

Some open excavation work of especial significance will be quoted to illustrate this division; it has been described in a paper presented to the Institution of Civil Engineers.[19] This was the opening out of the Cofton tunnel on the Birmingham to Gloucester section of the London Midland and Scottish Railway in England. The tunnel was constructed in 1838-1841 and forms a part of the route taken by this line of railway in crossing a fairly high ridge of land immediately south of Birmingham. Modern traffic requirements had made necessary its opening up and reconstruction as a cutting. The strata shown up in the cuttings on either side of the tunnel were soft false bedded sandstones with thin beds of marl (north) and thick beds of hard sandstone and beds of tough marl (south) so that to the civil engineer they can be classified generally as neither rock nor earth. No records of the construction of the tunnel and the strata passed through were available, but the Geological Survey map of the district showed a major fault traversing the tunnel. Troubles due to earth movements were therefore anticipated and some of a serious nature were encountered very early in the work. Before the final eighty yards of tunnel were demolished a careful geological survey of the surrounding country was made in order to attempt a deduction of the hidden structure yet to be encountered. The survey was considered in conjunction with the records of dip and details of faults recorded from the start of the work. This investigation, carried out in the midst of construction, although incomplete was yet of sufficient value to be of great service.

The work was finally completed satisfactorily, but only after surmounting great difficulties. The evidence tended to show that the tunnel had originally been built instead of an open cutting because of a realization of the troubles to be encountered. Examination of the Geological Survey map showed that if the original line had been located either 200 yards west or 300 yards east of its actual position, little or no trouble due to the Longbridge Fault would have been experienced. The paper describing the work is one of those rare civil engineering publications dealing with unusual difficulties in construction and their surmounting and as such is worthy of special study. It is interesting also to note that at least one member of the staff of the Geological Survey of Great Britain was in constant attendance on the work.

### Foundation Work—General

The main criterion in all foundation work is the maximum bearing pressure which can be utilized without there being fear of settlement of the structure to be erected or the setting up of undue stresses in adjacent strata. This necessitates a knowledge of the strata and structure beneath the surface on and near the site, in addition to the usual "local" knowledge of the final surface to be built on and the loads it will carry. The Trenton limestone underlying the city of Montreal provides a good example of the need for such additional information, the thin beds of clay to be found beneath the surface having already caused trouble in certain foundation work.

The procuration of these data comes generally under the preliminary work already described. In built up industrial areas direct investigation of this kind is usually an impossibility unless time can be spent by putting down test borings. Records of adjacent excavations therefore provide the only means of obtaining the desired information accurately. Unfortunately the publication of such records is not a common occurrence and particularly is this true in Canada. Could they be regarded as the equivalent of design or the result of costly and special research by the parties concerned, publication could only be suggested as desirable. But the structure and composition of the earth's crust is part of the fixed order of nature and is not the prerogative of any one man or industrial group. It is therefore almost a duty to make available, for legitimate purposes, records obtained in excavation for foundations, the drilling of wells, etc., not only of rock formations encountered but also of underground water levels. The most careful records of all geological features met with in such foundation excavation work should therefore be kept, not only for the benefit of the particular job, but for the use and convenience of adjacent works and the enrichment of the public records.


Fig. 6—L.M. and S. Railway, England. Combination of Trough Slips as under X and Hanging Wall Slips.

The geological departments of the universities can and do act as repositories and clearing houses for such geological data. The compilation and co-ordination of these are part of the normal activities of the Dominion Geological Survey. When these records are known to be available, specifications can be drawn up by the engineer which cover fully the work to be done, and leave open no possibility for unreasonable claims for extra payments due to foundation-bed conditions.

These observations on foundation-bed records apply to work in all classes of earth and rock. The study of rock foundation beds can be regarded as reasonably complete after bearing tests have been made and all relevant data examined. Foundations which are to rest on clay and sand, however, introduce further complications, so much so that there may be said to be arising to-day a new branch of study, belonging solely to the field of civil engineering geology, namely, that which has been termed soil mechanics.

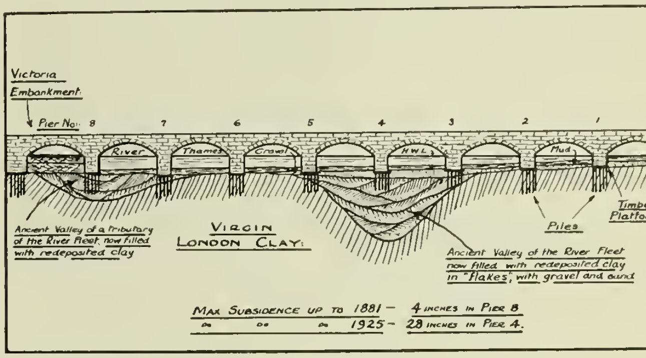


Fig. 7—Waterloo Bridge, London, England.

Great strides have been made in the study of the mechanism of the soil in the last decade, both in Europe and on this continent, and many ingenious lines of research have been opened up. The subject has already attained considerable proportions and so this reference to it can only be brief. Investigation has proceeded, and still does, by experiment and analytical study of the composition of sands and clays. Because of its complexities, the art of erecting structures on "unstable" foundation beds is fascinating and has provided in the past some most ingenious solutions through the co-operation of geologist and engineer. On the other hand, recent researches have detected signs of movement in most unusual locations, the Tower of London for instance having been found to be moving towards the River Thames. Another unusual result of recent research work has been the demonstration that in certain cases the driving of piles through clay foundation beds decreases instead of increases the bearing capacity of the foundations.

The founding of bridge piers requires special mention. The actual location of a bridge will be fixed in the first instance by economic considerations and in many cases the position of the centre line cannot be changed by more than a few yards. A geological section along such centre lines is imperative if the bridge piers are to be located economically. Due to the submersion of most of the solid surfaces along the centre lines of all waterway bridges, the preparation of sections is often fraught with unusual difficulties. Yet with the aid of a few carefully located under-water borings, a section can often be built up with some reasonable degree of accuracy when the local geological conditions have been correlated with drilling results. The drilling of such test holes must be conducted with the utmost care and the records obtained must be without blemish since no change of location can generally be made when once construction of a bridge pier has been started. A paper to which reference has already been made[3] describes some unusual difficulties in founding bridge piers in New South Wales, Australia, and repays careful study.

An interesting theory has been advanced by Mr. F. H. Macintosh, who states that the failure of the central piers of the world famous Waterloo bridge spanning the River Thames at London, England, is due to the underlying geological structure.[20] He suggests that the existence of an old river valley in the blue clay of the present river bed since filled up with redeposited clay is the direct cause of the subsidence of the piers at fault as shown in Fig. 7. It is urged, by the same writer, that no scheme for the reconstruction of the bridge should be considered until the geological strata beneath the piers have been adequately examined.

Finally the question of vibration must at least be mentioned, for each year the problem becomes more intense due to the loading, frequency, and speed of road traffic adjacent to engineering structures and tall buildings. The noticeable vibration at the top of comparatively old buildings is a telling reminder of the existence of a real problem. As yet it is comparatively unexplored, but the research that has been done into the natural period of vibration of buildings, etc., in areas subjected to earthquakes may prove to be the start of a branch of study of great significance in the future.

This extended reference to foundation problems is pardonable, since it covers so wide a field, and is certainly suggestive of a great deal of co-operative work in the future between the geologist, civil engineer and architect.

### The Foundation of Dams

It is perhaps not generally appreciated that the erection of a dam to retain water causes more interference with natural conditions than does any other civil engineering operation. The most general effect of the engineers' activities is to put unusual loads on to certain parts of the earth's surface or to cause undue stresses by interference with the natural structure of the earth's surface. The construction of a dam will often have both of these effects, but in addition hydrological conditions are changed, often to a remarkable degree. Above the dam, the levels of the underground water tables at each end of a dam are raised correspondingly to the level of the impounded water; below the dam, the water table level is unchanged or possibly lowered and so steep underground hydraulic gradients may be set up. Further, increased hydrostatic pressure is exerted on all rock in the bed of the reservoir formed by the dam, as well as below the foundation of the dam itself, and in the case of a porous foundation bed, this may often lead to surprising results. Underground water tables are also affected throughout the entire valley above the artificial reservoir formed by the dam.

If broad consideration be given to the question as to why dams stand up, it can clearly be seen that no matter how safe may be the structural design of the dam itself, it cannot be expected to stand up if the foundation beds are not adequate. From a selection of engineering papers descriptive of dam design and construction, one would probably obtain very little, if any, insight into the subject other than the mathematical proportioning of the dam section and the means adopted for constructing the work to these lines. Foundations, on the other hand, always obtain full publicity whenever any dam failure occurs, and defective foundations are generally, and often rightly, blamed for such disasters. In view of this wide publicity, dam failures will not be referred to again, the constructive aspect of the subject rather receiving attention.

There are three geological problems to be investigated in connection with the design of all dams, namely, the ability of the foundation bed to support the superimposed load proposed, the resistance that the foundation bed will offer to the increased hydrostatic pressure, and the possible effects of the creation of underground hydraulic gradients at the ends of the dam. A fourth problem has to be faced in all cases where earth movement has occurred at any section of the area to be covered by the dam, in determining how far the effects of this extend in the adjacent rock and in assisting in the selection of the necessary protective features in the design.

A detailed geological survey of the dam site is the prime necessity, to be obtained as outlined in the earlier part of this paper. In practically every case of the investigation of a dam site, diamond drilling (or geophysical prospecting) will be a necessary resort at key locations, to complete and/or confirm the results of surface investigations. The survey will include full details of overburden on the banks and will extend upstream and downstream for some appreciable distance. Detailed investigation of the rocks to be encountered will be a vital part of such work, including an investigation of the effect of prolonged contact with water.

One result of the survey will be the preparation of a geological section along the base line of the dam and one down stream crossing the centre line of the dam approximately at right angles. From these sections the practicability of the construction of a dam can be determined and the especial difficulties to be expected anticipated. Some idea of the depth to which excavation will have to be taken can also be obtained. From a consideration of all data available, it should be possible to draft specification clauses that will result in the foundation beds being prepared in a satisfactory manner, leaving no doubt as to what will be required of the contractor. The general occurrence of faulting in the rocks under dam foundations is of especial significance in eastern Canada due to prevalence of faults running up existing river valleys, and to the frequent traces of earth movement so widely distributed in many sections of the Pre-Cambrian rocks.

In cold weather exposed rock foundations will become so chilled that it is extremely difficult to determine their physical properties under normal temperature ranges. The author has seen some diabase which, when frozen, appeared to be absolutely solid, but which was actually thoroughly disintegrated. So well had the frost cemented the fragments together that even steam jets made no impression on it, but its location adjacent to a fault was evidence enough for its removal before concreting operations started.

From the many examples of dam foundations presenting special geological features two only can be mentioned. The Hales Bar dam on the Tennessee river, U.S.A., has

Fig. 8—Foundation Beds, Prettyboy Dam.

been described as "the greatest object lesson that the history of engineering foundations has to offer" by reason of the disastrous results of ignorance of geological conditions at the dam site. Leakage occurred under the dam to an alarming degree, and although the dam stands to-day it has cost about $10,000,000 and taken over ten years to conquer this condition. Amongst the unsuccessful means used in an attempt to stop the leakage were train loads of cement, bales of hay, wrecked bedsprings and corsets. Finally, liquid asphalt was pumped into the cracks under pressure, and this proved effective.[21]

There has recently been completed on the Gunpowder river, the Prettyboy dam which is to impound water to improve the supply of the City of Baltimore, Maryland, U.S.A.[22, 23] Work on the dam was started in 1930, the site being 25 miles to the north of the city. The site is physically a good one, the valley being quite deep, but geological conditions have required unusual precautions in the excavation of the cut off trench below the base of the main structure. This has called for the placing of about 190,000 cubic yards of concrete. The rock formation

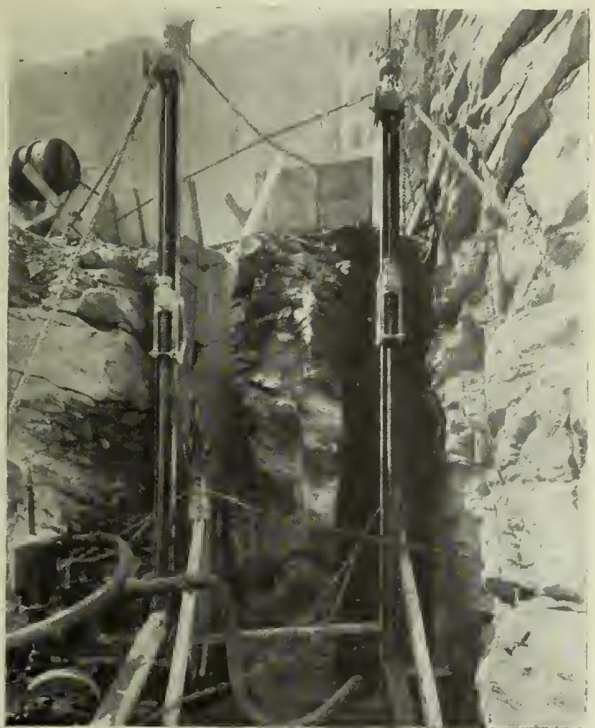

Fig. 9—Wire Saw Rigs Set up in Calyx Drill Holes.

beneath the dam is mainly mica schist with some limestone, gneiss and intruded quartz, and it has been twice subjected to earth movement. Faulting was therefore to be expected. The exposed rock had undergone weathering to a considerable degree. It was realized that extreme care would have to be taken in blasting for the excavation of the foundation bed. As a preliminary operation, it was decided to drill several deep shafts, 36 inches in diameter, excavated with Calyx core drills, which permitted the consulting geologists of the Johns Hopkins University, under Dr. J. T. Singewald Jr., to be lowered into them so as to study the formation of the schist in place. By this means, the geologists were enabled to prepare accurate sections showing the position of all faults and large seams as well as the direction of their strike and dip.

Disintegration of the schist on the hanging-wall side of a major fault, traced in this way, caused a considerable increase in the volume of excavation. Further, it was in this way possible to obtain truly representative samples of the schist wherever desired, and the study of these samples constituted an interesting investigation in pure geology.[24] The highly foliated nature of the rock, together with the extensive faulting, resulted in such overbreak and general rock movement in blasting operations that other methods had to be adopted for the excavation of the cut off trench. After repeated trials, a novel expedient was adopted. Wire rope saws were rigged up between pairs of the Calyx drill holes and with these the necessary trenching work has been successfully carried out, this being probably the first occasion on which wire saws have been used on a highly quartzose rock. Two wire saw rigs can be seen in Fig. 9.

### Reservoirs and Catchment Areas

Geological examination of reservoir sites and catchment areas introduces some special problems. The sides of a valley are generally assumed to be natural watertight dams withholding the water impounded in a reservoir in a manner similar to that of the man-made dam across the valley, and causing all rainfall to drain towards the watercourse running out of the valley. But they may not be, and for two general reasons.

These two broad types of escape are best demonstrated in diagrammatic form; Figs. 10 and 11 illustrate them. The first shows a valley underlain by porous and impervious strata. It will be seen that rain water falling on to the upper part of the left hand side of valley "A" and soaking into the ground will not drain into that valley, but will eventually reach the stream in valley "B." Similarly if the water level of a reservoir in the former valley is raised above point "X" water will escape by leakage through the pervious strata.

Figure 11 illustrates a not uncommon structure which in certain special cases may cause loss of water from a reservoir. The section is taken across the side of a valley at some depression in the ridge. The saddle effect given by anticlinal structure is frequent and erosion will occasionally lead to such a case as that illustrated. Should there be constructed a dam across the valley which will bring the water level opposite this saddle up to such a point that the gradient of the water table between valleys "A" and "B" is large enough for flow to ensue, leakage will result. This leakage may often have disastrous effects in

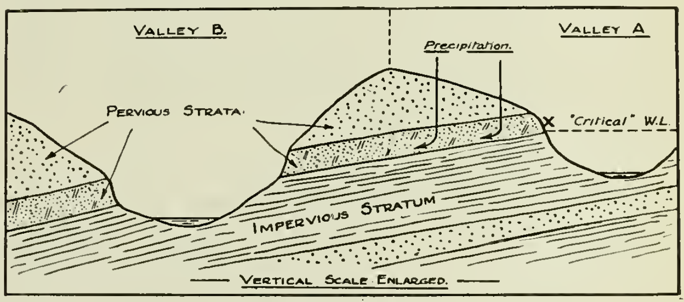


Fig. 10

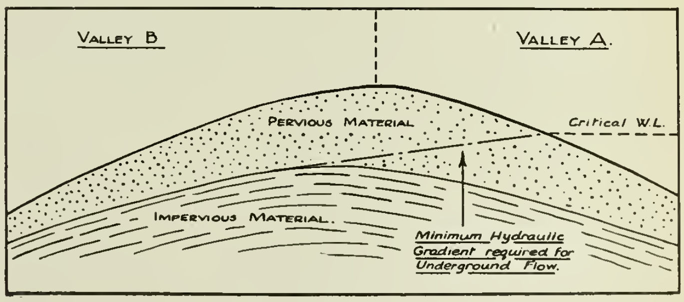


Fig. 11

the adjoining valley and in at least one such case, resulting landslides necessitated a considerable lowering of the water level in the reservoir. Although neither of these cases is common, both are always a possibility and so steps must be taken to ensure that no such leakage can occur.

On the other hand, pervious strata following the topography of the valley can have the opposite effect and provide more run-off than the area of the valley warrants (as in valley "B" supra) and also a vast underground reservoir. This underground water storage may be of special value since it will drain more slowly than an open body of water. The capacity of such a reservoir can sometimes be calculated, at any rate roughly, when sufficient geological information has been acquired, and this may have an appreciable effect on the height of the dam to be built. A minor investigation often necessary in the design of reservoirs is a study of the earth movements possible when once the water level has been raised and natural underground water conditions have been interfered with. If serious damage will result from such movement, an investigation along these lines is imperative.

### Underground Water Problems

This section of applied geology is perhaps the most difficult of all to discuss adequately in this paper. The diversity of the problems involved makes it of supreme importance, whether the water be utilized for supply, or removed as drainage, for in each case a vast number of people depend on the success attained in handling the water underground. It is a fascinating study because of the many structural geological problems involved and also of the debatable question of the origin of plutonic waters, the existence of which cannot be doubted. And it is essentially a matter for study by a geologist since the existence of water underground depends solely on certain features of geological structure. At this statement, the supporter of the "divining rod" will demur. While admitting the successes of water diviners in many instances, the author has yet to be convinced that such success was not a combination of luck and shrewd superficial knowledge of surface geology in so far as it affects water supply.[25, 26] Whether a divining rod is used to discover underground water or not, the fact that its existence is due to certain geological structure remains unchanged. And so, as an essential preliminary to all well drilling, except in localities where proved wells exist, a geological study should be made if waste of time and money is to be avoided. Artesian conditions are generally recognizable after a broad study of local geology, whilst waterless substrata can also be detected readily. Underground drainage has been mentioned previously.

### Construction Materials

The study of the properties of rock used in construction, such as building stone, road stone, or concrete aggregate, to be effective should be a co-operative effort on the part of the geologist and civil engineer. To test for compressive strength alone is not enough.

Stone, using the generic term to cover all types of rock used for construction, unlike artificial structural materials, is not a uniform material with predeterminate qualities. It is, generally, a mass of granular particles cemented together, not always of stable chemical composition and not always as strong structurally as may at first appear. Knowledge of the type of rock from which a specimen is taken is a first essential to a proper study of its qualities. Further it is desirable generally to know the relation of the specimen to the bedding planes of the stratum from which it has been taken. Microscopical examination of thin sections of rock specimens under investigation is generally an essential part of such work, as being the most convenient means of examining the texture of the rock. This feature is of the utmost importance in rock selected as road material, as is also the mineral composition of the rock. Detailed explanation of the significance of these features will be found in references noted, the Geological Survey of Canada having paid special attention to the selection of good road material in the course of its work.[27]

Building stones have been the subject of much research work, particularly in Great Britain in recent years, and there are available many excellent publications dealing with the selection, testing, weathering and preservation of stones used for building purposes.[28, 29] Tests which may be suggested as imperative for all stones are for weight, porosity, effect of repeated wetting and drying, effect of alternate freezing and thawing, mineral composition in relation to local atmospheric conditions and texture as revealed by the microscope. All these tests are additional to the usual tests of compressive strength.

### General

In conclusion, certain specialized branches of civil engineering work may be mentioned, in which geological principles can often be of real avail but which do not belong to the field of Canadian practice to the same extent as the divisions already considered.

(*a*) *Silting up of Reservoirs.* Reference to the serious silting up effect caused by impeding the flow of silt laden streams receives mention by as early a writer as Herodotus. It affects dam design considerably, but the probable rate of silting can only be calculated by empirical rules based on observations of the silt carrying capacity of the stream considered in conjunction with the geological aspects of the river bed from its source to the dam. Based on such calculations it is estimated that the reservoir to be formed by the Boulder dam will take at least one hundred and ninety years to silt up to a serious degree.[30]

(*b*) *Irrigation.* Irrigation engineering in arid lands introduces some problems akin to those caused by silting, and others on the borderline of soil mechanics. Such problems are, however, in the main localized and so do not call for more than this recognition of their existence.

(*c*) *River Training Works.* The erosion of river banks is a problem often encountered in civil engineering: in some cases the solution is not by any means an obvious one. In this, as in associated river training work, the science can often prove of avail, physical geology including the special study of river flow and river movement.

(*d*) *Coastal Works.* On certain coasts, notably the east and south coasts of England, trouble is continually being experienced due to littoral drift and other movements of shore material. Remedial works for such movements can only be effective if based on a careful study of the causes of movement. Study of this kind definitely constitutes a section of physical geology—the science thus again being an essential aid to the engineer.

(*e*) *Earthquake Construction.* Seismology forms a distinct and highly specialized branch of physical geology. Despite a certain well remembered shock in the Lower St. Lawrence valley some years ago, Canada can be regarded as generally free from the possibility of seismic disturbances. Interest in all engineering work in areas not so fortunate has, however, a universal appeal, and so the work that is being done in the direction of adjustment of design to cover the possibility of earth movement is fairly generally known. Vibration is again an aspect of the subject which must at least be mentioned.

### *Conclusion*

Some indication has now been given of the very definite and widely distributed relationship of the science of geology and the art of civil engineering. The practical examples quoted have generally been typical, although some were unique at the time of their original presentation, being selected from an ever widening field of such useful contacts.

This brings the line of thought suggested back to the widely current argument stated in the introduction, which was therein pronounced as fallacious. No direct reference has been made to it in the main body of the paper, but it is hoped that indirectly its falsity has been proved. If a summary answer may be attempted, it is this. Geology can be to civil engineering the broadest type of insurance. While in many cases the geologist will be able only to confirm what surface indications suggest, in others he will be able to warn the civil engineer of unseen dangers and difficulties. In all cases he will be able to eliminate very largely the general element of risk in civil engineering undertakings, due to their nature. When difficulties do occur due to troublesome geological conditions, the civil engineer may be able to surmount them unaided, but a geologist will in most cases be able materially to assist with advice based on his special experience. Further, in detailed work involved in the correct application of construction methods the geologist will often be able to proffer advice of material value. In all such cases, it must be observed, the geologist is but the adviser of the civil engineer; it is the latter who must act on the advice so received, and make all decisions. Finally, the existence of so many "border line" subjects between geology and civil engineering should do much in the future towards bridging whatever gaps remain between the two.

The relation of the two has been likened also to that of faith to works, the "works" of the engineer being based on the "faith" of the geologist.[31] As faith has been defined as confidence in things unseen, the metaphor is by no means far fetched. And this faith will be needed more and more in the future, as the best sites for dams are used up, as foundation loads increase, and as more attention is paid to the economic aspect of engineering work.

Throughout this paper, for the sake of clarity, geology and civil engineering have had to be considered as separate, whereas in actual practice many civil engineers by training and through experience are acquainted with methods of investigation herein classed strictly as geological, and these they apply in the ordinary course of their work. It is thought that they are, however, a small minority, and it is certain that a notable change must be effected in the general reaction towards geology in relation to civil engineering if full avail is to be taken of all the benefits that may accrue from their co-operation. It is for this reason that the last of the "indirect causes" for the past neglect of geology in civil engineering is so singularly unfortunate, since it is by the general training of all undergraduate civil engineers in geology as applied to their professional work that the desired change can best be attained. The general field of engineering education cannot, however, be encroached upon here, and so beyond emphasizing the vital importance of such training, nothing further can be said. Table I has been prepared to show the present status of geological studies as an integral part of the civil engineering courses of Canadian universities.

It may be convenient to summarize, in conclusion, the principal ways in which the essential contacts of the science and the art may be maintained and strengthened to their mutual benefit. No mention will be made of the obvious recourse to a specialist in civil engineering geology for consultation on all unusual and special problems.

(*a*) Preliminary studies of all civil engineering projects, apart from certain isolated small cases, should include as a leading part of the work a geological examination of the ground under consideration, and an investigation of all publications, records, etc., dealing in any way with the geological structure of the area concerned and/or the materials there to be encountered.

(*b*) If trial drill holes are found necessary or even advisable, as will be practically always the case, such holes should only be put down under the guidance of someone trained in geology, so that by the economic location of holes, waste may be prevented and full benefit obtained. Drilling work should always be done on a day-labour basis; it should be constantly under competent supervision; and the records of the work should be kept with extreme accuracy.

(*c*) In the preparation of specifications due regard should be had for all special geological aspects of the work to be undertaken, and suitable safeguarding clauses inserted. The dip and strike of rock in tunnel work, and the possible effect of

TABLE I

A COMPARATIVE STATEMENT OF THE PERIODS OF INSTRUCTION IN GEOLOGY INCLUDED IN THE REGULAR CIVIL ENGINEERING COURSES OF STUDY AT CANADIAN UNIVERSITIES AND COLLEGES.

| University or College. | Titles of Lectures and Notes. | Lecture Periods/Week. | | | | | Laboratory Work: Hours/Week. | Geological Surveying and Work in the Field |
|---|---|---|---|---|---|---|---|---|
| | | 1st Year. | 2nd. Year. | 3rd. Year. | 4th Year. | 5th Year. | | |
| University of British Columbia | "General Geology" (Physical and Historical) | — | — | 2. | — | — | 2 (3rd year) | Occasional Local Excursions in place of Lab. work |
| University of Alberta. | "Introductory Geology." | — | 3. 1st half only | — | — | X | 3. (2nd. half of 2nd. Year) | —— |
| University of Saskatchewan | "Engineering Geology" (General Outline) | — | 2. | — | — | X | 1. (2nd year) | —— |
| University of Manitoba. | "Engineering Geology" (General Outline) | — | — | 2. | — | X | 2. (3rd. year) | —— |
| University of Toronto. | (a) "Elementary Geology" (Historical)<br>(b) "Engineering Geology" (Applications) | — | 2. (a) 2nd. half only | 1. (b) | — | X | —— | —— |
| Queen's University. | "Engineering Geology" (Mainly Applications) | — | — | 2. | — | X | —— | —— |
| McGill University. | "General Geology" (Comprehensive) | — | — | 2. | — | X | 2 (3rd. year) | Six local excursions on Sat. mornings. |
| École Polytechnique. | "Geology" and "Mineralogy" (Outlines) | — | — | 2. | — | — | —— | —— |
| University of New Brunswick | "Engineering Geology" (General) | — | — | 3. | — | X | 1. (3rd year) | —— |
| Dalhousie University. | —— | — | — | — | X | X | — | —— |
| Nova Scotia Technical College. | —— | X | X | — | — | X | — | —— |

Compiled from Official Calendars for 1932–1933 Session.

overbreak; the levels of underground water, and rock, in foundation work; the strength of local stones; adequate examination and preparation of foundations; facilities for the taking of ample records; all are matters which should receive definite and unequivocal mention in all general specifications for work to which they apply.

(*d*) All qualified civil engineers engaged on construction projects should have had training in geology. They should be entrusted with the inspection of all foundations and the study of adjoining formations. They will be able to recommend consultation with a specialist if any unusual or doubtful features are revealed in the course of construction.

(*e*) On the record drawings of every civil engineering work the fullest possible details of geological structure should be given, this being an essential part of the work of the qualified engineers mentioned above.

(*f*) All publications dealing with civil engineering works should contain some reference, if not a whole section, devoted to the geological aspects of the foundation beds, etc. This is necessary in order to bring to light the only unknown elements in design and construction. As each project will differ in this respect to some extent, publication of such details will never be a routine matter, proving rather to be the source of valuable information.

(*g*) The attention of the Director of the Geological Survey of Canada should be drawn to any excavation work of unusual size, or of an unusual nature, so that if necessary he may arrange for a member of the Survey staff to visit and examine the sections uncovered. This applies particularly to all excavation which is to be covered permanently. The courtesy, where possible, should be extended to the head of the Geological Department of the nearest university for a similar reason. Likewise if any records of strata, as in boring of trial holes, or data of underground water levels, as in wells, are obtained, copies of these should be forwarded to the two geologists suggested, together with the record drawings of foundations mentioned in (*e*) supra.

This last suggestion can be classed definitely as a courtesy, since it involves the expenditure of but little time, money, or trouble on the part of those in charge of works. And as illustrating how such co-operation is appreciated by geologists, the following extract from the report of a speech by Dr. T. Robinson of the Geological Survey of Great Britain, at the Institution of Civil Engineers, forming part of the discussion of the paper referred to under reference[19] can hardly be bettered.

"The records of the Geological Survey showed conclusively that closer co-operation between the geologist and the engineer would be greatly to the advantage of both, and it was a pity that there was no direct way in which geologists could be kept informed of the progress of important excavations. Such information would teach them more about the rocks themselves, and so enable them to anticipate their behaviour more precisely; it would also assist in engineering operations."

Science is generally regarded as a great disciplinarian, the scientist being well versed in all the implications of the doctrine of acceptance. The civil engineer can be regarded as even in advance of this position. For not only does he accept the unalterable facts of Nature but he advances, armed with all the technique of his art, and adapts them for the use and convenience of his fellow men. With how much more confidence can he thus carry on the work of his profession if he is armed also with reasonably accurate information about that part of the earth's crust in which his operations are to be conducted?

## APPENDIX

*A list of the publications, papers, etc., referred to in the foregoing text.*


1. "Memoirs of William Smith, LL.D.," by John Phillips; John Murray, London. (1884)
2. Second report to the Directors of the London Westminster and Metropolitan Water Company, (1841), p. 15. Copy in Vol. 78 of octavo tracts in the library of the Inst. of C.E.
3. "The George's River Bridge, New South Wales," by Percy Allan, M.Inst.C.E. Min. of Proc. of Inst. of C.E., Vol. 232, p. 229. (1932)
4. Reports of the Isthmian Canal Commission, 1899 to 1911.
5. Article in Edinburgh Review by Vaughan-Cornish, January 1913, pp. 21 to 42.
6. Geographical Journal, Vol. 41, pp. 239 to 243. (1913)
7. "The Silent Valley Reservoir," by the Board of Engineers (Messrs. Hill, Sandman and Binnie, M.M.Inst.C.E.), Annual Meeting of the British Waterworks Association, July 22nd, 1931. See Water & Water Engineering, Aug. 20th, 1931, p. 429. London.
8. "Topographical Study of a Hidden Bedrock Surface by Resistivity Measurements," by E. G. Leonardon, Engineering Journal, Vol. 14, p. 331. (1931)
9. "Applied Geophysics in the Search for Minerals," by Drs. A. S. Eve and D. A. Keys; Cambridge University Press. (1929)
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# The Elements of Hydrodynamic Analysis

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**SUMMARY.**—A presentation in condensed form of the mathematical analysis necessary as a preparation for the study of the stream line motion of a fluid. The fundamental equations are derived which relate to such quantities as stream functions. velocity potential, sources and sinks, and combined stream lines, and which are needed in understanding many papers on hydrodynamic and aeronautical topics.

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The following paper is placed before the readers of engineering literature in the hope that it may serve as a guide to further study by those interested in hydrodynamic problems. The writer feels that the reader who tries to look all this up for himself may become discouraged by the maze in which he finds himself involved, and consequently has attempted to put together into one paper the various steps which are to be found in many texts and which go to make up a certain type of interesting analysis of stream line flow.

## Partial Differentiation

Throughout the following presentation, it will be necessary to consider functions of two or more variables; and in order to save time should the reader not have been following mathematical work continuously, some of the basic principles of partial differentiation are given concisely without going into proofs which can be verified easily if any one wishes to do so.

A function $z$ of two variables $x$ and $y$ may be indicated as follows:

$$z = f(x, y)$$

The partial derivative (as it is called) of $z$ with respect to $x$ is written: $\frac{\partial z}{\partial x}$ and is found by assuming that $y$ is constant. The partial derivative of $z$ with respect to $y$ is found by assuming $x$ constant and is written: $\frac{\partial z}{\partial y}$.

For instance, if $z = x^2 + y^2$, $\frac{\partial z}{\partial x} = 2x$; and $\frac{\partial z}{\partial y} = 2y$.

Partial derivatives of higher orders are found by differentiating again with respect to the desired variable and keeping the other variable constant. For instance, using the same given function:

$$\frac{\partial^2 z}{\partial x^2} = 2; \text{ and } \frac{\partial^2 z}{\partial y^2} = 2.$$

It is possible, however, with a function of two or more variables to get a form of derivative, which when indicated, might lead to confusion if the simple process were not understood.

Taking $z = x^2y + y^2x$, we get $\frac{\partial z}{\partial x} = 2xy + y^2$.

Now, it may be desirable to find the next higher derivative with respect to $y$ which is indicated as follows:

$$\frac{\partial^2 z}{\partial y\, \partial x} = 2x + 2y,$$

which was found by keeping $x$ constant since the derivative was with respect to the other variable $y$.

The same result may be obtained by another path:

$$\frac{\partial z}{\partial y} = x^2 + 2xy; \text{ and } \frac{\partial^2 z}{\partial y\, \partial x} = 2x + 2y.$$

The partial differential of a function of two or more variables is found by differentiating with respect to the desired variable and keeping the other variables constant. Thus, if $z = x^2y + y^2x$, $d_xz = 2xy\,dx + y^2dx$

and $d_yz = x^2dy + 2xy\,dy.$

Now it will be noticed that if we write

$$d_xz = (2xy + y^2)\,dx,$$

the quantity in the brackets is $\frac{\partial z}{\partial x}$: so that symbolically we may write $d_xz = \frac{\partial z}{\partial x} . dx.$ In the same way,

$$d_yz = \frac{\partial z}{\partial y} . dy.$$

The total differential of a function of two or more variables is expressed as the sum of the partial differentials. Thus, using the last function $z = x^2y + y^2x$, by ordinary differentiation we get:

$$dz = (2xy + y^2)\,dx + (x^2 + 2xy)\,dy$$

which may be expressed:

$$dz = \frac{\partial z}{\partial x} . dx + \frac{\partial z}{\partial y} . dy \quad \text{(A)}$$

This is the sum of the partial differentials.

This last symbolic expression of a total differential will be most useful later on and should be kept in mind.

## Exact Differentials

The following proposition is generally presented to students of the calculus as one of many others without sufficient emphasis being placed upon its value in mathematical analysis, especially in the realm of physics.

Let $P\,dx + Q\,dy$ be a given relation where $P$ and $Q$ are functions of $x$ and $y$. It is desirable to know under what conditions this quantity is what is called an "exact differential." In other words, what are the relations between $P$, $Q$, $x$ and $y$ which make the given quantity the differential of some function which we may designate as $\psi$? If the given quantity is an exact differential of $\psi$, then:

$$d\psi = P\,dx + Q\,dy \quad (1)$$

But $P$ and $Q$ are functions of $x$ and $y$, therefore the differential may be written in general terms as indicated by equation (A) in the former section on partial differentiation:

$$d\psi = \frac{\partial \psi}{\partial x} . dx + \frac{\partial \psi}{\partial y} . dy \quad (2)$$

And since (1) and (2) are expressions of the same operation, it follows that

$$P = \frac{\partial \psi}{\partial x} \quad (3)$$

$$Q = \frac{\partial \psi}{\partial y} \quad (4)$$

Differentiating $P$ with respect to $y$ and $Q$ with respect to $x$, we get:

$$\frac{\partial P}{\partial y} = \frac{\partial^2 \psi}{\partial y . \partial x}$$

$$\frac{\partial Q}{\partial x} = \frac{\partial^2 \psi}{\partial y . \partial x}$$

From which it follows that:

$$\frac{\partial P}{\partial y} = \frac{\partial Q}{\partial x} \quad \ldots\ldots\ldots\ldots\ldots\ldots(5)$$

Now this result was derived on the assumption that the given relation $P\,dx + Q\,dy$ was an exact differential. So that (5) is a relation which must follow if we have an exact differential; and is therefore called *the test for an exact differential.*

It also follows that if $P\,dx + Q\,dy$ is an exact differential, there exists a function $\psi$ related to $P$ and $Q$ by the partial derivatives with respect to $x$ and $y$, as shown in (3) and (4).

The following simple examples illustrate the use of the above propositions.

Determine whether or not the following are exact differentials.

(*a*) $2\,x\,dx + 2\,y\,dy$

In this case $P = 2\,x$ and $Q = 2\,y$

$$\frac{\partial P}{\partial y} = 0 \qquad \frac{\partial Q}{\partial x} = 0$$

therefore $$\frac{\partial P}{\partial y} = \frac{\partial Q}{\partial x}$$

and (*a*) is an exact differential.

(*b*) $2\,(x + y)\,dx + 2\,(x + y)\,dy$

$$P = 2\,(x + y) \text{ and } Q = 2\,(x + y)$$

$$\frac{\partial P}{\partial y} = 2 \qquad \frac{\partial Q}{\partial x} = 2$$

therefore $$\frac{\partial P}{\partial y} = \frac{\partial Q}{\partial x}$$

and (*b*) is an exact differential.

### Complex Numbers and Variables

In the general discussion of the theory of functions it is found necessary to introduce the idea of what is called a complex number. The reader if he so desires can find the full explanation of the necessity of this step in any good treatise on the theory of functions. This necessity will be accepted here without further explanation.

The relation $(a + ib)$ where $a$ and $b$ are real values and $i = \sqrt{-1}$, is called a "complex number." It is seen that this number is made up of a real and an imaginary part: $a$ and $ib$ respectively.

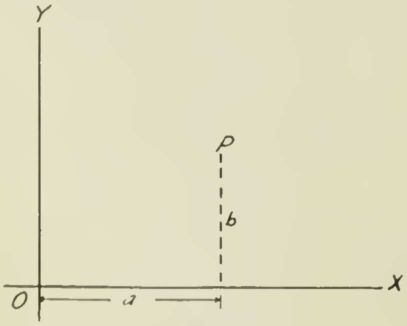


Fig. 1

This idea can be extended to form "complex variables" such as $(x + iy)$; where values of the real variables $x$ and $y$ determine the values of the whole "complex variable."

These complex numbers and variables may be represented graphically by certain conventional agreements which if understood are easily followed.

The complex number $z = (a + ib)$ may be represented on the $X$, $Y$ plane by laying off the real values $a$ and $b$ in the usual manner of co-ordinate geometry as indicated in Fig. 1. It is agreed, then, that the point $P$ found by this process represents the complex number $z$. A particular value of the complex variable $z = (x + iy)$ may be represented by the same conventional process as indicated in Fig. 2; where the point $P$ is said to represent $z$. These diagrams such as Figs. 1 and 2 are called Argand Diagrams.

In the representation of these variables, it is seen that if $y = 0$, the values of $z$ will all be real and will be represented by points on the axis of $X$ which consequently is

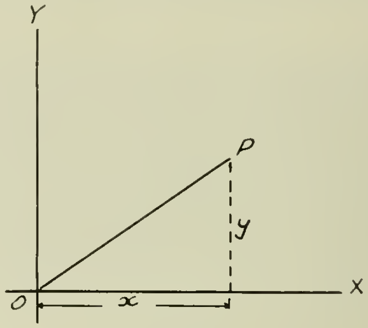


Fig. 2

referred to as *the axis of reals.* On the other hand, if $x = 0$, $z$ will have purely imaginary values all represented on the axis of $Y$ which is called *the axis of imaginaries.*

In Fig. 2, let $OP = r$. Then this distance $OP = r$ is called the *modulus of z* and is conventionally written $|z| = r$. The angle which the modulus of $z$ makes with the axis of $x$ is called either the *argument of z* or the *amplitude of z*, abbreviated to arg. $z$ or amp. $z$. In this case, arg. $z = \theta$ the angle $XOP$ in Fig. 2.

If polar co-ordinates are used, the complex variable $z = (x + iy)$ may be written:

$$z = (r\cos\theta + ir\sin\theta) = r\,(\cos\theta + i\sin\theta)$$

Another useful form of expressing the complex variable may be obtained as follows:

$$d\,(\cos\theta + i\sin\theta) = (-\sin\theta + i\cos\theta)\,d\theta$$
$$= i\,(\cos\theta + i\sin\theta)\,d\theta$$

Then: $$\frac{d\,(\cos\theta + i\sin\theta)}{(\cos\theta + i\sin\theta)} = i\,.\,d\theta$$

Integrating:

$$\log\,(\cos\theta + i\sin\theta) = i\,.\,\theta$$

or $$(\cos\theta + i\sin\theta) = e^{i.\theta} \quad \ldots\ldots\ldots\ldots\ldots(B)$$

And since $$z = r\,(\cos\theta + i\sin\theta),$$

we get $$z = r\,.\,e^{i.\theta}$$

This gives three methods of expressing the complex variable:

$$z = (x + iy) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots(6)$$
$$z = r\,(\cos\theta + i\sin\theta) \quad \ldots\ldots\ldots\ldots(7)$$
$$z = r\,.\,e^{i.\theta} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots(8)$$

These complex numbers may be added, subtracted, multiplied and divided. The results are easily obtained if certain simple rules are remembered; otherwise the actual operations are tedious and wasteful of time.

In Fig. 3, let $P_1 = z_1;\; P_2 = z_2.$

Then, $OP_1 = |z_1|;\; O\,P_2 = |z_2|.$

Let $z_1$ be added to $z_2$, then:

$$z_1 + z_2 = (x_1 + iy_1) + (x_2 + iy_2)$$
$$= (x_1 + x_2) + i\,(y_1 + y_2)$$
$$= z_3$$

It is easily seen that this result is obtained by constructing $P_2P_3$ equal and parallel to $OP_1$. Obviously,

$$(x_1 + x_2) + i\,(y_1 + y_2) = z_3$$

is represented by $P_3$. $OP_3$, then, is the modulus of $z_3$. The value of $z_3$ which is represented by $P_3$ may be found by treating $|z_1|$ and $|z_2|$ in the same way as ordinary vectors. The $|z_3|$ is the resultant vector of $|z_1|$ and $|z_2|$. The operation of subtraction may be treated in the same vectorial manner.

If several complex numbers $z_1$, $z_2$, $z_3$ etc., are multiplied together, it is easily shown that:

$$z_1.z_2.z_3.\dots = r_1.r_2.r_3\dots\dots [\cos(\theta_1 + \theta_2 + \theta_3\dots) + i\sin(\theta_1 + \theta_2 + \theta_3\dots)]$$

From this result, it follows that the modulus of the product of several given complex numbers is the product of the given moduli; and the argument of the same result is found from the sum of the given arguments.

It may also be easily shewn by the actual but tedious operation that when two complex numbers such as $z_1$ and $z_2$ are divided, we get:

$$\frac{z_1}{z_2} = \frac{r_1}{r_2}[\cos(\theta_1 - \theta_2) + i\sin(\theta_1 - \theta_2)]$$

That is: the modulus of the result is found by dividing the given moduli and the argument is obtained by subtracting the original arguments.

### Functions of a Complex Variable

It is possible to establish functions of these complex variables, which have just been discussed, in very much the same manner as with ordinary functions.

Let us suppose that $w$ is a function of the complex variable $z$. This may be expressed in the ordinary manner.

$$w = f(z)$$

Then, $w$ being a function of a complex variable, is itself a complex quantity which may be written $w = (\phi + i\psi)$. It follows from this that:

$$w = (\phi + i\psi) = z = (x + iy)$$

or

$$(\phi + i\psi) = (x + iy)$$

It is seen that since a real value cannot have any imaginary portion to it, we get the following identities:

$$\phi = x$$
$$i\psi = iy$$

or

$$\psi = y$$

Another easy example of this operation is seen when we consider $w = z^2$, where $w = (\phi + i\psi)$ and $z = (x + iy)$. Expanding these results, we get:

$$(\phi + i\psi) = (x + iy)^2 = (x^2 + 2\,ixy - y^2)$$

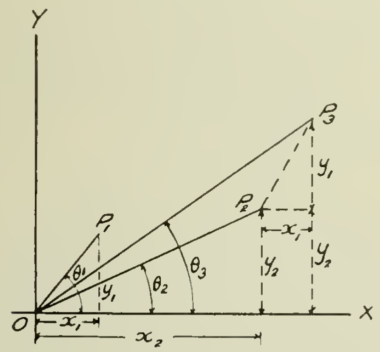


Fig. 3

Then equating real and imaginary parts of both sides, we get:

$$\phi = x^2 - y^2$$
$$\psi = 2\,xy.$$

This operation, illustrated with the simplest possible cases, is known as equating real and imaginary values; and it is from this process that very valuable results will be obtained with more complicated cases.

### Holomorphic Functions

When certain relations exist between a function and the variable, the function is said to be *holomorphic.* The terms monogenic and analytic functions are sometimes used to express variations of the same idea but space does not permit of a discussion of these points. For the present purpose, it is merely necessary to define a holomorphic function as one which is single valued, continuous and has a continuous derivative. Such a function may be differentiated without reference to the path by means of which successive values of the variable are arrived at. If $w = (\phi + i\psi)$ is a holomorphic function of $z = (x + i.y)$ then:

$$\frac{\partial\phi}{\partial x} = \frac{\partial\psi}{\partial y} \text{ and } \frac{\partial\phi}{\partial y} = -\frac{\partial\psi}{\partial x}\dots\dots\dots\dots(9)$$

For instance, if $w = z^2$; we get by equating real and imaginary parts:

$$\phi = x^2 - y^2$$
$$\psi = 2\,xy$$

Then,

$$\frac{\partial\phi}{\partial x} = 2\,x = \frac{\partial\psi}{y}$$
$$\frac{\partial\phi}{\partial y} = -\,2\,y = -\frac{\partial\psi}{\partial x}$$

so that $w$ is a holomorphic function of $z$.

The proof of (9) is tedious but simple and can be followed in any of the texts on Functions of a Complex Variable if the reader so desires.

### Laplace's Equations

Differentiating $\frac{\partial\phi}{\partial x} = \frac{\partial\psi}{\partial y}$ with respect to $x$, we get

$$\frac{\partial^2\phi}{\partial x^2} = \frac{\partial^2\psi}{\partial y\,\partial x}\dots\dots\dots\dots\dots\dots(B)$$

Differentiating $\frac{\partial\phi}{\partial y} = -\frac{\partial\psi}{\partial x}$ with respect to $y$, we get

$$\frac{\partial^2\phi}{\partial y^2} = -\frac{\partial^2\psi}{\partial y\,\partial x}\dots\dots\dots\dots\dots\dots(C)$$

Equating (B) and (C):

$$\frac{\partial^2\phi}{\partial x^2} = -\frac{\partial^2\phi}{\partial y^2} \text{ or } \frac{\partial^2\phi}{\partial x^2} + \frac{\partial^2\phi}{\partial y^2} = 0\dots\dots\dots(10)$$

In the same way, we obtain by differentiating $\frac{\partial\phi}{\partial x} = \frac{\partial\psi}{\partial y}$ with respect to $y$ and $\frac{\partial\phi}{\partial y} = -\frac{\partial\psi}{\partial x}$ with respect to $x$ a similar result for the function $\psi$, that is:

$$\frac{\partial^2\psi}{\partial x^2} + \frac{\partial^2\psi}{\partial y^2} = 0\dots\dots\dots\dots\dots\dots(11)$$

These two results (10) and (11) are known as Laplace's equations, solutions of which are referred to as *plane harmonic functions.*

It is understood of course, that the symbols $\phi$ and $\psi$ used above may be replaced by any other symbols or quantities suitable. $\phi$ and $\psi$ are solutions of Laplace's equations and are sometimes referred to as *conjugate functions.* If one of these functions is known, it is often possible to determine the other which may furnish a means of determining useful data when only part of it is fully known.

For instance, let $\phi$ be given as a function of $x$ and $y$ satisfying the required conditions of holomorphism. If $\phi$ is a solution of Laplace's equations, it is required to determine the conjugate function $\psi$ which must also be a function of $x$ and $y$.

From this we see that since $\psi$ is a function of $x$ and $y$,

$$d\psi = \frac{\partial\psi}{\partial x}dx + \frac{\partial\psi}{\partial y}.dy.$$

But since the conditions of holomorphism are satisfied,

$$\frac{\partial\phi}{\partial x} = \frac{\partial\psi}{\partial y} \text{ and } \frac{\partial\phi}{\partial y} = -\frac{\partial\psi}{\partial x}.$$

By substitution from these conditions, we get:

$$d\psi = -\frac{\partial\phi}{\partial y} \cdot dx + \frac{\partial\phi}{\partial x} \cdot dy.$$

So that by integrating:

$$\psi = \int\left(-\frac{\partial\phi}{\partial y} \cdot dx + \frac{\partial\phi}{\partial x} \cdot dy\right) \quad \ldots\ldots\ldots (12)$$

As an example, suppose $\phi = x^2 - y^2$ be given and it is required to determine the conjugate function $\psi$ and to form the function $w = (\phi + i\psi)$.

First determine the partial derivatives required in (12).

$$\frac{\partial\phi}{\partial y} = -2y; \frac{\partial\phi}{\partial x} = 2x.$$

Substituting these values in (12) we get:

$$\psi = \int(2y \cdot dx + 2x \cdot dy) = 2xy + C.$$

From these results the function $w = (\phi + i\psi)$ may be formed by putting in the above values of $\phi$ and $\psi$:

$$\begin{aligned} w &= (\phi + i\psi) \\ &= (x^2 - y^2) + i(2xy + C) \\ &= x^2 + 2ixy - y^2 + iC \\ &= (x + iy)^2 + iC \\ &= z^2 + \text{const.} \end{aligned}$$

If $\psi$ be given and it is required to determine the value of the conjugate function $\phi$, it is easily verified by the same process as that used in forming (12) that:

$$\phi = \int\left(\frac{\partial\psi}{\partial y} \cdot dx - \frac{\partial\psi}{\partial x} \cdot dy\right)$$

These conjugate functions have an interesting and very important property when they are placed equal to constant values. For instance, if:

$$(\phi + i\psi) = (x + iy)^2,$$

then $\phi = x^2 - y^2$ and $\psi = 2xy$

If $\phi$ and $\psi$ be placed equal to constant values, we get equations of a series of curves $(x^2 - y^2) = C$ and $2xy = C$ which are orthogonal; a property which will be shown later on to be of practical importance.

### Hydrodynamics

In the following discussion, the fluid flow will be considered as parallel to the $X$, $Y$ plane and of uniform thickness equal to unity, the fluid being perfect.

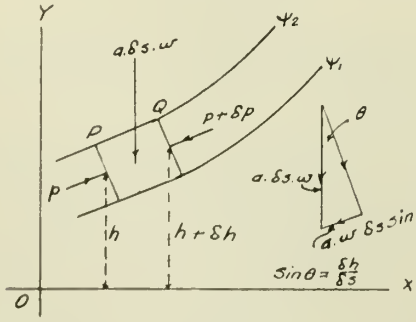


Fig. 4

A *stream line* will be considered as a curve across which there is no flow, the direction of the velocity of flow being tangential to this curve at all points.

### Bernoulli's Equation

In Fig. 4, let $\psi_1$ and $\psi_2$ be two stream lines. Take two right cross sections at $P$ and $Q$ very close to one another such that $PQ = \delta s$. The right cross section areas at $P$ and $Q$ being so close together may be considered equal with a value, $a$.

Consider the forces acting on the small mass of fluid $\delta m$ between $P$ and $Q$. The total pressure on the right cross section at $P = p \cdot a$ and at $Q$ is $(p + \delta p)\, a$. The weight of the fluid between $P$ and $Q = a \cdot \delta s \cdot w$ where $w$ is the weight of fluid per cubic foot. The resolved part of the weight of this

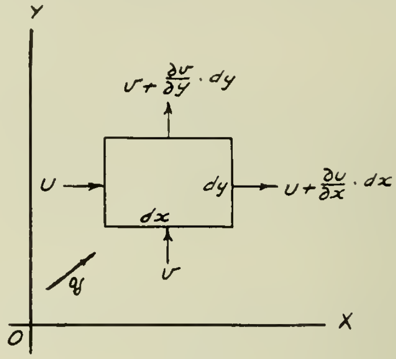


Fig. 5

small mass of fluid in the direction of the unit pressure $p$ is $a \cdot w \cdot \delta h$. This follows from the fact that if the inclination of the tangent to $\psi_1$ at the section through $P$ is $\theta$, then $\sin\theta = \frac{\partial h}{\delta s}$ and the required resolved part is

$$a \cdot \delta s \cdot w \cdot \sin\theta = a \cdot w \cdot \delta h.$$

This resolved part is opposed to the total pressure $(p \cdot a)$ on the section through $P$.

The effective force acting on $\delta m$ is

$$p \cdot a - (p + \delta p)\, a - a \cdot w \cdot \delta h = -\delta p \cdot a - a \cdot w \cdot \delta h$$

Then if the acceleration produced by this effective force is $\frac{\delta v}{\delta t}$, we may write the equation:

$$-\delta p \cdot a - a \cdot w \cdot \delta h = \delta m \cdot \frac{\delta v}{\delta t}$$

In the limit, this may be written:

$$\begin{aligned} -dp \cdot a - a \cdot w \cdot dh &= dm\frac{dv}{dt} \\ &= \frac{a \cdot ds \cdot w}{g} \cdot \frac{dv}{dt} \end{aligned}$$

But $$\frac{ds \cdot dv}{dt} = v \cdot dv;$$

so that $$-dp \cdot a - a \cdot w \cdot dh = \frac{a \cdot w \cdot v \cdot dv}{g};$$

or $$\frac{dp}{w} + \frac{v \cdot dv}{g} + dh = 0$$

Integrating this last result, we get:

$$\frac{p}{w} + \frac{v^2}{2g} + h = \text{const.} \quad \ldots\ldots\ldots\ldots\ldots (13)$$

This result is Bernoulli's equation from which it is possible to determine pressures and velocities at various sections provided these quantities are known at some starting point on a stream line. The equation forms the basis of a large part of hydraulic analysis when another factor is added to account for the various friction losses.

### Equation of Continuity

Let the small rectangular mass in Fig. 5 of dimensions $dx$, $dy$ and unit thickness be located at some point at which the velocity of the fluid is $q$. This velocity has resolved parts $u$ and $v$ in the directions of $X$ and $Y$ respectively. The magnitudes of the resolved parts are supposed to vary so as to give values at the opposite sides of the rectangle as indicated.

The condition of continuity of fluid mass requires that there shall be the same quantity of fluid flowing out as that which flows into the rectangular figure.

The quantity of fluid flowing into the rectangle is,

$$(u \,.\, dy + v \,.\, dx);$$

and the amount of fluid flowing out is:

$$\left(u + \frac{\partial u}{\partial x} \,.\, dx\right) dy + \left(v + \frac{\partial v}{\partial y} \,.\, dy\right) dx$$

Equating these two values, we get:

$$\left(\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y}\right) dy \,.\, dx = 0$$

or

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0 \qquad (14)$$

This last result is the analytical condition governing the continuity of fluid flow and is called the Equation of Continuity of Flow.

Now if (14) be written:

$$\frac{\partial u}{\partial x} = -\frac{\partial v}{\partial y},$$

we recognize this from (5) as the condition whereby an expression $(u \,.\, dy - v\, dx)$ is an exact differential of some function which we may designate $\psi$. In other words,

$$d\psi = (u \,.\, dy - v \,.\, dx).$$

If this is so, it follows from propositions (3) and (4) that:

$$u = \frac{\partial \psi}{\partial y} \quad \text{and} \quad v = -\frac{\partial \psi}{\partial x} \qquad (15)$$

So that if we can discover this function $\psi$, it will be possible to determine the resolved parts of the velocity $q$ in terms of the partial derivatives with respect to $x$ and $y$ as indicated by (15).

In order to determine the meaning of the function $\psi$, let it be assumed that it is related to another function $\phi$ such that $(\phi + i\psi)$ is a holomorphic function of $(x + iy)$.

If this is so, we know from (9) that:

$$\frac{\partial \phi}{\partial x} = \frac{\partial \psi}{\partial y} \quad \text{and} \quad \frac{\partial \phi}{\partial y} = -\frac{\partial \psi}{\partial x}.$$

Consequently, by substitution in (15), it follows that:

$$u = \frac{\partial \psi}{\partial y} = \frac{\partial \phi}{\partial x}$$

$$v = -\frac{\partial \psi}{\partial x} = \frac{\partial \phi}{\partial y} \qquad (16)$$

Now since $(\phi + i\psi)$ is a holomorphic function of $(x + iy)$, both $\phi$ and $\psi$ must be functions of $x$ and $y$. So that if we write the equations of a series of curves given by:

$$\psi = f\,(x \,.\, y) = \text{constant},$$

it follows that:

$$d\psi = \frac{\partial \psi}{\partial x} \,.\, dx + \frac{\partial \psi}{\partial y} \,.\, dy = 0;$$

and

$$\frac{dy}{dx} = -\frac{\partial \psi}{\partial x} \Big/ \frac{\partial \psi}{\partial y} \qquad (17)$$

This result (17) is the slope of the curves given by the equations $\psi$ = const.

But the slope of the velocity of $q$ in Fig. 5 is given by $\frac{v}{u}$

and this value is seen from (16) to be:

$$\frac{v}{u} = -\frac{\partial \psi}{\partial x} \Big/ \frac{\partial \psi}{\partial y},$$

which is identical with (17).

We see, therefore, that these curves, formed by putting the function $\psi$ = constant, have the same directions as the flow of the fluid. These curves, then, must be stream lines; and the function $\psi$ is consequently referred to as the *stream function.*

Another series of curves formed by putting $\phi$ = constant are orthogonal to the stream lines which follows from the fact that $\psi$ and $\phi$ are conjugate functions. This other series of curves has a meaning which will be referred to later on in the discussion.

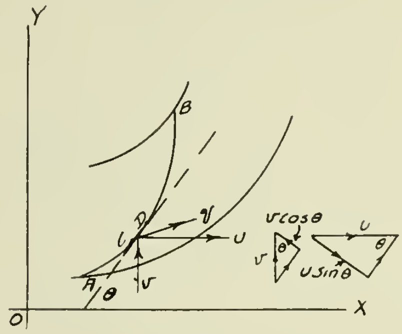


**Fig. 6**

From equations (16) it is also possible to write the value of the velocity $q$ in terms of these conjugate functions $\phi$ and $\psi$ as follows:

$$q^2 = u^2 + v^2$$

$$= \left(\frac{\partial \psi}{\partial y}\right)^2 + \left(-\frac{\partial \psi}{\partial x}\right)^2$$

$$= \left(\frac{\partial \phi}{\partial x}\right)^2 + \left(\frac{\partial \phi}{\partial y}\right)^2 \qquad (18)$$

Let $A$ and $B$ (Fig. 6) be any two points on the stream lines indicated, and let $ACDB$ be any curve connecting these two points. Let $CD$ be a distance $ds$ on this curve and let the slope of $ds$ with reference to the axis of $X$ be $\theta$ as indicated. Resolve $u$ and $v$ perpendicular to $ds$ as shown in the diagram.

Then the flow across $ds = (u \sin\theta \,.\, ds - v \cos\theta \,.\, ds)$

If we integrate along the curve $AB$, the total flow across this curve, which is really the flow between the stream lines is given by:

$$\int (u \sin\theta - v \cos\theta)\, ds.$$

Substituting in this the values of $u$ and $v$ from (16), we get for the flow between $A$ and $B$:

$$\int \left(\frac{\partial \psi}{\partial y} \sin\theta\, ds + \frac{\partial \psi}{\partial x} \cos\theta\right) ds.$$

But $\sin\theta\, ds = dy$ and $\cos\theta\, ds = dx$; so that the value of this flow becomes:

$$\int \left(\frac{\partial \psi}{\partial y} \,.\, dy + \frac{\partial \psi}{dx} \,.\, \partial x\right) = \int d\psi = \psi + C.$$

We see then that $\psi$ is in reality a function which may represent the actual flow of fluid between stream lines.

The usual procedure is to take one stream line as a base line and calculate the flow between this and any other stream line. It is also generally convenient to lay out stream lines so that the flow between any adjacent two is of equal amount.

### Velocity Potential

The function $\phi$ conjugate to $\psi$ is also capable of interpretation in hydrodynamic analysis.

It has been shown that if $w = (\phi + i\psi)$ is a holomorphic function of $z = (x + iy)$, we may write:

$$u = \frac{\partial \phi}{\partial x} \quad \text{and} \quad v = \frac{\partial \phi}{\partial y} \qquad \text{(See (16))}$$

But this last statement is merely the condition whereby there exists a function $\phi$ such that the following expression is its exact differential:

$$d\phi = u\,dx + v\,dy.$$

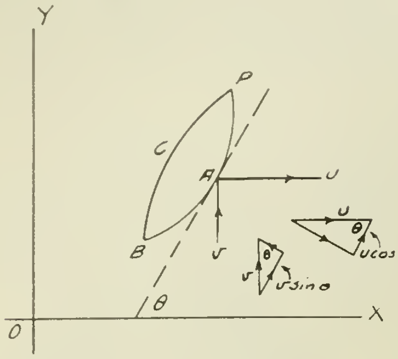


**Fig. 7**

From which, we get:

$$\phi = \int (u\,dx + v\,dy)$$
$$= \int \left( u \frac{dx}{ds} + v \frac{dy}{ds} \right) ds$$
$$= \int (u \cos\theta + v \sin\theta)\, ds \ldots\ldots\ldots (19)$$

From Fig. 7 we see that if the angle $\theta$ in (19) is the angle of inclination of the tangent at a point $A$ on any curve taken in the flow, then $u \cos\theta$ and $v \sin\theta$ are merely the resolved parts of the velocities $u$ and $v$ taken along this tangent. So that (19) is the integral of the tangential flow along any curve in the area being considered. This integral, in general, has not the same value for different paths from $B$ to $P$ along $BAP$ and $BCP$ for example. However, when the motion is irrotational, this integral has the same value for all paths from $B$ to $P$. In such cases the function $\phi$ is called the *velocity potential*.

If the integral is found along a closed curve such as $BAPCB$ the value is called the *circulation* along the curve. The circulation along a closed curve is zero for irrotational flow.*

Curves of equi-velocity potential are formed by putting $\phi$ = constant. These curves are orthogonal to the stream lines which follows from the fact that $\phi$ and $\psi$ are conjugate functions.

### Velocity of Flow

Now that we have established the relations of the functions $\phi$ and $\psi$ to stream line flow, it is possible to derive certain other practical results.

The velocity of flow at any point on a stream line may be found from the modulus of the derivative of

$w = (\phi + i\,.\,\psi)$ with respect to $z = (x + i\,.\,y)$.

Let $A$ and $B$ (Fig. 8) be two values of $z$ separated by infinitesimal amounts. The plane on which these values of $z$ are represented is called the $z$ plane. Similarly in Fig. 9 let $C$ and $D$ be two values of $w$ infinitesimally close together on the $w$ plane. Let $AB = ds$ and $CD = d\rho$, then:

$$\left(\frac{d\rho}{ds}\right)^2 = \frac{d\phi^2 + d\psi^2}{dx^2 + dy^2} \ldots\ldots\ldots\ldots\ldots (20)$$

But since $w$ is assumed to be a holomorphic function of $z$:

$$d\phi = \frac{\partial\phi}{\partial x}\,.\,dx + \frac{\partial\phi}{\partial y}\,.\,dy;$$

and
$$d\psi = \frac{\partial\psi}{\partial x}\,.\,dx + \frac{\partial\psi}{\partial y}\,.\,dy\ldots\ \ldots\ldots\ldots (21)$$

*This statement is true for paths which enclose fluid only. If the circulation is taken around a body it has a constant value.

Substituting values from (21) into (20), we get

$$\left(\frac{d\rho}{ds}\right)^2 = \left(\frac{\partial\phi}{\partial x}\right)^2 . dx^2 + \left(\frac{\partial\phi}{\partial y}\right)^2 . dy^2 + \frac{2\,\partial\phi^2}{\partial y\,\partial x} . dy\,.\,dx +$$
$$\left(\frac{\partial\psi}{\partial x}\right)^2 . dx^2 + \left(\frac{\partial\psi}{\partial y}\right)^2 . dy^2 + 2\,\frac{\partial\psi^2}{\partial y\,\partial x} . dy\,.\,dx/dx^2 + dy^2 \,.\,.\,(22)$$

But
$$2\frac{\partial\phi^2}{\partial y\,\partial x} = 2\frac{\partial\phi}{\partial y}\cdot\frac{\partial\phi}{\partial x}\ldots\ldots\ldots\ldots\ldots (23)$$

Substituting from (9) values for $\frac{\partial\phi}{\partial y}$ and $\frac{\partial\phi}{\partial x}$ into (23), we get:

$$2\frac{\partial\phi^2}{\partial y\,\partial x} = -\,2\frac{\partial\psi}{\partial y}\cdot\frac{\partial\psi}{\partial x} = -\,2\,\frac{\partial\psi^2}{\partial y\,.\,\partial x}\ldots\ldots (24)$$

If we substitute from (24) into (22), it is seen that the third and sixth terms of the right hand side of equation (22) cancel out and (22) becomes:

$$\left(\frac{d\rho}{ds}\right)^2 = \frac{\left[\left(\frac{\partial\phi}{\partial x}\right)^2 + \left(\frac{\partial\psi}{\partial x}\right)^2\right] dx^2 + \left[\left(\frac{\partial\phi}{\partial y}\right)^2 + \left(\frac{\partial\psi}{\partial y}\right)^2\right] dy^2}{dx^2 + dy^2}$$

This expression becomes by substitution from (9):

$$\left(\frac{d\rho}{ds}\right)^2 = \frac{\left[\left(\frac{\partial\phi}{\partial x}\right)^2 + \left(\frac{\partial\psi}{\partial x}\right)^2\right] dx^2 + \left[\left(-\frac{\partial\psi}{\partial x}\right)^2 + \left(\frac{\partial\phi}{\partial x}\right)^2\right] dy^2}{dx^2 + dy^2}$$
$$= \frac{\left[\left(\frac{\partial\phi}{\partial x}\right)^2 + \left(\frac{\partial\psi}{\partial x}\right)^2\right](dx^2 + dy^2)}{dx^2 + dy^2}$$
$$= \left(\frac{\partial\phi}{\partial x}\right)^2 + \left(\frac{\partial\psi}{\partial x}\right)^2 = \left(\frac{\partial\phi}{\partial x}\right)^2 + \left(-\frac{\partial\psi}{\partial x}\right)^2$$

Substituting values from (9) again this becomes:

$$\left(\frac{d\rho}{ds}\right)^2 = \left(\frac{\partial\phi}{\partial x}\right)^2 + \left(\frac{\partial\phi}{\partial y}\right)^2$$

This expression is the same as (18) which is the value of

$$q^2 = u^2 + v^2$$

So that we find:
$$q^2 = \left(\frac{d\rho}{ds}\right)^2 \ldots\ldots\ldots\ldots\ldots\ldots (25)$$

In Fig. 8, $A$ and $B$ are two values of $z$ differing by an infinitesmal amount. $OA$ is the modulus of one value and $OB$ the modulus of the other value. The difference between the values of $z$ will give $dz$; and from former discussions, it


**Fig. 8**

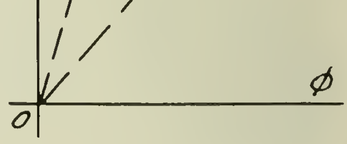


**Fig. 9**

is seen that, subtracting the moduli vectorially, $AB = ds$ has the same value as the modulus of $dz$. In the same way, it is seen that $CD = d\rho$ (Fig. 9) has the same value as the modulus of $dw$.

Result (25) may then be written:

$$q = \left|\frac{dw}{dz}\right| \ldots\ldots\ldots\ldots\ldots\ldots\ldots (26)$$

### Combined Stream Lines

It will be seen further on that certain types of stream lines are arrived at most conveniently by combining two or more well known and easily derivable flows. It is necessary, therefore, to derive the method by means of which these stream lines can be combined.

Consider two forms of stream lines given by $\psi_1 = C_1$ and $\psi_2 = C_2$.

The $x$ and $y$ resolved parts of the velocity of flow are related to the stream function as follows: (See 15)

$$u_1 = \frac{\partial \psi_1}{\partial y}; \quad v_1 = -\frac{\partial \psi_1}{\partial x}; \quad u_2 = \frac{\partial \psi_2}{\partial y}; \quad v_2 = -\frac{\partial \psi_2}{\partial x}.$$

Let the desired resultant stream function of $\psi_1$ and $\psi_2 = \psi$. Let $u = \frac{\partial \psi}{\partial y}$ and $v = -\frac{\partial \psi}{\partial x}$ be the $x$ and $y$ resolved parts of the velocity of flow related to $\psi$. Then combining resolved parts in the same direction, we get:

$$u = u_1 + u_2 = \frac{\partial \psi_1}{\partial y} + \frac{\partial \psi_2}{\partial y} = \frac{\partial (\psi_1 + \psi_2)}{\partial y} = \frac{\partial \psi}{\partial y}$$

$$v = v_1 + v_2 = -\left(\frac{\partial \psi_1}{\partial x} + \frac{\partial \psi_2}{\partial x}\right) = -\frac{\partial (\psi_1 + \psi_2)}{\partial x} = -\frac{\partial \psi}{\partial x}$$

From which it is evident that $\psi = (\psi_1 + \psi_2)$. That is: the resultant stream lines $\psi =$ const. are formed by adding together the superimposed stream functions.

### Types of Stream Lines

One of the most useful theoretical conceptions of stream flow is a point from which fluid issues at a uniform rate in all directions. Such a point is known as a *source*. The volume of fluid which appears from a source in unit time is known as its *strength*.

Let $O$ (Fig. 10) be a source of unit strength $m$. Take $OX$ as the base line from which to calculate stream flow, i.e. $OX$ is the stream line $\psi = 0$.

Then if a uniform depth is maintained at all points, the flow between $OX$ and any other stream line $OA$ will be

$$\psi = \frac{m}{2\pi} . \theta = \frac{m}{2\pi} \tan^{-1} \frac{y}{x}.$$

On the other hand, the conception of a point at which fluid disappears at a uniform rate is called a *sink* which may be regarded as a negative source.

Mathematically, the idea of a source can be arrived at by considering the function of a complex variable given by the expression:

$$w = \log z,$$

where $w = (\phi + i . \psi)$ and $z = (x + i . y) = r(\cos\theta + i \sin\theta)$ $w = \log z$ may be written $e^w = z$; and if the values of $w$ and $z$ be substituted, we get:

$$e^{(\phi + i\psi)} = e . ^\phi e^{i . \psi} = r(\cos\theta + i\sin\theta)$$

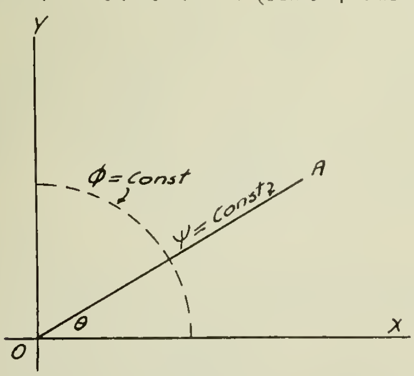


Fig. 10

But since $\quad e^{i\theta} = (\cos\theta + i\sin\theta)$ ............(See B)

it follows that: $\quad e^{i\psi} = (\cos\psi + i\sin\psi)$.

Then by substitution:

$$e^{(\phi + i\psi)} = e^\phi . e^{i\psi} = e^\phi(\cos\psi + i\sin\psi) = r(\cos\theta + i\sin\theta)$$

from which: $\quad e^\phi . \cos\psi + ie^\phi \sin\psi = r\cos\theta + i . r . \sin\theta$

Equating real and imaginary parts:

$$\begin{aligned} e^\phi \cos\psi &= r\cos\theta \\ e^\phi \sin\psi &= r\sin\theta \end{aligned} \quad \text{.............. (27)}$$

Squaring and adding these results:

$$(e^\phi)^2 (\sin^2\psi + \cos^2\psi) = r^2(\sin^2\theta + \cos^2\theta)$$

$$e^\phi = r \text{.................. (28)}$$

or

$$\phi = \log r = \log |z| \text{ ............. (29)}$$

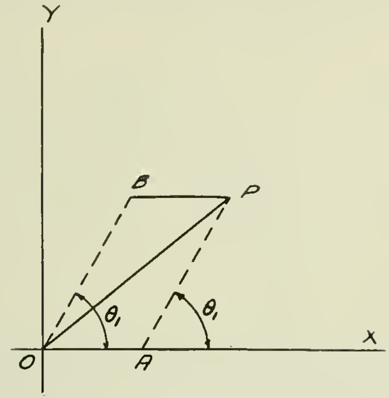


Fig. 11

Then by substituting the value of $r$ from (28) into (27), we get

$$e^\phi \cos\psi = e^\phi \cos\theta$$

$$\cos\psi = \cos\theta$$

$$\psi = \theta = \text{arg. } z \text{........... (30)}$$

So that it is seen that the original expression $w = \log z$ gives stream functions and velocity potential values which may be determined from (29) and (30).

The stream lines given by placing $\psi =$ const. are evidently straight lines. For $\psi = \theta =$ const. expresses the fact that these are straight lines radiating from a point which we recognize as a source.

The velocity potential curves are given by

$$\phi = \log r = \text{const.}$$

and are evidently a series of circles with the source as centre.

The velocity at any point (see 26) is given by:

$$q = \left|\frac{dw}{dz}\right| = \left|\frac{d \log z}{dz}\right| = \left|\frac{1}{z}\right| = \frac{1}{r}.$$

From which it is seen that the velocity varies inversely as the radius from the source.

It is easily seen from the above that a sink being a negative source, either of the following forms will give expressions from which sink results may be obtained:

$$w = -\log z = \log \frac{1}{z}.$$

The addition of a numerical constant to the variable in the above logarithmic functions gives a method by means of which any number of sources and sinks may be combined. For instance: $w = \log(z - 1)$ is a function from which source stream lines may be obtained; but the source has been shifted from the origin to a point $+1$ along the axis of $X$. This may be seen from Fig. 11.

Let $P$ and $A$ in Fig. 11 represent the points $z$ and $+1$ respectively with $O$ as origin. Then if $PB$ be constructed equal to $-(+1)$, the point $B$ represents $(z - 1)$ with $O$ as origin. But it can be seen from the construction that since $AP = OB = |z - 1|$, the point $P$ may represent $(z - 1)$ with $A$ as origin.

Let $|z - 1| = AP = r_1$ and arg. $(z - 1) = \theta_1$.

Then since

$$w = \log(z - 1)$$

$$(z - 1) = e^w = e^{\phi + i\psi} = e^\phi . e^{i\psi}$$

$$= e^\phi(\cos\psi + i\sin\psi) = r_1(\cos\theta_1 + i\sin\theta_1)$$

From which by the same process as for the derivation of (29) and (30). we get:

$$\phi = \log r_1 = \log |z - 1|$$
$$\psi = \theta_1 = \text{arg.}\ (z - 1)$$

It is seen that if $\phi$ and $\psi$ be placed equal to constant values, we have a source at $A$ (Fig. 11).

As an illustration of the usefulness of the last proposition, consider the case where

$$w = \log \frac{(z-1)}{(z+1)} = \log (z - 1) - \log (z + 1)$$

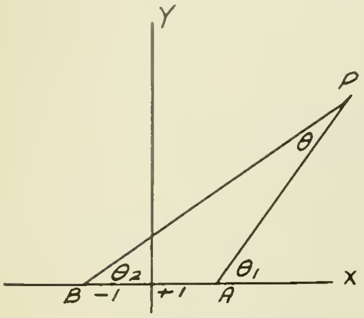


Fig. 12

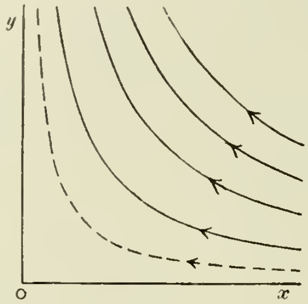


Fig. 13

Here we have the case of a source located at + 1 from the origin and a sink at a point − 1 from the origin.

The stream lines are given by the stream function:

$$\psi = \text{arg.}\ (z - 1) - \text{arg.}\ (z + 1) = \text{const.}$$

or $$\theta_1 - \theta_2 = \text{const.}$$

In Fig. 12, the source is located at $A$ and the sink at $B$. Then the point $P$ is located upon a stream line given by $\theta_1 - \theta_2 = \text{const.}$

But evidently $\theta_1 - \theta_2 = \theta$; and if $\theta$ is a constant value, then the point $P$ must be located on a circle passing through $A$ and $B$.

The combined stream lines of a source and sink may therefore give a series of circles passing through the source and sink. These stream lines have an analogy in the well known electromagnetic lines from a north to a south pole.

The theory of sources and sinks may be made use of to give a variety of stream lines especially when combined with uniform parallel flow. The reader will find numerous examples of these stream lines described in aeronautic and hydrodynamic literature.

The determination of stream line forms from other functions of complex variables gives a field of speculation which is very interesting. It is not easy to determine the equations for given forms as will be seen if the reader tries to find stream lines to fit a given predetermined outline.

Some of the simpler equations will give an idea of what can be done. Hard work and research must be depended upon to yield further results.

Throughout this discussion one simple form $w = z^2$ has been used for the purpose of illustration. This is one of the series: $w = z^n$. If $n = 2$, $w = z^2$ and

$$\phi = x^2 - y^2$$
$$\psi = 2\,xy$$

The stream lines for this take the form $\psi = 2\,xy =$ const. which if plotted give rectangular hyperbolae as shown in Fig. 13. The stream line $2\,xy = 0$ is formed by the axes of $x$ and $y$. So that in effect we get the theoretical flow between two planes perpendicular to one another.

If we put $n > 2$, we get a flow of the type indicated in Fig. 14. On the other hand by putting $n < 1$, we get the flow shown in Fig. 15.

The equation $w = z + \frac{1}{z}$ gives an interesting form from which further valuable results may be obtained. Expanding this equation, we get:

$$w = (x + iy) + \frac{1}{(x + iy)}$$
$$= (x + iy) + \frac{(x - iy)}{(x^2 + y^2)}$$
$$= \frac{x^3 + ix^2y + xy^2 + iy^3 + x - iy}{x^2 + y^2}$$
$$(\phi + i\psi) = \frac{(x^3 + xy^2 + x)}{x^2 + y^2} + \frac{i\,.\,y\,(x^2 + y^2 - 1)}{x^2 + y^2}$$

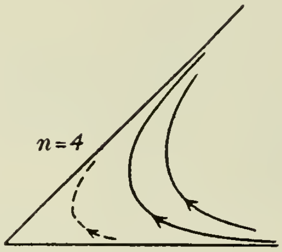


Fig. 14

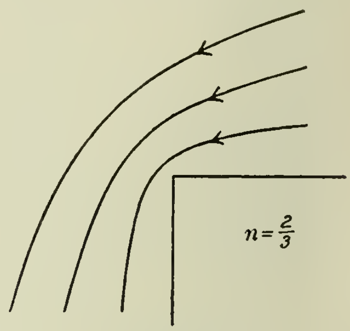


Fig. 15

Equating imaginary parts, it is seen that

$$\psi = \frac{y\,(x^2 + y^2 - 1)}{x^2 + y^2}$$

If this result be placed equal to constant values, the stream line resulting from $\psi = 0$ gives us:

$$\frac{y\,(x^2 + y^2 - 1)}{x^2 + y^2} = 0$$

So that either: $x^2 + y^2 - 1 = 0$ or $y = 0$.

The first result is the equation of a circle of radius unity, the other being the equation of the axis of reals.

We see then that the boundary of this stream line flow is the axis of $x$ and the circumference of a circle, the remaining stream lines giving a flow as indicated in Fig. 16.

### Conclusion

These fundamental ideas should enable the reader to continue his studies on the subject. It can be shown, for instance, that the flow around a circle placed in a uniform parallel flow may be transformed, as it is called, to flow around airfoil sections. Other combinations of sources and sinks will give outlines approximating air ship and boat sections. Of course, a great amount of design is dependent

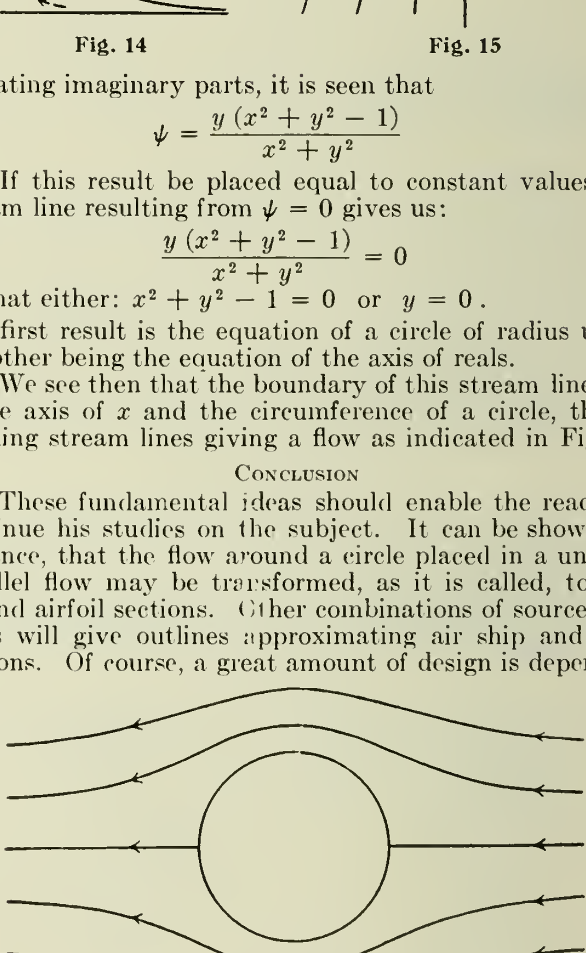

Fig. 16

upon experimental data; but a true comprehension of what is going on can never be had if the theoretical basis of hydrodynamics is not understood.

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**Erratum**: Page 447. Expression for flow from $A$ to $B$ should read:

$$\int \left( \frac{\partial \psi}{\partial y} \sin\,\theta\,ds + \frac{\partial \psi}{\partial x} \cos\,\theta\,ds \right).$$

# The National Parks of Canada and The Trans-Canada Highway

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**Presented together with Mr. Patrick Philip's paper on Highways and Highway Transportation in British Columbia, at the Western Professional Meeting of The Engineering Institute of Canada, Vancouver, B.C., July 11th to 14th, 1934**

There is a very close association between the National Parks of Canada and the Trans-Canada highway since, west of the Great Lakes, eight great parks are within an easy day's motoring, or less, of the highway, and the latter actually goes through two of them.

Banff National Park, with an area of 2,585 square miles, and Yoho National Park adjoining it to the west, with an area of 507 square miles, are practically bisected by the road. This geographical fact is of tremendous mutual advantage; on the one hand the two National parks mentioned have Canada's main highway as their main tourist artery, and on the other hand trans-Canada motorists will have the advantage of traversing some of the most scenic mountain areas of the Dominion.

After traversing the prairie sections of the highway, motorists, west bound, will see from Calgary the snow covered peaks of the Rocky Mountain range through which the route will lead them. Along it they will enjoy world famous views of mountain peaks, valleys, snowfields and lakes, and glaciers and alplands.

Seventy-three miles west of Calgary the highway enters Banff National Park—and for 89 miles traverses National park areas. Of this distance 57 miles is in Banff Park and 32 miles in Yoho Park. This section of the highway was constructed some years ago by the National Parks Branch of the Department of the Interior, and is maintained by that Branch to the degree necessary for the safety and comfort of the motoring public.

In addition to the splendid mountain scenery visible from the Trans-Canada highway itself, there are 96 miles of first class roads tributary to it in Yoho and Banff Parks,

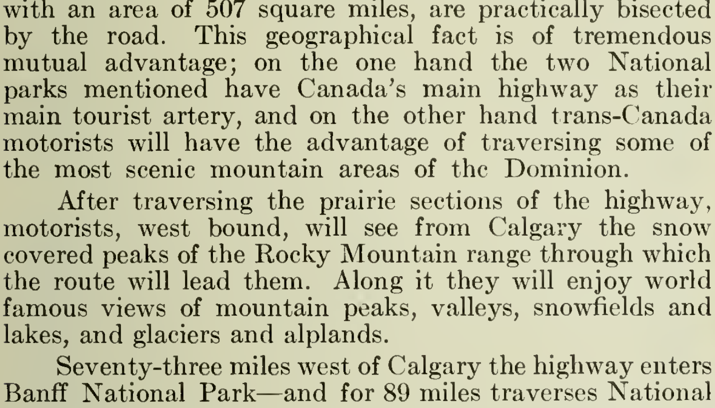


**Fig. 1**

that make accessible to the motorist many well known scenic points. Among them are

Moraine Lake and the Valley of the Ten Peaks,
Marble Canyon,
Lake Louise, Hector Lake,
The Yoho Valley and Takakkaw Falls, and
The Emerald Lake District.

Then 20 miles west of Banff, the Banff-Windermere road branches off to the south to go through Kootenay Park, crossing the Continental Divide by the Vermilion Pass at an elevation of 5,660 feet. After 73 miles it connects with a provincial road at Parkgate, B.C. By motoring north from this point some 67 miles, connection is made with the main highway again at Golden, B.C., thus providing an alternative route through the Rocky Mountain range.

While the National Park section of the highway is in the Rocky Mountain range, grades and alignment are

**Fig. 2—Trans-Canada Highway in Banff National Park. Massive Range in Background.**

remarkably good. The ruling grade is 6 per cent with a maximum of 8 per cent—the latter being found in only two short stretches totalling 2,500 feet.

Curvature is continually being reduced and particular attention is paid to superelevation.

The average width of actual road way is twenty feet —and all major revisions and improvements are now being constructed to a standard that provides a 22-foot wheelway exclusive of side ditches. Extra width is given on all curves in proportion to the degree of curvature. The road is well surfaced with screened gravel, and the entire 89-mile section through Banff and Yoho National Parks is treated with dust-laying oil each season. Motorists can consequently enjoy the mountain driving in comparative safety and comfort.

The elevation of the highway through Yoho and Banff Parks varies from 3,700 feet to 5,450 feet, the latter elevation being near the Continental Divide in the Kicking Horse Pass. Timber line is consequently not far away and the spring run-off from the bare rock exposures above it is usually short and intense.

These natural conditions result in a tremendous variation in stream flow. For forty-six weeks of the year half of the culverts may carry no water whatever. For the remainder of the year they must have sufficient capacity to carry flood run-offs. An interesting example of flow variation is that of the Bow river—which rises in the Bow

Lakes area on the continental divide—62 miles northwest of Banff.

The minimum flow of the Bow at Banff is some 350 second feet—while in the spring floods in June its flow reaches 9,300 second feet.

A much wider flow variation in proportion is shown by Corral Creek in the Lake Louise district. A short maximum flood run-off of 300 second feet is reduced in the low water period to 3 second feet. In the first instance

Fig. 3—Trans-Canada Highway in Yoho National Park. President Group of Mountains in Background.

the drainage structure required is a 70-foot bridge costing $4,500. In the second instance a 2-foot by 3-foot culvert at a cost of $80 would be sufficient.

The fan shaped gravel and loose rock ridges built up by the mountain streams when they reach the main valleys complicate the location of bridge sites and make the choice of the latter a matter of careful adjustment between alignment and length of span.

So far in maintaining the Parks section of the Trans-Canada highway as much trouble has been experienced in the winter months withice conditions, as in the spring run-off. Alternative flooding and freezing of streams at bridge sites—coupled with the formation of anchor ice—frequently raises the water surface above flood levels. Ice forming under bridges will reach a thickness of from 8 to 12 feet and on occasions has reached the lower chords. In such cases explosives are used to relieve the situation.

Culverts occasionally fill with ice during the winter months and are practically ice blocked when the spring run-off occurs. More than normal capacity is consequently provided in the case of all drainage structures where ice troubles are anticipated.

The comparatively high elevation of the Trans-Canada highway through the National Park section results in winter conditions prevailing for from six to six and one-half months of the year. Such conditions are however by no means extreme. The entire route is naturally open from about May 20th to November 1st, which gives an ample margin of time over and above the length of the average tourist season.

By the use of snow ploughing equipment the open season for the Parks section of the road can be indefinitely extended.

The 16½ miles of road west from Lake Louise—and crossing the Great Divide—is the only section where serious drifts occur and these offer no great obstacles to a rotary plough. The maximum depth of snow on the level ranges from four to six feet.

The Trans-Canada route through the Rockies is remarkably free of snow-slide areas and is perfectly safe in this respect.

At Leanchoil, B.C., the west boundary of Yoho Park is reached and the Trans-Canada highway there becomes the responsibility of the province of British Columbia. After 17 spectacular miles through the lower Kicking Horse Canyon, the road passes through the town of Golden on the way to Donald, B.C.—15½ miles further west.

The Golden-Donald section is still under construction. At Donald, the highway returns to the temporary jurisdiction of the National Parks Branch which is constructing the 78-mile section from Donald to Canoe river as a Federal Government project. This section is part of the uncompleted link of the highway in British Columbia between Golden and Revelstoke, B.C.

A short route between these two points could be found over Rogers Pass parallel to the main line of the Canadian Pacific Railway, and would pass through Glacier National Park. However, owing to the shorter summer season on this route, the prevalence of snow-slides, the heavier gradients encountered, and general construction difficulties, it was mutually agreed by the Federal and Provincial Governments that the longer but easier route following the Columbia river—and called the "Big Bend Road"—would be adopted.

The National Parks Branch is building the east leg of the Big Bend section in lieu of spending an equal amount in the construction of the 36-mile section through Glacier Park, which would have been necessary if the Rogers Pass route had been chosen.

The location of this section of the Trans-Canada highway, together with that of the section through the National parks, is shown on the maps accompanying this article. These show the close relation between Canada's parks and her trans-continental highway, each being a distinct asset to the other.

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## Young Engineers and The Institute

The young man who desires to enter upon an engineering career to-day finds himself greatly handicapped by existing economic conditions. His experience during the early years of his professional life should enable him to realize that his academic training is only the first stage in his engineering education, and this experience can only be obtained through actual contact with industry and with other members of his profession. Active membership in an engineering society is of particular value to him at this time, since it gives opportunities for personal contacts of the most valuable kind, and can exert a powerful influence on his professional development. Unfortunately, as things now are, he finds it difficult, if not impossible, to secure employment involving any professional responsibility or practical experience in industry or construction, and he may even feel that he cannot well afford the modest sum needed for the junior classes of membership in such a body as The Engineering Institute. These conditions, which are, of course, not peculiar to Canada, present a very definite problem, which demands and is receiving attention from practically all leading engineering societies. The graduating classes of our engineering schools are yearly turning out fresh additions to the ranks of these "engineers-in-training," if one may use the apt expression employed in British Columbia, and the graduates from these schools form the principal source from which our members of the future must be drawn. Actually, our Student and Junior members make up about a quarter of the total membership of The Institute.

Recently, the General Secretary, during his visits to the western branches, had the interesting experience of meeting and hearing the views of a considerable number of members of these younger groups from the western universities. They are keenly interested in the profession they have chosen. They are seeking, but not always finding, further training through professional employment, and need all the help that older members can give them. It must be remembered that many of these young graduates will eventually become corporate members of The Institute. It is therefore of primary importance to The Institute, as well as to the young men themselves, that membership should be available to them, and that they should be induced to take an active part in The Institute's affairs. This can be done if our branches, wherever the need exists, will take such measures as will bring these younger men within the influence of The Institute, assure them of the sympathy and help of the older members, and make definite arrangements for their participation in branch and Institute activities, both in regard to meetings and committee work. The actual course to be taken to secure this desirable result depends on local conditions. In some of our larger centres active and enthusiastic Junior Sections of the branch are already at work, the members of which organize and hold their own meetings for the presentation and discussion of papers arranged for by themselves. In other cases the sympathy and assistance of The Institute branch has been given to a junior engineering society formed within the local engineering school. In most of the smaller branches such arrangements as these are not possible, but much can be done by encouraging the participation of the younger men in meetings specially held for them, which may well be of a somewhat less formal nature than the regular meetings of the branch.

The Institute itself, and several of our branches, encourage the work of the Students and Juniors of The Institute in competing for special prizes awarded for meritorious papers, and in one of the western branches the younger members are invited to prepare short talks to be delivered before small groups at several of the meetings of the branch during the coming season. Many of the younger men, while anxious to work for and with The Institute, feel a natural diffidence in expressing their views in the presence of a large number of their older confrères. An article discussing the relations of Juniors and Students to The Institute will be found on another page, suggested by a thoughtful report recently presented to the American Society of Mechanical Engineers and prepared by a group of junior members of that body.

The report tells what an engineering society "can do for the junior member, and suggests activities for him that will strengthen his interest and increase his value and loyalty."

An enquiry of this kind is only one indication, among many others, of the sincere desire of the younger groups for constructive action leading to improvement and wider opportunities for self-development. Youth to-day is not content to accept as unchangeable existing conditions which are due to mere inertia, or which press hardly, and for which the rising generation does not feel itself responsible. The younger men are seriously concerning themselves with questions of the day, seeking solutions for them, and are anxious to help in bringing about the developments which are needed to make the world a better place to live in. The seniors have their part also, that of giving tactful guidance to these efforts, such help as is possible in securing professional experience and information, and encouragement in any movement showing constructive thought and activity on the part of their younger confrères. Such activities, if based on the enthusiasm and co-operative effort of youth, and rightly directed, will naturally bring out new points of view and throw unexpected light on time-worn problems. They can set in motion constructive agencies which are capable of great results when backed by the sympathy and tempered by the experience of the older men.

These considerations apply not only to our economic and industrial difficulties—they are equally applicable to the problems of professional education and training and to the questions of organization and administration which confront professional engineering societies.

## Meeting of Council

A meeting of Council was held at Headquarters on Friday, September 21st, 1934, at eight o'clock p.m., with President F. P. Shearwood, M.E.I.C., in the chair, and eleven other members of Council present.

A statement from the chairman of the Finance Committee indicated that to date the total revenue and expenditure were very close to the amounts anticipated in the budget.

The President and Secretary reported that during their visits to the western branches a number of questions had been raised and some suggestions made regarding Institute organization and policy, and these were presented for Council's consideration. It was decided that before taking any action, a memorandum covering the suggestions made should be forwarded to all members of Council with a request for written comments to be considered at the October meeting of Council.

It was felt that the Council should put on record its appreciation of the excellent work done by those responsible for the organization of the recent Vancouver meeting of The Institute and the American Society of Civil Engineers, which had been such an outstanding success. Accordingly the Secretary was directed to express Council's thanks and appreciation to the chairman of the local joint committee, Mr. E. A. Cleveland, M.E.I.C., M.Am.Soc.C.E., and to the committee members.

The report of the Nominating Committee was received and held over pending the receipt of all necessary letters of acceptance from nominees.

The tentative programme for the Annual General and General Professional Meeting of The Institute in February 1935, as submitted by the Toronto Annual Meeting Committee, was noted and approved.

Attention was drawn to the fact that following the change of government in Ontario a number of engineers employed by the government had been dismissed, the majority of whom, however, had been given the option of remaining at their tasks at salaries to be decided upon later.

The President reported the action so far taken, including the despatch of telegrams to the Premier of Ontario and to the Chairman of the Hydro-Electric Power Commission of Ontario, suggesting that action be delayed pending the receipt of representations from The Institute. After prolonged discussion, it was decided that a memorandum along the lines of a draft already submitted to the Ontario branches should be prepared and forwarded from the Council of The Institute to the Premier of Ontario.

Two resignations were accepted, a number of reinstatements were effected, and several special cases were dealt with.

A number of applications for admission and for transfer were considered, and the following elections and transfers were effected:

| *Elections* | | *Transfers* | |
|---|---|---|---|
| Assoc. Members | 8 | Assoc. Member to Member | 1 |
| Juniors | 3 | Junior to Assoc. Member | 6 |
| Affiliates | 2 | Student to Assoc. Member | 3 |
| Students admitted | 5 | Affiliate to Assoc. Member | 1 |
| | | Student to Junior | 5 |

The Council rose at eleven fifty p.m.

## Annual Meeting 1935

The Forty-Ninth Annual General and General Professional Meeting of The Institute is to be held at Toronto, Ont., on Thursday and Friday, February 7th and 8th, 1935. On Saturday, February 9th, a number of plants will be visited.

## OBITUARIES

### Sven Svenningson, M.E.I.C.

Widespread regret will be felt at the death of Sven Svenningson, M.E.I.C., which occurred suddenly at Bailey Island, Maine, on August 16th, 1934.

Mr. Svenningson was born at Oslo, Norway, March 19th, 1884, and graduated from the Polytechnic Institute of Christiania in 1907 with the degree of M.E. Upon his graduation he entered the turbine department of Kvaerner Brug, Christiania, where he was employed as a designer for a little over a year. In 1908 and 1909 he was in charge of the design and construction of a rubber factory for the Svenska Gummivarefabrik, Christiania.

SVEN SVENNINGSON, M.E.I.C.

In 1909 he left Norway for the United States and joined the engineering staff of the Pennsylvania Water and Power Company on the construction of their hydro-electric plant at Holtwood.

From that time Mr. Svenningson was engaged on hydro-electric work almost continuously until the time of his death, and gained recognition as a leader in this field.

After five years in the United States, during which time, in addition to his work at Holtwood he was engaged with the Fargo Engineering Company at Jackson, Mich., and on the Mississippi River development at Keokuk, Iowa, for Stone and Webster, he came to Canada in 1913 as assistant engineer in charge of structural and mechanical design on the Cedars' development of the Cedars Rapids Manufacturing and Power Company.

Upon the completion of this work in 1915, he became designing engineer of The Shawinigan Water and Power Company. In 1918, when The Shawinigan Engineering Company was formed to handle the major designing and construction activities of the parent company, he was appointed its chief engineer and in 1921 was made vice-president and chief engineer of Power Engineering Company, formed to supervise similar work for all the subsidiaries as well as for the allied interests of the parent company. These positions he held at the time of his death

These were busy years, marked by rapid growth in the Shawinigan Company's system and the engineering organization was called upon to investigate and design a large number of power developments for the Shawinigan Company and others. Upon Mr. Svenningson's advice, and in most cases under his direction, such outstanding developments as La Gabelle and Rapide Blanc on the St. Maurice river; Great Falls on the Winnipeg river; Chelsea, Farmers and Paugan on the Gatineau river; and others totalling more than a million horse-power were brought into successful operation. His contribution to the industrial upbuilding of his chosen country was outstanding. Of him, as of few members of his profession in Canada, can it be said in the beautiful words of Mr. Justice Holmes: "To gather the streams from waste and to draw from them energy, labour without brains, and so to save mankind from toil that it can be spared, is to supply what next to intellect is the very foundation of all our achievement and all our welfare."

Mr. Svenningson always took an interest in engineering society work. He was a Member of The Engineering Institute of Canada since 1919; a Charter Member of the Corporation of Professional Engineers of Quebec; an honoured Member of the National Electric Light Association on the Hydraulic Power Committee of which he was active for several years; a Member of the American Society for Testing Materials and of the Canadian Engineering Standards Association, serving on the Heavy Forgings Committee.

Keen of mind, sound in judgment and possessing engineering ability of a high order, Mr. Svenningson impressed his personality on all those with whom he came in contact and at the same time endeared himself to his associates by his kindliness, sympathy and good-fellowship.

On Sunday, the 19th of August, Mr. Svenningson's friends and colleagues laid him to rest in a little cemetery on the crest of Bailey Island, Maine. Not far away are the homes and wharves of the fisherfolk, whose company, year after year, he and his growing family sought, because the life along the rock-bound coast of Maine corresponded so closely to that of his boyhood in far off Norway.

The simplicity, dignity and peacefulness of his funeral were in perfect accord with the philosophy of his living, for in the midst of the crises that accompany the progress of the many large hydro-electric enterprises for which he was primarily responsible, he was invariably calm, confident and courageous. Notwithstanding his widespread professional responsibilities, his private life was extraordinarily simple and happy. Those of his colleagues in the public utility business in Canada and the United States, and those members of the engineering profession who were in attendance at his funeral, were all comforted with the knowledge that his long, useful and notable engineering career should be so fittingly concluded.

### John Herbert Munro, A.M.E.I.C.

Regret is expressed in placing on record the death at London, Ontario, of John Herbert Munro, A.M.E.I.C.

Mr. Munro was born at Inverness, Scotland, on September 5th, 1881, and received his education at the Inverness Royal Academy, the Merchiston Castle School, Edinburgh, and the Inverness Technical School. From 1899 to 1904 Mr. Munro was an apprentice with Mr. James Fraser, of Inverness, and in 1904-1905 he was assistant engineer with Mr. Fraser. In 1905-1907 he was assistant engineer with the Bombay Burmah Corporation of Burmah and Siam, and in 1907-1908 was again with Mr. Fraser as assistant engineer. In 1908-1909 he was resident engineer on Inverness harbour works, and in 1909-1910 was engaged in the same capacity on harbour works at Portgordon. Coming to Canada, Mr. Munro joined the staff of the Public Works Department at Ottawa as assistant engineer, and remained with the Department until 1915, when he went overseas with the Canadian Engineers. He was promoted to the rank of Captain early in 1918, and returned to Canada in 1919 when he was in the assistant chief engineer's office of the Department of Public Works, Ottawa. He was later attached to the Department at Antigonish, N.S., and Halifax, N.S., and in 1924 was transferred to London, Ont. where he remained until the time of his death.

Mr. Munro joined The Institute as an Associate Member on April 13th, 1912.

## PERSONALS

A. W. Crawford, A.M.E.I.C., Deputy Minister, Department of Labour, Ontario, of Toronto, Ont., has been appointed chairman of the Minimum Wage Board of the same Department.

G. Morrison, M.E.I.C., has become connected with the Commonwealth Electric Corporation Limited, and is located at Welland, Ontario. Mr. Morrison was at one time district manager in the maritime provinces for the English Electric Company of Canada Ltd., at Sydney, N.S., and was later with the same company at Toronto and St. Catharines, Ontario.

Brigadier J. L. Gordon, A.M.E.I.C., formerly O.C. of military district No. 12 at Regina, Sask., is now at Military district No. 10, Winnipeg, Man. Brigadier Gordon was at one time director of Civil Government Air Operations, with the Department of National Defence, Ottawa, Ont.

Gordon W. Hatfield, Jr.E.I.C., is now sugar chemist with Crosse and Blackwell (Canada) Limited, at Toronto, Ont. Mr. Hatfield, who graduated from McGill University in 1931 with the degree of B.Sc., was formerly assistant chemist with the Atlantic Sugar Refineries Limited, at Saint John, N.B.

A. T. Cairncross, S.E.I.C., who graduated from Queen's University in 1931 with the degree of B.Sc., has left Canada for Chungking, China, 2,000 miles in the interior up the Yangtze river, where he will be employed on railway construction and operation by the government of Chungking province.

## ELECTIONS AND TRANSFERS

At the meeting of Council held on September 21st, 1934, the following elections and transfers were effected:

*Associate Members*

ASSELIN, Jean Charles Leandre, B.A.Sc., C.E., (Ecole Polytechnique), town engineer and manager, La Tuque, Que.

BAIN, William Alexander, B.A.Sc., (Univ. of B.C.), res. engr., B.C. Pulp & Paper Co. Ltd., Woodfibre, B.C.

DUPUIS, René, E.E., (Univ. of Nancy), asst. supt., Quebec Power Company, Quebec, Que.

LIGERTWOOD, Henry Cormack Grant, B.Sc., (Univ. of Man.), Relief Project 103-2, Ethelbert, Man.

MacGREGOR, Kenneth Roy, B.Sc., (Queen's Univ.), foreman-in-charge, Race Horse Camp, Petewawa, Ont.

OLSEN, Aleksander, (Horten Navy College), estimator and engr., Atlas Construction Company, Montreal, Que.

WALKER, John Marshall, engr. and chief dftsman, water supply section, Dept. of Works, Toronto, Ont.

YAPP, Spencer Raymond Anthony, B.Sc. (Eng.), (Univ. of London), manager, Bepco Canada Limited, 1050 Mountain St., Montreal, Que.

*Juniors*

BROWN, William Edward, B.A.Sc., (Univ. of Toronto), asst. foreman, rope dept., The B. Greening Wire Company, Hamilton, Ont.

CAPE, John Meredith, (Grad., R.M.C.), estimator, E. G. M. Cape & Co., Montreal, Que.

COLPITTS, Gordon Lloyd, B.Sc., (N.S. Tech. Coll.), junior engr., Imperial Oil Refineries Limited, Dartmouth, N.S.

*Affiliates*

OLSON, Haldor Theodore, (Prov. Inst. of Tech., Calgary), switchboard operator, Island Falls, Sask.

VERRIER, Edward John, (Rugby Tech. Coll.), 2171 Dorchester St. West, Montreal, Que.

*Transferred from the class of Associate Member to that of Member*

KINGSTON, Laurence Bradley, B.Sc., (McGill Univ.), engr., Gulf Pulp & Paper Co., Quebec, Que.

*Transferred from the class of Junior to that of Associate Member*

BELL, Harry Heartz, B.Sc., (N.S. Tech. Coll.), M.Sc., (Mass. Inst. Tech.), engr., Calgary Power Company, Calgary, Alta.

GOODMAN, James Edward, B.Sc., (Queen's Univ.), county road engr. of Frontenac, Court House, Kingston, Ont.
HINCHCLIFFE, Joseph Edward, B.Sc., (McGill Univ.), R.R. No. 2, Mono Road, Ont.
JACKSON, Carl Henry, B.Sc., (McGill Univ.), engr., Canadian Industries Ltd., Montreal, Que.
LAURENCE, Emile, B.A.Sc., C.E., (Ecole Polytechnique), bridge engr., Dept. of Public Works, Quebec, Que.
MARTIN, Lucien, B.A.Sc., C.E., (Ecole Polytechnique), engr. on bridge constrn., Dept. Public Works, Quebec, Que.

*Transferred from the class of Student to that of Associate Member*

ATWOOD, Arthur Gerald Lysons, B.Sc., (N.S. Tech. Coll.), i/c engrg. dept., The Iron Fireman Mfg. Co. of Canada, Montreal, Que.
BOYER, Marc., B.A.Sc., C.E., (Ecole Polytechnique), mining inspr. and technologist, Quebec Bureau of Mines, Quebec, Que.
HALTALIN, B.Sc., (Univ. of Man.), asst. engr, Winnipeg Electric Company, Winnipeg, Man.

*Transferred from the class of Affiliate to that of Associate Member*

TOWNSEND, Charles Rowlatt, B.Sc., M.Sc., (Univ. of N.B.), Anticosti Island Manager, Port Menier, Anticosti Is., Que.

*Transferred from the class of Student to that of Junior*

CROSSLAND, Charles Wilfred, B.Sc., (McGill Univ.), M.Sc., (Mass. Inst. Tech.), technical asst., Hawker Aircraft Limited, Surbiton, Surrey, England.
ELLIOT, Donald George, B.Sc., (Univ. of Edinburgh), asst. engr., Monsarrat and Pratley, consltg. engrs., Montreal, Que.
FRECKER, George Alain, B.Sc., (N.S. Tech. Coll.), asst. professor of engrg., St. Mary's College, Halifax, N.S.
LEVERIN, Harald Leicester, Capt., R.C.E., (Grad., R.M.C.), B.Sc., (McGill Univ.), Works Officer, M.D. No. 11, Work Point Barracks, Esquimalt, B.C.
SPARKS, Wilbur Hamilton, (Univ. of B.C.), 829-14th Ave. East, Vancouver, B.C.

*Transferred from the class of Junior to that of Affiliate*

GUTHRIE, Kenneth MacGregor, Flt.-Lt., R.C.A.F., (Ottawa Collegiate Inst.), Air Staff Officer, M.D. No. 10, Winnipeg, Man.

*Students Admitted*

JONES, Allison Maurice Steeves, B.Sc. (Civil), (Univ. of N.B.), engr., Anglo-Canadian Pulp & Paper Co., Quebec, Que.
JORDAN, Jack McLean, B.A.Sc., (Univ. of Toronto), Dept. of Highways, Port Hope, Ont.
ESDAILE, Hector Milton, (McGill Univ.), 3450 Melrose Ave., Montreal, Que.
ESMOND, Douglas C., B.Eng., (McGill Univ.), 3592 University St., Montreal, Que.
McKINNON, Alexander Huntley, B.Sc., (N.S. Tech. Coll.), 345 Fraser St., New Glasgow, N.S.

# RECENT ADDITIONS TO THE LIBRARY

### Proceedings, Transactions, etc.

Highway Research Board, U.S. Proceedings of 13th annual meeting held at Washington, D.C., December, 1933.

### Reports, etc.

*Southern Rhodesia Geological Survey:*
The Mining Industry of Southern Rhodesia.
*International Boundary Commission:*
Establishment of the Boundary between the United States and Canada from the source of the St. Croix river to the Atlantic Ocean.
*Canada, Department of Labour:*
23rd annual report of Labour Organization in Canada, year 1933.
*International Tin Research and Development Council:*
First General Report, 1934.
*Canada, Bureau of Statistics, Transportation Branch*
Preliminary Report on Statistics of Steam Railways in Canada, 1933.

### Technical Books, etc., Received

Practical Everyday Chemistry, by H. Bennett. (*Chemical Publishing Company.*)
Use of Steelwork in Buildings, by D. H. Lee. (*E. and F. N. Spon Ltd., London.*)
The Elements of Reinforced Concrete Design, by H. C. Adams. (*Concrete Publications Limited.*)
Mechanical Vibrations, by J. P. DenHartog. (*McGraw-Hill Book Co.*)

# BOOK REVIEWS

## Planning, Estimating and Rate-fixing

*By A. C. Whitehead, Sir Isaac Pitman and Sons, London, 1933. 5½ by 8¾ inches, 293 pages. Figs., tables. 10/6. Cloth.*

Reviewed by Professor E. A. Allcut, m.e.i.c.*

During the past few years, considerable attention has been paid to the allied subjects of engineering economics, organization and management. These are cognate subjects because the object of all of them is to obtain economical production for the purpose of reducing selling prices or increasing profits. Such books may be divided into two classes viz.:—

(*a*) Those in which the primary object is to enunciate the *principles* of organization and management.
(*b*) Those that deal mainly with the *application* of those principles to practical problems.

The book under review must be placed in the second category as Chapters III to IX, comprising 162 pages, are devoted entirely to details of the principal workshop processes such as drilling and tapping, planing and shaping, milling, turning, grinding and sheet metal work. These, and other allied processes, are discussed exhaustively and are illustrated by many quantitative examples. If, for instance, it is desired to find the time to be taken by a new turning operation, the average times required for chucking various sizes of work in either self centring or independent jaw chucks is given in Table XXI. Following this are tables and formulae for cutting times and speeds, gauging times, handling times and costs. This brief analysis will give some idea of the information contained in the other chapters in which different processes are similarly analysed.

The introductory Chapters I and II are devoted respectively to a general consideration of planning and time study. The former indicates that "there is no appreciable difference in the speed of working in different parts of the country as regards the constituents, when the conditions are similar," and that "although exceptional operators vary by at least 20 per cent above or below the average in manipulative speed, the great majority are not far from the mean rating." Consequently, the time required to perform a given series of operations can be predicted with reasonable accuracy. The readings necessary and the precautions to be observed are described in Chapter II and are illustrated by examples of time study.

Three of the author's *obiter dicta* are noteworthy:

(1) That planning is one of the arts and requires imagination as well as opportunity and perseverance (page 6).
(2) That unfair contracts must be avoided (page 10).
(3) That the rate-fixer's idea of a fair bargain with the operator is usually correct and that the bargaining process is therefore short and relatively simple (page 17).

The reviewer is in general agreement with (1) and (2) but has very considerable doubts about (3).

Chapter XI is entitled "Works Economics" and deals largely with process costs. The book ends with a chapter on "Plant Capacity and Arrangement," describing the method of calculating the number and sizes of machines required for a given production programme with some observations on "loading charts."

This book is generally suitable for assistant foremen, time study men or senior apprentices who wish to become familiar with the details of time study and rate fixing methods. From a Canadian standpoint, however, it suffers from the disadvantages that examples and rates are given in sterling units and the larger weights in cwts. (112 pounds). The rates of pay quoted are different from those customary in the Dominion and consequently the examples given are not necessarily applicable in this country.

Also, in the chapter dealing with "Tapping," the threads referred to are Whitworth standard, which are not used in America.

Apart from, and in spite of, these minor defects, the book should be useful to those engaged in workshop practice.

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**Professor of Mechanical Engineering, University of Toronto, Toronto.*

## Railways and Roads in Pioneer Development Overseas

*By J. Edwin Holmstrom, P. S. King and Son Ltd., London, 1934. 5¾ by 8¾ inches, 304 pages, 15s. Cloth.*

Reviewed by S. W. Fairweather*

One of the most difficult and controversial problems of present day transportation policy is that of assessing the relative merits of railway and highway for purposes under various conditions. In attacking this problem, the author has spared no pains in assembling a comprehensive array of data, covering all phases of the subject. Unfortunately there are some phases which do not lend themselves to statistical analysis, and "logical guesswork" must be substituted. The necessity for interjecting justification or apology for so many weak links in the chain of argument detracts somewhat from the clarity and conciseness so desirable in any text-book or work of reference. This defect is no fault of Mr. Holmstrom, but merely an unavoidable stumbling block which must be faced by every writer venturing into the practically uncharted field of fixed and variable costs. That he is under no delusions as to the practical value of his work is shown by his modest conclusion:—

"Conditions change too rapidly, and too many factors are involved to allow of transport policy being dogmatically formulated for many years in advance. The problem demands unremitting study from every aspect, and if this work has suggested useful viewpoints its purpose will have been served."

To anyone not already thoroughly familiar with the pitfalls of the subject, but under the necessity of making a practical decision involving any phase of it, this book should be helpful. The author has kept his feet on the ground, and while his thesis is naturally linked with his own experience in eastern Asia, the main outlines of the problem and general nature of its solution are bound to be the same where any undeveloped territory is under consideration. To the student desiring a preliminary academic acquaintance with the "truck versus train" controversy in all its ramifications, the book should be not only enlightening, but, as obviously intended, provocative of original research and analysis.

* *Director, Bureau of Economics, Canadian National Railways, Montreal.*

## Practical Everyday Chemistry

*By H. Bennett, The Chemical Publishing Company, New York, 1934. 305 pages. 5¾ by 8½ inches. $2.00. Cloth.*

How is enameling put on steel saucepans? What is the difference in composition between Old Tom Gin and Gordon Gin (both presumably synthetic)? How does Roquefort cheese differ from Gorgonzola? How do you poison earthworms? What proportion of rubber is there in the material of a tire tread?

These are some of the thousands of questions which may be answered by referring to this book. The compiler has assembled a mass of information on the compositions or methods of making a multitude of things used in daily life. The work is not a chemistry book in the ordinary sense, but rather a collection of recipes and descriptions of manufacturing methods. There is a good index and a very necessary directory of trade names and suppliers.

The names of many of the substances mentioned will be unfamiliar to the layman, even if he has a smattering of chemistry: information as to some of these might have been included with advantage.

The book is interesting to anyone with an enquiring mind.

## BULLETINS

*Inert Gas Producers*—Roots-Connersville Blower Corporation, Connersville, Ind., have issued a 4-page folder describing the Harrison inert gas producer. These units are built to produce inert gas containing less than one per cent oxygen and zero per cent carbon monoxide when operating on manufactured or natural gas, or fuel oil. Built in sizes ranging from 7,500 to 40,000 cubic feet of inerts per hour, measured at 60 degrees F. against a pressure of 2 pounds, and the drive unit can be either a gasoline engine or an electric motor.

*Pumps*—An 8-page booklet issued by the Economy Machinery Company, Chicago, Ill., describes that company's non-clogging centrifugal pump and contains selection table for capacities ranging from 50 to 10,000 gallons per minute, heads up to 120 feet.

*Steel Sheet Piling*—An 8-page leaflet received from the Canadian Sheet Piling Company Ltd., Montreal, gives particulars of sheet piling used in the highway bridge across the Saguenay river at Chicoutimi, Que.

*Cement Bound Macadam*—The Portland Cement Association, Chicago, Ill., have issued a 24-page booklet containing particulars of design, the selection of aggregates, the latitude in the use of available materials, grout and methods of grouting, with a table for estimating material quantities, together with construction procedure and specifications.

*Vibrated Concrete*—A 32-page booklet issued by the Portland Cement Association, Chicago, Ill., contains details regarding the placing of concrete by the vibrating method describing the equipment used, and giving test data, information on the proportioning of concrete, recommended practice, and bibliography of recently published articles.

*Steam Operated Piston Pumps*—The Worthington Pump and Machinery Corporation, Harrison, N.J., have issued two 4-page folders describing their horizontal duplex piston pumps for general services. Type VA is for handling liquids at pressures up to 125 pounds per square inch, with capacities of 30 to 400 gallons per minute, and Type VC for handling liquids at pressures up to 250 pounds per square inch with capacities of 6 to 250 gallons per minute. The company has also issued two 4-page folders describing a similar line for the petroleum industry, type VB and VD, for handling oils at temperatures up to 350 degrees F. Type VB has capacities of 60 to 400 gallons per minute, and Type VD 30 to 280 gallons per minute.

*Centrifugal Pumps*—A series of four 4-page bulletins have been issued by the Worthington Pump and Machinery Corporation, Harrison, N.J., describing the company's centrifugal pumps for refineries, covering Type UV, four-stage, Type UT, two-stage, and Types LT, UW, UX, and UY.

*Compressors*—A 4-page folder issued by the Worthington Pump and Machinery Corporation, Harrison, N.J., gives particulars concerning steam booster compressors which can be furnished for either team or motor drive.

## Juniors and Students

The coming of the fall and winter, when Branch activities are once more in full swing, suggests the desirability of finding ways in which membership in The Institute could be made more beneficial to the younger engineers and also to The Institute. An opportune report* prepared by a group of junior members of the American Society of Mechanical Engineers makes some excellent suggestions in this connection.

This report observes that the principal objectives of a young engineer in joining a society may be stated as follows:

1. "Professional contact and acquaintance with other engineers.
2. Technical news and data supplied through meetings, society publications and the Engineering Societies Library.
3. Professional training and development.
4. Prestige gained from membership in a professional society of recognized high position."

"The act of joining a society signifies that the new member is in a receptive mood, and he should be met by something more than a membership certificate and a statement of dues payable. This is the opportunity to see that he retains his favourable attitude and to give some guidance to his contacts with the society."

In some of our branches the new member is welcomed by the branch officers, but in many cases a more systematic effort to establish friendly contact is needed, and would be well worth while. For instance a statement concerning the scope of the branch activities, the names of the officers, a summary of the work of their committees and a request that the new member introduce himself to the secretary or chairman, at the next meeting, would secure his interest and active support immediately.

While it may seem unnecessary to give detailed information regarding The Institute's activities to new members on what is apparently so obvious, yet it should be borne in mind that the young engineer may have only the vaguest conception of The Institute's activities, and further, may have little chance of learning about them if he does not subscribe to The Engineering Journal. Under a change in the by-laws introduced a few years ago, Students need not subscribe to The Journal unless they so desire, and this is taken advantage of to a considerable extent. The result is that to many young engineers, the Branch and its activities represent The Institute, and too much trouble cannot be taken by branch officers in informing them of branch and Institute affairs.

The junior (using this term to include all the younger members of a branch) is in real need of guidance and instruction during the first critical years of his professional life. It is suggested that great help could be furnished if each branch appointed a small group of tactful men who would act as advisers to the younger men, suggesting studies and reading, and keeping them informed of Institute affairs. The effort would be well worth while, as it would react to the good of the branch, and the capable man would soon be of assistance to his fellow members.

Possibly older members will say that the engineer's reticence will not allow him to welcome this assistance. It should be remembered, however, that this so-called reticence is usually only prevalent in the older engineer—the junior has not yet acquired the feeling. As evidence of this it may be noted that in several branches the younger men have already endeavoured to meet and discuss their problems, and organize activities of their own at which matters of general interest are discussed and technical papers on minor subjects are presented.

It would appear that it would be to the advantage of The Institute as a whole if each branch would start and guide efforts of this nature, as a result of which the more capable juniors would soon be prepared to be absorbed into the senior section. Further, until an engineer has learned to work for his professional society he has not any real appreciation of the worth of that society, nor does he obtain the full benefit of his membership. Perhaps the first efforts of the junior are not considered to be of much value to the society, however, they are an effort, and it is hoped a commencement to other activities.

The Institute has at the present time several awards† obtainable by juniors that are not sought after as they should be, or would be if the branches stressed them and pointed out the advantages to be gained in competing with other equally keen young men.

Senior awards and various branch awards are also open to the Juniors, and only last year the Past-Presidents' Prize was won by a Student.

Further, though the important technical and committee work of the society must be guided by experienced men, there is always a place for the capable junior, particularly in branch committee work.

It must be remembered also that work originated and carried on by these younger men will benefit those who initiated it.

*Mechanical Engineering, April, 1934.

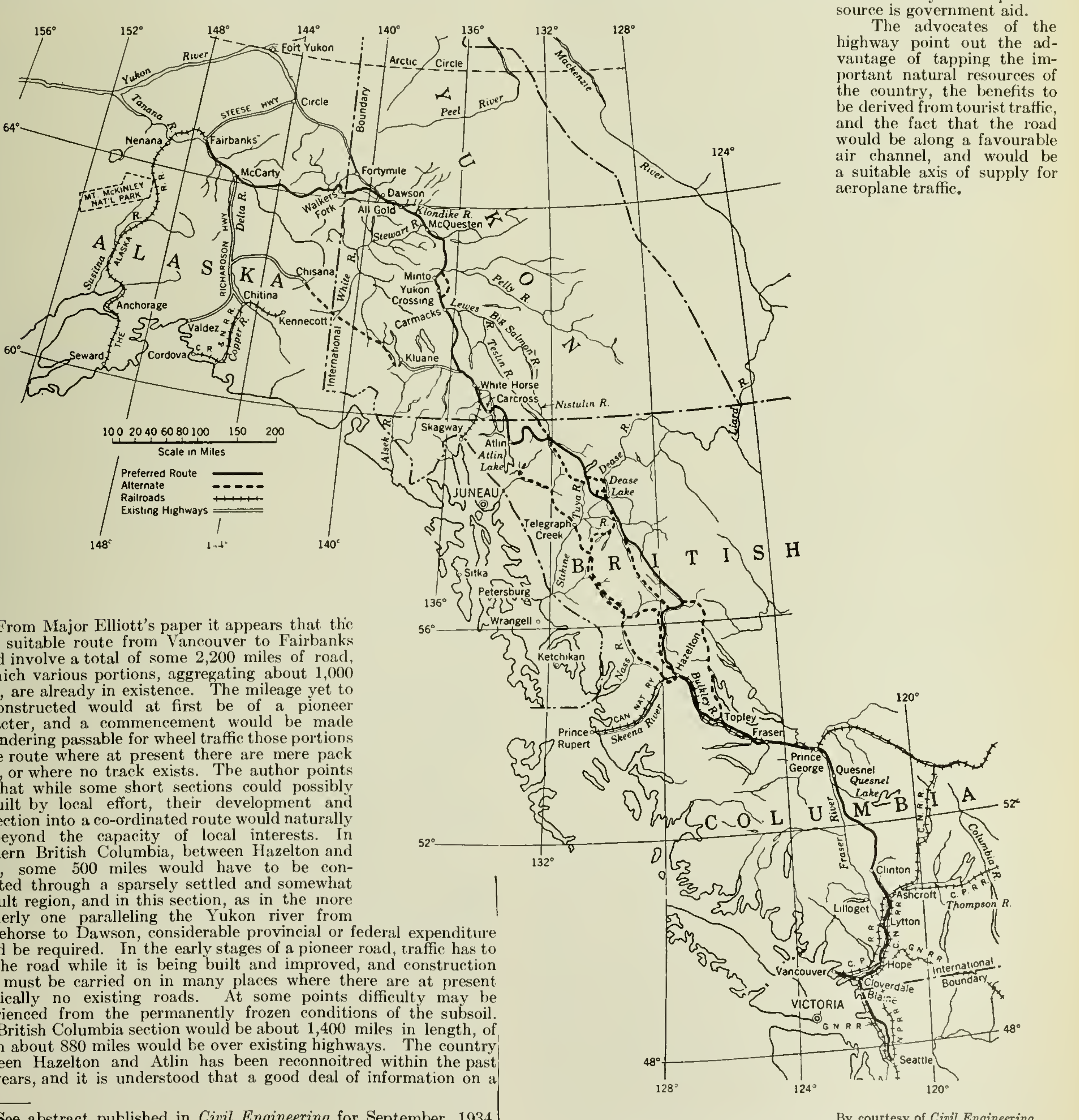
†Five prizes each of the value of twenty-five dollars may be awarded to Students and Juniors of The Institute each year as follows:

The H. N. Ruttan Prize in the four western provinces.
The John Galbraith Prize in the Province of Ontario.
The Phelps Johnson Prize for an English Student or Junior in the Province of Quebec.
The Ernest Marceau Prize for a French Student or Junior in the Province of Quebec.
The Martin Murphy Prize in the Maritime Provinces.

## The Alaska-United States Highway Project

One of the papers presented at the Vancouver convention of the American Society of Civil Engineers* was of special interest to Canadians, as it dealt with a project which has been under consideration for some time in the United States, that of building a through highway to connect the United States with Alaska by a road through British Columbia and the Yukon. The author, Major Malcolm Elliott, of the United States Corps of Engineers, was a member of a special commission appointed by the President of the United States to study the subject with the co-operation of Canadian representatives.

Another paper, by E. W. James, gave particulars as to the preliminary survey which has been made for a continuous motor route from Panama to the Rio Grande. Both schemes are stated to be practicable, and, if and when completed, would realize the hopes of the enthusiasts who visualize a Pan-American highway from South America to Alaska.




By courtesy of *Civil Engineering*

**Proposed Route of Alaska-United States Highway.**

From Major Elliott's paper it appears that the most suitable route from Vancouver to Fairbanks would involve a total of some 2,200 miles of road, of which various portions, aggregating about 1,000 miles, are already in existence. The mileage yet to be constructed would at first be of a pioneer character, and a commencement would be made by rendering passable for wheel traffic those portions of the route where at present there are mere pack trails, or where no track exists. The author points out that while some short sections could possibly be built by local effort, their development and connection into a co-ordinated route would naturally be beyond the capacity of local interests. In northern British Columbia, between Hazelton and Atlin, some 500 miles would have to be constructed through a sparsely settled and somewhat difficult region, and in this section, as in the more northerly one paralleling the Yukon river from Whitehorse to Dawson, considerable provincial or federal expenditure would be required. In the early stages of a pioneer road, traffic has to use the road while it is being built and improved, and construction work must be carried on in many places where there are at present practically no existing roads. At some points difficulty may be experienced from the permanently frozen conditions of the subsoil. The British Columbia section would be about 1,400 miles in length, of which about 880 miles would be over existing highways. The country between Hazelton and Atlin has been reconnoitred within the past few years, and it is understood that a good deal of information on a suitable general location for that portion of the road is in the hands of the British Columbia government. The highest summit on the route is not expected to be at an elevation of more than 4,500 feet.

The general topography of the proposed highway in the Yukon is much better known than in the northern part of British Columbia, for it parallels the now-travelled river route to Dawson. Major bridge work would be needed in crossing the Yukon and Stewart rivers. Passing through Dawson, connection would be made with the existing Richardson highway in Alaska, the distance from Dawson to Fairbanks being about 339 miles, of which 155 miles would be over existing roads in Alaska and the Yukon.

As regards cost, present estimates can only be of a tentative kind, but Major Elliott considers that for a gravelled surface 16 feet wide, the total cost of the construction necessary in Canada would be approximately twelve million dollars; and that in Alaska two million dollars. It seems unlikely that any large proportion of this sum would be covered by local contributions, and, as the author points out the only other possible source is government aid.

The advocates of the highway point out the advantage of tapping the important natural resources of the country, the benefits to be derived from tourist traffic, and the fact that the road would be along a favourable air channel, and would be a suitable axis of supply for aeroplane traffic.

*See abstract published in *Civil Engineering* for September, 1934, pages 461-465.

# Recovery By Construction

*Gilbert E. Jackson, B.A. (Cantab.),*
*Professor of Economics and Supervisor of Studies for the Course in Commerce and Finance, University of Toronto, Toronto, Ontario.*

**Address given before the Toronto Branch of The Engineering Institute of Canada, January 18th, 1934**

*(Abridged)*

There is no doubt that your group of industries has been the heaviest hit by the depression. It is your function to produce goods of a lasting character. Your contracts are financed by the savings of the community. The structures you build are additions to capital equipment.

It is characteristic of periods of prosperity that in them great additions to capital equipment can be made, and your industries are kept active.

But demands for capital equipment are of a postponable character. During a depression they are postponed; and this intensifies the depression. We live in a vicious circle; and your industries are at the centre of it.

By contrast, those industries which produce consumable goods, food and clothing, footwear and fuel and so forth, have suffered, and are suffering, very little. It is in proportion as the product is durable, that employers and workers engaged in making it have been compelled to suffer.

So when it is proposed that $50,000,000 or $100,000,000 should be spent by the government on construction, that is not only news of great moment to yourselves—it is also news of moment to the country—for such expenditures, setting to work the most seriously depressed industries, strike right at the heart of things.

May I begin by saying that I am not very much impressed by the proposal to spend in such a manner, and on such a scale: not if such a proposal is put forward as a recovery programme.

The proposal to revive industry by spending public funds is not in itself foolish. It is not original, either. In this, as in so many other things, we are copying our American cousins, whose lead we naturally follow because we are a politically timid people. President Roosevelt has shown us the way, spending dollars by the billion on construction. We propose now to follow his example, but spending a dime only, where he spends a five dollar bill.

My criticism of what we propose to do relates largely to the size of the sum that we propose to spend. We seem to be trying to make the best of both worlds; to be spending money for the revival of the most depressed industries (which is calculated to please them), and to be spending on a very modest scale (which is calculated to give the minimum of pain to the taxpayer).

If this expenditure is intended to revive construction, it is likely to be not enough; but if it is intended merely to substitute it for direct relief, then we are making a reversion from a cheap method of relieving unemployment, to one that is much more expensive—in short, I suggest that we must make a choice, which should, indeed, have been made some time ago; and that the projected expenditure of $50,000,000 is really nothing but a postponement of the necessary choice.

I do not want to make the choice for you. In fact, neither you nor I, but the country will make the choice. All that I hope for is that you will make a clear decision in your own minds, before proceeding to influence public opinion in its choice, as you may well do.

I said a moment ago, that the proposal to revive industry by spending public funds is not in itself foolish. In spending public funds on a colossal scale for this purpose, President Roosevelt can point to precedents in plenty in which this has been done, and in which industry, previously depressed, has again become active. We have only to study the great wars of modern times, to know that this is so.

For example, in August, 1914, industry was severely depressed in this Dominion, and conditions were daily getting worse. Hundreds of thousands of workers were unemployed. Actual starvation was not unknown.

Without warning, we were plunged into war on a world-wide scale. What happened? In the first few months, while our war expenditures were light, there was a further slump in business, and an increase in unemployment. The suffering of the people, in the winter of 1914-15, was as tragic as it has been in recent winters. Our war expenditures, in that winter, were quite modest.

But in the spring of 1915 we really began to spend. With the British Empire's existence at stake, we spent without counting the cost; and as we spent, we made industry once more active, so that our unemployed workers were absorbed, we lifted the country's business out of the trough of the depression. In 1916, 1917 and 1918; even in 1919 and the beginning of 1920, the wheels of industry were going at full speed. So long as we continued to spend, they kept on turning.

That is a triumphant instance of government expenditure on a large scale, and what it can do. What we did in the first years of the War, anybody can do. President Roosevelt can do it. We can do it. But on one condition. We must spend on a large enough scale. The force must be suited to the mass which needs moving. To spend on a small scale is worse than useless.

And so today—with the national income has been reduced by 40 per cent—when hundreds of thousands of our workers are still unemployed—I do not grow really enthusiastic over a relatively small expenditure. My own belief is that we should either spend with both hands, or else not spend at all for this purpose.

Does that mean that we should go further — should imitate President Roosevelt in the scale of his expenditures, as well as in their nature?

He proposes, apparently, that the United States government shall incur deliberately, during the next eighteen months, a deficit of about $10,000,000,000. Does that mean (allowing for the relative size of our countries) that the federal government in Canada should incur deliberately, within the same period a deficit of about $800,000,000?

Not necessarily; in fact, I think we should pause very carefully before considering such a possibility. Let me ask you to go back again to the tale of our war expenditures.

Everything went well until 1920. So long as we continued to spend money like water, this Niagara of public money continued to turn the wheels of industry.

But what happened in 1920? We ceased to spend public money thus freely. Governments began once more to practise economy. Private spending was needed, to take the place of public spending. But there was no private spending on the same, or even on a comparable, scale. The result was a great industrial crash, which is still fresh in all our memories, and all the familiar 1914 phenomena were back again.

While I have no fear but that Mr. Roosevelt, if he spends enough, can bring about in his own land an industrial recovery, I do rather fear for what may follow.

More particularly, I anticipate this: that recovery, and the devaluation of the dollar that accompanies it, may bring in their train an ungoverned rise of prices; and that then, when the rise of prices has occurred, the capitalists of the United States may realize that this spending orgy was really just our old friend the capital levy in disguise; and that a large proportion of their capital has been taken away from them; just as a large proportion of the French capitalists' possessions was taken from them, in the devaluation of the franc, five years ago.

While I feel frankly nervous about the results, nevertheless, I have attempted to present to you the case for public spending on a large scale, in a not unsympathetic manner. For it does deserve serious consideration. Among the members of my own profession, it has the support of lots of economists in the United States. Mr. Keynes in England has recently been preaching a sermon in behalf of deliberate public spending for recovery. Many Canadian economists could be found, who would endorse Mr. Keynes and (on this point at least, if not on some others) the Brain Trust of President Roosevelt. To yourselves, the notion of such spending has an obvious appeal of self-interest; and it would be strange indeed if it did not strike a responsive chord in your hearts.

But before we answer the question—whether a programme of this kind should be supported or not—let us remember that Britain has had a recovery programme of a very different kind: that she launched it long before President Roosevelt came into power: that it is based upon a quite different conception from that of President Roosevelt: and that subsequent events have done much to validate the British programme also.

The Mother Country does not advertise: or at least, when she does advertise, it is her mistakes and their consequences to which she generally calls attention. Her great strokes of policy she launches without advertisement.

The British act first, and talk about their actions afterwards. They launched their recovery programme in the fall of 1931; they have talked very little of it since then. But in the meanwhile, events have talked louder than words.

Whereas the recovery process in the United States is now more than twelve months old, there have been in Britain nearly three years of continuous recovery. We shall do well to ask, what were the policies preceding the British recovery, and on what conceptions do they seem to have been based?

Britain's recovery was certainly facilitated by two factors which do not directly concern us in this discussion—her abandonment of the gold standard, and the clearance of her glutted markets by the new tariff on imports. Without dwelling on these, let me proceed to the third aspect of British policy, the ruthless balancing of all budgets, governmental and municipal.

We all know that Britain was the first country, during the depression, to bring her budget into balance. I wonder, however, whether we have appreciated either the sacrifices that she made to do this, or the significance of her achievement.

She did it by ruthlessly cutting down all payments. She did it at the cost of her civil servants, at the cost of her teachers, at the cost of her (then nearly three million) unemployed, and at the cost of a lot of others. It is literally true that the great majority of her people were made temporarily the poorer by this effort. But they have a wonderful readiness to follow strong leadership. They gave their support, and without bitter feeling, to the proposals of the National Government.

What Britain did was to clear the government and the municipalities right out of her money market—which should properly be the meeting place of private investment and private enterprise, anyway. By this means, and only by this means, she was enabled to get down her dangerously high long term rate of interest; to bring about the lowest long term rate of interest to be found in the great money markets of the world; to put at the disposal of business cheap supplies of long term capital (so bringing down drastically her domestic costs of production); and to refund billions of dollars of her public debt at the new low rates.

As a result of all this the British Chancellor of the Exchequer has actually had a surplus to play with.

Britain has cleared government and municipalities alike out of her money market, and private business is borrowing both for purposes of expansion, and for the refunding, at low rates, of old obligations bearing high rates of interest. We, too, have experienced a drop in the long term rate of interest, but it is still, as you know, high—high, that is, in relation to present prices, or to past rates of interest in periods of low prices.

Not unconnected with our own relatively high rate of interest is the fact that in the past three years our governments and our municipalities, between them, have borrowed, either by guaranteed loans or directly, something like $1,200,000,000—by far the greater part of the savings made available to borrowers in this country. No wonder the rate of interest has been comparatively slow to fall!

Now what difference do high rates of interest make to business? In the price of a shirt the rate of interest, whether high or low, makes little difference. It does not take long to make a shirt. It is quickly paid for—even in this credit-ridden generation, we do not yet purchase our shirts with instalment payments. It is almost equally quickly worn out.

But what of more durable goods—goods which take time to construct, which last over a long period, and which involve heavy carrying charges over that period? What of the structures that you gentlemen build? What difference does a high rate of interest mean to the cost of these structures, and so to you who build them?

It is scarcely necessary to ask this question. In the case of durable goods the price depends, in a very large measure, on the rate of interest that has to be paid during the life of such goods. A high rate of interest may make the cost of them prohibitive. A low rate of interest may make them easy to carry. Whether the rate of interest is high or low, may decide the question whether they shall be constructed at all, or not.

During a depression such as this, there is a danger that we may forget the close connection between the rate of interest and the cost of construction. That is because we depend so much, just at present, upon public bodies for contracts. But you will agree that this is a most abnormal and unusual condition.

In these days of reduced construction activity, it is true that public contracts bulk relatively large. By my reckoning, in 1932, for instance, more than 40 per cent of all the construction contracts let in Canada were on account of public bodies. But in 1932 the total value of all construction contracts, public and private, was less than $140,000,000.

In ordinary times, on the other hand, public contracts bulk relatively small: in the period of eight years, from 1925 to 1932, they seem to have been little more than 25 per cent of all contracts. The bulk of the business was private business, brought, not by public bodies, but by corporations and individuals.

This means that, taking the long view, your business activity will depend upon the business brought to you, not by governments and municipalities, but, as in the past, by corporations and private persons. The business that they will bring you must obviously depend in a large measure on the cost to them of undertaking new construction; and in that cost the single element of interest bulks very large. It is imperative, for your sakes, that we get down the rate of interest.

That is what has been done in Britain. As we have seen, it was done, first of all, by clearing public borrowers out of the money market. That has not been done here: because every Canadian public body that we know has a deficit to meet. So long as the savings of our people are being absorbed by public bodies to meet their deficits, just so long will the fall of interest rates be delayed in Canada.

I should like now to lay down this proposition, which logically follows from what I have just said—that our own construction industry cannot function actively, during any long period of years together, unless the funds by means of which its activities are financed are obtainable at moderate rates. To men in other lines of business, low rates of interest are a convenience. To you, low rates are an absolutely vital necessity.

With this thought in mind, I ask you to look once more at the topic of my remarks this evening—Recovery by Construction. Your industry badly needs revival, but we shall not revive it effectively by spending public funds, only to the tune of a few scores of millions of dollars, upon new construction. On the other hand, we might produce a real revival by public spending on a scale much larger: by following the Roosevelt plan in Canada. But such expenditures, if we do make them on a sufficient scale, can keep construction active only for a limited time. Then the demand of private bodies for construction must replace the demand of public bodies—unless we are to have another slump: and the demand of private bodies will be conditional upon low carrying charges for construction.

Which should we do? Should we take as our slogan, "Bigger and better deficits," and act accordingly? Should we launch upon a programme of public spending on a large scale, as in the United States? Or should we launch upon a programme of the severest public economy, following the lead of Britain?

To do the former, to follow Mr. Roosevelt on a scale sufficiently large, would certainly revive business: how permanently, how safely, we do not know. On the other hand, to do the latter, to follow the lead of Britain, would be to provoke at first a deflationary movement, with a view to restoring more permanently the health of our money market and your industry.

As I see the problem, that is the choice before us. It is a choice which, so far, we have hesitated to make. We have lacked the nerve to declare in favour of inflation. We have lacked the nerve to declare in favour of deflation. Here is yet another instance of our political timidity.

Let me put one plea, in closing these remarks. It is that you will consider this problem impersonally, just as a physician considers the problems of disease: and not in relation to your immediate, personal self-interest.

If we look first to the forwarding of our own special interests, we make it impossible for this Dominion to have an efficient democracy. Self must be second in our politics to the general welfare, if we wish democracy to function as it should.

Our admiration goes out in full measure to Britain, because in a time of crisis, the British people will follow brave leadership; because the man in the street gladly makes great sacrifices to restore the general equilibrium. At the present stage in our affairs, we have the strongest reasons for following this good example.

And if we will not? Then I suppose we shall continue drifting, as we have drifted for the past four years. In a haphazard way, we shall pile up more debts for posterity, because we have not the courage rigidly to retrench.

Ultimately, no doubt, if we cannot make the choice, if we cannot choose a course to steer by, we shall drift into some sort of harbour. But the way will be long, and the passage tedious.

## Highway Lighting with the Sodium Vapour Lamp

**(As installed near Three Rivers, Que.)**

*A. C. Abbott, A.M.E.I.C.,*
*Distribution Engineer, Shawinigan Water and Power Company, Three Rivers, Que.*

The hope held by many that some day main highways between important centres will be brightly illuminated either over their entire length or at least throughout their most hazardous sections, may have been brought a step nearer realization by the development of the sodium vapour and high pressure mercury lamps. Both these units have high efficiencies of between 40 and 50 lumens per watt and the belief is held that 70 lumens per watt is a distinct probability.

It is only within recent years that this type of lighting has been applied to street and highway illumination and to date, the development has been largely European. Carbon dioxide, mercury and sodium have been the gases in most general use, and each appears to have its advantages and disadvantages.

Carbon dioxide, while it gives a fine white light, does so at an efficiency comparable to that of the incandescent lamp and it is for that reason that the larger number of known existing installations make use of either mercury or sodium. Germany and Holland have a number of installations of sodium lighting, while English engineers seem to have pinned their faith to the high pressure mercury lamp, as evidenced by the original installation in June 1932 at Wembley of the 'Osira' lamp followed by many additional installations, including those at Croydon, Lewisham and Manchester.

While the development has been more recent on this continent, the sodium lamp is attracting particular attention and there are now five known installations of highway lighting using the sodium unit.

The first of these installations was made near Schenectady, N.Y., in 1933 on a section of the Balston road, while the others are at Revere Beach and Newton, Mass., Wallingford, Conn., and in Canada the installation put into service by the Shawinigan Water and Power Company in June 1934, on a half-mile stretch of the Montreal-Quebec highway just west of the city of Three Rivers.

The Shawinigan Water and Power Company has for some time been actively interested in the possibilities of highway lighting, and some years ago made a trial installation with 1,000 candle power incandescent lamps. At that time, however, interest in the question did not run to the same pitch as to-day. This was possibly due in part to the lack of appreciation of the extent to which accidents could be reduced by good highway illumination and, in part, to the fact that the volume of traffic has increased tremendously during even the past few years. As a result, nothing came of the original trial, but interest in the possibilities of this form of lighting was still maintained and close touch kept with following developments in lighting technique, with the result that the experimental installation mentioned above was decided upon.

### Description of Sodium Lamp

The present form of 10,000 lumen A.C. sodium lamp in use in the five installations on this continent (see Fig. 1) consists of a long bulb of special glass enclosing at each end a coiled filament, which serves as a cathode, and an open-ended box of molybdenum, which serves as an anode; the lamp then has two anodes and two cathodes. Each anode is connected electrically to one side of the filament coil so that only two conductors lead from each assembly. The leads pass through a seal at one end of the bulb and are fastened to the tubes of a pin base cemented to it. A sodium resistant washer is cemented in the neck of the bulb to prevent the sodium vapour from attacking the seal. A small quantity of metallic sodium and a small amount of neon gas are included in the bulb, the neon being used for starting. The lamp is about 16 inches long from tip to base, excluding the pins on the base, and about 3 inches maximum diameter.

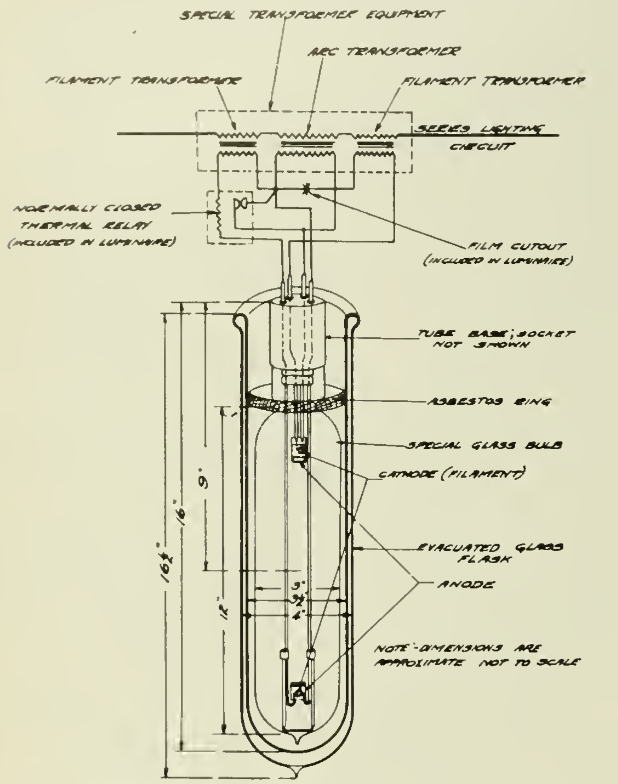



**Fig. 1—10,000 Lumen A.C. Sodium Lamp with Series Transformer.**

A double-walled evacuated glass flask having an outside diameter of about 4 inches and an overall length of some 16½ inches is used with this lamp. Asbestos washers around the neck of the bulb fill the open end of the vacuum flask to prevent heat loss.*

The lamps recently installed near Three Rivers, P.Q., are operated on a 6.6 amp. series circuit, the ten 10,000 lumen units being supplied from one 3 kw. type "RO" constant current pole type transformer having a 2,300-volt primary. Mounted on the pole with each unit is an "IL" transformer 6.6 to 6.6 amperes which is required largely as a result of insulation limitations in the luminaire of the unit. Each luminaire, which is the complete lighting unit with reflector as mounted on the end of the channel cross arm, contains auto transformers for reducing the voltage to the cathode to between 2 to 3 volts, the cathode heating current being approximately 10 amperes at that voltage. In addition, a choke and capacitor are supplied as a guard against possible radio interference.

The arc current is 6.6 amperes and is maintained by a voltage of about 27 volts. A higher voltage is required to strike the arc and this is obtained from the open circuit voltage of the "IL" transformer which exists for a very short interval prior to the arc being struck. This starting voltage is said by manufacturers of the lamp to be in the neighbourhood of 185 volts.

*Taken from a description of the lamp furnished by the General Electric Company.

Briefly, the operation of the lamp is as follows: With the energizing of the main 6.6 ampere series circuit, the cathodes of each lamp become energized while the anodes are short-circuited by a timing device contained in each luminaire. The anodes are held short-circuited for a period of about one minute, known as the heating period. The timing device then operates momentarily open-circuiting the "IL" transformer and the arc is struck from the open circuit voltage of the transformer as already described. The lamp first glows with red from the neon gas which is used for starting but soon sufficient heat is generated to vapourize the sodium and the colour changes from red to red-orange, and finally, to the characteristic orange-yellow of sodium, this change taking in all some thirty minutes during which time the lamp does not develop its full output of 10,000 lumens. For this reason, an installation of sodium lamps should be energized some time before any incandescent lighting in the same neighbourhood.

**Fig. 2—Installation at Three Rivers, Que.**

It is interesting here to note that the lamp now in use differs quite radically in some respects from the original units installed by the General Electric Company at Schenectady about a year ago. These were 4,000 lumen units requiring both alternating and direct current for their operation. The cathode circuit was much the same as that of the new lamp requiring 10 amperes at approximately 2 volts, but the arc circuit was direct current. To obtain direct current the original installation called for rectifier equipment and constant current regula-

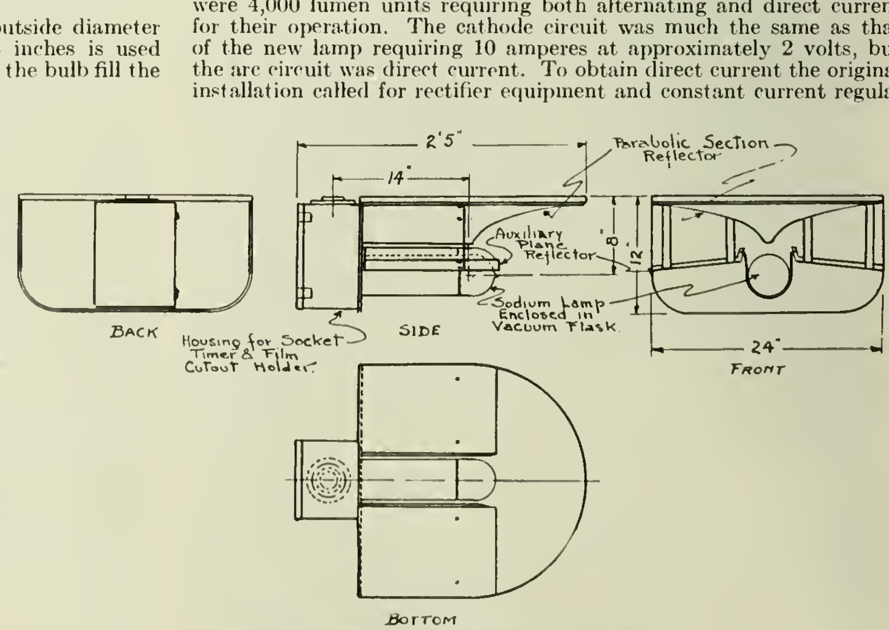



**Fig. 3—Assembly of Sodium Luminaire.**

tion for the arc circuit. These facts are mentioned with the idea of illustrating how rapidly improvements and simplification have already been made.

Description of Installation

The ten units on the Montreal-Quebec highway are installed over a two strip concrete section of the roadway with a spacing between the units of 250 feet. The lamps are staggered and so installed as to have a distance of 25 feet from the roadway surface to the light centre. As the Bell Telephone Company have a pole line along the opposite side of the highway from the Shawinigan Company's distribution line, permission was obtained to overbuild the telephone company in order to provide for the staggering of the units. Figure 2 shows a daytime view of a section of the installation and brings out clearly the typical difficulties to be encountered in work of this kind along Quebec highways, namely trees and foreign plant usually in the form of telephone circuits.

The "IL" transformer can be seen on the pole above the level of the mast arm. Twin conductor rubber insulated cable with a single braid of weatherproofing was used to run from the transformer to each luminaire.

Figure 3 illustrates the general appearance of the lamp when assembled with the aluminum reflector.

As has already been mentioned, the ten lamps are supplied by a 3-kw. "RO" transformer. This transformer is energized through a Novalux controller which in turn is controlled by a Weston photronic relay.

Figure 4 shows the transformer and controller on the upper level and the Weston photronic control made up of the light collector seen on the left hand side of the picture and its related relays contained in the left hand weatherproof wooden box.

The control is set for a light intensity of about 12 foot-candles, and it is interesting to note that during one severe storm the lamps actually came on as a result of a dropping in the light intensity to a figure below that of the relay setting. This condition must have existed for an appreciable time as the control is equipped with a small time delay to guard against any pumping through occurrences of a similar nature.

Figure 5 illustrates a wiring diagram of the 609 model photronic relay which device functions as follows: When the light intensity has reached the level for which the sensitive relay is set, the low contact is made. This completes the circuit to the time delay relay. After approximately one minute its low contacts make which causes the

Fig. 4—RO Transformer, Novalux and Photronic Controls and Metering.

power relay contacts to close. The power relay contacts will stay closed even after the low contacts on both the sensitive and time delay relays have opened. When the light intensity in the morning has come up to the upper value for which the sensitive relay has been adjusted the high contacts close. This completes the local circuit to the high contacts on the time delay relay causing them to close after approximately one minute. This releases the contacts on the power relay and opens the circuit to the artificial illumination.

The lead resistance between the cell box and the relay cabinet does not affect the correct operation of the equipment and permits the cell box to be located at a distance from the circuits that are to be controlled.

In order to obtain operating data on the sodium lamp, it was decided to install a simple form of metering equipment and to meter the installation from the 6.6 amp. side of the constant current transformer. This was done in order to meter only the input to the lamps and the losses of the circuit and equipment, and was considered quite

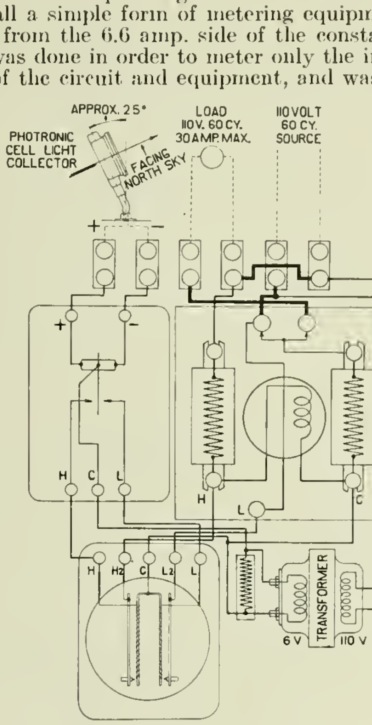



Fig. 5—Wiring Diagram of Photronic Relay.

safe practice as the open circuit voltage of a transformer with that rating is not high, being approximately 650 volts. The metering consists of a Lincoln type ED demand meter from which the input to the ten lamps and their kilowatt hour consumption can be obtained and this meter, together with current and potential transformers and the usual test links, is contained in the weatherproof box shown in Fig. 4 on the right hand side of the pole opposite the Weston control.

The meter is read at regular intervals and the input measured corresponds to the information given by the manufacturers, being in the neighbourhood of 2.5 kw. for 10 lamps or 250 watts per lamp. From the kilowatt hour registration, it is expected to obtain a fairly close approximation of the burning hours.

From June 9th to September 8th, comprising a total of ninety-one nights, the kilowatt hour consumption of the ten lamps was 2,149 or an average nightly consumption per lamp of 2.36 kw.hrs. Of course, due to the fact that the nights are now getting longer, the consumption has increased, as during the early part of the summer there was an average consumption per lamp per night of 2.2 kw.hrs. The average kilowatt peak as measured by the demand meter which includes the input and losses to the ten lamps and the half mile of circuit is 2.7 kw. over the period considered.

At present the lamps are guaranteed for thirteen hundred and fifty burning hours, but it is understood that a considerably longer life is hoped for.

Future Possibilities of Highway Lighting

There would appear to be two requisites necessary for the development of this form of lighting, namely the interest of those making use of the highways and of the local or provincial road departments, as the case may be, and the first cost of an installation or installations.

Already, considerable interest has been shown both by automobile owners and automobile clubs. Those who have travelled through the section at night have generally commented on the definition of detail made possible by the monochromatic light from the units and on the complete absence of glare. The only adverse criticism heard has been that the light intensity appears to be too high in contrast to the unlighted highway at both ends of the experimental section.

As to costs, it is obvious that before power companies can hope to develop this additional outlet equipment, costs must of necessity be low. While it is admitted that with a light output from the sodium lamp of between two and a half and three times that of an incandescent lamp with the same power input, it is now possible to cut down the number of units per mile over what would be necessary in a corresponding section lighted by incandescent lamps and still give the same intensity of illumination on the roadway, yet when the great stretches of highway which might be illuminated are considered, it can easily be seen that power companies will have difficulty in selling this possible service if their yearly charge per unit is high due to high installation costs. At the present time, however, it is hardly fair to talk of installation costs—the units now in use are made to order and, in the opinion of the manufacturers, costs would be very much reduced with an appreciable increase in demand.

# BRANCH NEWS

## Montreal Branch

*C. K. McLeod, A.M.E.I.C., Secretary-Treasurer.*

Some two hundred members of the Montreal Branch of The Institute were the guests of the Dominion Bridge Company Limited on the evening of September 6th, 1934, when they had an opportunity of inspecting the plant of the Chas. Walmsley Company of Canada Limited at Longueuil, and witnessed the actual prestressing and measuring of one of the 2,500-foot cable strands for the Isle d'Orleans suspension bridge.

Each strand is 1⅜ inch in diameter and is composed of 37 main wires (.201 and .193 inches diameter) and 8 filler wires .080 inch diameter. The outer layer of 18 wires is laid opposite hand to the inside wires to counteract any uncoiling tendency. The strand has a cross sectional area of 1.12994 square inch, a specified minimum ultimate strength of 217,000 pounds, a specified minimum yield point (.70 per cent elongation in 100 inches) of 167,000 pounds, a minimum modulus of elasticity (up to 50 per cent of ultimate strength) of 24,000,000 pounds per square inch, and is manufactured by the Dominion Wire Rope Company Limited of Montreal and Toronto.

### Prestressing Operations for Main Cable Strands

After being unreeled in the trough, one end of the strand is connected to a dead anchorage and the other end connected, through a series of adjustable links, to the hydraulic prestressing machine.

The applied loads are measured on two special extensometers which are located in the line of pull, one at each end of the strand. During prestressing and marking operations the strand is wholly supported on ball bearing rollers to minimize friction.

Sensitive thermometers are clamped on the strand near each end and temperatures are carefully recorded.

Marking stations are located in the trough at points corresponding to the intersection of the strand on the cable bents, towers, centreline of span, and the faces of the sockets. Their locations have been carefully chained and adjusted for the difference between average and actual marking stress and an allowance for subsequent shortening due to reeling.

The sequence of prestressing operations is as follows:—

1. Apply sufficient load to take up slack. Check the manufactured length.
2. Raise load to 10,000 pounds. Paint reference mark on strand at end station.
3. Raise load to 120,000 pounds and lock for thirty minutes. Measure elongation at end station to check uniformity of manufacture.
4. Unlock strand and lower load to 10,000 pounds by decrements of 10,000 pounds. Note shortening at each stage and calculate modulus of elasticity.
5. Increase load until close to marking load (59,000 pounds). Calculate pull and temperature corrections and apply to strand at end marking station.
6. Bring mark to alignment at end station and lock. Apply intermediate reference marks to strand.
7. Unlock strand, raise load to about 65,000 pounds, slack off to about marking load thus reversing friction and repeat as in No. 5. Apply permanent paint marks, the mean of Nos. 5 and 7, and re-reel strand.

Specimens for the specified tests are cut after prestressing and marking. A tolerance of one inch, plus or minus, is allowed in the geometric length of 2468.392 feet, face to face of sockets.

Each main cable is composed of 37 prestressed strands, banded together in hexagonal form, rounded out by wooden fillers, and wrapped with soft galvanized wire. The strands of each horizontal layer are of opposite lay to those of the adjacent layers, there being 17 right hand and 20 left hand laid strands in each cable.

At the close of the meeting refreshments were served through the courtesy of the Dominion Bridge Company Limited.

## Quebec Branch

*Jules Joyal, A.M.E.I.C., Secretary-Treasurer.*

### Visite au Pont de l'Ile d'Orleans

Le 15 juillet dernier, les membres de la Section de Québec et quelques-uns de leurs amis, soit une cinquantaine en tout, avaient le privilège d'aller visiter les travaux du pont de l'Ile d'Orléans.

Cette visite, organisée par M. Théo. M. Déchêne, A.M.E.I.C., ingénieur au Ministère des Travaux Publics de la Province de Québec et membre du Comité d'Excursions de notre section, fut un véritable succès; la température était idéale et le départ s'est effectué du Palais Montcalm à 4 heures 30 pour arriver sur les lieux vers cinq heures p.m.

Le groupe des visiteurs fut accueilli avec la plus grande cordialité par MM. J. W. Roland, M.E.I.C., et W. H. Smick respectivement ingénieur résident pour Monsarrat et Pratley, ingénieurs-conseils qui ont préparé les plans et devis de la partie centrale du pont, et surintendant des travaux pour la compagnie "Foundation of Canada"; ces messieurs se prêtèrent volontiers à fournir aux visiteurs toutes les informations de nature à les intéresser.

Tous ont pu examiner à loisir les travaux en voie d'exécution et l'outillage parfait que possède la Cie "Foundation" pour des travaux de cette nature; cette visite des lieux a duré environ deux heures et tous ceux qui y ont pris part étaient enchantés de cette petite excursion récréative en même temps qu'instructive.

Ce pont est construit sur le St-Laurent entre le village de Montmorency et l'Ile d'Orléans pour le compte du département des Travaux Publics qui est représenté par MM. Ivan E. Vallée, A.M.E.I.C., Sous-Ministre et Ingénieur-en-chef et O. Desjardins, A.M.E.I.C., Ingénieur-en chef adjoint.

La longueur totale du pont, y compris les approches est de 14,600 pieds répartis comme suit: Approches du côté de Montmorency village: 2,145; du côté de l'Ile d'Orléans: 6,755; longueur entre culées: 5,700.

La longueur de 5,700 entre les culées se répartit comme suit: 2,128 pieds de viaduc du côté de Montmorency, 1,678 pieds du côté de l'Ile et 1,894 pieds de tablier en suspension répartis en trois travées dont l'une, la centrale, a une longueur de 1,059 pieds et laisse un dégagement de 106 pieds au-dessus des eaux hautes.

La voie charretière a 20 pieds de largeur et est bordée de chaque côté par des trottoirs ayant cinq pieds de largeur. Les culées et les piliers sont en béton mais ces derniers sont recouverts d'un revêtement en granit jusqu'au dessus des hautes eaux.

Les tours supportant les cables auront une hauteur de 227 pieds au-dessus des piliers et les cables seront constitués de 37 torons de un pouce et trois huitièmes chacun pour donner avec l'enveloppe un cable d'environ 10 pouces de diamètre.

La culée et les piliers du côté nord, sauf le pilier de support principal reposent sur pilotis, du côté de l'Ile, de même que le pilier de support du côté nord, toutes les unités de support reposent sur le roc.

Ce pont sera terminé au cours de l'été 1935.

## Saguenay Branch

*J. W. Ward, A.M.E.I.C., Secretary-Treasurer.*

On Thursday evening, August 2nd, 1934, a meeting of the Saguenay Branch was held in the main office of the Aluminum Company of Canada Ltd. at which thirty-five members and friends were present.

The speaker of the evening was F. L. Lawton, A.M.E.I.C., who read a paper on "Heat Economy and Comfort in the Home, as Influenced by Heating Methods and Building Construction."

Mr. Lawton has spent considerable time in the study of this subject, in connection with the house-heating experiment being carried on in this district by the Saguenay Electric Company. The tremendous waste, through faulty building construction, is estimated by the Dominion Fuel Board at thirty million dollars annually. The effect of insulation, weather-stripping, storm doors and windows, as well as exposure to wind and sunshine were mentioned.

He went into the heat requirements, heating methods and costs very thoroughly. For day-time comfort a temperature range of 68 to 72 degrees F. with a relative humidity of 40 to 50 per cent was required. In the coldest weather, that is from 20 degrees to 40 degrees below zero, a relative humidity exceeding 40 per cent will cause frosting on the windows, and the formation of ice around doors which are not well weather-stripped. The cost of heat insulation for a new house will average 5 per cent of the cost of the house, and should result in a reduction in the heating cost over that of an uninsulated house of 30 to 50 per cent.

The Saguenay Electric Company have fifty or more houses in the Saguenay district equipped for electric heating. Where the house was heated by a hot air furnace, heating elements were installed inside the casing of the furnace, and operated automatically through a contactor and thermostat which is located usually in the dining or living room. Where hot water was used as a heating medium, a water heater of the electrode type was used, connected in parallel with the furnace. The control is through a contactor and thermostat located in one of the central rooms.

One of the slides shown was that comparing the cost of a given amount of heat (B.t.u.'s) delivered to a house, using different heat producers. The point on this diagram of particular interest to the members present was that showing the cost of electricity at one-third of a cent per kilowatt-hour. This compares with anthracite coal at $13.00 per ton, fuel oil at $0.105 per imperial gallon and wood at $3.75 per short cord. In this comparison the coal contains 13.500 B.t.u.'s per pound, and burned at 50 per cent seasonal efficiency. The fuel oil contains 168.600 B.t.u.'s per gallon, and burned with a seasonal efficiency of 65 per cent. The wood is assumed to be air dry white birch, cut 16 inches long and contains 23.400.000 B.t.u's per standard cord, and is burned with a seasonal efficiency of 50 per cent. Electricity is consumed at 100 per cent seasonal efficiency.

Heating by reversed refrigeration is one of the latest developments in the house heating field, and one which holds promise for the near future.

Radiation or panel heating is increasing in popularity.

District heating is a development which has met with considerable success also.

At the close of the address an active discussion took place, and many questions were asked concerning some of the features of electric heating. A vote of thanks was tendered to Mr. Lawton for this very interesting paper.

Following the address, a business meeting was held. A Nominating Committee was first appointed to make nominations for the annual elections. N. F. McCaghey, A.M.E.I.C., and S. J. Fisher, M.E.I.C., were appointed by the executive, and M. G. Saunders, A.M.E.I.C., G. H. Kirby, A.M.E.I.C., and F. L. Lawton, A.M.E.I.C., were appointed by the other members attending the meeting.

Following the closing of the nominations a discussion took place concerning the programme in connection with the annual meeting. The date was set for August 30th, 1934.

### Annual Meeting

The annual meeting of the Saguenay Branch was held on the evening of August 30th, 1934, at the Arvida Staff Club.

During the afternoon several of the members enjoyed a round of golf at the Saguenay Country Club. At 5.30 in the afternoon members were taken through the plant of The Aluminum Company of Canada.

At 7.00 p.m. seventeen members met at the Arvida Staff Club where dinner was served. Following the dinner the meeting was called to order by the chairman, A. W. Whitaker, Jr., A.M.E.I.C., who asked the Secretary-Treasurer to read the minutes of the last annual meeting, also the report of the secretary for the year. The motion for the adoption of the minutes and the secretary's report as read was made by B. Pelletier, A.M.E.I.C., and seconded by H. R. Wake, A.M.E.I.C.

The chairman then read the report of the scrutineers for the ballots of the annual election, the results of which were as follows:

For Chairman: G. E. LaMothe, A.M.E.I.C.

For Vice-Chairman: J. Shanly, A.M.E.I.C.

For the two vacancies in the Executive committee made through the retirement of S. J. Fisher, M.E.I.C., and A. Cunningham, A.M.E.I.C., the following two were elected: M. G. Saunders, A.M.E.I.C., and E. Lavoie, M.E.I.C.

Before turning the meeting over to the new chairman, Mr. Whitaker expressed his appreciation for the assistance he had received from the members of the Executive and extended his good wishes to the new chairman.

Mr. LaMothe now took the chair, and expressed his appreciation of the honour given him in electing him to the chairmanship of the branch. He hoped to be able to procure speakers for the coming year who would maintain interest in the meetings. He also thought the members should be more active in their attempts to obtain more members. There are a number of engineers in this district who are qualified for membership, and could be persuaded to join if a more determined effort was made to induce them to do so.

### The Production and Explosibility of Gases Generated in Electric Steam Generators

The chairman then introduced M. G. Saunders, A.M.E.I.C., who read a paper on "The Production and Explosibility of Gases Generated in Electric Steam Generators." Mr. Saunders commenced by giving a résumé of all the published data on this subject he had been able to collect. One of the first research results published was that of Messrs. Shipley and Blackie, who collected samples of gases from electrode type water heaters using alternating current, and found them to be explosive when mixed with air. Messrs. Kaelin and Matheson, who have done a great deal of research in connection with electric steam generators, brought out the information that the formation of gases in such generators is mainly a function of current density, and that electrodes should be designed to distribute the current evenly over the whole surface of the electrodes. Most commercial boilers are designed so as not to exceed one ampere per square inch of electrode surface, which is well below the point at which any gas will be generated, provided of course the electrodes are clean.

A further contribution to the published work on this subject was made by Messrs. Campbell and Rogers, who summarize their results as follows:

1. Under certain operating conditions, steam coming from an electric boiler may be contaminated by electrolytic gases, produced by the decomposition of the water or the steam in the boiler, although the gas is not known to be explosive when diluted with steam under ordinary operating conditions. It has been known however to corrode iron surfaces. When the steam condenses and the gas becomes concentrated it is very explosive.
2. When the electrodes are free from scale and condensate is used for feed water, no electrolytic gas could be detected.
3. Gradual scaling of the electrodes due to the use of impure feed water causes a gradual increase in gas formation. Under these conditions more gas is produced with 25-cycle than with 60-cycle current.

In studying these results and their application to the electric steam generating system at Arvida, tests were made to find out whether gases in explosive proportions were generated, and if so, if there was any tendency to accumulate in any part of the system. Also whether an explosion hazard existed as long as these gases were combined with steam.

The results of these tests may be summarized as follows:

1. Gases are generated by an electric boiler in explosive proportions.
2. These gases have not been found in any quantity in any part of the system.
3. Where steam is exhausted from radiators by a vacuum pump, the gases are diluted with so much air as to render them non-explosive.
4. At temperatures and pressures met with in ordinary boiler operation a very small quantity of steam is sufficient to prevent any gas explosion, and any smaller quantities of steam tends to dampen the effect of the explosion appreciably.
5. In some cases segregation of gases may permit an explosion, but only when one part of the container is cooler than 100 degrees C.

After the reading of the paper, which was illustrated with slides, an active discussion took place. The meeting closed with a vote of thanks for the paper so interestingly presented by Mr. Saunders.

## Sault St. Marie Branch

*H. O. Brown, A.M.E.I.C., Secretary-Treasurer.*

The Sault Ste. Marie Branch of The Institute discontinued the regular monthly dinner meetings for the summer after the meeting of May 25th, 1934, which was addressed by D. S. Lloyd, A.M.E.I.C.

The Executive committee met from time to time as items of business required attention. The chairman, E. M. MacQuarrie, A.M.E.I.C., was out of town on survey work most of the summer and F. Smallwood, M.E.I.C., vice-chairman, acted in his place.

Two special meetings were held during the summer when the General Secretary, R. J. Durley, M.E.I.C., and the president, F. P. Shearwood, M.E.I.C., visited the Branch. These were in the form of dinner meetings at the Sault Country Club, and gave the visitors an opportunity to become acquainted with the members of the Branch. The attendance was very good.

Mr. Durley was entertained on July 26th, and after dinner gave a very interesting talk to the members of the Branch on his visit to the western Canada branches and the Western Professional Meeting of The Institute at Vancouver. A general review of the work of The Institute was also given and various points brought up for discussion with members of the Branch.

The President, Mr. Shearwood, was a guest on August 3rd, and after dinner addressed the Branch on the general affairs of The Institute. Mr. Shearwood also gave a talk on "Bridge Erection," which was illustrated with excellent slides. This meeting was well attended as almost all of the resident members of the Branch took advantage of this opportunity to meet Mr. Shearwood.

## Short Count Traffic Surveys and their Application to Highway Design

A 40-page booklet by Dr. Miller McClintock of Harvard University, which has been received outlines a practical, simple and low-cost way to make traffic studies. The "short count" method makes it possible for road officials with limited funds to give the same study to their problems as is given the larger problems of state and Federal systems.

This method is based on the fact that the percentage of total daily traffic occurring in any given hour is approximately constant at different points along the same route, or on routes of the same character in the same district or region.

As few stations are counted as is necessary to provide a control, or hourly relation, for each type of route and neighbourhood in the area to be studied. With twenty-four-hour counts of traffic at these stations, two-hour counts may be made at base stations, and a twenty-four-hour total can be computed. The base stations may be located wherever the highway engineer feels a need for traffic data.

Factors for both passenger cars and trucks are derived from the control station count.

This information gives a sound and logical basis for planning road improvements.

The booklet is No. 3 of a Highway Planning and Design series and is available without cost on request to the Portland Cement Association, 33 West Grand Avenue, Chicago, Ill.

## Rapid Acceleration

The London, Midland and Scottish Railway have introduced a new passenger service in East Lancashire, operated by a Lancashire-made 40-seater Diesel-hydraulic light rail car. This service is additional to the ordinary passenger service.

The rail car is specially designed with a view to rapid acceleration, being able to attain a speed of 50 miles an hour in 49 seconds from a dead stand. It weighs ten and a half tons, and is powered by a 130-h.p. Diesel engine with hydraulic transmission.—*Industrial Britain.*

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*The H. E. Mott Company Limited*, of Brantford, Ontario, has purchased the assets of the Goold, Shapley and Muir Company Limited of Brantford, pertaining to the tower, tank and textile part of their business, including all business and engineering records, patterns, drawings, machinery and equipment, and will continue the manufacture of these lines. The president and general manager of the new company is H. E. Mott, A.M.E.I.C. It is the intention of the H. E. Mott Company Limited to extend the engineering control and development of the business, with a view to keeping in the van of new developments and assuring the maintenance of the very highest quality in their products.

# Preliminary Notice

## of Applications for Admission and for Transfer

September 27th, 1934

The By-laws provide that the Council of The Institute shall approve, classify and elect candidates to membership and transfer from one grade of membership to a higher.

It is also provided that there shall be issued to all corporate members a list of the new applicants for admission and for transfer, containing a concise statement of the record of each applicant and the names of his references.

In order that the Council may determine justly the eligibility of each candidate, every member is asked to read carefully the list submitted herewith and to report promptly to the Secretary any facts which may affect the classification and selection of any of the candidates. In cases where the professional career of an applicant is known to any member, such member is specially invited to make a definite recommendation as to the proper classification of the candidate.*

If to your knowledge facts exist which are derogatory to the personal reputation of any applicant, they should be promptly communicated.

**Communications relating to applicants are considered by the Council as strictly confidential.**

The Council will consider the applications herein described in November, 1934.

R. J. Durley, Secretary.

* The professional requirements are as follows:—

**A Member** shall be at least thirty-five years of age, and shall have been engaged in some branch of engineering for at least twelve years, which period may include apprenticeship or pupilage in a qualified engineer's office, or a term of instruction in a school of engineering recognized by the Council. The term of twelve years may, at the discretion of the Council, be reduced to ten years in the case of a candidate for election who has graduated from a school of engineering recognized by the Council. In every case the candidate shall have held a position in which he had responsible charge for at least five years as an engineer qualified to design, direct or report on engineering projects. The occupancy of a chair as a professor in a faculty of applied science of engineering, after the candidate has attained the age of thirty years, shall be considered as responsible charge.

**An Associate Member** shall be at least twenty-seven years of age, and shall have been engaged in some branch of engineering for at least six years, which period may include apprenticeship or pupilage in a qualified engineer's office or a term of instruction in a school of engineering recognized by the Council. In every case a candidate for election shall have held a position of professional responsibility, in charge of work as principal or assistant, for at least two years. The occupancy of a chair as an assistant professor or associate professor in a faculty of applied science of engineering, after the candidate has attained the age of twenty-seven years, shall be considered as professional responsibility.

Every candidate who has not graduated from a school of engineering recognized by the Council shall be required to pass an examination before a board of examiners appointed by the Council. The candidate shall be examined on the theory and practice of engineering, with special reference to the branch of engineering in which he has been engaged, as set forth in Schedule C of the Rules and Regulations relating to Examinations for Admission. He must also pass the examinations specified in Sections 9 and 10, if not already passed, or else present evidence satisfactory to the examiners that he has attained an equivalent standard. Any or all of these examinations may be waived at the discretion of the Council if the candidate has held a position of professional responsibility for five or more years.

**A Junior** shall be at least twenty-one years of age, and shall have been engaged in some branch of engineering for at least four years. This period may be reduced to one year at the discretion of the Council if the candidate for election has graduated from a school of engineering recognized by the Council. He shall not remain in the class of Junior after he has attained the age of thirty-three years, unless in the opinion of Council special circumstances warrant the extension of this age limit.

Every candidate who has not graduated from a school of engineering recognized by the Council, or has not passed the examinations of the third year in such a course, shall be required to pass an examination in engineering science as set forth in Schedule B of the Rules and Regulations relating to Examinations for Admission. He must also pass the examinations specified in Section 10, if not already passed, or else present evidence satisfactory to the examiners that he has attained an equivalent standard.

**A Student** shall be at least seventeen years of age, and shall present a certificate of having passed an examination equivalent to the final examination of a high school, or the matriculation of an arts or science course in a school of engineering recognized by the Council.

He shall either be pursuing a course of instruction in a school of engineering recognized by the Council, in which case he shall not remain in the class of Student for more than two years after graduation; or he shall be receiving a practical training in the profession, in which case he shall pass an examination in such of the subjects set forth in Schedule A of the Rules and Regulations relating to Examinations for Admission as were not included in the high school or matriculation examination which he has already passed; he shall not remain in the class of Student after he has attained the age of twenty-seven years, unless in the opinion of Council special circumstances warrant the extension of this age limit.

**An Affiliate** shall be one who is not an engineer by profession but whose pursuits, scientific attainments or practical experience qualify him to co-operate with engineers in the advancement of professional knowledge.

The fact that candidates give the names of certain members as reference does not necessarily mean that their applications are endorsed by such members.

### FOR ADMISSION

FARNHAM—ANSELL CASS, of 151 London St., Sherbrooke, Que., Born at Martinville, Que., Aug. 17th, 1905; Educ., Junior Matric. (Science), McGill Univ., 1923; 1923-25, dfting., and 1925-31, gen. engrg., designing, and supervision of steel erection, MacKinnon Steel Corporation, Sherbrooke, Que.; 1931 to date, chief designer, Stewart Construction Co. Ltd., Sherbrooke, Que.

References: G. D. MacKinnon, G. M. Dick, J. T. Morkill, F. H. Hibbard, W. L. R. Stewart.

### FOR TRANSFER FROM THE CLASS OF JUNIOR

BANKS—SHEWELL REGINALD, of Lachine, Que., Born at Liverpool, England, Jan. 11th, 1904; Educ., B.Eng., 1924, M.Eng., 1926, Univ. of Liverpool. A.M.Inst.C.E. (Great Britain); 1922-23, marine experience during vacations; 1924-27, junior engr., Dept. of Scientific and Industrial Research, England. Investigation of impact stresses in rly bridges. In charge of various recording instruments; 1927-29, asst. with Messrs. Rendel, Palmer & Tritton, consltg. engrs., Westminster. Design and drawing of long-span rly. bridges and locomotive shops for rlys. in India; 1929-32, with Dominion Bridge Company, Lachine, Que. Design, estimating, and detailing of various types of structures including movable bridges. Also field engr. on foundation and erection of steelwork (pulpwood equipment and hydro sluice gates); 1932 to date, asst. engr., with Messrs. Monsarrat & Pratley, consltg. engrs., Montreal. Design, inspection, etc., sub-aqueous foundations and suspension bridge superstructures. (*Jr. 1930.*)

References: C. N. Monsarrat, P. L. Pratley, F. Newell, D. C. Tennant, D. B. Armstrong, F. A. Bowman.

CORNISH—WILFRED ERNEST, of Edmonton, Alta., Born at Broadview, Sask., Feb. 22nd, 1901; Educ., B.Sc. (E.E.), Univ. of Man., 1925; M.Sc., Univ. of Alta., 1933; 1926-27, testing, Can. Gen. Elec. Co.; 1927-33, lecturer, and 1933 to date, asst. professor, dept. of elec. engrg., University of Alberta, Edmonton, Alta. (*St. 1926, Jr. 1930.*)

References: R. S. L. Wilson, E. P. Fetherstonhaugh, F. K. Beach, W. M. Cruthers, H. J. MacLeod.

### FOR TRANSFER FROM THE CLASS OF STUDENT

DOVE—ALLAN BURGESS, of Hamilton, Ont., Born at Ayr, Scotland, April 9th, 1909; Educ., B.Sc., Queen's Univ., 1932; 1925-26, Can. Westinghouse Co.; With the Steel Company of Canada, Hamilton, Ont., as follows: 1928-32 (summers), gen. control, costs, plant operation, etc.; 1932 to date with same company, and at present chem. engr. and asst. to West Mill supt., in charge of chemical operation and gen. plant operation and control of West Mill, galvanizing and wire depts., etc., including operation throughout mill, electroplating, equipment design and plant layout. (*St. 1932.*)

References: A. Love, V. S. Thompson, L. F. Goodwin, D. S. Ellis, A. Macphail.

PORTEOUS—JOHN WARDLAW, of Edmonton, Alta., Born at Galt, Ont., Jan. 12th, 1907; Educ., B.Sc. (E.E.), Univ. of Alta., 1928; 1925 and 1927 (summers), Dominion Forestry Survey; 1926, C.P.R. constrn. survey; 1930 to date, lecturer, Univ. of Alta., Edmonton, Alta. (*St. 1929.*)

References: H. J. MacLeod, R. S. L. Wilson, H. R. Webb, F. K. Beach, J. R. Dunbar.

## List of New and Revised British Standard Specifications

(Issued during June, 1934)

B.S.S. No.

485—1934. Tests on Thin Metal Sheet and Strip (not exceeding 0.128 in. (10 S.W.G.) in Thickness).

This specification—which supersedes B.S.S. No. 485-Part 1 issued last year—has now been amplified by the addition of two further sections dealing with bend and hardness testing respectively. An interesting note on the usefulness of cupping tests is also included. The scope of the specification has been extended so that it now covers the testing generally of thin sheet and strip material up to 10 S.W.G. (0.128 in.) thick.

556—1934. Cement Concrete Cylindrical Pipes and Tubes (not Reinforced).

Provides for nominal sizes from 6 inch upwards and includes requirements as to quality and hydraulic pressure, crushing, and absorption tests. The thicknesses are not standardized and only such dimensions for the sockets are laid down as will ensure interchangeability of pipes.

557—1934. Alternating-Current Line Relays (single-element, 2-position) for Railway Signalling Purposes.

An addition to the series of specifications for railway signalling relays. This issue covers relays of the induction type, intended for use on railway signalling circuits not exceeding 250 volts.

558—1934. Nickel Anodes (for Electroplating).

This specification has been compiled to ensure the purity of nickel anodes. The maximum amount of each purity is given; also the methods for their determination.

559—1934. Electric Signs.

Covers construction, electrical apparatus and wiring of electric signs of box, or other forms using filament lamps and/or discharge tubes operating in conjunction with double-wound transformers, and auxiliary apparatus.

Copies of the new specifications may be obtained from the Publications Department, British Standards Institution, 28 Victoria Street, London, S.W.1, and from the Canadian Engineering Standards Association, 79 Sussex Street, Ottawa, Ont.

## EMPLOYMENT SERVICE BUREAU

The Service is operated for the benefit of members of The Engineering Institute of Canada, and for industrial and other organizations employing technically trained men—without charge to either party.

*All correspondence should be addressed to*

**The Employment Service Bureau, The Engineering Institute of Canada**
**2050 Mansfield Street, Montreal**

## Situations Wanted

ESTABLISHED SALES ENGINEER. Univ of Toronto '24, with plant and manufacturing experience, wishes to represent manufacturers of technical equipment. Connections with automobile and electrical equipment dealers, throughout Canada. Will make small investment if necessary. Apply to Box No. 1-W.

MECHANICAL ENCINEER, Canadian, with technical training and executive experience in both Canadian and American industries, particularly plant layout, equipment, planning and production control methods, is open for employment with company desirous of improving manufacturing methods, lowering costs and preparing for business expansion. Apply to Box No. 35-W.

MECHANICAL ENGINEER, A.M.E.I.C. Married. Experience in machine shops, erection and maintenance of industrial plant mechanical and structural design. Reads German, French, Dutch and Spanish. Seeks any suitable position. Apply to Box No. 84-W.

MECHANICAL ENGINEER, graduate McGill Univ. Experience on hydro-electric power construction and design and installation of equipment of pulp and paper mills. Desires position as mechanical engineer in an industrial plant or pulp and paper mill, or as representative on the sale of heavy machinery. Apply to Box No. 142-W.

PURCHASING ENGINEER, graduate mechanical engineer, Canadian, married, 34 years of age, with 13 years' experience in the industrial field, including design, construction and operation, 8 years of which had to do with the development of specifications and ordering of equipment and materials for plant extensions and maintenance; one year engaged on sale of surplus construction equipment. Full details upon request. Apply to Box No. 161-W.

REINFORCED CONCRETE ENGINEER, B.SC., P.E.Q., eight years experience in construction design of industrial buildings, office buildings, apartment houses, etc. Age 30. Married. Apply to Box No. 257 W.

MECHANICAL ENGINEER, age 28, nine years allround experience, Grad. Inst. of Mech. Engs. England, S.E.I.C. Technical and practical training with first class English firm of general engineers; shop, foundry and drawing office experience in steam and Diesel engines, asphalt, concrete machinery, boilers, power plants, road rollers, etc. Experience in heating and ventilation design and equipment; 18 months designing draughtsman with Montreal consulting engineers. 2½ years sales experience, steam and hot water heating systems, power plant equipment, machinery, oil-burning apparatus. Canadian 4th class Marine Engineers Certificate; C.N.S. experience. Available at short notice. Apply to Box No. 270-W.

DESIGNING DRAUCHTSMAN, experience in layout of steam power house equipment and piping. Wide experience in mechanical drive and details of machinery, gearing, and hoists. Accustomed to layout of small mill buildings of steel and timber, structural design and details. Good references. Present location Montreal. Apply to Box No. 329-W.

ELECTRICAL ENGINEER, B.SC., A.M.E.I.C., AM.A.I.E.E., age 30, single. Eight years experience H.E. and steam power plants, substations, etc., shop layouts, steel and concrete design. Location immaterial. Available immediately. Apply to Box No. 435-W.

CIVIL ENCINEER, B.A.SC., and C.E., A.M.E.I.C., age 30, married. Experience over the last ten years covers construction on hydro-electric and railway work as instrumentman and resident engineer. Also office work on teaching and design, investigations and hydraulic works, reinforced concrete, bridge foundations and caissons. Location immaterial. Available at once. Apply to Box No. 447-W.

SALES ENGINEER, M.A.SC. Univ. of Toronto, wishes to represent firm selling building products or other engineering commodities, as their representative in Western Canada. Located in Winnipeg. Apply to Box No. 467-W.

MECHANICAL ENCINEER, B.SC. Age 28, married. Four and a half years on industrial plant maintenance and construction, including shop production work and pulp and paper mill control. Also two and a half years on structural steel and reinforced concrete design. Available at once. Apply to Box No. 521-W.

## Situations Wanted

CIVIL ENGINEER, Canadian, married, twenty-five years' technical and executive experience, specialized knowledge of industrial housing problems and the administration of industrial towns, also town planning and municipal engineering, desires new connection. Available on reasonable notice. Personal interview sought. Apply to Box No. 544-W.

ELECTRICAL AND MECHANICAL ENGINEER, B.SC., A.M.E.I.C. Experience includes C.G.E. Students' Test Course and six years in engineering dept. of same company on design of electrical equipment.Four summers as instrumentman on surveying and highway construction. Several years experience in accounting previous to attending university. Desires position with industrial concern where the combination of technical and business experience will be of value. Apply to Box No. 564-W.

MECHANICAL ENGINEER, A.M.E.I.C. Experienced on plant maintenance, steel plant, cement plant and mining plants. Available on short notice. Apply to Box No. 571-W.

DOMINION LAND SURVEYOR, and graduate engineer with extensive experience on legal, topographic and plane-table surveys and field and office use of aerophotographs, desires employment either in Canada or abroad. Available at once. Apply to Box No. 589-W.

### Up-to-date Information

Members registered with the Employment Service Bureau are requested to keep the Bureau advised of any change of address or of any temporary employment they may secure.

Considerable difficulty has arisen during the past few months through employers not being able to secure the services of men recommended due to these men being already employed.

Are you interested in selling?

Have you registered?

CHEMICAL ENGINEER, S.E.I.C., B.SC., University of Alberta, '30. Age 31. Single. Six seasons' practical laboratory experience, three as chief chemist and three as assistant chemist in cement plant; one year's p.g. work in physical chemistry; three years' experience teaching. Desires position in any industry with chemical control. Available immediately. Apply to Box No. 609-W.

DESIGNING ENGINEER AND ESTIMATOR, grad. Univ. of Toronto in C.E., A.M.E.I.C., twenty years experience in structural steel, construction and municipal work. Available at once. Apply to Box No. 613-W.

CIVIL ENGINEER, A.M.E.I.C., R.P.E., Ontario; three years construction engineer on industrial plants; fourteen years in charge of construction of hydraulic power developments, tower lines, sub-stations, etc.; four years as executive in charge of construction and development of harbours, including railways, docks, warehouses, hydraulic dredging, land reclamation, etc. Apply to Box No. 647-W.

ELECTRICAL ENGINEER, B.SC. in E.E. (Univ. of Man., '30). Age 25. Two year Can. Westinghouse Apprentice Course. Depts.—Switchboard assembly, general draughting office, switchboard engineering, test office. One year's experience since then designing and rewinding small motors and transformers. Location immaterial. Apply to Box No. 651-W.

DIESEL ENGINEER. Erection and industrial engineer, A.M.E.I.C., technically trained mechanical engineer with English and Canadian experience in erection and operation of steam and Diesel equipment in power house and mines, pumping, rock drilling, air compressors. Experienced in industrial and steel works operations including rolling mills, quarries, sales. Open for position on maintenance, operation or sales engineer. Location immaterial. Apply to Box No. 682-W.

## Situations Wanted

MECHANICAL AND STRUCTURAL ENCINEER. Six years experience with prominent manufacturer, designing, heating and power boilers, boiler installations, coal and ash handling equipment. Good practical knowledge of steel plate work welding. Also wide experience in designing, estimating and detailing structural steel for buildings and bridges. Cood education. Have held position of responsibility. Above can be verified by best of references. Available at once. Apply to Box No. 692-W.

ELECTRICAL AND CIVIL ENGINEER, B.SC., Elec., 29, B.SC., Civil '33. Age 27. JR.E.I.C. Undergraduate experience in surveying and concrete foundations; also four months with Canadian General Electric Co. Thirty-three months in engineering office of a large electrical manufacturing company since graduation. Good experience in layouts, switching diagrams, specifications and pricing. Best of references. Available immediately. Apply to Box No. 693-W.

MECHANICAL ENCINEER, B.SC., '27, JR.E.I.C. Four years maintenance of high speed Diesel engines units, 200 to 1,300 h.p. Also maintenance of D.C. and A.C. electrical systems and machinery. Draughting experience. Westinghouse apprenticeship course. Practical mechanical and electrical engineer with a special study of high speed Diesel engine design, application and operation. Location in western or eastern Canada immaterial. Apply to Box No. 703-W.

COMBUSTION ENGINEER, R.P.E., Manitoba, A.M.E.I.C. Wide experience with all classes of fuels. Expert designer and draughtsman on modern steam power plants. Experienced in publicity work. Well known throughout the west. Location, Winnipeg or the west. Available at once. Apply to Box No. 713-W.

ELECTRICAL ENGINEER, B.SC., University of N.B., '31. Experience includes three months field work with Saint John Harbour Reconstruction. Apply to Box No. 722-W.

MECHANICAL ENGINEER, age 41, married. Eleven years designing experience with project of outstanding magnitude. Machinery layouts, checking, estimating and inspecting. Twelve years previous engineering, including draughting, machine shop and two years chemical laboratory. Highest references. Apply to Box No. 723-W.

CIVIL ENGINEER, B.SC. (Alta. '31), S.E.I.C. Experience includes three seasons in charge of survey party. Transitman on railway maintenance, and concrete bridge designing Nature of work and location immaterial. Apply to Box No. 724-W.

YOUNC CIVIL ENGINEER, B.SC. (Univ. of N.B. '31), with experience as rodman and checker on railroad construction, is open for a position. Apply to Box No. 728-W.

DESIGNING ENGINEER, M.SC. (McGill Univ.), D.L.S., A.M.E.I.C., P.E.Q. Experience in design and construction of water power plants, transmission lines, field investigations of storage, hydraulic calculations and reports. Also paper mill construction, railways, highways, and in design and construction of bridges and buildings. Available at once. Apply to Box No. 729-W.

MECHANICAL ENCINEER, S.E.I.C., B.A.SC., Univ. of B.C. '30. Single, age 24. Sixteen months with the Allis-Chalmers Mfg. Co. as student engineer. Experience includes foundry production, erection and operation of steam turbines, erection of hydraulic machinery, and testing texropes and centrifugal pumps. Location immaterial. Available at once. Apply to Box No. 735-W.

CIVIL ENGINEER. M.SC., A.M.E.I.C., R.P.E. (Ont.), ten years experience in municipal and highway engineering Read, write and talk French. Married. Served in France. Will go anywhere at any time Experienced journalist. Apply to Box No 737-W.

RADIO AND ELECTRICAL ENGINEER, B.SC. '31, S.E.I.C. Age 27. Experience in installation of power and lighting equipment. Temporary operator in radio station; studio experience with part time announcing. Two summers in switchboard and installation department of telephone company, eight months on extensive survey layouts. Interested in sales work of electrical or radio equipment. Available on short notice. Location immaterial. Apply to Box No. 740-W.

CIVIL ENGINEER, B.SC. '29, A.M.E.I.C. Married. One year building construction, one year hydro-electric construction in South America, eighteen months resident engineer on highway construction, one year on harbour design and construction. Working knowledge of Spanish. Apply to Box No. 744-W.

## Situations Wanted

SALES ENGINEER, B.Sc., McGill, 1923, A.M.E.I.C. Age 33. Married. Extensive experience in building construction. Thoroughly familiar with steel building products; last five years in charge of structural and reinforcing steel sales for company in New York state. Available at once. Located in Canada. Apply to Box No 749-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. Queen's Univ. '29. Age 25. Married. Three years experience as construction supt. and estimator for contracting firm. Experience includes general building, bridges, sewer work, concrete, boiler settings, sand blasting of bridges and spray painting. Available at once. Apply to Box No. 776-W.

CIVIL ENGINEER, B.Sc., '25, Jr.E.I.C., P.E.Q., married. Desires position, preferably with construction firm. Experience includes railway, monument and mill building construction. Available immediately. Apply to Box No. 780-W.

DRAUGHTSMAN, experience in civil engineering, forestry engineering, land surveying and house construction. Good references. Apply to Box No. 781-W.

ELECTRICAL AND SALES ENGINEER, S.E.I.C., grad. '28. Experience includes one year test course, one year switchboard design and two years switchboard and switching equipment sales with large electrical manufacturing company. Three summers Pilot Officer with R.C.A.F. Available at once. Apply to Box No. 788-W.

ELECTRICAL ENGINEER desires position as engineer or manager for industrial plant or factory. Over ten years diversified electrical and mechanical experience in the industrial field. Apply to Box No. 795-W.

CIVIL ENGINEER, S.E.I.C., graduate '30, age 23, single. Experience includes mining surveys, assistant on highway location and construction, and assistant on large construction work. Steel and concrete layout and design. Apply to Box No. 809-W.

CIVIL ENGINEER, college graduate, age 27, single. Experience includes surveying, draughting concrete construction and design, street paving both asphalt and concrete. Available at once; will consider anything and go anywhere. Apply to Box No. 816-W.

CIVIL ENGINEER, B.E. (Sask. Univ. '32), S.E.I.C. Single. Experience in city street improvement; sewer and water extensions. Good draughtsman. References. Available at once. Location immaterial. Apply to Box No. 818-W.

CIVIL ENGINEER, B.Sc., A.M.E.I.C., with fifteen years experience mostly in pulp and paper mill work, reinforced concrete and structural steel design, field surveys, layout of mechanical equipment, piping. Available at once. Apply to Box No. 825-W.

CIVIL ENGINEER, B.A.Sc., D.L.S., O.L.S., A.M.E.I.C., age 46, married. Twelve years experience in charge of legal field surveys. Owns own surveying equipment. Eight years on technical, administrative, and editorial office work. Experienced in writing. Desires position on survey work, assisting in or in charge of preparation of house organ, on staff of technical or semi-technical magazine, or on publicity, editorial or administrative office work. Available at once. Will consider any salary, and any location. Apply to Box No. 831-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. '32 (Univ. of N.B.). Age 25. married. Two years experience in power line construction and maintenance; one year of highway construction; one summer surveying for power plant site, location and spur railway line construction. Available at once. Location immaterial. Apply to Box No. 840-W.

CIVIL ENGINEER, B.Sc. '15, A.M.E.I.C., married, extensive experience in responsible position on railway construction, also highways, bridges and water supplies. Position desired as engineer or superintendent. Available at once. Apply to Box No. 841-W.

CIVIL ENGINEER, B.Sc. (Alta. '31), S.E.I.C., age 24. Experience, three summers on railroad maintenance, and seven months on highway location as instrumentman. Willing to do anything, anywhere, but would prefer connection with designing or construction firm on structural works Available immediately. Apply to Box No. 846-W.

BRIDGE AND STRUCTURAL ENGINEER, A.M.E.I.C., McGill. Twenty-five years' experience on bridge and structural staffs. Until recently employed. Familiar with all late designs, construction, and practices in all Canadian fabricating plants. Desirous of employment in any responsible position, sales, fabrication or construction. Apply to Box No. 851-W.

STRUCTURAL ENGINEER, B.A.Sc., A.M.E.I.C. Twenty-two years experience in design of bridges and all types of buildings in structural steel and reinforced concrete. Three years experience in railway construction and land surveying. Apply to Box No. 856-W.

MECHANICAL ENGINEER, B.Sc. '32, S.E.I.C. Good draughtsman. Undergraduate experience:—One year moulding shop practice; two years pipe fitting and sheet metal work; one year draughting and tracing on paper mill layout; six months machine shop practice; and eight months fuel investigation and power heating plant testing. Desires position offering experience in steam power plants or heating and ventilating design. Will go anywhere. Apply to Box No. 858-W.

MECHANICAL ENGINEER, age 31, graduate Sheffield (England) 1921; apprenticeship with firm manufacturing steam turbine generators and auxiliaries and subsequent experience in design, erection, operation and inspection of same. Marine experience B.O.T certificate thoroughly conversant with Canadian plants and equipment. Available on short notice. Any location. Box No. 860-W.

CHEMICAL ENGINEER, B.Sc. (McGill '21), A.M.E.I.C., age 36, married; three years since graduation with pulp and paper mills; eight years in shops, estimating and sales divisions of well-known gas engineering and construction companies in the United States. Excellent references. Available on short notice. Apply to Box No. 866-W.

CONSTRUCTION ENGINEER (Toronto Univ. of '07). Experience includes hydro-electric, municipal and railroad work. Available immediately. Location immaterial. Apply to Box No. 886-W.

ELECTRICAL ENGINEER, graduate 1929, S.E.I.C. Single. Experience includes two years with electrical manufacturing concern and one on highway construction work. Available at once. Will go anywhere. Apply to Box No. 887-W.

AGENCIES WANTED, Young engineer, B.A.Sc. in C.E., with business and sales experience, speaking fluent French, would consider representing a firm as agent for Montreal or the province of Quebec. Apply to Box No. 891-W.

ELECTRICAL ENGINEER, grad. Univ. of N.B. '31. Experienced in surveying and draughting, requires position. Available at once. Will go anywhere. Apply to Box No. 893-W.

CIVIL ENGINEER, B.A.Sc., Jr.E.I.C., age 29, single. Experience includes two years in pulp mill as draughtsman and designer on additions, maintenance and plant layout. Three and a half years in the Toronto Buildings Department checking steel, reinforced concrete, and architectural plans. Available at once. Location immaterial. At present in Toronto. Apply to Box No. 899-W.

DESIGNING ENGINEER, A.M.E.I.C. Permanent and executive position preferred but not essential. Fifteen years experience in designing power plants, engine and fan rooms, kitchens and laundries. Thoroughly familiar with plumbing and ventilating work, pneumatic tubes, and refrigeration, also heating, electrical work, and specifications. Apply to Box No. 913-W.

ELECTRICAL ENGINEER, Dipl. of Eng., B.Sc. (Dalhousie Univ.), S.B. and S.M. in E.E. (Mass. Inst. of Tech.), Canadian. Married. Seven and a half years' experience in design, construction and operation of hydro, steam and industrial plants. For past sixteen months field office electrical engineer on 510,000 h.p. hydro-electric project. Available at once. Apply to Box No. 936-W.

CIVIL ENGINEER, B.Sc., O.P.E. Experience includes several years on municipal work-design and construction of sewers, steel and concrete bridges, watermains and pavements. Available at once. Apply to Box No. 950-W.

CIVIL ENGINEER, B.Sc. (Univ. of Sask. '33), S.E.I.C., age 28, single. Experience in testing hydro-electric equipment, draughting, surveying, city street, improvements, technical photography. Available at once. Location immaterial. Apply to Box No. 986-W.

ELECTRICAL ENGINEER, S.E.I.C., B.Sc., (N.S. Tech. Coll., '33), desires work. Experience in transmission line construction. Location or class of work immaterial. Apply to Box No. 1010-W.

ENGINEER SUPERINTENDENT, age 44. Engineering and business training, executive ability, tactful, energetic. Had charge of several large projects. Intimate knowledge of costs and prices, reports and estimates. Available immediately. Any location. Apply to Box No. 1021-W.

CIVIL ENGINEER, B.Sc. (Queen's 14), A.M.E.I.C., Dominion Land Surveyor, 5 months' special course at the University of London, England, in municipal hygiene and reinforced concrete construction. Experience covers legal and topographic surveys, plane tabling and stadia surveying, railway and highway construction, drainage and excavation work. Available at once. Apply Box No. 1035-W.

ELECTRICAL ENGINEER AND GEOPHYSICIST. Age 36. Married. Seven years experience in geophysical exploration using seismic, magnetic and electrical methods. Two years experience with the Western Electric Company of Chicago, working on equipment and magnetic materials research. Experienced in radio and telephone work, also specializing in precise electrical measurements, resistance determinations, ground potentials and similar problems of ground current distribution. Apply to Box No. 1063-W.

ELECTRICAL ENGINEER, B.A.Sc. Univ. Toronto '28. Experience includes Can. Gen. Elec. Co. Test Course. Also more than two years in the engineering dept. of the same company. Available on short notice. Preferred location central or eastern Canada. Apply to Box No. 1075-W.

ELECTRICAL ENGINEER, B.Sc. Married. Eight years electrical experience, including operation, maintenance and construction work, electrical design work on large power development, mechanical ability, experienced photographer, employed in electrical capacity at present. Available on reasonable notice. Apply to Box No. 1076-W.

GRADUATE IN MECHANICAL ENGINEERING, 1927, desires opportunity in Diesel engine field, preferably in design and development work. Skilled draughtsman and clever in design. Familiar with basic theories of the Diesel engine and in touch with recent developments and applications. Anxious to obtain a foothold with up-to-date company. No objection to shopwork or other duties as a start but would prefer shopwork and assembly if possible. Apply to Box No. 1081-W.

CIVIL ENGINEER, age 27, graduate 1930, single. Experience includes detailing, designing and estimating structural steel, plate work and pressure vessels; also hydrographic surveying. Available at once. Apply to Box No. 1111-W.

ELECTRICAL ENGINEER, B.Sc., in E.E. (Univ. of N.B. '34), S.E.I.C. Experience in bridge and road construction and auto repairing, desires position in industrial or power plant. Any locality. References on request. Apply to Box No. 1114-W.

CIVIL ENGINEER, B.Sc. Sask. '30. S.E.I.C. Age 24 years. Experience in municipal engineering, including sewer and water construction, sidewalk construction, paving, storm sewer design, draughting, precise levelling, and reinforced concrete bridge construction. Unmarried. Available at once. Will go anywhere. Apply to Box No. 1115-W.

ELECTRICAL ENGINEER, B.Sc.E.E. (Univ. of N.B. '31). C.G.E. Test Course included industrial control, induction motors and transformers; the transformer test included desk work for two months on computing losses, efficiencies, etc. Available at once. Apply to Box No. 1119-W.

MECHANICAL ENGINEER, B.A.Sc. (Univ. of B.C.), M.S. (Univ. of Pittsburgh). Canadian. Age 26. Single. One year graduate student course, W.E. and M. Co., East Pittsburgh. Three and a half years engineering research in mechanics with the same company. Location immaterial. Available at once. Apply to Box No. 1123-W.

GEODETIC AND TOPOGRAPHICAL ENGINEER, D.L.S., M.E.I.C. Experience in all kinds of geodetic and topographical surveys, especially photo-topography, well versed in all kinds of air photo surveys; Canadian and U.S. patent method of determining position and elevations of points from air photographs. Available at once anywhere in Canada or the United States. Apply to Box No. 1127-W.

PETROLEUM CHEMIST, B.Sc. in Chem. Eng. Age 25, Single. One and a half years experience as assistant chemist. Capable of taking charge in small refinery. Wishes position anywhere in Canada. Apply to Box No. 1130-W.

ELECTRICAL ENGINEER. B.Sc., Queen's '33. Single, age 23. Anxious to gain experience. Present experience installing small private hydro-electric plant. Location immaterial. Available at once. Apply to Box No. 1137-W.

CIVIL ENGINEER, A.M.E.I.C., with over twenty years experience in field and office on construction, maintenance, surveying, location, etc., desires position preferably of a permanent nature. At present near Montreal, but willing to locate anywhere. Apply to Box No. 1168-W.

CIVIL ENGINEER, B.A.Sc., S.E.I.C., age 26, single. Experience includes one year in bridge construction, plain and reinforced concrete, pneumatic caissons and surveying. Available at once. Any location. Apply to Box No. 1204-W.

PHYSICIST ENGINEER, B.Sc.Mech. (Queen's 1913), M.Sc., Ph.D.Physics (McGill 1929, '30). Experience in municipal engineering, producer gas installation and operation, university plant maintenance. Experienced teacher of college physics. Industrial and pure physical research experience. Age 42. Married Apply to Box No 1207-W.

## For Sale

ONE ZEISS 11 level with telescopic tripod. Compact, three screw, internal focussing, with gradienter-controlled buddle viewed from eyepiece end. Offered at $100.00, (roughly half present market price new). Apply to Box No. 20-S.

## Wanted to Purchase

COMPASS. Good second hand surveyors compass required. Suitable for use on surveys in connection with timber leases. One with four inch needle preferred. Apply to Box P-23.

# Purchasers' Classified Directory

*A Selected List of Equipment, Apparatus and Supplies*

For Alphabetical List of Advertisers see page 26.

A

**Acids:**
Canadian Industries Limited.
**Aerial Survey:**
Canadian Airways Ltd.
**Ammeters and Voltmeters:**
Bepco Canada Ltd.
Crompton Parkinson (Canada) Ltd.
**Angles, Steel:**
Bethlehem Steel Export Corp.
**Ash Handling Equipment:**
Babcock-Wilcox & Goldie McCulloch Ltd.
Combustion Engineering Corp. Ltd.
**Asphalt:**
Barrett Co. Ltd.
**Axles, Steel, Forged:**
Dominion Foundries & Steel Ltd.
Dominion Steel & Coal Corpn. Ltd.

B

**Ball Mills:**
Dominion Engineering Works Limited.
Wm. Kennedy & Sons Ltd.
Foster Wheeler Ltd.
Wm. Hamilton Div. Canadian Vickers Ltd.
**Balls, Steel and Bronze:**
Can. S.K.F. Co. Ltd.
Wm. Kennedy & Sons Ltd.
**Barking Drums:**
Canadian Ingersoll-Rand Company, Limited.
**Bars, Steel and Iron:**
Bethlehem Steel Export Corp.
Dominion Foundries & Steel Ltd.
Dominion Steel & Coal Corpn. Ltd.
**Bearings, Ball and Roller:**
Can. S.K.F. Co. Ltd.
**Billets, Blooms, Slabs:**
Bethlehem Steel Export Corp.
Dominion Foundries & Steel Ltd.
**Bins:**
Canada Cement Co. Ltd.
**Blasting Materials:**
Canadian Industries Limited.
**Blowers, Centrifugal:**
Can. Ingersoll-Rand Co. Ltd.
B. F. Sturtevant Co. of Can. Ltd.
**Blue Print Machinery:**
Montreal Blue Print Co.
**Boilers:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Canadian Vickers Ltd.
Combustion Engineering Corp. Ltd.
Foster Wheeler Limited.
E. Leonard & Sons Ltd.
Vulcan Iron Wks. Ltd.
**Boilers, Electric:**
Can. General Electric Co. Ltd.
Dominion Engineering Works Limited.
Northern Electric Co. Ltd.
**Boilers, Portable:**
Foster Wheeler Ltd.
E. Leonard & Sons Ltd.
**Boxes, Cable Junction:**
Northern Electric Co. Ltd.
**Braces, Cross Arm, Steel, Plain or Galvanized:**
Northern Electric Co. Ltd.
**Brackets, Ball Bearing:**
Can. S.K.F. Co. Ltd.
**Brakes, Air:**
Can. General Elec. Co. Ltd.
**Brakes, Magnetic Clutch:**
Northern Electric Co. Ltd.
**Bridge-Meggers:**
Northern Electric Co. Ltd.
**Bridges:**
Canada Cement Co. Ltd.
Canadian Vickers Ltd.
Dominion Bridge Co. Ltd.
**Bucket Elevators:**
Jeffrey Mfg. Co. Ltd.
**Buildings, Steel:**
Dominion Bridge Co. Ltd.

C

**Cables, Copper and Galvanized:**
Northern Electric Co. Ltd.
**Cables, Electric, Bare and Insulated:**
Can. Westinghouse Co. Ltd.
Can. General Electric Co. Ltd.
Northern Electric Co. Ltd.
**Caissons, Barges:**
Dominion Bridge Co. Ltd.
**Cameras:**
Associated Screen News Ltd.
**Capacitors:**
Bepco Canada Ltd.
Can. Westinghouse Co. Ltd.
Lancashire Dynamo & Crypto Co. of Can. Ltd.
**Castings, Brass:**
The Superheater Co. Ltd.
**Castings, Iron:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Dominion Engineering Works.
Foster Wheeler Ltd.
Wm. Kennedy & Sons Ltd.
E. Leonard & Sons Ltd.
The Superheater Co. Ltd.
Vulcan Iron Wks. Ltd.
**Castings, Alloy Steel:**
Dominion Foundries & Steel Ltd.
**Castings, Steel:**
Dominion Foundries & Steel Ltd
Wm. Kennedy & Sons Ltd.
Vulcan Iron Wks. Ltd.
**Catenary Materials:**
Can. Ohio Brass Co. Ltd.
**Cement Manufacturers:**
Canada Cement Co. Ltd.
**Chains, Silent and Roller:**
Hamilton Gear & Machine Co.
Jeffrey Mfg. Co. Ltd
**Channels:**
Bethlehem Steel Export Corp.
**Chemicals:**
Canadian Industries Limited.
**Chemists:**
Milton Hersey Co. Ltd.
Roast Laboratories Reg'd.
**Chippers, Pneumatic:**
Canadian Ingersoll-Rand Company, Limited.
**Choke Coils:**
Ferranti Electric Co.
**Circuit Breakers:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.
**Clarifiers, Filter:**
Bepco Canada Ltd.
Crompton Parkinson (Canada) Ltd.
**Clutches, Ball Bearing Friction:**
Can. S.K.F. Co. Ltd.
**Clutches, Magnetic**
Northern Electric Co. Ltd.
**Coal Handling Equipment:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Combustion Engineering Corp. Ltd.
**Combustion Control Equipment:**
Bailey Meter Co. Ltd.
**Compressors, Air and Gas:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Canadian Ingersoll-Rand Company, Limited.
**Concrete:**
Canada Cement Co. Ltd.
**Condensers, Steam:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Canadian Ingersoll-Rand Company, Limited.
Foster Wheeler Limited.
**Condensers, Synchronous and Static:**
Bepco Canada Ltd.
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Crompton Parkinson (Canada) Ltd.
Harland Eng. Co. of Can. Ltd.
Lancashire Dynamo & Crypto Co. of Can. Ltd.
Northern Electric Co. Ltd.
Bruce Peebles (Canada) Ltd.
**Conditioning Systems, Air:**
B. F. Sturtevant Co. of Can. Ltd.
**Conduit:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co Ltd.
**Conduit, Underground Fibre, and Underfloor Duct:**
Northern Electric Co. Ltd.
**Controllers, Electric:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.
**Couplings:**
Dart Union Co. Ltd.
Dresser Mfg Co. Ltd.
**Couplings, Flexible:**
Dominion Engineering Works Limited
Dresser Mfg. Co. Ltd.
**Couplings, Flexible:**
Wm. Hamilton Div. Canadian Vickers Ltd.
Hamilton Gear & Machine Co.
Wm. Kennedy & Sons Ltd.
**Cranes, Hand and Power:**
Dominion Bridge Co.
**Cranes, Locomotive:**
Dominion Hoist & Shovel Co. Ltd.
**Cranes, Shovel, Gasoline Crawler, Pillar:**
Canadian Vickers Ltd.
Dominion Hoist & Shovel Co. Ltd.
**Crowbars:**
B. J. Coghlin Co. Ltd.
**Crushers, Coal and Stone:**
Canadian Ingersoll-Rand Company, Limited.
Jeffrey Mfg. Co. Ltd.
Wm. Kennedy & Sons Ltd.

D

**Dimmers:**
Northern Electric Co. Ltd.
**Disposal Plants, Sewage:**
W. J. Westaway Co. Ltd.
**Ditchers:**
Dominion Hoist & Shovel Co. Ltd.
**Drills, Pneumatic:**
Canadian Ingersoll-Rand Company, Limited.
**Dynamite:**
Canadian Industries Limited.

E

**Economizers, Fuel:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Combustion Engineering Corp. Ltd.
Foster Wheeler Limited.
B. F. Sturtevant Co. of Can. Ltd.
**Elbows:**
Dart Union Co. Ltd.
**Electric Blasting Caps:**
Canadian Industries Limited.
**Electric Railway Car Couplers:**
Can. Ohio Brass Co. Ltd.
**Electrical Repair Work:**
Montreal Armature Works.
**Electrical Supplies:**
Can. General Elec. Co. Ltd.
Can. Ohio Brass Co Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.
**Electrification Materials, Steam Road:**
Can. Ohio Brass Co. Ltd.
**Engines, Diesel and Semi-Diesel:**
Canadian Ingersoll-Rand Company, Limited.
Harland Eng. Co. of Can. Ltd.
Waterous Limited
**Engines, Gas and Oil:**
Canadian Ingersoll-Rand Company, Limited.
Waterous Limited
**Engines, Steam:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Canadian Vickers Ltd.
Harland Eng. Co. of Can. Ltd.
E Leonard & Sons Ltd.
Waterous Limited
**Evaporators:**
Foster Wheeler Limited.
**Expansion Joints:**
Foster Wheeler Limited.
**Explosives:**
Canadian Industries Limited.

F

**Feed Water Heaters, Locomotive:**
The Superheater Co. Ltd.
**Filtration Plants, Water:**
W. J. Westaway Co. Ltd.
**Finishes:**
Canadian Industries Limited.
**Fire Alarm Apparatus:**
Northern Electric Co. Ltd.
**Floodlights:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.
**Floor Stands:**
Jenkins Bros. Ltd.
**Floors:**
Canada Cement Co. Ltd.
**Forcite:**
Canadian Industries Limited
**Forgings:**
Bethlehem Steel Export Corp.
Dominion Steel & Coal Corpn Ltd
**Foundations:**
Canada Cement Co. Ltd.

G

**Gaskets, Asbestos, Fibrous, Metallic, Rubber:**
The Garlock Packing Co. of Can. Ltd.
**Gasoline Recovery Systems:**
Foster Wheeler Limited.
**Gates, Hydraulic Regulating:**
Canadian Vickers Ltd.
Dominion Bridge Co. Ltd.
**Gauges, Draft:**
Bailey Meter Co. Ltd.
Bristol Co. of Can. Ltd.
**Gear Reductions:**
Hamilton Gear & Machine Co.
**Gears:**
Dominion Bridge Co. Ltd.
Dominion Engineering Works Limited.
Hamilton Gear & Machine Co.
Wm. Kennedy & Sons Ltd.
**Generators:**
Bepco Canada Ltd.
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Crompton Parkinson (Canada) Ltd.
Harland Eng. Co. of Can. Ltd.
Lancashire Dynamo & Crypto Co. of Can. Ltd.
Northern Electric Co. Ltd.
Bruce Peebles (Canada) Ltd.
**Governors, Pump:**
Bailey Meter Co. Ltd.
**Governors, Turbine:**
Dominion Engineering Works Limited.
**Gratings, M. & M. Safety:**
Dominion Bridge Co. Ltd.

H

**Hangers, Ball and Roller Bearing:**
Can. S.K.F. Co. Ltd.
**Headlights, Electric Railway:**
Can. General Elec. Co. Ltd.
Can. Ohio Brass Co. Ltd.
Can. Westinghouse Co. Ltd.
**Heat Exchange Equipment:**
Foster Wheeler Limited.
**Heating Systems:**
C. A. Dunham Co. Ltd.
**Hoists, Air, Steam and Electric:**
Canadian Ingersoll-Rand Company, Limited.
Dominion Hoist & Shovel Co. Ltd.
Wm. Hamilton Div. Canadian Vickers Ltd.
**Humidifying Equipment:**
W. J. Westaway Co. Ltd.

I

**Indicator Posts:**
Jenkins Bros. Ltd.
**Industrial Electric Control:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.
**Injectors, Locomotive, Exhaust Steam:**
The Superheater Co. Ltd.
**Inspection of Materials:**
J. T. Donald & Co. Ltd.
Milton Hersey Co. Ltd.
**Instruments, Electric:**
Bepco Canada Ltd.
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Crompton Parkinson (Canada) Ltd.
Ferranti Electric Ltd.
Moloney Electric Co. of Canada, Ltd.
Northern Electric Co. Ltd.
**Insulating Materials:**
Canadian Industries Limited.
**Insulators, Porcelain:**
Can. Ohio Brass Co. Ltd.
Northern Electric Co. Ltd.
**Intercoolers:**
Foster Wheeler Limited.

J

**Journal Bearings and Boxes, Railway:**
Can. S.K.F. Co. Ltd.

L

**Lacquers:**
Canadian Industries Limited.
**Lantern Slides:**
Associated Screen News Ltd.
**Leading Wire:**
Canadian Industries Limited.

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FAIRBANKS-MORSE men are trained to analyse transmission problems and to recommend the most suitable belt, pulley, shafting, bearing or hanger for any drive. And they will accept undivided responsibility for every installation. At our Branches you will find large stocks of all necessary equipment including such proven leaders as Flex-Mor V-Belt Drives, Graton & Knight Leather Belting, Dick's Balata Belting, Hyatt Roller Bearings, Barry Steel Pulleys, Fairbanks Wood Pulleys, Shafting, Hangers, Pillow Blocks and general supplies.

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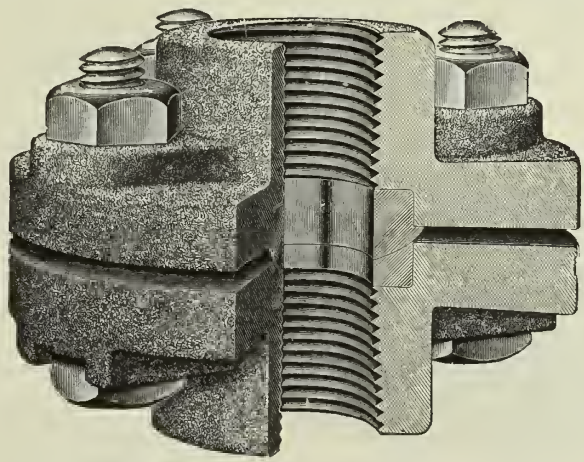
**Bronze to Bronze**



**Ground Ball Joint**

**Made In Canada**

**Sold By Jobbers**

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*The "Most Service Value" In Flange Unions On The Market*

## Purchasers' Classified Directory

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Associated Screen News Ltd.
**Lighting Equipment, Industrial and Street:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.
**Lightning Arresters:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Ferranti Electric Ltd.
Northern Electric Co. Ltd.
**Line Materials:**
Can. Ohio Brass Co. Ltd.
Northern Electric Co. Ltd.
**Locomotives, Electric:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.

**M**

**Machinery, Hydraulic:**
Dominion Engineering Works Limited.
**Machinery, Metal and Wood-Working:**
Dominion Engineering Works Limited.
**Magnetic Separators:**
Northern Electric Co. Ltd.
**Material Handling Equipment:**
Jeffrey Mfg. Co. Ltd.
**Metallurgists:**
Roast Laboratories Reg'd.
**Meters, Boiler, and Coal:**
Bailey Meter Co. Ltd.
**Meters, Electric:**
Bristol Co. of Can. Ltd.
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Ferranti Electric Ltd.
Northern Electric Co. Ltd.
**Meters, Flow:**
Bailey Meter Co. Ltd.
Neptune-National Meters Ltd.
**Meters, Liquid (Hot or Cold):**
Bailey Meter Co. Ltd.
Neptune-National Meters Ltd
**Mine Cars:**
Canadian Vickers Ltd.
**Mining Machinery:**
Canadian Ingersoll-Rand Company, Limited.
Canadian Vickers Ltd.
Dominion Engineering Works Limited.
**Motion Pictures:**
Associated Screen News Ltd.
**Motors, Electric:**
Bepco Canada Ltd.
The Can. Fairbanks-Morse Co. Ltd.
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Crompton Parkinson (Canada) Ltd.
Harland Eng. Co. of Can. Ltd.
Lancashire Dynamo & Crypto Co. of Can. Ltd.
Northern Electric Co. Ltd.
Bruce Peebles (Canada) Ltd.
**Moulded Goods, Rubber and Asbestos:**
The Garlock Packing Co. of Can. Ltd.

**O**

**Oil Burning Equipment:**
Bethlehem Steel Export Corp.
**Oil Refining Equipment:**
Foster Wheeler Limited.
**Ornamental Iron:**
Vulcan Iron Wks. Ltd.

**P**

**Packings, Asbestos, Cotton and Flax, Metal, Rubber:**
The Garlock Packing Co. of Can. Ltd.
**Paints, all purposes:**
Canadian Industries Limited.
**Paving Materials:**
Barrett Co. Ltd
**Penstocks:**
Canadian Vickers Ltd.
**Phase Rotation Indicators:**
Ferranti Electric Ltd.
**Photographs, Commercial and Portrait:**
Associated Screen News Ltd.
**Piling, Steel Sheet:**
Bethlehem Steel Export Corp.
**Pillow Blocks, Plain, Ball and Roller Bearing:**
Can. S.K.F. Co. Ltd.
**Pinions:**
Hamilton Gear & Machine Co.
**Pipe, Wood Stave:**
Canadian Wood Pipe & Tanks Ltd.
**Pipe Coils:**
The Superheater Co. Ltd.
**Pipe Couplings and Nipples:**
Dart Union Co. Ltd.
**Plates, Steel:**
Bethlehem Steel Export Corp
Dominion Foundries & Steel Ltd.
**Pneumatic Tools:**
Canadian Ingersoll-Rand Company Ltd.
**Pole Line Hardware:**
Can. Ohio Brass Co. Ltd.
Northern Electric Co. Ltd.
**Polishes:**
Canadian Industries Limited.
**Powder, Black and Sporting:**
Canadian Industries Limited.
**Power Switchboards:**
Bepco Canada Ltd.
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Crompton Parkinson (Canada) Ltd.
Harland Eng. Co. of Can. Ltd.
Northern Electric Co. Ltd.
**Preheaters, Air:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Combustion Engineering Corp.
Foster Wheeler Limited.
**Projectors:**
Associated Screen News Ltd.
**Pulleys:**
Plessisville Foundry.
**Pulleys, Ball Bearings, Loose:**
Can S.K.F. Co. Ltd.
**Pulp and Paper Mill Machinery:**
Can. General Elec. Co. Ltd.
Canadian Ingersoll-Rand Company, Limited
Can. Westinghouse Co. Ltd
Dominion Engineering Works Limited.
Wm. Hamilton Div. Canadian Vickers Ltd.
Harland Eng. Co. of Can. Ltd.
**Pulverized Fuel Systems:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Bethlehem Steel Export Corpn.
Combustion Engineering Corp. Ltd.
Foster Wheeler Limited.
Wm. Kennedy & Sons Ltd.
**Pump Valves, Rubber:**
The Garlock Packing Co. of Can. Ltd.
**Pumps:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Canadian Ingersoll-Rand Company, Limited.
Foster Wheeler Limited.
Wm. Hamilton Div. Canadian Vickers Ltd.
Harland Eng. Co. of Can. Ltd.
Waterous Limited
**Purifiers, Water:**
W. J. Westaway Co. Ltd.

**R**

**Radiator Air Vents and Traps:**
Jenkins Bros. Ltd.
**Radiator Valves:**
Can. Ohio Brass Co. Ltd.
Jenkins Bros. Ltd.
**Radio Receiving Sets:**
Can. General Elec. Co. Ltd
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.
**Radio Transformers:**
Ferranti Electric Ltd.
**Rail Bonds:**
Can. Ohio Brass Co. Ltd
U.S. Steel Products Co.
**Rail Braces and Joints:**
B. J. Coghlin Co.
**Railway Equipment:**
Can. General Elec. Co. Ltd.
Canadian Ingersoll-Rand Company, Limited.
Can. Ohio Brass Co. Ltd.
**Receivers, Air:**
Canadian Ingersoll-Rand Com- Limited.
E. Leonard & Sons Ltd.
**Recorders**
Bailey Meter Co. Ltd.
Bristol Co of Can. Ltd.
**Refrigerating Machinery:**
Canadian Ingersoll-Rand Company, Limited.
**Regulators, Feed Water:**
Bailey Meter Co. Ltd.
**Reservoirs:**
Canada Cement Co. Ltd.

# Purchasers' Classified Directory

**Riveted Pipe:**
Dominion Bridge Co. Ltd.
**Roads:**
Canada Cement Co. Ltd.
**Road Machinery:**
Plessisville Foundry.
**Rods:**
Bethlehem Steel Export Corp.
**Rolls, Paper Machine:**
Dominion Engineering Works Limited.
**Roofing, Prepared:**
The Barrett Co. Ltd.
**Roofs, Built-up:**
The Barrett Co. Ltd.
**Rope, Wire:**
Dom. Wire Rope Co. Ltd.

S

**Screening Equipment:**
Canadian, Ingersoll-Rand Company, Limited.
Foster Wheeler Ltd.
**Separators, Electric:**
Northern Electric Co. Ltd.
**Sewers:**
Canada Cement Co. Ltd.
**Shingles, Prepared Asphalt:**
The Barrett Co. Ltd.
**Shovels — Powered Electric or Gasoline:**
Canadian Vickers Ltd.
**Smokestacks:**
Canada Cement Co. Ltd.
Canadian Vickers Ltd.
Foster Wheeler Ltd.
E. Leonard & Sons Ltd.
**Softeners, Water:**
W. J. Westaway Co. Ltd.
**Sporting Powder:**
Canadian Industries Limited.
**Springs — Automobile, Railway, Wire:**
B. J. Coghlin Co. Ltd.
**Stains:**
Canadian Industries Limited.
**Steam Plant Equipment:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Combustion Engineering Corp. Ltd.
Foster Wheeler Limited.
Harland Eng. Co. of Can. Ltd.
**Steel Plate Construction:**
Canadian Vickers Ltd.
Dominion Bridge Co. Ltd.
Foster Wheeler Ltd.
E. Leonard & Sons Ltd.
**Stokers:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Combustion Engineering Corp. Ltd.
**Structural Iron and Steel:**
Canadian Vickers Ltd.
Dominion Bridge Co. Ltd
Vulcan Iron Works Ltd.
**Superheaters:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Foster Wheeler Limited.
The Superheater Co. Ltd.
**Surge Absorbers:**
Ferranti Electric Ltd.
**Switchboards, Power Lighting:**
Bepco Canada Ltd.
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Crompton Parkinson (Canada) Ltd.
Harland Eng. Co. of Can. Ltd.
Northern Electric Co. Ltd.

T

**Tanks:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Braithwaite & Co. Engineers Ltd.
Canada Cement Co. Ltd.
Canadian Vickers Ldt.
Dominion Bridge Co. Ltd.
Foster Wheeler Ltd.
E. Leonard & Sons Ltd.
Vulcan Iron Wks. Ltd.
**Tanks, Wood:**
Canadian Wood Pipe & Tanks Ltd.
**Tees:**
Dart Union Co. Ltd.
**Telegraph Line Material:**
Northern Electric Co. Ltd.
**Testing Sets:**
Moloney Electric Co. of Can., Ltd.
**Thermometers, Recording:**
Bailey Meter Co. Ltd.
Bristol Co. of Can. Ltd.
**Tiles:**
Canada Cement Co. Ltd.
**Tinplate:**
Bethlehem Steel Export Corp.
**Towers, Cooling, Fractionating:**
Foster Wheeler Limited.
**Track Tools:**
B. J. Coghlin Co. Ltd.
**Transformers, Instrument, Testing, Distribution:**
Bepco Canada Ltd.
Ferranti Electric Ltd.
Moloney Electric Co. of Can., Ltd.
**Transformers, Lighting and Power:**
Bepco Canada Ltd.
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Crompton Parkinson (Canada) Ltd.
Ferranti Electric Ltd.
Moloney Electric Co. of Can., Ltd.
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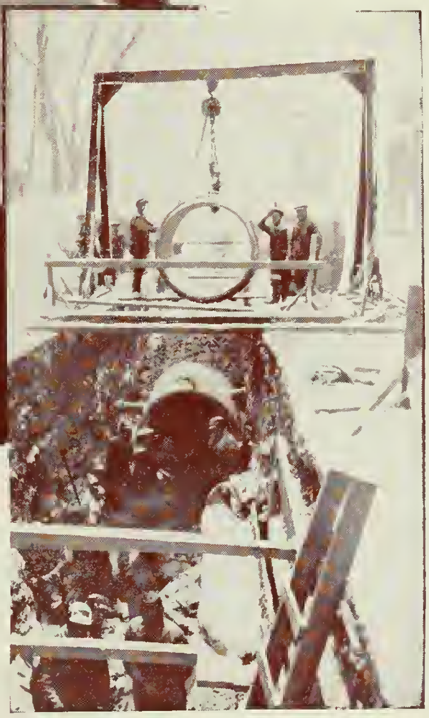
## INDEX TO ADVERTISERS

Top: — Manufacturing Concrete Pipe.
At right: — Laying Concrete Pipe.

# Longueuil Sewer
## is a notable example of
### ALL-CANADIAN RELIEF-WORK



Winter, the season when relief work is needed most, presents no serious handicap to carefully planned concrete sewer construction.

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Hillaire Dubuc, Chairman Public Works Commission.
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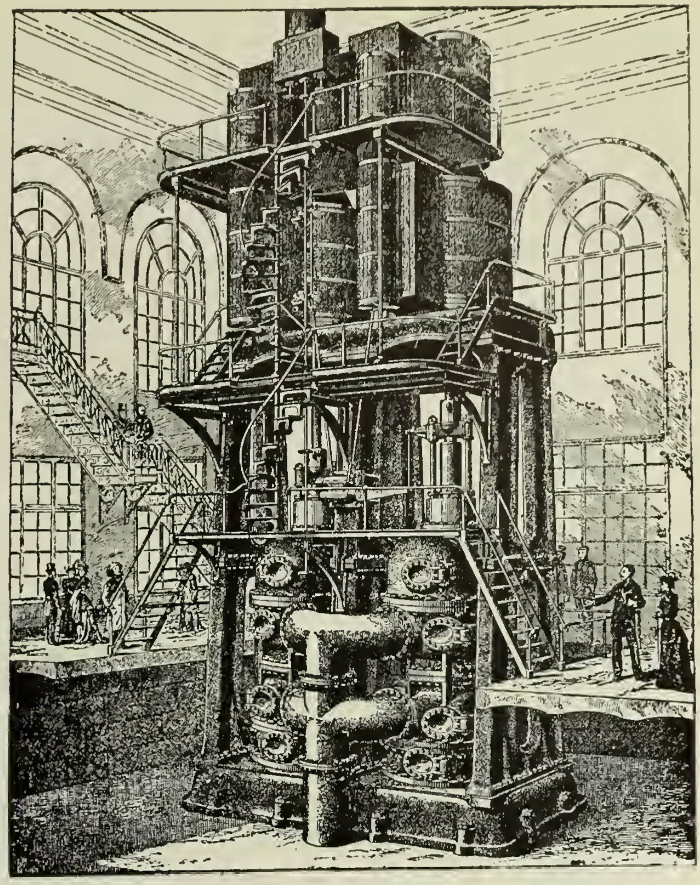

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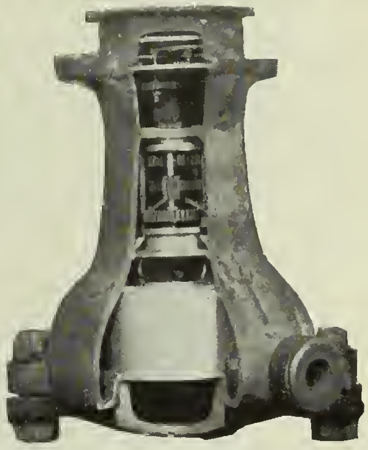

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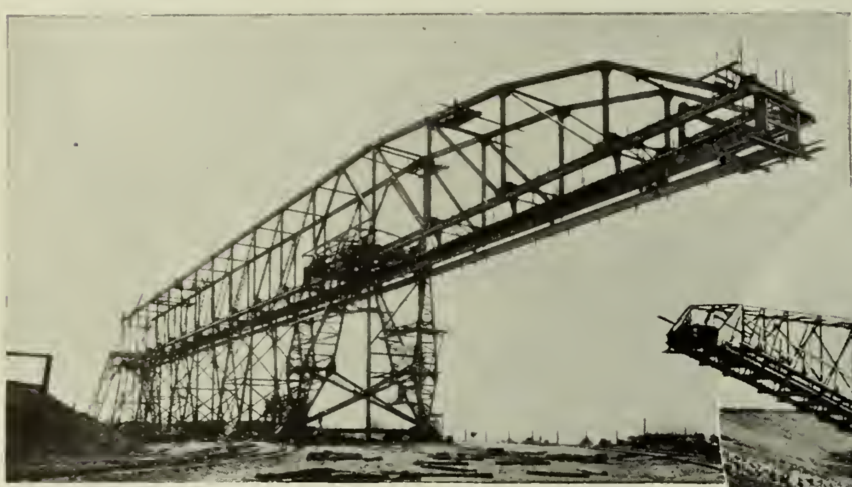

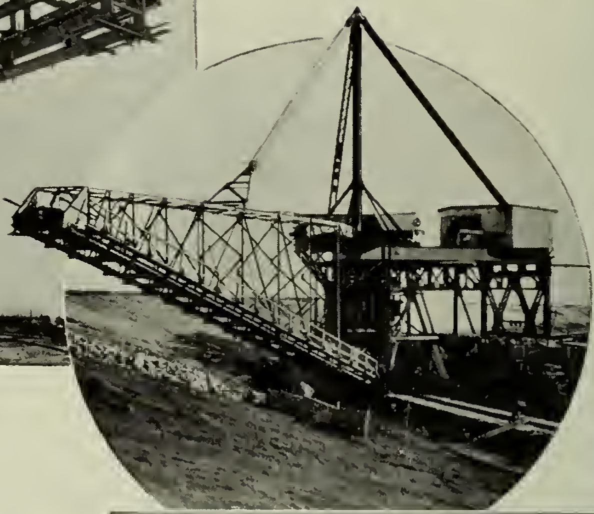



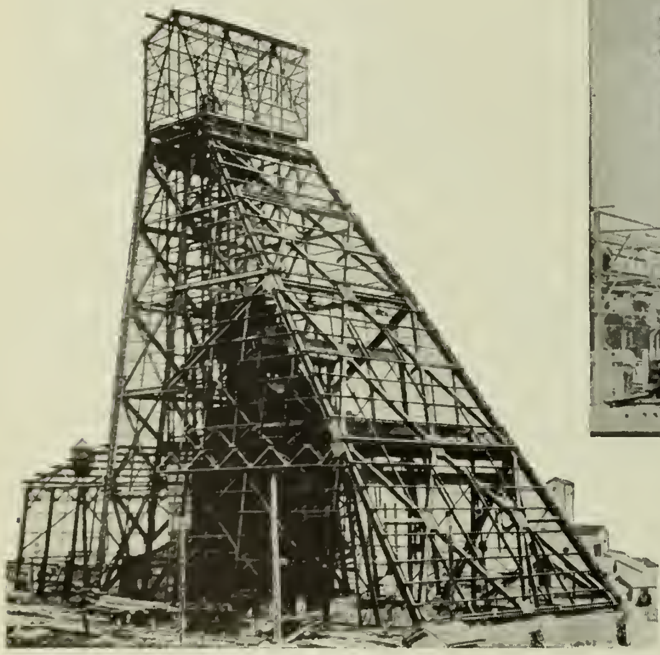

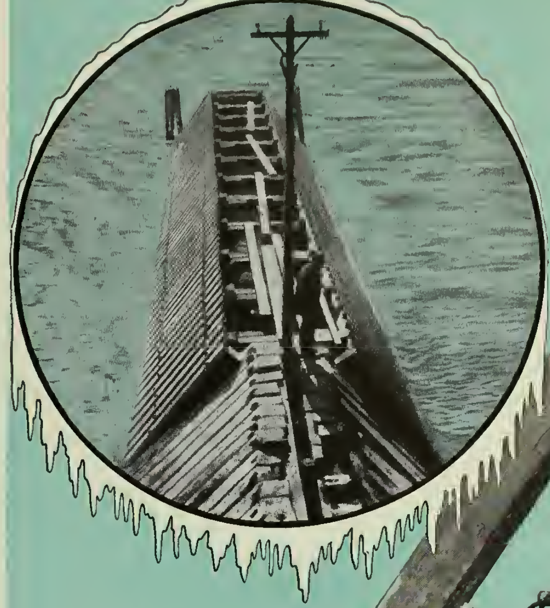




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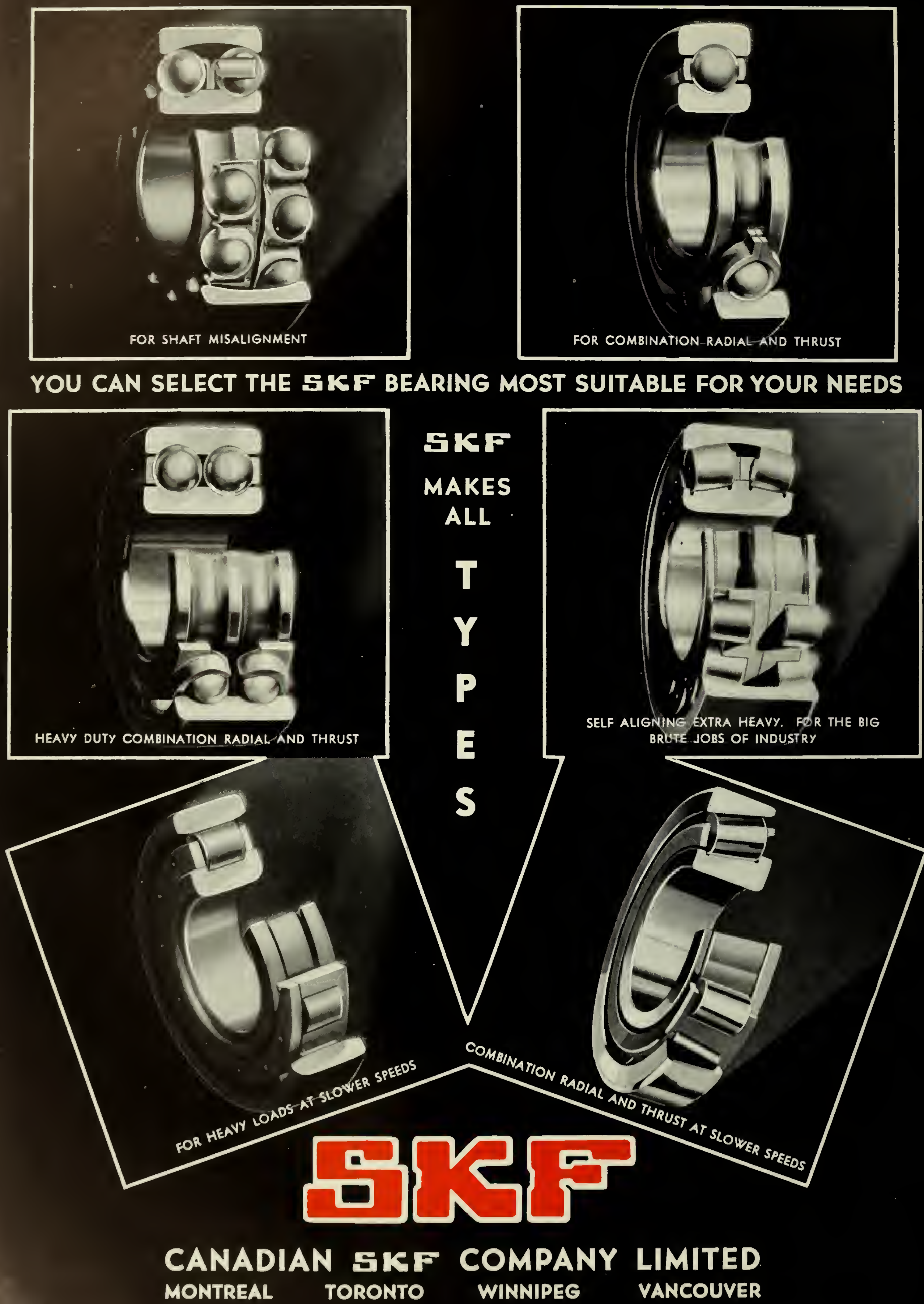
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**November 1934** **Volume XVII, No. 11**

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# The Columbia River in Canada

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**Paper presented before the Western Professional Meeting of The Engineering Institute of Canada, July 11th to 14th, 1934, at Vancouver, B.C.**

SUMMARY.—Beginning with a summary of the early history of the Pacific coast, the author describes the Columbia river and its drainage area north of the international boundary. He describes the facilities for navigation, the irrigation problems, questions of dyking and drainage, power development and water storage possibilities on the Canadian side of the border.

As a supplement to the paper, abstracts are given of three papers by American engineers dealing with the projects in the United States for power, navigation and reclamation at Grand Coulee and the Columbia Basin north of the Snake river and those for power and navigation below its mouth.

The portions of the Columbia river and its tributaries that lie north of the international boundary are relatively of much less importance than those to the south. It may be as well, therefore, to devote some considerable part of this paper to the historical and international viewpoints.

With the exception of the Skagit river and one or two negligible streams near the coast, the Columbia and its tributaries are the only streams which cross the international boundary west of the continental divide. The Flathead, the Kootenay, the Pend d'Oreille or Clark's Fork, the Kettle, the Okanagan, the Similkameen, are all parts of the great Columbia system. (See Fig. 1.)

The uses and development of the river constitute the main international water problem on the west coast. Fortunately, there are few phases of the question which are likely to be contentious, but if the early history of the Pacific coast had been different, the situation might have been quite otherwise.

Perhaps the most magnificent gift in recorded history was that of Pope Alexander VI to the Court of Spain, when he gave to His Catholic Majesty the Pacific Ocean and lands bordering thereon. This was in 1493. The title so acquired by Spain was strengthened by a vigorous policy of exploration, settlement and spoliation. Although Queen Elizabeth of England had expressed her disregard of the exclusive Spanish right, the first serious challenge came from the Russians, who, attracted by the fur trade, had come down from the north and set up several establishments in the Aleutian Islands. The Spaniards investigated the Russian activities and remonstrated with the Russian government, but apparently decided to limit their claims to the coast south of latitude 54–40.

In 1776 Captain Cook set out from England by way of the Cape of Good Hope to locate the western end of the long-sought Northwest Passage. At Plymouth he anchored beside three ships of the Royal Navy which were awaiting favourable weather to set out with the last division of Hessian troops which took part in the war of the American Revolution. Cook was strictly enjoined not to interfere with Spanish ships or settlements on the Pacific coast. Cook's ships returned to England with stories of the great wealth of furs on the coast and of the possibilities of trade in these commodities with China. Within a few years adventurers from England and the eastern coast of the newly-formed United States of America were actively engaged in the new trade and were having their troubles with the Spaniards. The difficulties became so serious that England and Spain began to mass their fleets and to rally their allies in preparation for war. An open breach was avoided by the Nootka Sound Convention by which in 1792 Spain recognized the British right to trade and settle on those parts of the coast not already occupied. This convention recognized the parallel of 54–40 as the southern limit of Russian territory.

The Americans began to move westward and in 1811 Astor's company, the Pacific Fur Company, established a post at Astoria at the mouth of the Columbia. Spain's hold was weakening. She was having her troubles in Europe and was no longer in a position to force her claim so far west. The more bleak and sparsely populated shores of the North Pacific did not furnish the rich harvest of loot she had gathered in the south, and in 1819 by the Florida Treaty she relinquished her claims to territory north of the 42nd parallel. This left the United States and Great Britain as the only claimants on the coast between latitudes 42 and 54–40.

Great Britain had never occupied or been interested in the sections south of the Columbia river and the dispute narrowed down to the ownership of the coast from the mouth of that river to the Russian boundary. In 1818 the 49th parallel had been adopted as the boundary from the Lake of the Woods to the Stoney mountains, but there the agreement stopped. Clauses of old treaties, discoveries, occupation and settlement were all drawn into the argument, which was settled for the time being by a convention like that of Nootka Sound to the effect that the country with its harbours, bays and creeks and the navigation of the rivers should be free and open to the subjects of both powers for a term of ten years. In 1827 this was extended indefinitely, being terminable on twelve months' notice by either party.

The dispute continued until 1846, at times being forgotten and at times forming the main topic of discussion in the American Congress and to a lesser extent in the British House of Commons. The British proposed an extension of the 49th parallel to the Columbia and the

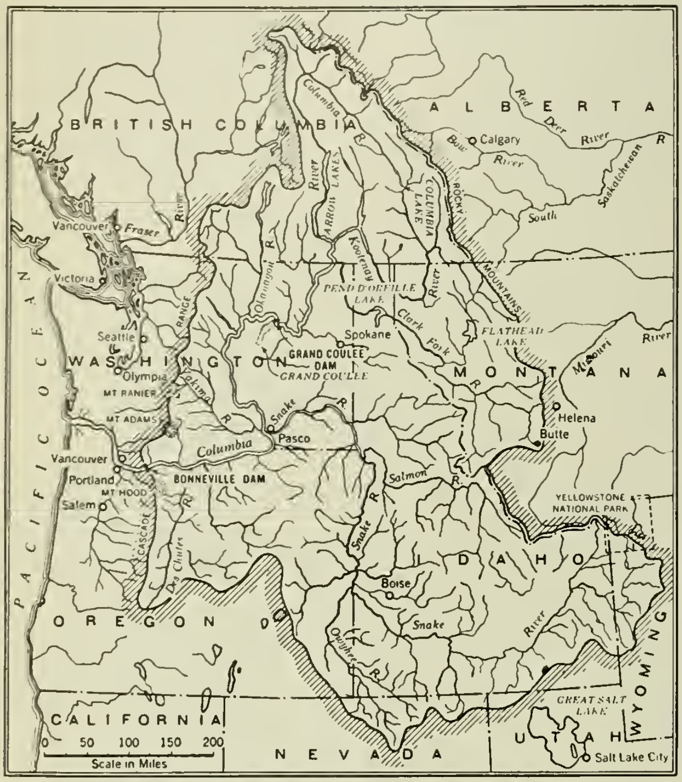



**Fig. 1—Columbia River Basin.**

centre of that river to the coast as the dividing line. The Americans stood out for the whole country to 54–40.

As time went on American settlement increased in what is now the State of Washington, and British settlement on the south end of Vancouver Island grew in size and importance. Public feeling in the United States, excited by the slogan of the politicians "54–40 or Fight!" became more intense. The British ships on the coast offered to settle the question in their way. But for some years the saner heads on both sides had been tending toward the extension of the 49th parallel with a deviation around the southern end of Vancouver Island. In 1846 one proposed it, the other at once accepted it, and the question was settled.

It must be remembered that during all this discussion California was in the hands of the Spaniards. There was not one good harbour between Spanish territory and Puget Sound. The British never seriously viewed the country as a settlement project—it was too remote, and the part of it they knew too rugged to interest them. They wanted an outlet on the Pacific and the nearer to China the better.

Had the Americans had access to the port of San Francisco and the British a true appreciation of the great wealth of the land, the Columbia river might have been the boundary between the two nations, and a real problem would have resulted—another St. Lawrence river problem. But fortunately negotiation and its attendant ill-feeling are past, and the present problem is one of co-operation to secure the maximum benefits to the people of both countries.

Description of the River System

The watershed of the Columbia and its tributaries in British Columbia comprises just over 40,000 square miles and lies entirely within the North American cordillera between the 49th and 53rd parallels of latitude. A cross section of the country gives one an appreciation of its general character. (Fig. 2.)

Only about 15 square miles in the entire area lie under the 1,000-foot contour. Narrow valleys among the mountain peaks contain the only land suitable for human habitation. Roughly 8,000 square miles lie between 1,000-foot and 4,000-foot contours, and only about 310 square miles or 200,000 acres are suitable for cultivation. The population of the watershed is seventy-eight thousand, of whom approximately half are engaged in agriculture and half in mining with some few in lumbering. The precipitation varies from 65 inches in the summits of the Selkirks to under 20 inches in the valleys. The valleys and adjacent benches are fertile, and, where irrigation water is available, very productive.

The climate is temperate, except for short distances up the Okanagan and Similkameen rivers, where subtropical flora and fauna are found.

The area is estimated to have thirteen billion, eight hundred million feet of accessible merchantable timber. Of this from 250 to 300 million feet are cut in a normal year, giving employment to about two thousand men. Up to the present transportation difficulties have prevented the manufacture of pulp and paper.

Mining has been the main industry in the area. Many of the tributary streams carry placer gold and have been worked spasmodically since 1863. Large deposits of high-grade coal occur in the Crow's Nest Pass and at Princeton and Coalmont, and have been mined continuously for many years. The recent general slump in the coal mining industry has had its effect in these localities. Lode gold mining began seriously in the late 80's and has been stimulated recently by the increased price of that metal. The whole area is highly mineralized and large deposits of copper, lead and zinc which carry good value in silver and gold occur in many places.

The main stream of the Columbia has its source in Columbia lake, which lies at an elevation of 2,650 feet in the great trough between the Rocky and Selkirk mountains just north of the 50th degree of latitude. The mountains on either side of the narrow valley rise to a height of 11,000 feet. At its source the river drains the east slope of the Selkirks, the drainage from the Rockies being cut off by its tributary, the Kootenay. The river flows in a north-westerly direction on an easy grade through the beautiful Windermere lake to Golden just north of the

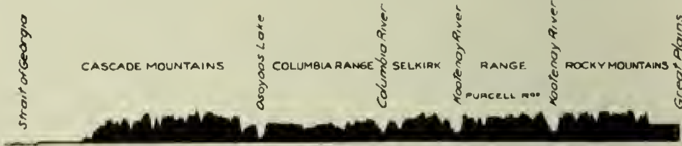



**Fig. 2—Cross Section of the Cordillera at the 49th Parallel.**

51st degree. Here its moderate flow is increased by that of the Spillimacheen river from the Selkirks and the Kicking Horse, which brings in the first of the Rocky Mountain drainage. The character of the stream changes. It flows through a series of canyons and rapids unbroken save for a short stretch through Kinbasket lake. At Boat Encampment just north of the 52nd parallel, it is joined by the Canoe river from the north and turns abruptly south between the Selkirks and the Monashee ranges. It continues its turbulent course through a narrow valley with mountain rising over the 10,000-foot level on each side.

to Revelstoke. Between Golden and Revelstoke the river drops 1,130 feet in 180 miles. Here the profile flattens out. It falls only 40 feet in the next 30 miles, and in flood spreads itself over what might otherwise be a fertile valley. At Arrowhead it widens and deepens into the Arrow lakes, which extend with a minor restriction to Castlegar, about 25 miles north of the boundary. Here it is joined by the Kootenay. It picks up speed and drops 70 feet in 28 miles, being joined almost at the boundary by the Pend d'Oreille or Clark's Fork.

As would be expected from the character of the country drained, the Columbia is a very flashy stream, having its major discharge when the hot suns of the summer solstice attack the everlasting snow and ice of the glaciers, and its minimum flow during the late winter when the mountain tops are frozen and the effect of the stored ground water generally exhausted. The lakes of the main system have very little regulatory effect. Columbia and Windermere lakes are too small and too near the source to be of any value. Arrow lake is 110 miles long, but very narrow, being not much more than a widening and deepening of the river. The natural storage is almost negligible. The river at Golden has a maximum recorded flow of 23,700 cubic feet a second (June 25, 1916) and a minimum of 502 cubic feet a second (January 2, 1926). At the international boundary the maximum recorded flow is 451,000 cubic feet a second and the lowest since records have been kept was approximately 17,500 cubic feet a second. The phenomenal run-off of 1894, before any records were established, greatly exceeded the maximum given above, probably to the extent of fifty per cent.

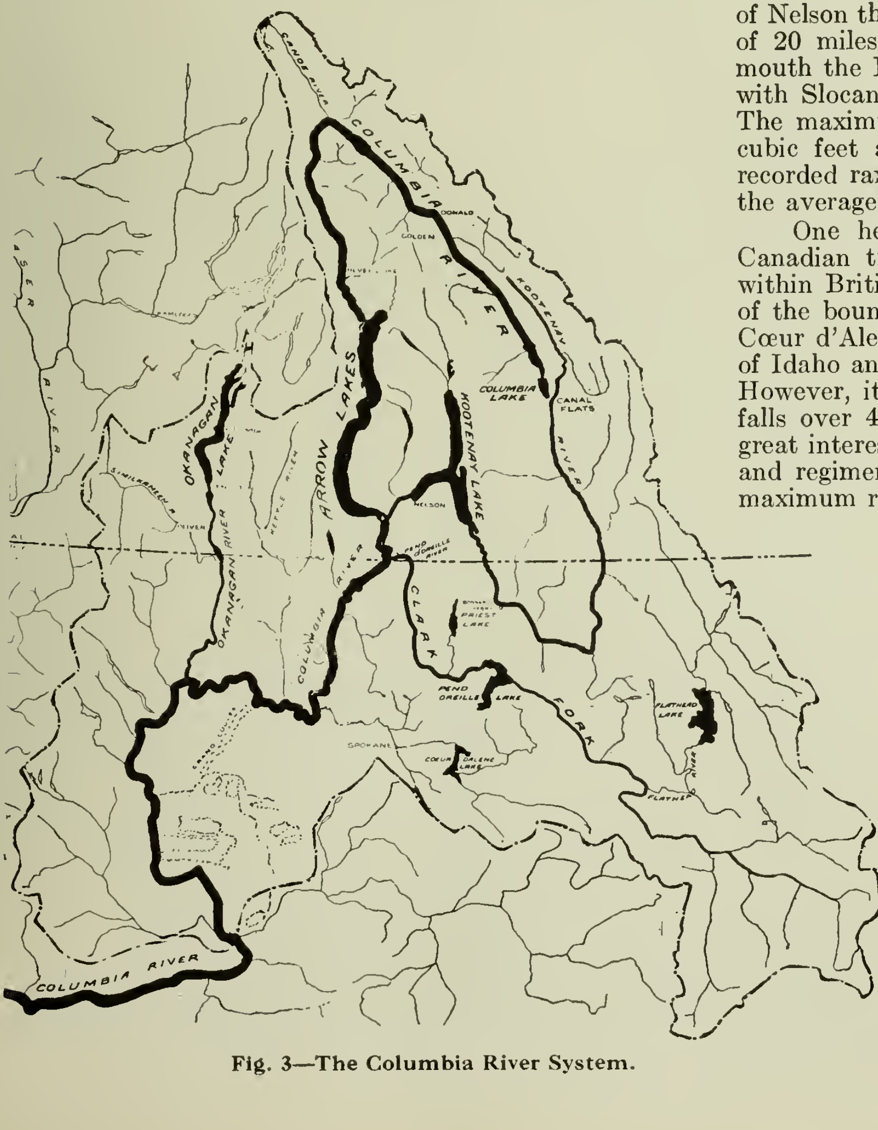



Fig. 3—The Columbia River System.

The main Canadian tributary of the Columbia, the Kootenay, has its source in a small lake on the west slope of the Rockies about the 51st parallel of latitude. This lake is only 8 miles from the main Columbia at Castledale. A considerable tributary, the Vermilion, heads some 15 miles further north. The Kootenay flows parallel to but in a reverse direction to the Columbia for some 60 miles and approaches within 2 miles of Columbia lake at Canal Flats. At this point it is about 11 feet in elevation above Columbia lake and could be easily diverted into the main river. The Kootenay flows in a southerly direction with a fairly constant grade of 3½ feet to the mile. It picks up St. Mary's river from the west and the Bull and Elk rivers from the east, and enters the state of Montana at Gateway. It continues south to Jennings, then turns northwest to Bonners Ferry in Idaho. Here the river flattens out and at low water flows in a tortuous and sluggish channel which twists back and forth across a fertile alluvial valley about 4 miles wide. At high water it overflows its banks and, except where confined by dykes, floods the entire valley. Then it re-crosses the international boundary at Porthill and enters Kootenay lake. This last stretch of the river offers an extremely interesting reclamation problem, which will be referred to later.

Kootenay lake is 65 miles long and varies from 4 miles in width at the south end to 2 miles at the north and occupies a deep trench in the heart of the Selkirk mountains. The lake is fed at the north end by Lardeau and Duncan rivers, which with their lakes, collect the drainage of the interior of the Selkirks.

Midway on the west side Kootenay lake thrusts a narrow arm into the mountains and just below the city of Nelson the river begins a drop of 360 feet in the distance of 20 miles to the Columbia. About 10 miles from its mouth the Kootenay is joined by the Slocan river, which, with Slocan lake, drains another section of the Selkirks. The maximum recorded flow of the Kootenay is 146,000 cubic feet a second; the minimum 2,400. The extreme recorded range in level of Kootenay lake is 24.8 feet and the average annual fluctuation is about 17 feet.

One hesitates to describe the Pend d'Oreille as a Canadian tributary, for though it enters the Columbia within British Columbia about a quarter of a mile north of the boundary it collects its water in the Flathead and Cœur d'Alene mountains of Montana and the Bitterroots of Idaho and its flow is regulated by lakes in those states. However, it flows for 14 miles in Canadian territory and falls over 400 feet in that length. It is consequently of great interest because of its power potentialities. Its flow and regimen are similar to those of the Kootenay. The maximum recorded is 139,000 cubic feet a second and the minimum 2,500 cubic feet a second.

The tributaries to the west of the Columbia are all of minor importance. The Kettle rises in the Columbia range and flows south to the international boundary at Midway. At Midway it turns east and crosses and recrosses the boundary to Cascade, where it turns south and joins the main river at Marcus. One of the early power developments in the boundary country was situated on this river at Cascade. In recent years, due perhaps to extensive logging in the watershed, the flow of the Kettle has become very flashy and the power plant has been abandoned.

Okanagan river rises in Okanagan lake and its course in Canada is about 35 miles long with very little fall. It joins the Columbia at Brewster.

The Similkameen rises on the north slope of the Cascades and is a flashy stream with a maximum flow of 23,700 cubic feet a second and a minimum of 760 cubic feet a second. It joins the Okanagan at Oroville, where it is used for irrigation on the American side of the line.

### Navigation

The Columbia river with its tributaries and lakes formed an important transportation system in the early development of the Kootenay country. Prior to 1885 placer miners and occasional prospectors found their way into the district from the coast over the Dewdney trail or along the lakes and rivers from the south. In 1885 the main line of the Canadian Pacific Railway was finished, touching the navigable parts of the Columbia system at Golden and Revelstoke. The possibility of transporting machinery, and ore and concentrates of the base metals brought into life the lode mining which has been the main activity of the district.

Palatial steamers of the type so well-known on the Mississippi plied the waters of Kootenay, Arrow, Slocan and Okanagan lakes. Small shallow-draught boats worked their arduous passages up and down the river stretches carrying machinery and supplies to the mines, and high-grade ore and concentrates to the smelters. The Kootenay river was navigable by such small craft from Jennings, Montana, to Canal Flats, British Columbia, the Columbia from Canal Flats to Golden, from Downie creek to Northport.

During the 90's short lines of railway were built along the shores of the faster waters from Nelson to Robson, from Revelstoke to Arrowhead, from Kuskanook to Porthill, and the smaller craft disappeared.

The larger boats continued to do business until in 1916 the Kettle Valley Railway was carried over the mountain tops to the coast, cutting the time from Vancouver to Nelson by ten hours. The Crow's Nest Pass branch of the Canadian Pacific Railway had been built to Kootenay Landing at the south end of the Kootenay lake in 1900, and after 1915 a stern-wheeler maintained a daily service for passengers and express between Nelson and Kootenay Landing on this branch transcontinental line. Freight was carried across the gap on car barges. In January, 1931, railway construction along the shore of the lake was completed, and the steamer service ceased.

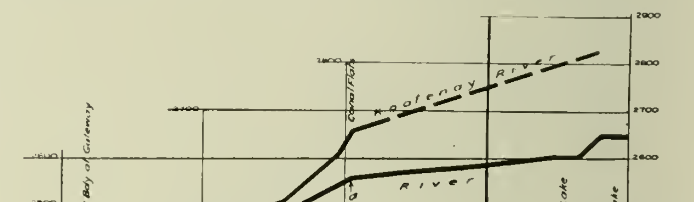
On Okanagan lake, before the completion of the Kettle Valley, a branch line from Sicamous to Okanagan Landing and the boats on the lake served the whole valley and the adjacent country. The Kettle Valley cut heavily into the traffic, but in the fruit season the boats still carried capacity loads. In 1925 the Canadian National Railway built through to Kelowna, and since then the improvement in the roads and the ferry service crossing the lake have induced a heavy motor and truck traffic. The boat still runs, but more as a concession to local public sentiment than as a utility.

Automobile ferries operate across Okanagan lake at Kelowna, across the Columbia at Sidmouth, Castlegar and Edgewater and across the Kootenay at Nelson, Harrop and Balfour, and car barges on the lakes still serve isolated local points, but navigation on the Columbia system in Canada is done, unless some major economic change revives it. The remaining steamer services are temporary links in the railway and highway systems.

This history further demonstrates the axiom that water transportation on a small scale cannot compete with railways and has even less chance against the new agencies that are now threatening the reign of the locomotive.

### Irrigation

The irrigation problem in the Columbia unfortunately cannot be as easily dismissed as the navigation. A large percentage of the land irrigated in British Columbia lies in the Columbia basin and although the acreage is small relative to the states to the south, the problems are just as acute.



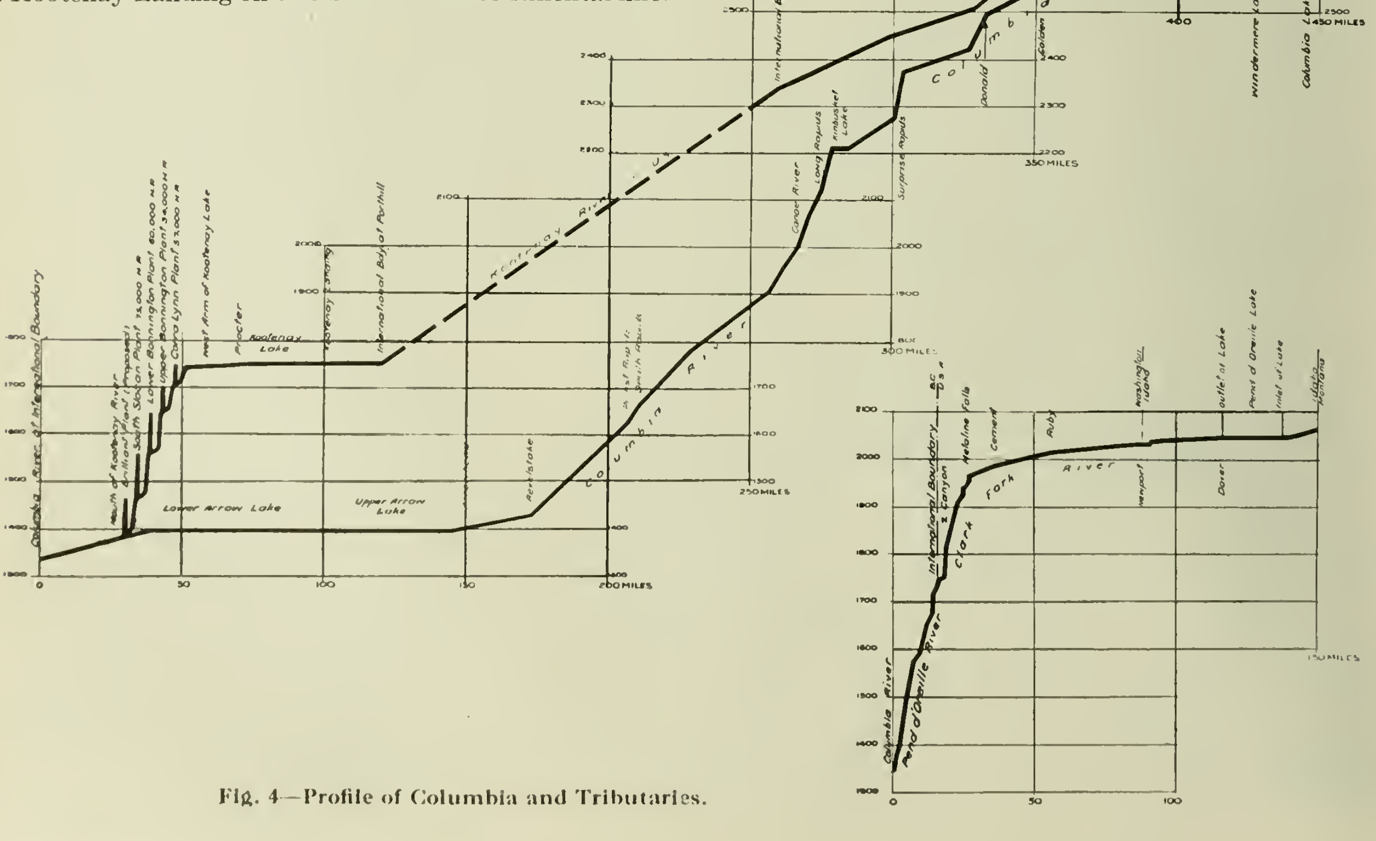



Fig. 4—Profile of Columbia and Tributaries.

Organized irrigation as a means of stimulating land sales began in the interior of British Columbia about 1900. Some of the early promoters received prompt and handsome dividends, and as a consequence by 1910 some fifteen to twenty companies were selling irrigated land in the dry belt. Although attempts were made to induce colonization, the number of incoming settlers was entirely inadequate, and the companies found themselves in difficulties.

About 1914 the water-users began to realize that the companies could not be relied on for the replacement of the perishable portions of the works and that there was grave danger that the supply to their lands and orchards, which were then becoming valuable, would cease. They approached the government for some assurance of protection or assistance. In 1918 the situation became so acute that the government created a special conservation fund to finance necessary repairs and reconstruction. In 1920 legislative provisions were made for the organization of irrigation districts and thereafter the necessary funds were loaned to these districts. The districts took over the systems formerly operated by the companies, compensation, if any, being arranged for by negotiation.

The funds necessary for the acquisition and reconstruction of the systems were advanced by the provincial government. No bonds or other form of security were demanded, but the moneys loaned were made a direct charge against the lands within the district. Six per cent interest was charged and repayment was required on terms depending on the probable life of the irrigation structures built by the district. The regulations required that all moneys needed for interest and repayment of borrowings for capital expenditure should be collected as a special district tax on the land and provided that any portion of the remaining requirements of the district, such as for operation and maintenance, might at the option of the local authorities be collected as a tax or as a toll or charge on the water delivered.

Considerable latitude was allowed to the district authorities, but in general taxes were levied only on the land that could be benefited by the use of irrigation water, and were applied irrespective of whether or not the land was actually cultivated. The method of collecting tolls varied, but they generally applied only on the land actually cultivated and producing. In some cases, a higher toll was charged for water delivered after the natural run-off had passed and the storage reservoirs were opened.

The relative functions of the district and the individual users were quite definitely laid down, and generally, the districts carried water to the boundary of each individually-owned parcel. In larger holdings water was delivered to several points within their boundaries.

The first payments from the districts were demanded in 1921 and were promptly met. The payments due in 1922 were met before it was recognized that there was a serious collapse in the market for agricultural produce. As a result of the importunities of the growers, the government declared a two-year moratorium on irrigation loans and thus the problem definitely entered the political field. This moratorium was continued for a further two years and since that time the problem has never left the doorstep of the parliament buildings.

It is now quite evident that the estimates of assessable land made at the time of organization of the districts were too optimistic and that a considerable portion of the land included can not survive if required to pay its portion of the total indebtedness. The land lies above the natural storage basins and the water is taken from mountain tributaries and carried relatively long distances along the mountain sides to reach the arable benches. The natural flow of these tributary streams fades out early in the season necessitating the creation of storage at high elevations. The capital cost of the developments is consequently high, in some cases approaching $150.00 per acre. Only intensive cultivation and high-priced crops, such as fruit and truck, can pay the resultant costs, and unfortunately only a part of the land is suitable for such produce. The seasons are relatively late and the various varieties of fruit reach the market too late to bring the best prices. The marketing problem is even bigger than the irrigation and is apparently far from a successful solution.

There is only one government owned and operated irrigation project in the province. This is in the Okanagan valley just north of the international boundary and was started in 1919 in response to a post-war demand for employment and for land for soldier settlers. To date only about 30 per cent of the land has been taken up and there have been several adjustments of prices and terms of payment with the settlers demanding further concessions.

### Dyking and Drainage

British Columbia has a dyking problem as well, but so far it is associated with the Columbia river in only a small way. The main dyking areas in the province lie in the lower valley of the Fraser. As mentioned earlier, the Kootenay river, before it enters the main lake, flows for some 45 miles through an alluvial valley which is annually flooded at high water. This land on the Idaho side of the boundary has nearly all been successfully reclaimed.

About 1890, a promoter proposed to reclaim the whole Kootenay flat by diverting the upper reaches of the Kootenay river into Columbia lake. He even secured approval and a concession from the provincial government. Luckily the scheme was blocked and the proposed diversion channel converted into a navigation canal. This work was completed about the time navigation on the upper reaches of the Kootenay ceased and one boat was passed through the locks and the canal was permanently closed.

An attempt was made to dyke some 7,000 acres adjacent to the international boundary, but the 1894 floods wiped out most of the work almost before it was completed and attempts to restore these dykes since have met with indifferent success.

About eight years ago a group of residents of Creston secured a provisional grant of 10,000 acres of the flats to be reclaimed near that town. This brought forward an interesting international angle. Under the "Boundary Waters' Treaty" of 1912 between the United States and Canada, it was agreed that except in cases provided for in special agreement, they would not permit the construction or maintenance on their respective sides of the boundary of any remedial or protective works or dams or other obstructions... in waters at a lower level than the boundary in rivers flowing across the boundary, the effect of which was to raise the natural level of the waters on the other side of the boundary, unless the construction or maintenance thereof was approved by the International Joint Commission. This provision applied to the proposed reclamation on the Canadian side but not to that on the American side, therefore the Canadians had to secure permission from the Commission before such work could be undertaken. The Commission has quite naturally recognized that what has already been done on one side should be permitted on the other, and has given unconditional approval to the two applications which have been made.

### Power

On the Canadian side the main interest in the Columbia river lies in its power potentialities. Plants with an installed capacity of 259,000 h.p. are at present in operation on the river and its tributaries. According to our present information, the system is capable of providing a total of 803,400 continuous and 1,348,000 seasonal horsepower.

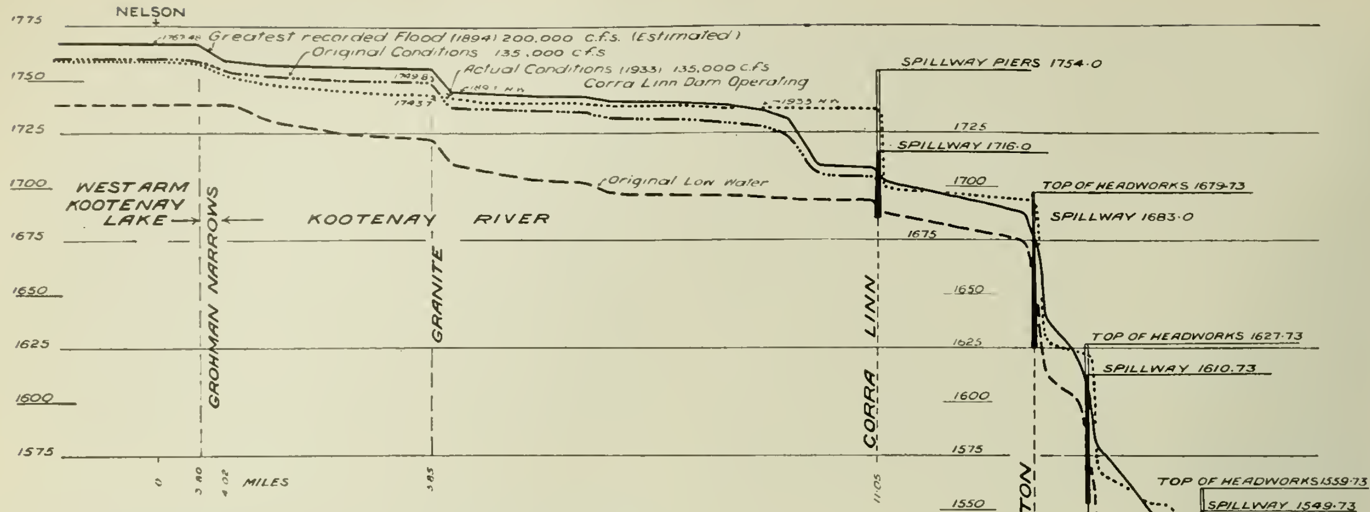
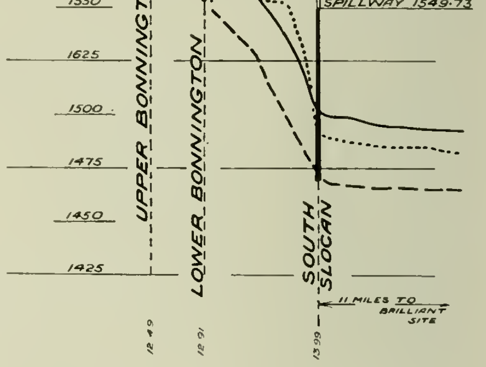




**Fig. 5—Profile showing Location of Power Plants on the Kootenay River.**

The tributaries west of the main river are all of minor importance and their uniform gradients and flashy flows make development of appreciable size very improbable. A plant of 1,600 h.p. on the Similkameen supplies the mines at Hedley, one of 660 h.p. on Granby creek supplies the city of Grand Forks, and one of 100 h.p. on Trepanier creek supplies the town of Peachland. As this tributary area is within reach of the transmission lines of the West Kootenay Power and Light Company, it is unlikely that any further development will take place.

Along the Columbia proper a plant of 1,400 h.p. on the Illecillewaet river supplies the city of Revelstoke and one of 150 h.p. on Nakusp creek supplies the town of Nakusp. Throughout the length of the river similar small plants could be installed on the tributaries to serve any local needs. The main river between Golden and Revelstoke drops over 1,100 feet in 180 miles. This stretch is estimated to be capable of producing 104,000 continuous and 246,000 seasonal horsepower, but nothing has been attempted.

The Kootenay, like the parent stream, has on its tributaries many possible small developments to supply local needs. The larger possibilities of the river have been quite intensively developed. The East Kootenay Power and Light Company has a 15,000-h.p. plant on the Elk river and one of 7,200 h.p. on the Bull. These developments in conjunction with a steam plant at Coleman just across the provincial boundary in Alberta, supply the mines in the Crow's Nest Pass and at Kimberley, the cities of Cranbrook and Fernie and the adjacent territory. The West Kootenay Power and Light Company has a development of 1,050 h.p. on the Goat river to supply the town of Creston.

The main Kootenay above the lake has easy gradients and no power possibilities, but between the lake and the Columbia the river has a drop of 360 feet concentrated in a distance of 20 miles, on which there are completed developments of 232,000 h.p. and a projected further development of 90,000. With the exception of a 6,500-h.p. plant owned and operated by the city of Nelson, this stretch of the river is held under licence by the West Kootenay Power and Light Company, a public utility company which serves the entire boundary country to the west as far as Princeton and up the Okanagan valley to Kelowna. This company has four power plants in this stretch of the river:

| | | |
|---|---|---|
| No. 1 | at Lower Bonnington with an installed capacity of | 60,000 h.p. |
| 2 | Upper Bonnington " " " | 34,000 " |
| 3 | South Slocan " " " | 75,000 " |
| 4 | Corra Linn " " " | 57,000 " |

Each plant consists of three vertical units and there are four interchangeable transmission lines operating at 60,000 volts to Trail.

The development of the river offers an interesting example of careful conservation of head. The tailrace of each plant is practically the forebay of the next below. Obstructions to flow in the intervening stretches have been cleared away to the economic limit. In the three lower plants long spillways have been developed to hold down the levels of the tailraces above. Above the upper plant at Corra Linn some 900,000 yards of material were taken out of the river, giving a minimum cross section of 24,000 square feet, and completely removing all restrictions below Grohman rapids. The dam at this plant is a sluice-gate structure, having fourteen openings 34 feet wide, and is capable of passing the maximum flood in the river without affecting the levels above. With the exception of Upper Bonnington, which shares the stream-flow with the Nelson city installation, the plants are designed to use 10,000 cubic feet a second. The flow available on the average over twenty years of record may be observed in Table I.

Table I

| | | |
|---|---|---|
| Over 10,000 c.f.s. | for 250 | days in the year |
| " 9,000 " | " 267 | " " " |
| " 8,000 " | " 290 | " " " |
| " 7,000 " | " 311 | " " " |
| " 6,000 " | " 330 | " " " |
| " 5,000 " | " 360 | " " " |

The company has the right to install another plant at Brilliant near the mouth of the river and when this is built every available foot of head on the Canadian section of the main Kootenay will be developed.

As previously mentioned, the Pend d'Oreille has a fall of over 400 feet in 14 miles in Canadian territory. Over twenty-two years of record the river flowed on the average as noted in Table II.

TABLE II

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 11,000 | c.f.s. | for | 240 | days | of | the | year |
| 10,000 | " | " | 261 | " | " | " | " |
| 9,000 | " | " | 301 | " | " | " | " |
| 8,000 | " | " | 431 | " | " | " | " |
| 7,000 | " | " | 347 | " | " | " | " |
| 6,000 | " | " | 359 | " | " | " | " |
| 5,000 | " | " | 363 | " | " | " | " |

It is considered to be good for 210,000 continuous and 350,000 seasonal horsepower.

STORAGE

On a stream with as wide a fluctuation of flow as the Columbia river, the storage of flood water for the purpose of increasing the low-water flow is all important from the power standpoint. The maximum economic development of the stream is governed by a number of factors, the basic one of which is the minimum flow. Navigation as well is usually benefited by regulation.

The flow of the Columbia river, including the Kootenay river, at Trail, available on the average over eighteen years of record, may be observed from the following Table III.

TABLE III

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Over | 40,000 | c.f.s. | for | 186 | days | in | the | year |
| " | 40,000 | " | " | 217 | " | " | " | " |
| " | 30,000 | " | " | 240 | " | " | " | " |
| " | 25,000 | " | " | 274 | " | " | " | " |
| " | 20,000 | " | " | 298 | " | " | " | " |
| " | 17,500 | " | " | 324 | " | " | " | " |
| " | 15,000 | " | " | 351 | " | " | " | " |
| " | 12,500 | " | " | 364 | " | " | " | " |
| " | 10,000 | " | " | 365 | " | " | " | " |

The area of the lakes on the Columbia system in Canada is small compared to the total drainage area, and consequently complete regulation of flow is quite impossible, but sufficient storage can be economically developed to materially increase the power capacity of the river. It is in this connection that the greatest opportunity for international co-operation lies. It must be remembered that every cubic foot per second added to the dependable flow of the Columbia at the boundary means a cubic foot per second added to the dependable flow of each of the plants now operating, or that may be constructed, on the river south of the line, and each cubic foot per second added to the dependable flow of Clark's Fork at Metaline Falls means an additional cubic foot per second at the plant it is hoped to construct on the Pend d'Oreille, as well as at those on the lower Columbia.

The Arrow lakes on the main Columbia have an area of 155 square miles and a normal rise and fall of 20 feet. This gives a storage capacity of nearly 2,000,000 acre-feet between high and low water, which would have no very serious effect upon any adjacent property. On the basis of the lowest year of record, this would increase the minimum flow at the international boundary by 6,460 cubic feet a second. Unfortunately from the international aspect this storage is of no value on the Canadian side of the line and our legislation makes no provision for storage by other than our own nationals.

The regulating dam would be an interesting structure. It would of necessity be capable of passing the extreme flood in the river without any appreciable increase in the natural water level.

Kootenay lake has an area of 170 square miles and a normal rise and fall of about 18 feet, which would produce a storage of about 1,950,000 acre-feet. Unfortunately this range of elevation is not available as some 60,000 acres of arable land are below the high-water line.

The West Kootenay Company's power dam at Corra Linn could be operated to hold up the lake level to 6 feet above extreme low water. The company has applied to the International Joint Commission for permission to operate the dam for storage to that extent and estimates that the dependable flow of the river will be increased from under 5,000 to over 10,000 cubic feet a second. There would be as well an arithmetically similar increase in the flow of the Columbia.

The briefs presented to the Commission by and on behalf of the company and the objectors in Idaho constitute a very interesting and instructive engineering discussion.

Duncan and Trout lakes at the north end of Kootenay lake have an area of 10.5 and 11 square miles respectively. The normal range of elevation is not great and the storage compared with that of the larger lakes is of minor importance.

By an arrangement which has been in force since 1913, all hydrometric work in British Columbia is done by the Dominion Water Power and Hydrometric Bureau.

The government of British Columbia is initiating a series of snow surveys, on the Nevada system, and is establishing ranges at the headwaters of the Columbia and Kootenay. The area is not one that lends itself to accuracy of prediction from snow data, but it is hoped that within a few years seasonal records will be available which will be of material assistance in estimating total run-off.

The various parties interested in the river on the two sides of the line should make the most of every opportunity to become better acquainted, and it might be of advantage to get together in a semi-formal way for the specific purpose of promoting a co-operation that will be of advantage to both countries.

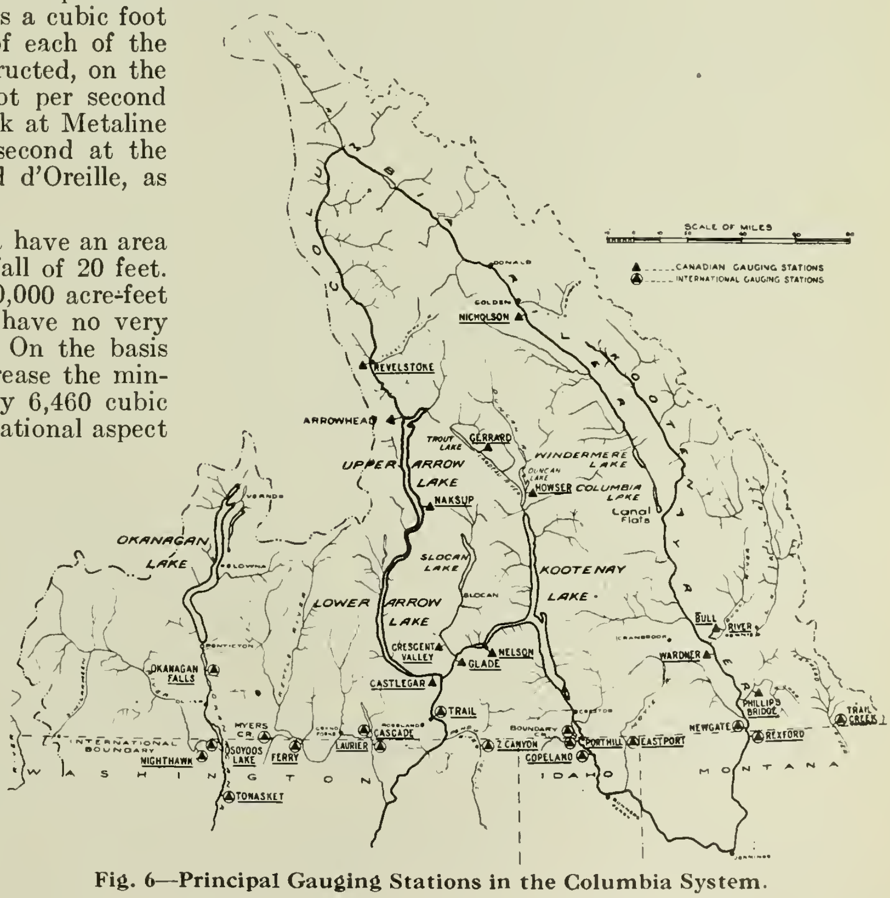



Fig. 6—Principal Gauging Stations in the Columbia System.

# DISCUSSION

C. E. Webb, M.E.I.C.[1]

All water problems concerning navigation, development of water power, irrigation possibilities and control of floods are dependent on basic stream flow data.

The Dominion Water Power and Hydrometric Bureau of the Department of the Interior maintains gauging stations on the principal lakes and rivers throughout Canada in co-operation with the different provinces, and under an agreement of 1930 between Canada and the United States, international gauging stations have been established to obtain basic data in connection with the utilization of waters flowing across the boundary line west of the Great Lakes.

By maintaining these international stations under the joint supervision of the United States Geological Survey and the Dominion Water Power and Hydrometric Bureau, the basic stream flow data developed therefrom are immediately acceptable to interests in either country.

As mentioned by the author, the Columbia drainage basin includes the majority of the international streams west of the Rocky Mountains, and gauging stations are maintained on them as indicated on Fig. 6. From east to west they may be noted as follows: Flathead river on Canadian side near Trail Creek, Montana; Kootenay river at Newgate, B.C., and Rexford, Montana, where the Kootenay flows south into the United States; Moyie river at Eastport; Kootenay river at Copeland and Porthill, Idaho, where the Kootenay flows north into British Columbia; Boundary creek near Porthill; Pend d'Oreille river at "Z" Canyon below Metaline Falls; Columbia river at Trail; Kettle river at Ferry, Washington, at Cascade, B.C., and at Lautier, Washington; Myers creek near Myncaster, B.C., Okanagan river at Okanagan Falls, B.C., at Osoyoos lake near Oroville and at Tonasket, Washington. A station is also maintained on the Similkameen river at Nighthawk. Aside from these seventeen international gauging stations, continuous records are being obtained on thirteen other stations in the Columbia basin, in co-operation with the province of British Columbia, the more important of which are the following:

In the upper reach Columbia river at Nicholson, 361 miles above the international boundary, at an elevation at low water of 2,560 feet; at Revelstoke above the Arrow lakes, 176 miles above the boundary, low water elevation 1,428 feet; at Arrowhead and Nakusp in the Arrow lakes, 145 and 115 miles respectively above the international boundary, low water elevation 1,380 feet, and at Castlegar below the Arrow lakes, 30 miles above the boundary, low water elevation 1,372 feet. On the Kootenay river stations are maintained at Wardner (elevation 2,600 feet), Nelson (elevation 1,740 feet) and Glade (elevation 1,455 feet), along with gauging stations as previously intimated on all minor tributary streams. Hydrometric records of these stations constitute the basis of hydraulic studies of the Columbia river in Canada.

It should be noted that discharge records in this area are available since 1913.

Extensive hydraulic studies have been carried out, both above and below Kootenay lake, in connection with the application now before the International Joint Commission, of the West Kootenay Power and Light Company, for permission to utilize their recently constructed dam at Corra Linn for storage of six feet on low water in Kootenay lake.

Some interesting international slope observations have recently been developed, in co-operation with the United States Geological Survey, on the Columbia river between Birchbank, B.C., and the Little Dalles, Washington, a distance of 37 miles, throughout two years range of stage. Additional slope studies have this year been extended to Revelstoke above the Arrow lakes. From a study of these records it would appear that backwater from the Little Dalles is reflected during high water for some distance above the international boundary line.

For several years bulletins have been issued each spring giving a rough synopsis of existing snow cover and anticipated runoff resulting therefrom, on the Columbia and Fraser river drainages, being the two major streams in the province. It is interesting to note the author's statement that the government of British Columbia is initiating a series of snow surveys at the headwaters of the Columbia and Kootenay rivers. These data will presently be of very material assistance in predicting runoff in that area.

With the close co-operation of the two railways and the provincial government, a very satisfactory flood warning service has been maintained on the Fraser river for a number of years past. This has developed to such an extent that it is now possible to predict closely the water elevations on the lower Fraser three to four days in advance. This same service could be developed on the Columbia river whereby the anticipated flow at the international boundary might be similarly predicted.

Every country where water power studies are being carried on has, up to the present time, used its own particular method for calculating potential water powers. In Canada all estimates by the Dominion Water Power and Hydrometric Bureau represent continuous twenty-four-hour power at 80 per cent efficiency and have been based on calculations for "Ordinary Minimum Flow" which is the average over all years for which records are available of the mean flow for the two lowest consecutive seven-day periods in each year, and "Ordinary Six-Month Flow" which is the average over all years for which records are available of the mean flow for the lowest seven consecutive days in the lowest of the six high months in each year.

The United States Geological Survey base their power computations on 70 per cent efficiency and results have been computed in horse power available 90 and 50 per cent of the time respectively.

These two methods, although different, give results that are quite comparable.

The World Power Conference in preparing statistics on power resources has decided to follow the same method for computations in every country. These statistics will include a write-up on water power sites, potential power resources, gross capacity of power sites computed for three different rates of flow, defined as follows by the International Electro-Technical Commission, 95 per cent of the time, 50 per cent of the time and arithmetical mean flow.

[1] District Chief Engineer, Dominion Water Power and Hydrometric Bureau, Department of the Interior, Vancouver, B.C.

# Abstract of Symposium on United States Aspect of the Columbia River Drainage Basin Project

**Taken from Papers read at the Annual Convention of the American Society of Civil Engineers at Vancouver, July 11th, 1934**

(See *Civil Engineering*, September, 1934.)

## POWER AND NAVIGATION BELOW THE SNAKE RIVER

*C. F. Williams,*

*Corps of Engineers, District Engineer, Portland, Ore.*

The distance from the Snake river to the mouth of the Columbia river is about 325 miles; the tidal section has a length of 145 miles and extends upstream to approximately the Bonneville dam site: the non-tidal portion, 180 miles in length, rises some 305 feet. (See Fig. 7.)

The combined watershed area at the mouth of the Snake river is 212,000 square miles. Below the mouth of the Snake, the combined additional tributary watershed is 47,000 square miles. The mean annual flow at Bonneville for the period 1878-1933 was 210,000 cubic feet per second. The lowest year produced about 60 per cent of the mean, and the highest 155 per cent. The maximum flood flow recorded at this point is 1,170,000 cubic feet per second, and the minimum 40,000 cubic feet per second.

At the mouth of the Columbia the tidal heights vary from a maximum of about 12 feet above to a minimum of about 2.5 feet below mean lower low water and the range averages about 8 feet. At Portland, Ore., little or no tidal range is noticeable when the river stage is about 10 feet. At low stages in the river the average range is about 2½ feet.

Two rubble mound jetties have been constructed at the mouth of the river. The south jetty, about 7 miles long, and the north jetty, about 2½ miles long, have their ends 2 miles apart and were completed in 1918 at a cost of about $14,000,000. These jetties have succeeded in providing and maintaining a depth of 45 feet over the ocean bar without the aid of dredging.

The present project provides for an inner channel 35 feet deep and 500 feet wide from the mouth of the Columbia to the mouth of the Willamette river, a distance of 99 miles and thence up the Willamette to Portland, about 14 miles; a channel 28 feet deep and 300 feet wide in the Columbia from the mouth of the Willamette to Vancouver, Wash., 4½ miles; and other auxiliary channels.

All initial dredging and dyke construction under the project were completed in 1933 at a total cost of about $4,900,000.

This artery of commerce averages 6,600,000 tons per annum in inter-coastal and foreign trade, and an equal tonnage, although of less value, moves between ports on the river.

The non-tidal section of the river is a series of pools and rapids. There are two principal rapids, the first extending from the Bonneville dam site to the head of the Cascade locks, where there is a fall of 35 feet in a distance of 4 miles, and the second extending from The Dalles to the head of Celilo Falls, where there is a fall of 82 feet in 11 miles.

Above The Dalles, where in many places the river is flowing on basalt, the selection of good foundations has not been particularly difficult. On the other hand, the location of a suitable foundation for a dam at or near tidewater has been a very difficult problem. Extensive borings have failed to locate bedrock at depths permissible for a dam foundation anywhere below Bonneville.

At The Dalles site, at the upper end of the Bonneville pool, foundation conditions would permit the construction of a dam of sufficient height to back the water up to the mouth of the Snake. However, considerations of economics, influenced greatly by flowage costs and carrying charges on one high dam, led to the selection of three dams for the complete canalization of this section of the river.

In its present state the non-tidal section of the Columbia is navigable at low water for boats of 5-foot draught to the mouth of the Snake river, although navigation

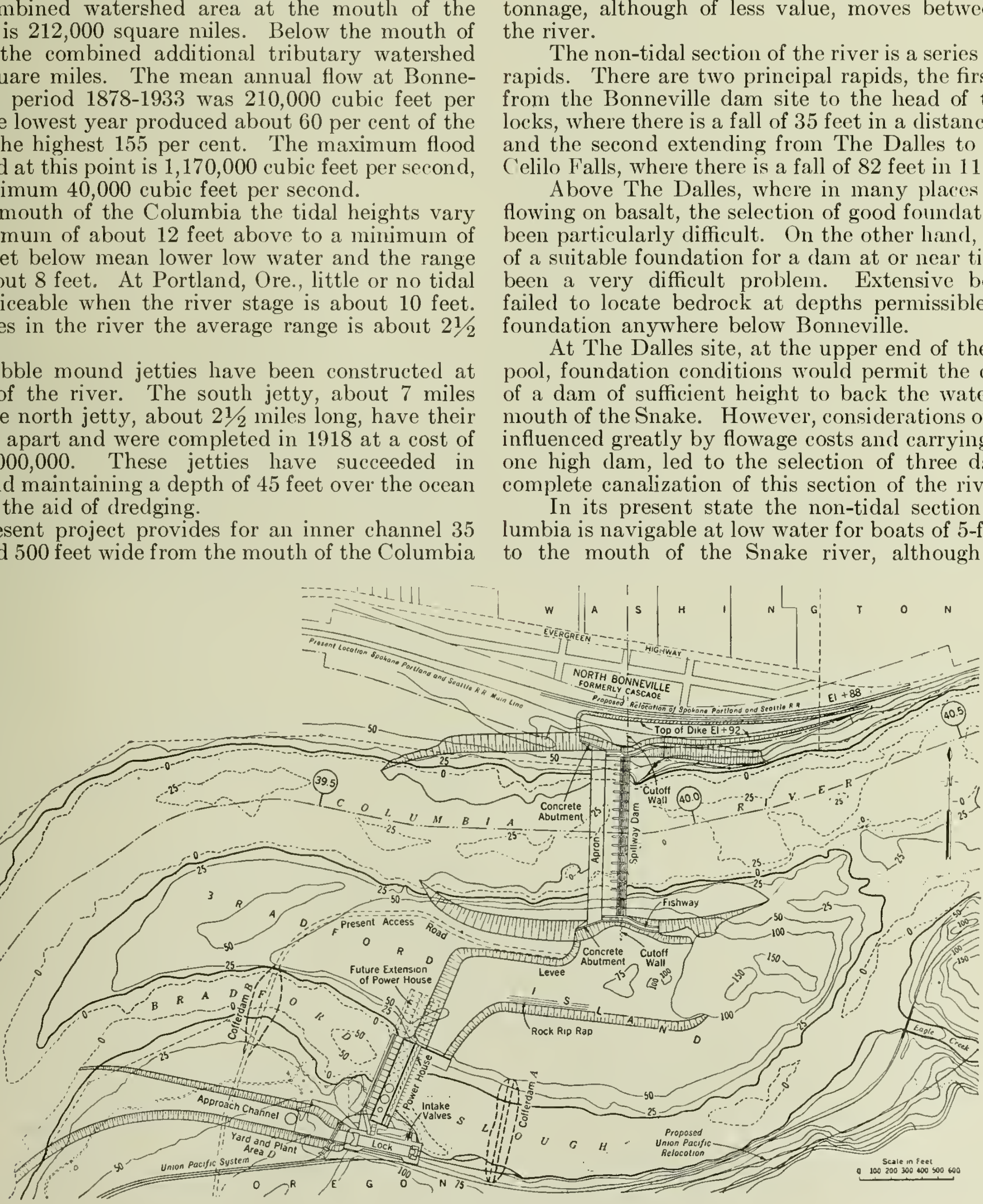



**Fig. 7—Site of Bonneville Dam.**

above The Dalles is difficult because of swift currents. The Cascades and Celilo rapids are passed by lateral canals with locks.

TABLE I

PROPOSED DAMS ON THE COLUMBIA RIVER BELOW THE SNAKE

| Site | Distance above Mouth in miles | Maximum height in feet | Useful storage thousands of acre-ft. | Flow 90% of time thousands of cu. ft. per sec. | Corresponding head in feet | Power* capacity 90% of time thousands of kw. |
|---|---|---|---|---|---|---|
| Umatilla Rapids..... | 292 | 104 | 135 | 66.0 | 71 | 318 |
| John Day Rapids..... | 216 | 159 | 245 | 66.0 | 108 | 485 |
| The Dalles... | 192 | 260 | 80 | 70.7 | 75 | 360 |
| Bonneville.... | 143 | 130 | 100 | 74.0 | 60 | 300 |

*(Flow 90 per cent of time) × (corresponding head) × 8.600.

As now authorized at an estimated cost of $31,000,000 the Bonneville project provides for a gate-controlled spillway dam across the main river channel, creating a head of 67 feet at low water; a power plant with two complete units with a partially completed or skeleton structure for four additional units; a barge lock having a width of 76 feet, a clear length of 360 feet, and a minimum depth of 10 feet on the sills; and fishways in both the dam and power house channels. (Fig. 7.) The power house is being constructed across Bradford Slough so that it can be extended in the future to permit a total installation of ten or even twelve units of 43,000-kw. capacity each. The lock, also in Bradford Slough, is so designed that it may in the future be used as an integral part of a tandem-lift ship lock.

The pool formed by the dam will have a length of 48 miles, a minimum depth of over 30 feet, and an area of 30 square miles.

In the main channel, the spillway dam is to be an overflow, gravity-type structure, consisting essentially of a base block of mass concrete, approximately 75 feet high, 180 feet wide and 1,000 feet long across the river, with eighteen steel gates of the vertical-lift type each 50 feet wide by 50 feet high.

At the dam the principal engineering problems are the unusual volume of flood water to be passed, the soft rock available for the foundation, the large scale river diversion, and the construction and unwatering of the cofferdams.

Precedent in the design of a navigation structure with a maximum lift of 67 feet would dictate a double lift or tandem lock, but foundation conditions at Bonneville would require expensive construction for such a lock and as core borings showed definitely that a single-lift chamber could be founded entirely on rock, designs were made accordingly.

Studies of models in operation form an important part of the design programme for the Bonneville dam. Model studies for the dam centre around the choice of a spillway-deck and baffle-sill combination best suited to the maintenance of a stable hydraulic jump over the range of flows and combinations of gate operation required. The problem is complicated by a possible range of 60 feet in tailwater elevation and by the desire to operate a central group of gates to care for all minor fluctuations in flow in order to maintain near the abutments the most desirable flow conditions for trapping fish and transporting them safely over the dam.

As at July 1st, 1934, the cost of work done or under construction amounted to $16,000,000 and it is contemplated that the power plant will be ready for operation by December 31st, 1937.

## BONNEVILLE POWER HOUSE AND EQUIPMENT

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*Member, American Society of Civil Engineers,*
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Full regulation of the Columbia during the past fifty-five years would have required a storage of 450 million acre-feet; for regulation during the past twenty-nine years 200 million would have been necessary. Obviously long-time regulation cannot be obtained. The ultimate storage of 12 million acre-feet useful for power would provide a minimum continuous flow of 100,000 cubic feet per second at Bonneville, but this development lies so far in the future that it has not been considered an important factor in the present design.

As authorized, the Bonneville project consists of ten 43,000-kw. generating units, of which only two are to be completed now.

TABLE I

POWER OUTPUT OF THE BONNEVILLE PROJECT AT VARIOUS HEADS

| Gross head in feet | Corresponding flow in Columbia river cu. ft. per sec. | Percentage of time this flow is exceeded | Turbine horse-power | Generator kilowatts | Cubic feet per second required per unit |
|---|---|---|---|---|---|
| 35 | 950,000 | 0.1 | 38,250 | 28,100 | 11,470 |
| 45 | 550,000 | 5.6 | 53,000 | 38,700 | 12,330 |
| 50 | 286,000 | 22.5 | 60,000 | 43,860 | 12,420 |
| 55 | 150,000 | 47.5 | 60,000 | 43,860 | 10,600 |
| 65 | 40,000 | 100 | 60,000 | 43,860 | 9,000 |

Since the width of the south channel is about 500 feet and the power units are spaced 82 feet apart on centres, only six are required to make the closure. The power house superstructure for the present will consist of a control room, an assembly bay, one 2,500-kw. house unit, and two 43,200-kw. main units. The intakes and skeleton substructures for four more main units will be constructed at this time to complete the dam across the south channel. The ultimate extension of the power house beyond this point is provided for by the present construction of a reinforced concrete cantilever wing wall about 120 feet high to retain the backfill and to act as a future cofferdam for unwatering footings for the ultimate installation of four or six more units.

Three gates 21.33 by 43 feet are required for each unit. On the downstream side of the power house a single intermediate 6-foot pier divides the draught tubes into two 34-foot spans for closure by stoplogs during unwatering. (Fig. 8.)

In the intake the openings will be closed by gates of conventional structural steel design. The gate wheels will run on hardened nickel-steel tracks attached to heavy structural guide members which will distribute the loads over the concrete bearing area. The gate and stop-log grooves were placed as far downstream as practicable to ensure a large water load on the intake slab during unwatering operations. The value of the water load may be realized from the fact that about $20,000 worth of concrete per unit would be required to give equal stability.

The power house turbines will be of the Kaplan type with blades automatically adjustable. Extreme variations in head may be from 20 to 70 feet but a characteristic of this type of turbine is its high efficiency over a wide range of head and load.

The turbines will be designed for 60,000 h.p. at a 50-foot head for 75 r.p.m. and for 85 per cent of efficiency. Under these conditions each unit will require only 12,200 cubic feet per second. As the flow at Bonneville corresponding to this head is 286,000 cubic feet per second, which is exceeded for 22.5 per cent of the time, more than half the available water must be wasted.

When the flow falls to 75,000 cubic feet per second of water or less, which happens only 7.5 per cent of the time, the gross head increases to 60 feet or more because of lowered tailwater elevation. The efficiency at 60,000 h.p.

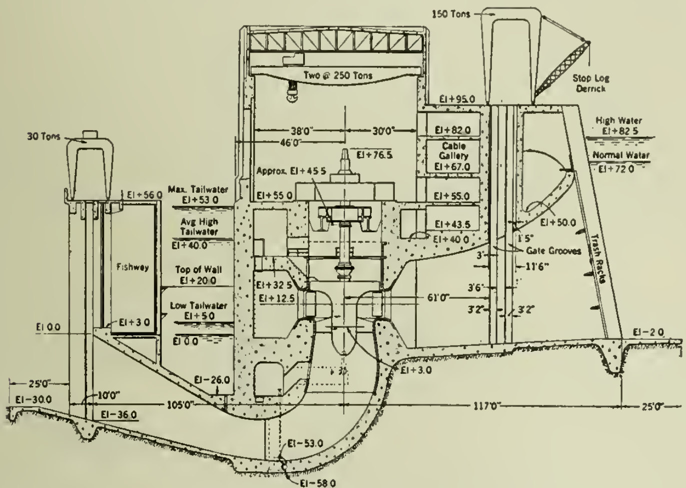

**Fig. 8—Section through Power House at Bonneville.**

at a 60-foot head is 90 per cent, and a flow of only 9,650 cubic feet per second is required. The efficiency at a 60-foot head is maintained at about 90 per cent for outputs varying from 60,000 h.p. down to about 35,000 h.p. by the automatically adjustable blades and gates of the turbine. For other heads similar characteristics prevail.

Tests on small models of scroll cases and draught tubes are being conducted to determine the most efficient types.

The rating of the 3-phase, 60-cycle generators will probably be about 43,200 kw. at 13,800 v. Because of the physical location of the power house, the surrounding topography and uncertainty as to ultimate uses, the selection of electrical equipment is particularly difficult.

## COLUMBIA BASIN AND GRAND COULEE PROJECTS

*F. A. Banks,*
*Associate Member American Society of Civil Engineers, Construction Engineer, U.S. Bureau of Reclamation, Almira, Wash.*

Millions of years ago, after the Columbia river had laboriously cut its way through 1,500 feet of solid basalt and granite, a glacier advancing southward from Canada crossed the canyon of the Columbia east of the Okanagan river and became the original Grand Coulee dam. It raised the water surface of the river 1,500 feet and caused it to cut a new channel, now designated as the Grand Coulee—50 miles long, up to 900 feet deep, and 5 miles wide—and constituted the first step in the construction of the Columbia Basin project. Receding later, the glacier permitted the river to return to its former channel and left the Grand Coulee a monument to its efforts.

During the process of erosion, a cataract was formed in the lower part of the coulee, the crest of which is 400 feet high and 6 miles long, now known as Dry Falls.

Present plans for the construction of the Columbia Basin project involve the utilization of that part of the Grand Coulee above the Dry Falls for the storage of Columbia river water. This would be conveyed to the lands of the project by building dikes at each end of the Upper Coulee and by lifting the water up to the reservoir thus formed by means of the Grand Coulee High Dam, power plant and pumping plant. The Grand Coulee Low Dam which constitutes about a third of the work involved in the High Dam is now being constructed exclusively for power purposes as a part of the national programme for industrial recovery and should be completed in the early part of 1939.

The irrigable lands of the Columbia Basin project lie in the northeastern part of the state of Washington, east of the Columbia river, south of Quincy, Ephrata and Soap Lake and north of Snake river. (Fig. 1.)

Present plans for the pumping project involve the irrigation of about 1,200,000 acres of land and include the following major features, here listed in the order in which they will probably be constructed: (1) The Grand Coulee High Dam and power plant; (2) the Grand Coulee pumping plant and pipe line; (3) the Grand Coulee north and south dikes, forming the Grand Coulee reservoir; and (4) the main canals and distribution system.

The site chosen for the High Dam and power plant is on the Columbia river just below the head of Grand Coulee. The dam will be of the straight gravity type 4,000 feet long and 500 feet high above the lowest foundation. Its purpose is to raise the water surface of the river 350 feet above low water, regulate the flow of the river, and provide a pressure head for the generation of power. Its spillway controlled by drum gates, will have a length of 1,800 feet and a capacity of 1,000,000 cubic feet per second. In addition there will be in the east end of the spillway section at least twenty sluice gates, 5 feet 8 inches by 10 feet in size. Since 1913 the discharge of the Columbia river at this point has varied from 17,000 to 492,000 cubic feet per second, and the annual run-off has varied from 56,830,000 acre-feet in 1929 to 98,800,000 acre-feet in 1927, the mean being 79,000,000 acre-feet for the calendar year, corresponding to an average discharge of 109,000 cubic feet per second.

Extending upstream, 151 miles to the Canadian boundary, the reservoir created by this dam will have a capacity of 5,000,000 acre-feet in the top 80 feet of its depth. It is of prime importance in the development of the river as a whole, since the regulation effected by it will increase the firm power output at all sites between the Grand Coulee and the mouth of the Snake river by 100 per cent and at all sites below that point by 50 per cent. It is for this reason that the Grand Coulee High Dam holds the key position in the development.

The power plant will have an installed capacity of 1,890,000 kw. and will consist of eighteen units of 105,000 kw. capacity, nine on each side of the river. There will also be two service units of 6,000 kw. each. This power plant will furnish power for the operation of the pumping plants and for commercial purposes. It is estimated that 2,400 million kw. hours will be required annually for irrigation pumping and that 7,500 million kw. hours of energy will be available for sale.

Just upstream of the west abutment of the dam will be a pumping plant containing twenty units each consisting of a pump having a capacity of 800 cubic feet per second when operating under a total head of 370 feet. Each pump will be direct connected to a 33,000 h.p. motor.

The Grand Coulee reservoir, formed by the north and south dykes at each end of the upper Grand Coulee, will have a length of 23 miles, an area of 2,100 acres and a capacity of 1,050,000 acre-feet. Its function will be to convey irrigation water through the coulee, regulate the supply to meet the demand, and permit the use of off-peak and secondary power for pumping purposes. The north and south dykes will be respectively 92 and 97 feet in height above the original ground.

The main canal will extend southward from the south dike about ten miles and then divide into an east and a west canal which will serve 1,000,000 acres directly and 200,000 acres indirectly by re-pumping to a height not to exceed 100 feet.

It is estimated that the cost of the dam and power plant will be $168,366,000, and that of the irrigation features $208,265,000, exclusive of interest during construction.

In the construction of the Grand Coulee Low Dam and power plant, which has been under way since the first of this year, about a third of the work involved in the High Dam is required. This dam will be of the straight gravity type, 3,500 feet long and 300 feet high above the lowest foundation.

The spillway, which is uncontrolled, is 1,800 feet long and 150 feet above low water. With an overflow depth of 26 feet, leaving a freeboard of 5 feet, it will discharge 1,000,000 cubic feet per second. Into the east end of the spillway twenty sluice gates, 5 feet 8 inches by 10 feet, will be built.

A section of the west side power house of the High Dam is to be constructed to house three main units, two service units, and the repair shop. Consideration is being given at this time to the installation of High Dam units with a capacity of 105,000 kw. each but with runners adapted to the head at Low Dam which will produce 34,300 kw. each.

The building of the High Dam would probably take five or six years after authorization, and the time required for the construction of the irrigation features would depend on the rate of possible settlement. At the rate of 20,000 acres per year, as has been estimated, it would take sixty years to complete the work.

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# Heat Economy and Comfort in the Home

## As Influenced by Heating Methods and Building Construction

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**Paper presented before the Saguenay Branch of The Engineering Institute of Canada, August 2nd, 1934:**

The demand on the part of the public for greater economy in home heating has been accentuated by the present economic depression. The possible savings are indicated by the estimate of the Dominion Fuel Board that some 30,000,000 dollars or more are wasted annually in the heating of Canadian homes, which losses could be saved by the application of sound methods in house building construction.

People are today desirous of more comfort in the home, particularly insofar as heating is concerned. They are demanding convenience, cleanliness, an even temperature, with properly-conditioned air, the heating being as nearly automatic as possible. Moreover, they are beginning to appreciate the very definite relationship of heat comfort to health.

This paper accordingly deals with the two major aspects of home heating: (*a*) economy and (*b*) comfort, as influenced by heating methods or systems and house construction. Of the two aspects, that of comfort is undoubtedly the more important with the majority of people.

For illustration, studies made during the last three years in connection with a large-scale experimental application of electric heating to homes in the Saguenay district,* made possible by the pioneering enterprise of the Saguenay Electric Company, have been largely drawn upon.

### *HEAT ECONOMY*

Heat economy in the home is influenced by a number of variable factors which may be most readily discussed under the following major headings: (i) heat requirements, (ii) heating methods, (iii) heating costs.

#### *Heat Requirements*

The heat requirements of a house depend on the three principal factors of: (i) weather conditions, (ii) building construction, (iii) inside conditions.

There is little that can be done about weather conditions, except in the matter of exposure and orientation for sunlight. The builder has entire control of the construction of a house. The inside conditions are subject to the builder to some extent, but largely to the householder.

#### Weather Conditions

Weather conditions influencing the heat necessary for a house are:—

(i) Temperature.
(ii) Wind velocity.
(iii) Sunshine.

*Temperature.*—It is common knowledge that the heat losses from a building vary directly with the outside temperature under still-air conditions. A glance at the curve of daily maximum and minimum temperatures for any Canadian town illustrates the variable nature of heat requirements for a house. The variation in heating demand is exemplified by the spread between curves *A* and *C* of Fig. 1, showing monthly mean, maximum and minimum temperatures observed at Chicoutimi in the eight years 1926-33, inclusive. During the nine-month heating season from September 1st to May 31st, Chicoutimi averages 9.6 degrees F. below Toronto and 5.8 degrees F. below Montreal.

As expressed by electrical men, the load factor (based on maximum daily heat requirement and average seasonal requirement) inherent in the temperature curves shown for Chicoutimi is approximately 50 per cent for the 1932-3 and 49 per cent for the 1933-4 heating season of eight months (September 15th to May 15th).

*Wind Velocity.*—Wind movement affects the heating of a house in three ways:—

By increasing the heat transmission of exposed walls, glass and roof surface.

By increasing the infiltration of cold air through the walls.

By increasing the infiltration of cold air through the cracks at window sash and frames, etc.

Wind movement wipes heat off the exposed wall, glass and roof surface of a house in the same manner as air currents from a fan increase the heat output of a radiator. Computations based on the latest surface coefficients indicate that a 15 m.p.h. wind increases the heat loss from a

*"Practical Aspects of Heating Residences by Electricity," by F. L. Lawton and P. Tellier in advance Reports and Proceedings of the Canadian Electrical Association for 1934.

standard frame wall consisting of clapboards, sheathing, studding, lath and lime plaster by 11.6 per cent.

Published data indicate that the leakage of cold air through well-built 13-inch brick walls ranges from 0.5 cubic foot per square foot per hour at a wind velocity of 5 m.p.h. to 2.5 cubic feet per square foot per hour at 15 m.p.h., a ratio of 5. Good plastering cuts the infiltration to approximately 1 per cent of the above values. Generally speaking,

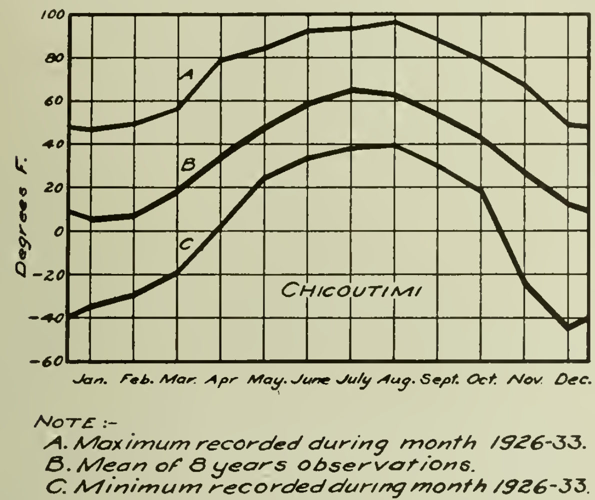



**Fig. 1—Climatic Temperature, Chicoutimi, Que.**

plaster with proper sealing at base-boards cuts the infiltration through ordinary walls (brick, frame, etc.) to a negligible quantity.

The infiltration of cold air around the uncaulked frame of a double-hung wood-sash window increases sixteen times for an increase in wind velocity from 5 to 15 m.p.h., reaching approximately 23 cubic feet per hour per lineal foot of crack. A non-weather-stripped double-hung wood-sash window has about thirteen times the infiltration obtaining after the application of weather-stripping, at 5 m.p.h. wind velocity, and about 5.5 times the infiltration at 15 m.p.h.

The range of wind movements encountered in the Saguenay district is shown in Fig. 2. It will be noted that the monthly mean wind velocity is roughly 8 to 10 m.p.h., although the maximum velocity runs as high as 40 m.p.h. The prevailing direction is west during most months.

While it is common knowledge that a house located on a hill top and exposed to every breeze is harder to heat than a similar house in a hollow or sheltered from the full force of the wind by trees, the extent of the increased heating demand may not be fully appreciated. Figure 3 depicts the effect of wind velocity on the heating requirements of a typical wood-frame house. The curves are based on daily observations of the electrical energy required for heating, the mean temperature and the mean wind velocity. The use of the factor kilowatt hours per 1,000 cubic feet gross volume per degree-day below 65 degrees F. automatically takes care of daily temperature variations and shows the true effect of increased wind velocities.

It may be noted that a 15 m.p.h. wind from the west increased the heat consumption some 32.5 per cent; from the east 26.8 per cent; from the northwest 34.0 per cent. These percentages indicate the gains to be anticipated from building on a sheltered site.

Computed heat losses, for the house on which Fig. 3 is based, gave a value of 0.234 kilowatt hour per 1,000 cubic feet gross volume per degree-day as compared with the experimental value of 0.191, for still-air conditions. With a 15 m.p.h. west wind, the computed value was 0.271 and the experimental 0.253 kilowatt hour per 1,000 cubic feet gross volume per degree-day. That is, the computations show an increase of 15.8 per cent whereas actual observations indicate an increase of 32.5 per cent.

It will be interesting to see how wind velocity affects the heating requirements of a group of residences. Figure 4 is based on observations made on a total of twenty-seven electrically-heated homes in one town. It shows the total house-heating load, wind velocity and temperature over a full day. The load curve fluctuates somewhat from hour to hour due to factors other than wind velocity and outdoor temperature. This chart covers a day with very low wind velocities, but a large temperature change. Observe the decrease in load with rising temperature.

*Sunshine.*—The relative value of various window exposures has been compared by Atkinson* on the basis of the quantity of sunlight passing through an opening one foot square, in a plane normal to the sun's rays, in one hour, which quantity is termed a "sun-hour." Table I gives data on the relative value of various window exposures for a room 24 feet square with a window 3.5 feet wide by 8 feet high, wall thickness 1 foot, sill of window 2 feet above floor, in latitude 40 degrees north.

The heating effect of the sun's rays admitted through the windows of a house is difficult to compute. However, experiments made by Mr. Atkinson with sun boxes show definitely the heating value of windows having a southern exposure. Table II illustrates the relative value of south

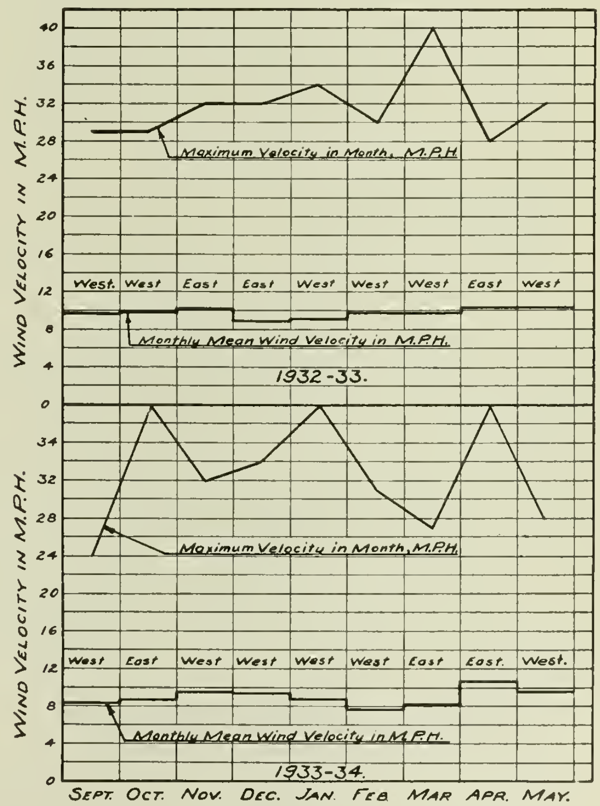



**Fig. 2—Wind Movement, Arvida, Que.**

and east exposures as determined from tests with sun boxes constructed of ordinary ⅞-inch pine boards nailed together without grooving or dovetailing, containing an inner box of similar construction (one foot square inside) covered with one layer of lino-felt, made of flax fibre quilted between two thicknesses of building paper. Sash glazed with ¼-inch plate glass was screwed into place and fitted

*"The Orientation of Buildings or Planning for Sunlight."

tightly against a felt weather strip all around the edges. The boxes were protected from the direct rays of the sun by wooden hoods or covers, except on the window side. The thermometer used for measuring the inside temperature was screened from the sun's rays. The observations were taken with the boxes exposed on a platform three feet above the ground in an open field with free access of sunlight from every quarter.

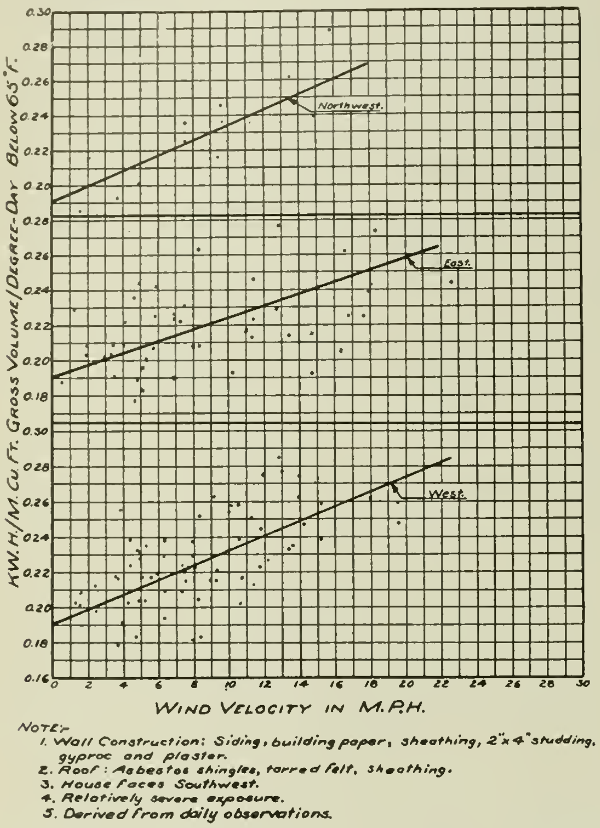



**Fig. 3—Effect of Wind Velocity on Heating Requirements of Typical Wood-Frame House.**

Other experiments of similar nature show that a temperature of 100 degrees F. and over is frequently attained in well insulated sun boxes with the outside air at zero F. or lower.

Lewis* draws attention to the fact that ordinary window glass only retards the entrance of sunlight and sun heat approximately 10 per cent.

While the capacity of the heating system in a house has to be sufficient to take care of the coldest weather conditions which may be experienced and hence cannot be reduced by taking advantage of sunlight, nevertheless the fuel consumption during the heating season may be considerably decreased.

Table I
Relative Value of Window Exposures, in Terms of Sun Hours

| Location of Window | Winter Solstice | Equinoxes | Summer Solstice |
|---|---|---|---|
| North | | | 6.8 |
| Northeast and northwest | | 18.6 | 73.2 |
| East and west | 32.9 | 82.7 | 110.7 |
| Southeast and southwest | 108.5 | 105.5 | 53.4 |
| South | 152.9 | 81.1 | 16.2 |

Note:—For latitude 40° N.

*"Air Conditioning for Comfort."

Table II
Relative Values of Window Exposures, Based on Sun Box Tests

| Date | South Exposure | | | East Exposure | | |
|---|---|---|---|---|---|---|
| | Outside air temperature at time of sun box maximum | Maximum temperature reached in sun box | Temperature rise in sun box | Outside air temperature at time of sun box maximum | Maximum temperature reached in sun box | Temperature rise in sun box |
| October 24 | 59° F. | 125° F. | 66° F. | 45° F. | 93° F. | 48° F. |
| December 22 | 25° F. | 115° F. | 90° F. | 20° F. | 46° F. | 26° F. |

*Estimation of Heat Requirements*

The part played by outdoor temperature, wind velocity and sunshine relative to the heat requirements of a house have been discussed already. The question arises "What is the over-all yardstick of measurement for determining heat requirements?"

Such a yardstick is the degree-day, defined as the equivalent of one degree Fahrenheit difference in temperature between the temperature of reference and the outside temperature over a period of twenty-four hours. The temperature of reference may be 65 or 70 degrees F. It is commonly taken as 65 degrees F. where the house temperature is maintained at 70 degrees for sixteen hours and 55 degrees for eight hours. If the temperature in the house over the day is about 70 degrees, the temperature of reference is taken as 70 degrees F.

If the mean temperature over a period, say thirty days, is 25 degrees and the base is 70 degrees F. the degree-days below 70 in the period equal $(70 - 25) \times 30$ or 1,350.

American and Canadian heating practice makes no allowance in the computation of degree-days for the effect of wind movement and sunshine. However, the two factors partially cancel out. It will be shown in what follows that the heating requirements of a house or group of houses are essentially proportional to the degree-days.


**Fig. 4—Typical Residence Heating Load as Affected by Wind Velocity and Atmospheric Temperatures.**

The relation between degree-days and the fuel requirement for heating residences is clearly shown by Fig. 5, which is based on data for a group of fifteen electrically-heated houses in the Saguenay district. Inspection of the graph reveals that the energy consumption corresponds more closely to the degree-days below 70 degrees than 65 degrees F. This would be expected as the heating was on a flat-rate basis, and a temperature of 70 degrees or higher was maintained twenty-four hours a day. The relationship is quite close, the maximum error due to departure from strict proportionality being about 4 per cent, except in the month of September. The much higher error in September is attributable to the relatively high daytime temperatures and lack of demand for heat by occupants. It should be remembered, of course, that a variable component of the energy consumption is actually accounted for by wind movement.

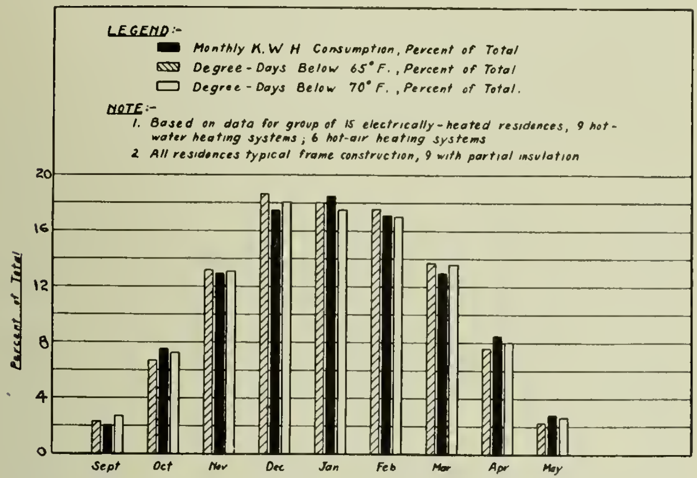



**Fig. 5—Relation Between Degree Days and Consumption of Electrical Energy for Heating Residences.**

There is also a great similarity in the relation between degree-days and heating requirements as derived from data on a large district heating system, supplying steam heat to residences, etc., from a central station.*

One would expect a similar relationship between degree-days and energy consumption used for heating an individual residence, with possibly slightly greater departure from true proportionality, and such has been found to be the case.

### Building Construction

The physical construction of a house has a very important bearing on the heat requirements, being the principal factor which is definitely subject to control.

When stable temperature conditions exist, the heat requirements must equal the heat losses. These result from the flow of heat from the warm interior of the house to the cold exterior atmosphere. Such flow takes place along two channels, and the mechanism of flow may be briefly described as follows. Firstly, heat is received by the inside surface of the exposed walls by radiation from the warm interior walls, radiators, etc., and convection currents, then passes to the exterior surface by conduction and thence to the outside air by radiation and convection. Secondly, difference of air pressure between the interior and exterior of the house due to wind movement and temperature difference results in warm air leaking out and cold air leaking in at cracks and joints and through porous wall materials.

The percentage heat losses from a typical small-to-medium-size residence, based on a relatively large-scale analysis by the American Gas Association, show that transmission through doors and the glass of windows accounted for 29.4 per cent of the total heat losses, infiltration or air leakage 21.0 per cent, and transmission through walls, roof and floor the other 49.6 per cent. An analysis of a limited number of typical residences in the Saguenay district indicates fairly close agreement, the glass and door loss, however, being lower at 15 to 20 per cent, and the roof and wall loss somewhat higher. Mallory† states that under Canadian conditions the loss through doors and windows probably averages about 20 per cent, with a similar figure for air infiltration.

The effect of the installation of storm sash and storm doors is to decrease the heat loss by transmission through windows and doors in the order of 50 per cent. Published test data indicates the application of storm sash to a poorly-fitted window may reduce the infiltration 50 per cent, but has little effect on a properly-fitted window.

In Fig. 6 note the extreme fluctuation in energy consumption with rather moderate changes in wind movement during the period when no storm sash was installed as compared with a similar period afterwards. Allowing for the somewhat higher mean wind velocity existing after the installation of storm sash, the saving due to the addition of storm sash figured out at 5 per cent of the total energy consumption. Values approaching this saving have been noted in other houses studied.

Everyone has recollections of the uncomfortable effect of cold walls when seated nearby. Windows have a similar effect, which may be largely mitigated by the application of storm sash, as depicted by Fig. 7. Note the drop in temperature of the film of air adjacent to the sash from 42 to 16 degrees F. when the inside sash was open. A similar range is encountered when the storm sash is open, leaving only the inside sash closed.

The use of weather-stripping to eliminate leakage around window sash and doors will return large dividends on the small necessary investment, if properly applied. Table III illustrates the very substantial savings arising from the use of weather-stripping on double-hung wood-sash windows and doors. The tabulation is based on published test data for air leakage at windows and doors with average fit, with heat derived from anthracite coal

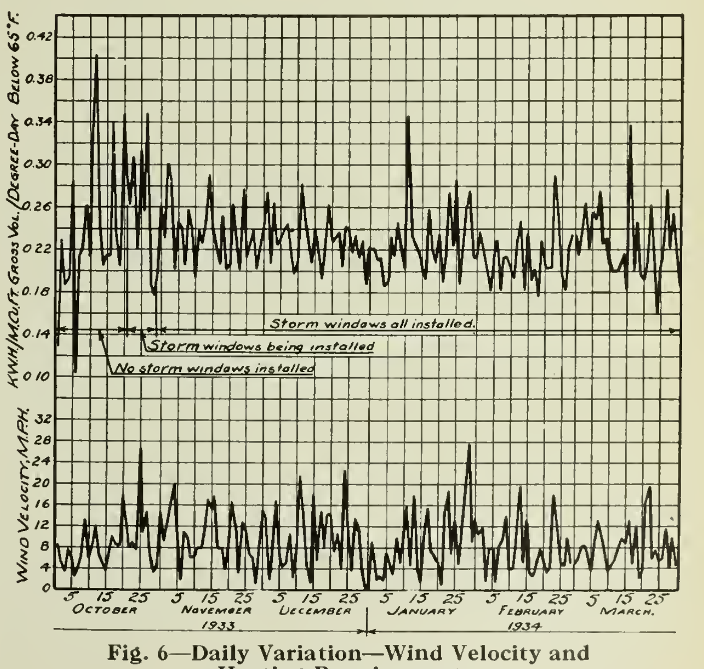



**Fig. 6—Daily Variation—Wind Velocity and Heating Requirements.**

containing 13,500 B.t.u. per pound, costing $15 a ton, and burnt at 50 per cent seasonal efficiency. It is assumed that the outside air is at 0 degrees F. The values stated would be proportionately greater for lower temperatures.

While the tabulation shows the daily cost in cents of infiltration at doors and windows per 100 linear feet of

*"Central Heating System of City of Winnipeg," by G. W. Oliver, Engineering Journal, January, 1932.

†"The Insulation of New and Old Houses," publication of the Dominion Fuel Board.

crack, it will be of interest to look into the probable daily cost of infiltration in a typical small-to-medium-size residence. Such a house may average twelve windows at 4 feet by 2 feet 6 inches each and three at 3 feet by 2 feet 6 inches each. There would be two doors at 6 feet 10 inches by 2 feet 10 inches each. Take one-half of the total crack length as effective for air infiltration, say 124 linear feet for windows and 19 feet for doors, and assume a 15-

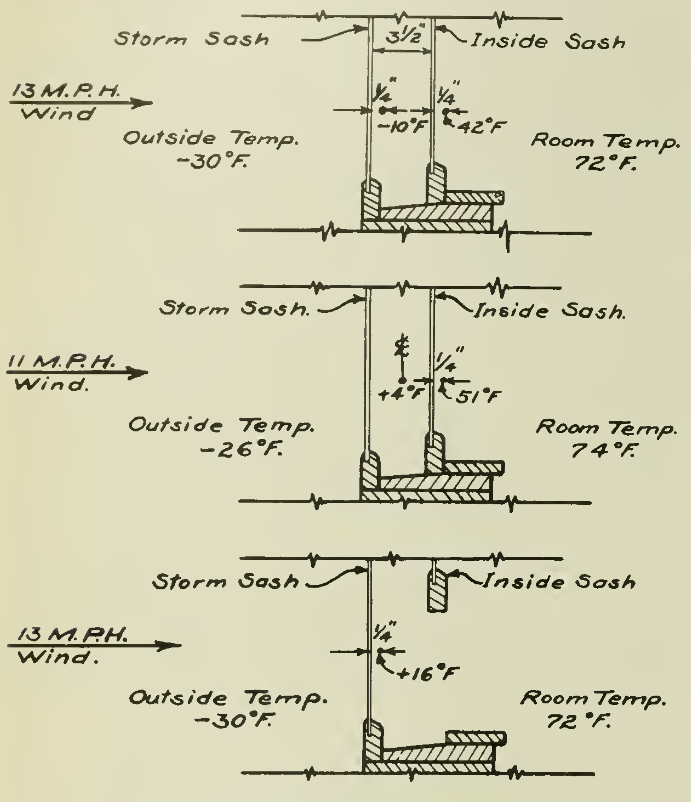



Fig. 7—Effect of Storm Sash on Temperature Gradient at Windows.

m.p.h. wind velocity and 0 degrees F. air temperature outside. The daily cost of infiltration without weather-strip will be 61.2 cents and with weather-strip 9.6 cents. That is, the saving due to weather-strip is 51.6 cents or 84 per cent. It is, of course, assumed ventilation requirements are obtained otherwise than through infiltration.

Heat losses from a house naturally fall into two classifications—unavoidable and avoidable. The unavoidable losses include the window and door loss together with infiltration losses. As indicated previously, the former may be taken at 20 per cent in round figures. The latter ranges around 20 per cent but with proper precautions may be reduced to 10 per cent which is ample for all ventilation requirements. The total unavoidable losses are then 30 per cent, leaving 70 per cent avoidable losses, which take place through the walls, roof and floor. That is to say, 70 per cent of the total heat losses from a house will be affected by improved wall and roof construction and the addition of heat insulation.

McMillan* summarizes the essential requirements for heat insulation as follows:—"Next to perfect vacuum, the most effective insulation against the flow of heat is the minute confined air space. To be most effective the air space must be absolutely enclosed and so small that circulation cannot take place within it nor heat radiate across it to any appreciable extent. Even perfect vacuum would be ineffective for anything except very low temperatures unless it were broken up into very small units or unless the surface were mirrored to prevent radiation."

* In a paper on "Heat Insulation Facts" before the American Society of Heating and Ventilating Engineers.

Table III

Daily Cost in Cents of Infiltration at Doors and Windows per 100 Lineal Feet of Crack

| Infiltration | 5 m.p.h. Wind | 15 m.p.h. Wind |
|---|---|---|
| Around uncaulked frame of a double-hung wood sash window | 0.47 | 7.60 |
| Around sash of a double-hung wood sash window, no weather stripping | 13.21 | 41.66 |
| Around sash of a double-hung wood sash window, with weather stripping | 1.01 | 7.69 |
| Around door, not weather-stripped | .... | 50.40 |
| Around door, with weather-stripping | .... | 0.17 |

*Heat Insulation.*—The various forms of heat insulation in use today are: Air spaces, fillers, rigid boards, flexible boards, slabs, blankets, foil.

It is commonly known that the use of air spaces in wall construction is helpful in cutting down heat losses. However, it is the exception to find maximum advantage taken of the notable savings possible. An illustration of what can be done is indicated by the work of a German investigator who found that a well designed, hollow brick wall with air spaces properly sealed would transmit from 20 to 25 per cent less heat than a solid brick wall of the same thickness.

While the experimental data are such as to lead to some divergence of opinion on the optimum size of air space, it appears that a width of ¾ to 1 inch is as efficient as a greater width. If the air space is wider, the height of the space should not be over 2 feet in most cases, greater heights leading to undue losses from convection currents, amounting to 15 per cent in a two-storey wall without stops.

Appreciable savings at little cost are secured with hollow tile and block walls by placing the tile or block with air spaces horizontal. If placed vertically, the air spaces should be confined in each course.

Heat insulation of the filler, rigid wallboard, flexible board, slab and blanket types is made from a variety of materials, organic and mineral, but in general conforms to the previously-given definition of good heat insulation, containing a multitude of small confined air spaces per volume.

Most heat insulation serves a dual purpose. Fillers act as fire-stops, preventing the spread of flames through air spaces. Rigid wallboard may be used for structural sheathing, plasterboard, exterior or interior finish, etc. Fillers, boards, slabs and blankets possess considerable sound-deadening properties. Rigid wallboards and slabs are also used for acoustical treatment in homes.

Mineral fillers are fire and vermin proof. Other types of heat insulation may usually be chemically treated to render them fire and vermin resistant.

A foil type of insulation, which offers considerable promise, has recently been devised. The low conductivity of air has been combined with the low radiating power of bright aluminum foil in a foil-air cell structure designed to minimize convection currents.

If approximately 70 per cent of the total heat losses are subject to reduction by improved wall and roof construction and the addition of a suitable heat insulator, what over-all saving in heat losses can be secured?

Two small 1½-storey-and-basement frame houses, in the Saguenay district, of identical size and construction, except for heat insulation, have been heated electrically, enabling a direct comparison of heat losses. Exposure was the same for both houses. Heating systems were both similar, of the hot-air type.

The walls of house *A* were constructed of siding, building paper, sheathing, 2-inch by 4-inch studding, plasterboard and plaster. Those of house *B* were identical except for a filler of wood shavings and sawdust. The second-floor ceiling of house *A* consisted of plaster, plasterboard, joists and ⅜-inch rigid insulating board. The second-floor ceiling of house *B* consisted of plaster, plasterboard, joists and 6 to 7 inches of sawdust and shavings. The roofs were of asbestos shingles, paper and sheathing in both cases. Both houses were fitted with storm sash carefully caulked.

House *A* was occupied by two adults, house *B* by two adults and two children. The occupants of house *A* tried to conserve heat by closing an unused room but nevertheless had a slightly lower mean temperature and used 30 per cent more energy over the six-month period of comparison.

That is to say, the complete insulation with sawdust and shavings resulted in a saving of somewhat more than 30 per cent although house *A* was partially insulated.

A similar comparison between houses *C* and *D*, of the same general type of frame construction, indicated a saving of over 35 per cent during an eight-month heating season. In this case, the partially insulated house had 2 to 3 inches of sawdust on the second-floor ceiling instead of the ⅜-inch rigid board.

An analysis of the heat losses for a typical frame-construction 2-storey-and-basement house revealed that filling the 3⅝-inch air space in the walls with 12-pound dry insulex and the space between the second-floor ceiling joists with 6 inches of the same material would reduce the heat losses to 50 per cent of the original total.

Insulating a large fifty-year old, light frame-construction residence with 3⅝ inches granulated cork in the walls and 4 inches between joists in the attic resulted in a saving of 47.5 per cent in heat losses secured for a total expenditure of $175.00 for labour and material. Part of the saving, however, is attributable to metal weather-stripping placed at the time of insulating the house.

The cost of heat insulation for a new house varies from 3 to 7 per cent of the total cost, 5 per cent being about the average. That is, an average outlay of 5 per cent of the total cost will secure a saving of 30 to 50 per cent of the total annual heating cost. It must not be forgotten, also, that the lower heat requirements mean a proportionately lower investment in heating plant. In fact, the difference in heating equipment cost may offset entirely the cost of the insulation.

The cost of heat insulation for existing houses runs higher than for new houses but nevertheless constitutes a very attractive investment. Mr. C. N. Shanly in an informative paper* has fully discussed the cost of insulating seventeen frame houses in River Bend, Que. The material used was a dry gypsum filler made in Canada. Cost of complete insulation for houses with 2-inch by 4-inch studding varied from $9.50 to $15.00 per 1,000 cubic feet gross volume, the average being $11.50.

Not only does heat insulation cut down heat requirements in the winter but it improves acoustical properties of the house, deadens noise, decreases the fire hazard by preventing spread of flames through air spaces or by reason of less forcing of the furnace during extreme weather, decreases the possibilities of an over-heated chimney, improves winter comfort with warm walls and roof, and summer comfort by a cool interior. In some cases, heat insulation is found desirable to prevent wall condensation in extreme weather, with resultant high maintenance costs for wall finish.

*"An Experiment in House Insulation," The Engineering Journal, November, 1929.

The heat-insulation properties of lumber due to its low density and multitude of entrained air cells are often neglected by the average house-builder, who buys solely on a price basis. The heat-insulation value is a function of the density. Accordingly, the lumber used in a house should be cut from low-density wood, durable, properly seasoned, free from cracks, warping, knot holes, etc.

The lumber used in wall construction should be protected against the losses from air leakage through cracks which may develop by one or more layers of tough waterproof building paper. If more than one layer is used it will be found desirable to apply each layer separately, with nailing strips between the layers.

Window and door frames should be properly fitted. The lumber should be carefully fitted and laid on so that no cracks exist in walls and roof. Carpentry work at the gable joins should be of the best, because warm air rising to the top of the house escapes through any available crevice; also at floor junctions and floors over open verandahs to avoid infiltration of cold air.

Good results are secured by using a plastic caulk driven into cracks around door and window frames, etc., with a compressed air gun. Cost of such work is quite moderate.

*Waste Space*.—It is really astonishing how little advance has been made during the last few decades in types of houses and house construction designed to secure maximum advantage from the material used in respect of useful space, minimum heat loss in winter, minimum heat gain in summer, and cost.

Anyone who stops to consider for a moment the average residence of 2-storey-and-basement type will see that 30 to 40 per cent of the total gross volume is given over to unused attic space and inefficiently-used basement space. Probably the most economical house to build and maintain is the 1½-storey type, without dormers or breaks in the roof.

However, this type of construction still includes a basement. Messrs. Clement and Govan have recently stated†:—"The largest item of saving in construction cost is the omission of the usual cellars and concrete foundations. The building can be carried on concrete piers with their bases below frost level, or on creosoted cedar posts; and the floor should be well above the ground, to give good ventilation and to provide access to piping. Sewer and water pipes can be carried below frost level in a protected wooden box. If an insulated floor is used, a plain lattice or slat-work may inclose the under space. If a cellar is desired it should not be large. If a furnace is required where the rocky or swampy nature of the ground would make a cellar too costly, it can be placed in a small insulated addition at the ground level, but under these conditions a hot-air furnace is not satisfactory without fan circulation."

Additional benefits are secured by going to a flat-topped type of construction for two reasons. First, the enclosed space may be utilized to the limit. Second, full advantage can be taken of the natural heat insulation provided by nature in the form of snow which cuts down appreciably the heat losses through a roof on which it is permitted to remain.

### Inside Conditions

Under this heading are grouped those factors largely dependent on the occupants, such as temperature maintained, humidity, ventilation, etc.

Mankind is so constituted physically that it is necessary to maintain in the home a relatively narrow range

†"Planning and Design of Housing and Community Buildings," by Messrs. H. E. Clement and Jas. Govan, Engineering and Mining Journal, March 2, 1929.

of temperature for maximum comfort. This optimum temperature is approximately 68 degrees F. at 45 per cent relative humidity.

Assume the temperature is maintained at 69 degrees F. Then, for Chicoutimi, the seasonal heat requirements will be 2.5 per cent higher, as the requirement is directly proportional to the difference between the average temperature maintained inside and the mean outdoor temperature.

If the householder operates the heating system to maintain an average inside temperature of 70 degrees F. for twenty-four hours a day, it may cost 13.5 per cent more, in this district, than if 70 degrees F. were held for the sixteen daytime hours only and 55 degrees F. for the eight night hours, giving a daily average of 65 degrees F. While the value given is computed, considerable evidence has been accumulated during two years experience with some fifty electric house-heating installations showing it to be approximately correct. Moreover, there is no doubt that the mean daily temperature of 65 degrees F. meets all requirements as to comfort more satisfactorily than the higher temperature.

Numerous observations indicate that the occupants of an artificially-heated house are entirely comfortable with somewhat lower temperature during the daytime than at evening when seated at rest, when the temperature should be about 68 degrees F. at 45 per cent relative humidity. The daytime temperature may be possibly as much as 5 degrees F. lower but should approach the optimum comfort temperature gradually, reaching it at approximately 6 p.m. Such a temperature cycle results in a slight additional heat saving.

Maximum comfort and most healthful living conditions are secured by keeping the air at the right relative humidity or moisture content. Medical authorities agree that the relative humidity should be 40 per cent at least under the usual winter heating conditions. When the relative humidity is above 50 per cent. it will be found that condensation takes place on windows with storm sash in severe winter weather. That is, 40 to 50 per cent relative humidity is about the required range.

Numerous investigators have determined experimentally the relation between air temperature and relative humidity for maximum comfort. (See Fig. 8.) It will be noted that, with about 45 per cent relative humidity, a temperature of 68 degrees F. is comfortable, whereas at 30 per cent humidity 71.5 degrees F. is required. The apparent saving in heat requirement due to the lower temperature has been already indicated. The actual overall saving is much smaller, however, as a large proportion of the apparent saving is consumed in the evaporation of the necessary moisture. The real saving is the intangible one arising from better health and decreased deterioration of fabrics, furniture, etc.

Investigation has shown relative humidities as low as 15 per cent in better-class homes of the Saguenay district, and on the other hand, humidities of 50 to 75 per cent have been observed in some instances where occupants have closed every chink and cut down ventilation to a minimum. Such high humidities have been accompanied by condensation of moisture on the walls during severe weather with resultant damage to interior finish, etc.

It is unnecessary to add that great improvement in humidity can be cheaply secured in the average home by any one of numerous methods. This is particularly true with hot-air heating as the furnace can usually be designed with ample provision for humidification, or readily altered to secure it.

As indicated previously, infiltration of air into the average house is responsible for 20 per cent or more of the total heat requirements. It is also customarily considered that there should be one complete air change per hour in the occupied space. However, there is considerable evidence that all requirements of ventilation are satisfactorily met with about one-half or even one-third of the fresh air now admitted, provided there is good circulation of air within the room. That is, a saving of at least 10 per cent of the total heat requirements for the house can be secured.

One of the serious defects of most present-day house-heating systems is that no attempt is made to overcome the natural tendency of warm air to rise. It is the temperature of the strata in which the human body is immersed under normal conditions of rest and work that must be maintained at a suitable value. The higher temperatures occurring near the ceiling result in increased heat losses through the walls and ceiling or roof.

Observations in moderately well-constructed houses and buildings in this district, with hot-water and steam heating, has revealed at times temperature differences of 18.5 degrees F. between floor and ceiling, the ceiling being about 9 feet 6 inches high. With substantial construction, about 10 degrees F. represents the maximum difference ordinarily observed in −30 degrees F. weather. The highest differences, of course, occur when warming up in the morning.

It is generally considered desirable to hold room temperature constant at what is termed the "breathing line," a horizontal plane 5 feet above the floor. Observation indicates, however, that people at rest breathe in air at a level about 4 feet above the floor. Moreover, even in well-constructed houses, a temperature difference of 4.5 degrees F. between floor and breathing line has been noted. In view of the above, and considerable evidence in favour of warmer floors, it is probable that the optimum level for temperature maintenance is 2.5 feet above the floor.

The personal element has an extremely large influence on heating requirements and from the preceding, it is obvious that the temperature cycle followed, the humidity, and amount of ventilation maintained, affect the heat losses very appreciably and are subject to the control of the occupants.

In the case of fuel heating, there is considerable variation among householders in their ability to secure best results from a given quantity of fuel.

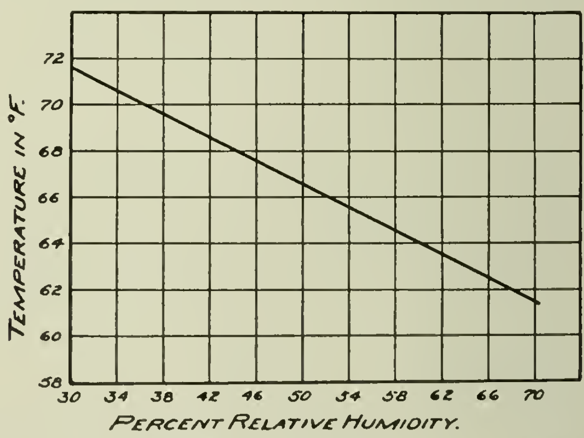



**Fig. 8—Relation Between Humidity and Air Temperature for Maximum Comfort.**

An illustration of the influence of the personal element on heat requirements is furnished by Fig. 9 which depicts the variation of monthly electrical energy consumption required for heating two identical houses due to occupancy changes and type of control over a period of four and a half years. These houses are adjacent and have about the same exposure. Note the extreme increase in consumption of house *A* in the early part of 1932 due to occupancy by three bachelors who regulated temperature by leaving the heater on and opening windows. In spite of a much more severe heating season for 1933-4 than for the 1932-3 season, house *A* had a lower consumption due to using automatic temperature control.

### *Heating Methods*

The heat transfer medium, type of heating equipment and control play an important part in the heat economy of a house. It is therefore proposed to briefly review the more important features, with additional detail on the recent developments in the Saguenay district.

#### Heat Transfer Medium

Heat may be transferred from the heating plant to the occupied space by four mediums: (*a*) hot air, (*b*) hot water, (*c*) steam, (*d*) radiation.

In general, heating systems in use in Canada are designed to maintain the required air temperature in the room. The air temperature then slowly warms the wall, floor and ceiling surfaces. The net result is a high air temperature and cool enclosing surface temperatures. A recent development in England, known as panel or radiant heating, is based on maintaining the proper amount of radiation to the body. The result is that the air temperature slowly increases. With radiant heating the mean air temperature is less so that there is a saving in heat loss through ventilation.

Hot-air heating is cheap, moderately flexible, moderately satisfactory in regard to circulation of air and probably ideal insofar as humidification is concerned. However, it possesses a disadvantage in that it is rather difficult to prevent dust getting into the air stream. Moreover, unless the warm-air distribution system is carefully designed, it is impossible to prevent serious air stratification and dead-air pockets. As the hot-air system has no inherent heat storage any undue diminution of the fire results in a decided degree of discomfort.

Hot-water heating is moderate in cost, simple, and has a considerable range in heating effect due to temperature. It has, however, a rather high temperature inertia and the heat supply lags behind demand. The inertia, nevertheless, tends to smooth out variations in heat supply from the fuel.

A modern development has increased the relative desirability of hot-water heating for houses enormously. It consists in the combination of a small noiseless fan with the radiator in a suitable cabinet. The use of a fan permits a smaller radiator surface for the same heat output, in fact about one-third of that which would be required without a fan. The total installation cost, including the fan, motor and wiring, works out at about the same as for the older system. Much better circulation of the air within a room is obtained. In addition, the fan-equipped radiator makes possible the use of the heating system for summer cooling by forcing room air over the radiator coils containing circulating cold water.

Figure 10 compares test and computed values for a radiator based on a temperature difference of 30 degrees F. between water and room temperatures. It emphasizes the effect of increased air velocities over the radiator surface.

Steam heating with the best modern control permits satisfactory maintenance of room temperature by varying either the quantity or temperature of the heating medium. While flexible as far as heat supply is concerned, steam heating does not appear suitable for home heating, being too complex and too difficult to operate and maintain.

Radiation or panel heating may be accomplished in several ways, such as coils of small pipe embedded in the walls or ceiling and furnished with hot-water or steam from the heating plant; similar coils located in the floor may be used; low-temperature electric heating elements embedded in walls, ceiling or floor surfaces. Developments in radiation heating utilizing low-temperature electrically-heated screens are under observation and offer promise.

#### Fuel-Burning Heating Equipment

Generally speaking, moderately comfortable conditions can be maintained reasonably economically with fuel-burning heaters in one or two rooms, but it is difficult to secure uniformly satisfactory temperatures throughout a house. However, research and inventive ability have resulted in the modern heating system, supplied from a central furnace, which is capable of meeting most requirements in respect of comfort, if properly designed for the particular application.

The fuel-consuming unit or furnace is the most important element in the heating system. Today, there are numerous well-designed furnaces for firing with various types of coal, coke, oil or gas. Some furnaces, such as the

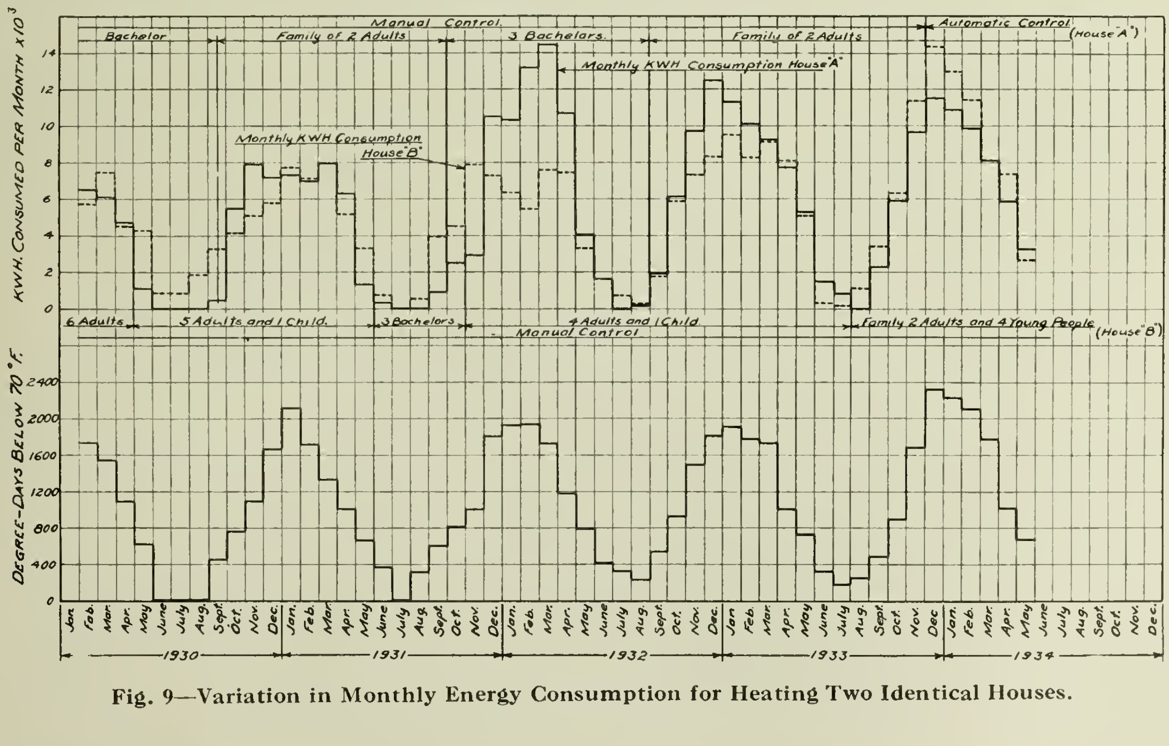



Fig. 9—Variation in Monthly Energy Consumption for Heating Two Identical Houses.

magazine type with blower, oil-burning and gas-fired, are designed for automatic operation with thermostatic control. Others are intended for manual firing only.

Automatic operation generally results in desirable savings, as there is not the tendency to overheat so evident with manual operation during periods of mild weather. Savings of 25 per cent have been secured with conversion

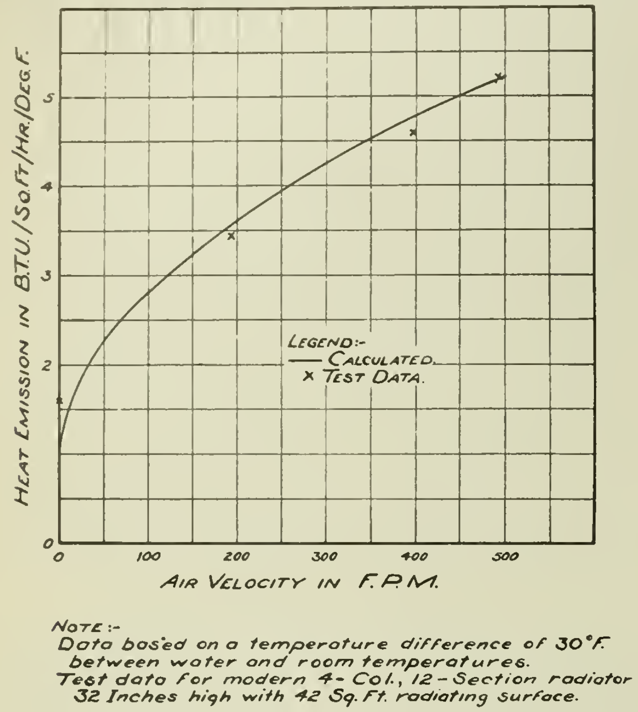



**Fig. 10—Heat Emission in B.t.u. per sq. ft. per hour per degree F. vs. Air Velocity; for Cast Iron Radiators.**

of ordinary steam heating systems circulating steam at pressures above atmospheric to sub-atmospheric systems due to the more perfect control. Also, the conversion of manually-controlled electric heating systems to fully automatic operation have resulted in savings of close to 30 per cent over a relatively long period of time.

To those interested in securing optimum economy from the fuel burnt, a perusal of report No. 10, a publication of the National Research Council, entitled "Fuel Saving Possibilities in House Heating," is recommended.

Table IV presents data derived from various sources relative to the efficiency of coal-fired domestic-type furnaces. The higher values, such as those from the Dominion Fuel Board's Second Progress Report, and tests by the United States Bureau of Mines, were secured during test runs under controlled conditions. Careful observations on furnace performance derived from comparisons between houses heated electrically and similar houses heated by fuel have shown an average efficiency of 50 per cent for the eight months heating season September 15th to May 15th, in the Saguenay district. The best seasonal efficiency appears to be approximately 55 per cent from the above set of comparisons.

While efficiencies approaching 60 per cent have been secured on test runs with the best Canadian air-dry wood fuel burnt in a hot-water boiler of the domestic type, it appears that not over 50 per cent seasonal efficiency, and probably less, would be secured with the air-dry wood fuel obtainable in this territory.

Oil-fired furnaces of the more modern type will probably give test efficiencies of about 75 per cent maximum. Average efficiency over the heating season would be about 65 per cent.

In connection with furnace efficiencies, it is well to remember that it is sometimes stated the hot-water needs of a household can be secured for practically nothing through the medium of a furnace coil. Far from it. Such a coil has been shown by test to require 16 to 20 per cent of the total fuel consumption.

Not all of the heat delivered to the heat transfer medium by combustion of the fuel in the furnace reaches the occupied space. A considerable amount is sometimes dissipated from uninsulated pipes and mains. For instance, in a typical house with hot-water heating some 15 to 20 per cent of the total radiating surface is possessed by the mains and risers in the basement and walls. Not all of this radiation constitutes a loss but a large part is used most inefficiently in heating a large basement space.

District heating is a further development of the idea of supplying heat from a central furnace to radiators or outlets throughout the house. Heat is produced by the consumption of fuel or excess hydro electric power in an

Table IV
Efficiency of Coal-Fired Domestic-Type Furnaces

| Source | Data on which Efficiency is Based | Per Cent Efficiency | | |
|---|---|---|---|---|
| | | Minimum | Average | Maximum |
| General literature. | Publications on heating, building insulation, etc. | | 60 | |
| Oil burner manufacturer. | In connection with oil-burner business | | 40-50 | 60 |
| Handbook of Building Construction, by Hool and Johnson. | Statement that average hot air furnace secures 7,000 to 8,000 B.t.u. per pound of anthracite coal | | 52-64 | |
| De Kermor, pp. 576-580, Electrical World, March 28, 1931. | Comparison between groups of similar houses, one group coal heated, the other electrically:— Climate with minimum temperature— | | | |
| | 48° F., degree-days 11,500, all season | | 36 | |
| | 10° F., degree-days 7,500, all season | | 28 | |
| | 3° F., degree-days 6,050, all season | | 26.05 | |
| | Tests by U.S.A. Bureau of Mines with hot-water furnace:— | | | |
| | Anthracite | 46.6 | 62.8 | 70.7 |
| | Semi-bituminous | 42.2 | 54.7 | 64.9 |
| Kent's Mechanical Engineers Handbook, p 1938. | Tests on cast iron sectional boilers of average residence size, steam, 8-hour test | | 64.1 | |
| Montreal Branch E.I.C. Fuel Committee, 1923, p. 344, July Eng. Journal. | Comparison on basis of cost of fuel in Montreal climate per 100 square feet radiator capacity:— | | | |
| | Welsh anthracite (all season) | | 62.3 | |
| | American anthracite (all season) | | 46.1 | |
| Second Progress Report, Dominion Fuel Board, pp. 29-30. | Tests on standard hot-water boilers of domestic type burning 1,000 pounds:— | | | |
| | Welsh anthracite | | 80.4 | |
| | American anthracite | | 70.2 | |
| | American semi-bituminous | | 65.2 | |
| Tests in Saguenay district. | All-season efficiency burning anthracite coal, metallurgical coke | | 50.0 | |

efficient central plant and distributed, throughout the area or community served by the district-heating utility, by means of well-insulated mains to the radiation in customers' homes and buildings. The heat transfer medium is commonly steam but hot water is used in some instances. Mr. F. A. Combe* has summarized the substantial advantages accruing from district heating.

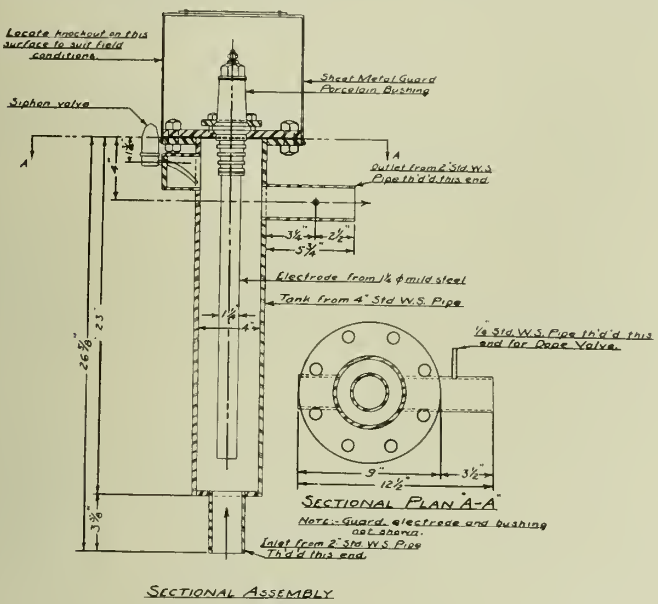



**Fig. 11—Electric Hot Water Heater for Residences.**

### Electric House Heating

House heating electrically is accomplished in a number of ways. Various forms of small radiant-type heaters may be located in rooms. Radiators with electric immersion heaters may be utilized. Low-temperature tubular heaters located around the baseboard are used to an increasing extent. Other systems utilize off-peak power at moderate cost by means of thermal storage in well-insulated hot-water tanks. If the heat transfer medium is hot-water, the hot-water may be circulated to the radiation by a small pump; if hot-air, air is drawn over heated surfaces and discharged through ducts by fans. Such systems are completely automatic.

A large-scale experimental application of electric heating to homes has been in progress in the Saguenay district for the last two years.

The heater used is a small electrode-type hot-water heater, as illustrated by Fig. 11. Power is supplied to the heater at 440 to 550 volts and is dissipated in the water between the electrode and tank. The hot water then carries heat to the radiation by natural or forced circulation.

The system is fully automatic. A thermostat responsive to air temperature controls the heater or heaters, where more than one is used, through a small magnetic switch, as illustrated by Fig. 12. When the air temperature rises slightly above the thermostat setting, power is cut off the heater by the opening of the magnetic switch. Likewise when the temperature drops below the thermostat setting, the magnetic switch is closed, throwing power on the heater.

The heater in this system is capable of meeting a wide range of heating demands as provision is made for changing the conductivity of the water in the heating system through the admission of a weak solution of soda ash or other suitable salt.

The system functions very well, and appears to meet all requirements. No particular difficulties have been encountered with approximately fifty installations.

Figure 13 depicts twenty-four hours of operation with such a heating system, the data being obtained from

*"Central and District Heating," by Mr. F. A. Combe, Report No. 3 of the Dominion Fuel Board.

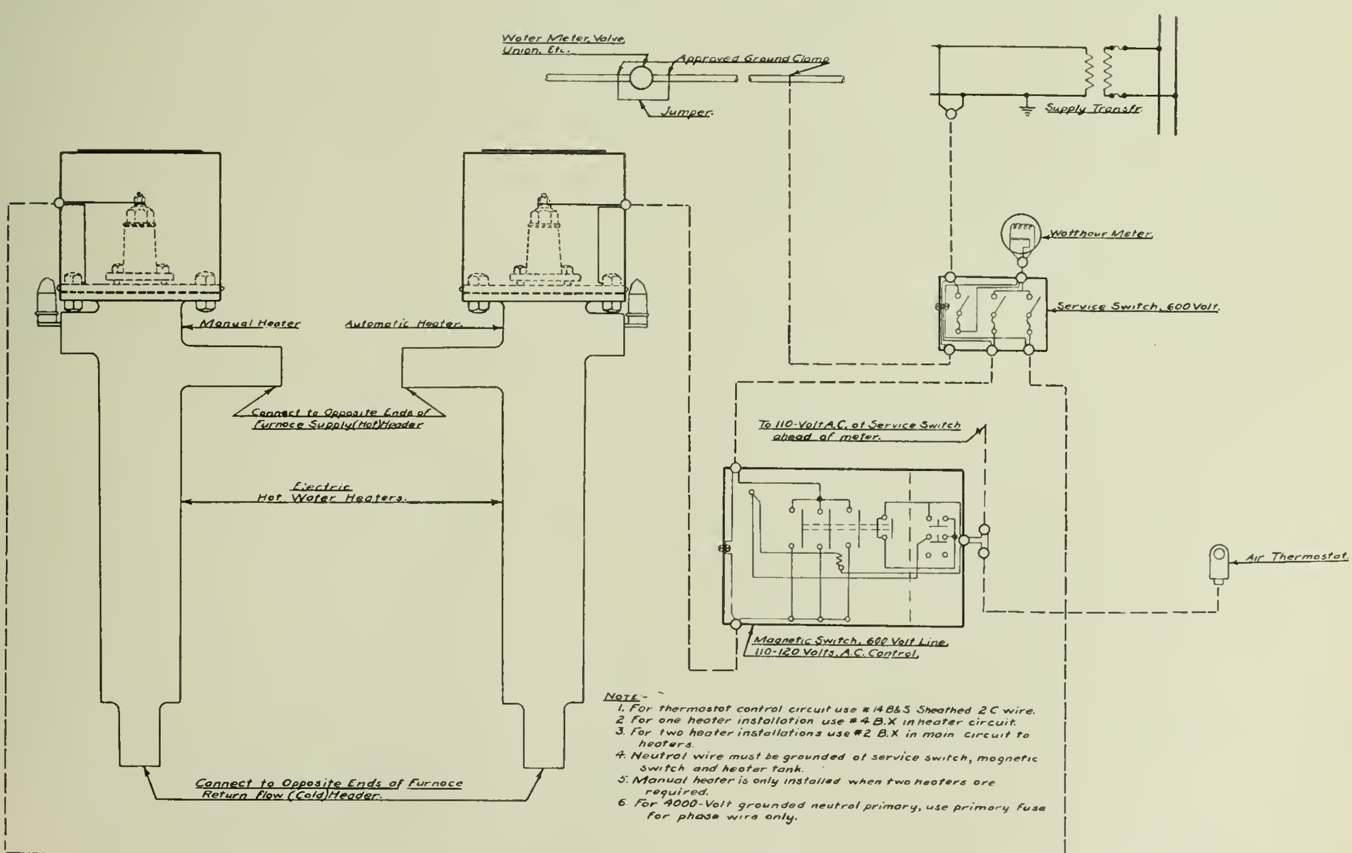


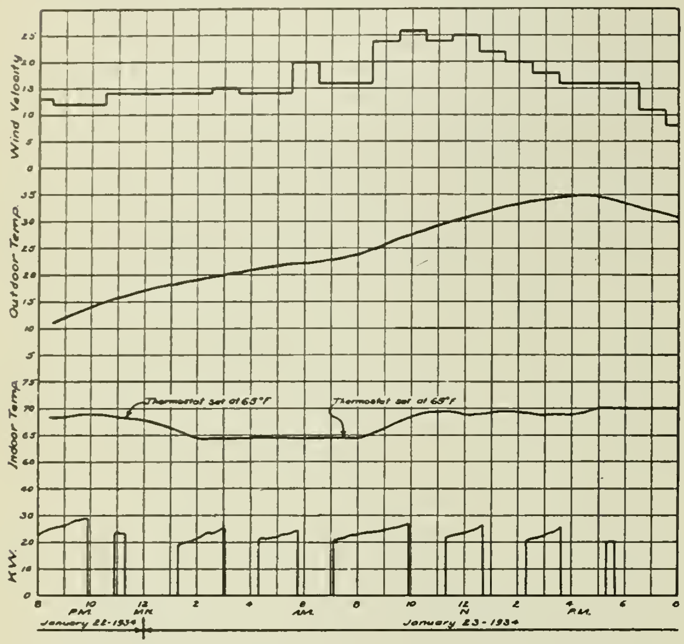

**Fig. 12—Wiring Diagram for Electric Hot Water Heaters.**

various graphic recorders. It shows the variation in power input with inside temperature, outdoor temperature and wind velocity.

Among the advantages of electric heating are the following:—

No smoke, smudge, ashes, dust or dirt, hence absolute cleanliness.

No gases or odours due to combustion of fuel.




NOTE :-
1. One and one-half story and basement. Substantial wood construction of 1" sheathing, 6" x 6" squared timbers, lath and plaster. Very substantial roof.
2. Moderate exposure.
3. Gross volume 34,270 cu.ft., Net volume 20,740 cu.ft.
4. KW.H/M.Cu.Ft. gross volume/degree-day below average inside temperature. = 0.1796

**Fig. 13—Power Input to Electric Hot Water System.**

Elimination of combustion, fire and flame from house, with increased fire-safety.

Constant temperature regulated as desired.

Automatic control so that house heating can be easily regulated to suit, or even left untouched for weeks at a time with the house vacant.

Heat available when and as required.

No coal and ash handling.

Maximum possible cleanliness of draperies, curtains, wall finish, etc.

No chimneys required.

Decreased ventilation requirements due to no air being required for combustion, and absence of chimneys.

Finally, one of the latest developments in the house-heating field, and the one which holds promise for the near future, is heating by reversed refrigeration.

While the cost of equipment is prohibitive at present, there is every prospect that the relatively near future will see it reduced to a point where the process is economically feasible for the home. Moreover, it offers manifest advantages in air conditioning the year round.

### *Heating Costs*

The final and all-inclusive consideration in a discussion of the heat economy of a house is the net over-all heating cost. This cost comprises two major factors which are: (*a*) Fuel costs, (*b*) intangible costs.

#### Fuel Costs

Everyone is fairly conversant with fuel costs. Probably not everyone, however, realizes, as shown in the preceding discussion, that every time he throws coal on the furnace fire not much over one-half of the heat units inherent in it reach the heating system, or that if he stopped the sources of loss in the house construction the shovelful would last much longer.

Fuel costs obviously vary with requirements, the skill with which the householder fires the furnace, etc. Naturally, best results are secured with a fuel such as electricity capable of 100 per cent efficiency in use and most suitable for automatic control.

To illustrate the relative fuel costs over the heating season, Fig. 14 has been prepared. It shows the cost relationship between the various sources of heat available in the district, based on the probable average seasonal efficiency of conversion, as stated.

#### Intangible Costs

The intangible costs of heating are much harder to ascertain than the fuel cost; however, they are quite real.

The United States Health Service has shown that all respiratory diseases increase from a minimum in summer to a maximum in February, the curve being roughly an inverse of the mean outdoor temperature curve, with a slight time lag.

Medical and associated services affect all so vitally that it is indeed strange more attention is not given to the maintenance of the most healthful conditions in the home.

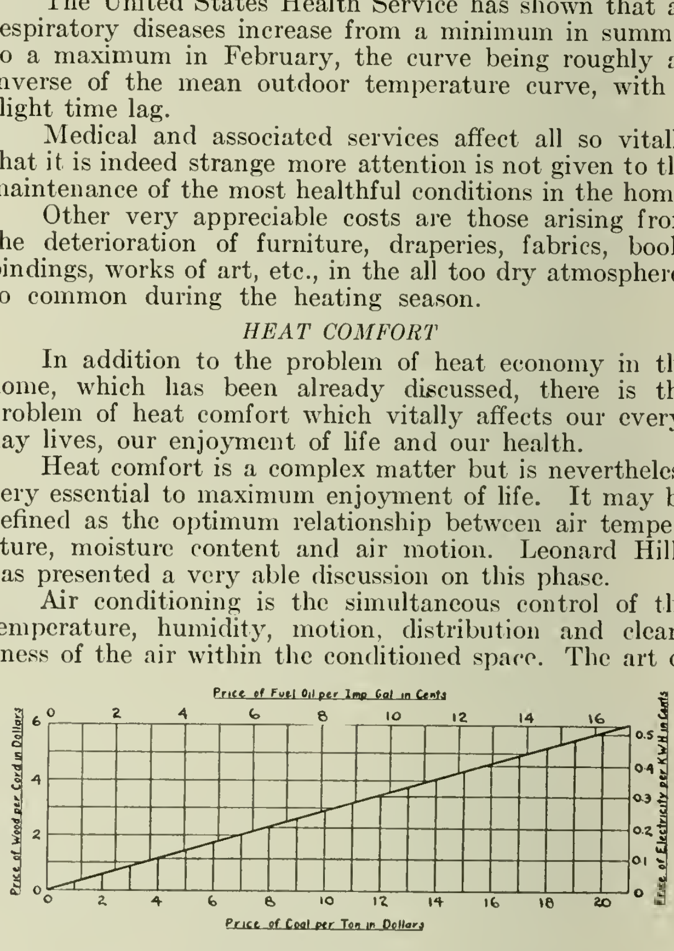
Other very appreciable costs are those arising from the deterioration of furniture, draperies, fabrics, bookbindings, works of art, etc., in the all too dry atmospheres so common during the heating season.

### *HEAT COMFORT*

In addition to the problem of heat economy in the home, which has been already discussed, there is the problem of heat comfort which vitally affects our everyday lives, our enjoyment of life and our health.

Heat comfort is a complex matter but is nevertheless very essential to maximum enjoyment of life. It may be defined as the optimum relationship between air temperature, moisture content and air motion. Leonard Hill* has presented a very able discussion on this phase.

Air conditioning is the simultaneous control of the temperature, humidity, motion, distribution and cleanliness of the air within the conditioned space. The art of




NOTE -
1 Wood assumed air-dry white birch, cut 16 ins long, containing 25,400,000 B T U per standard cord, burnt at 50% seasonal efficiency (From "Heating Value of Wood Fuels" by J D Hale, Forest Products Laboratories of Canada)
2 Coal assumed to be anthracite containing 13,500 B T U per pound as fired, burnt at 50% seasonal efficiency
3 Electricity consumed at 100% seasonal efficiency
4 Fuel oil assumed to contain 168,600 B T U per Imp. gal burnt at 65% seasonal efficiency

**Fig. 14—Comparative Seasonal Fuel Costs.**

air conditioning is really an enlargement of the art of heating, inclusive of those factors necessary to the maintenance of heat comfort the year round.

Under the head of "Inside Conditions" it was pointed out that a relative humidity of 40 to 50 per cent was required for most satisfactory comfort conditions in this climate. Considering Fig. 8, it will be noted that there

*"The Science of Ventilation and Open Air Treatment," His Majesty's Stationery Office, London.

is a definite relationship between temperature and relative humidity or moisture content.

Let us examine the moisture requirement for a home in the Saguenay district. Table V presents in tabular form the mean outdoor temperature and relative humidity at Arvida, Que., during 1933. While the relative humidity of the air during the heating season was high, the temperature was low, and hence the absolute humidity was low. The amount of water which must be evaporated daily to secure 45 per cent relative humidity at 68 degrees F. air temperature in 1,000 cubic feet of occupied space with one air change per hour was worked out and the daily requirement and its variation from month to month is given in Table VI.

Table V

Mean Outdoor Temperature and Relative Humidity at Arvida, Que., During 1933

| Month | Temperature Deg. F. | Per cent Relative Humidity |
|---|---|---|
| January | 11.4 | 93.97 |
| February | 9.5 | 93.14 |
| March | 16.9 | 88.50 |
| April | 36.3 | 80.15 |
| May | 48.3 | 66.95 |
| June | 59.2 | 71.50 |
| July | 63.9 | 75.85 |
| August | 61.4 | 79.63 |
| September | 54.6 | 87.13 |
| October | 40.8 | 82.60 |
| November | 15.4 | 89.90 |
| December | − 2.8 | 98.51 |

It is then evident that the maintenance of maximum comfort in a home in this district during January, 1933, required an average daily evaporation of 7.2 imperial pints per 1,000 cubic feet of occupied space assuming normal ventilation of one air change per hour, or a daily total of 9 gallons for an occupied space of 10,000 cubic feet.

The element of heat comfort which probably has the largest effect on our health is humidity. When the relative humidity is low in the home, the hot, dry air breathed into the lungs absorbs moisture from the mucous membranes and decreases their ability to filter out, as it were, the various disease germs.

Table VI

Amount of Water Which Must Be Evaporated per 1,000 Cubic Feet of Occupied Space, for Maximum Comfort, Assuming One Air Change per Hour

| Month | Amount of Water which must be Evaporated to Secure 45% R.H. at 68° F. Inside Temperature* |
|---|---|
| January | 7.2 Imp. pints daily |
| February | 7.4 |
| March | 6.8 |
| April | 3.9 |
| May | 2.3 |
| June | 0 |
| July | 0 |
| August | 0 |
| September | 0 |
| October | 3.2 |
| November | 6.9 |
| December | 8.1 |

*For Arvida, Que., based on 1933 data.

Temperature plays an important part also, as evidenced by the incidence of accidents in industry. The minimum occurs at about 68 degrees F. On either side, the accident rate is higher.

Properly-designed heating systems are necessary to maintain the correct balance between air temperature, humidity, and air movement which is so necessary to the proper functioning of the bodily temperature regulating mechanism.

It is probable that the apparent greater comfort experienced with radiation heating is due to a better balance between the bodily heat losses through convection and radiation than is secured with most present-day heating systems.

No matter how satisfactory a heating system may be installed in a house, it is impossible to secure real heat comfort unless the wall, floor and ceiling or roof construction is suitable.

It may be concluded that in the average home there are many ways in which better over-all results can be secured from the money spent for heating.

Another conclusion which may be drawn is that the average householder should give more consideration to his house heating from the angle of its effect on the enjoyment of health and comfort by his family and himself.

# THE SUBSTRUCTURE OF THE RECONSTRUCTED SECOND NARROWS BRIDGE

*P. L. Pratley, M.E.I.C.*[1]

## DISCUSSION

Major J. R. Grant, m.e.i.c.[2]

Since making a report for Messrs. Cleveland and Cameron, engineers for the Bridge Company, on the designs submitted for the Second Narrows bridge in 1914, the writer has followed with interest the different chapters in the eventful history of the project.

It was unfortunate that the high standards that governed the design in 1914 had to be so completely sacrificed in 1923. Mr. A. D. Swan in his paper on the Second Narrow bridge in the October, 1928, Proceedings of the Institution of Civil Engineers, stated:

> "Before the scheme was proceeded with, he informed the Bridge Committee and the people of Vancouver that it appeared to be possible to built a bridge which would be good enough for the purpose intended until such time as more money was available to provide a better structure."

The costs have increased until now the capital charge is a heavy burden while the poor facilities for highway traffic have not been improved.

In 1927, after many serious accidents to shipping, a Joint Committee of the Vancouver Merchants Exchange, Board of Trade and Shipping Federation of British Columbia requested a committee of local engineers to report as to the feasibility and cost of making such alterations to the bridge as would materially improve conditions. The writer as one of this committee recommended the conversion of the 300-foot fixed span into a lift span if the piers at either end proved to be satisfactory. The publication of Mr. Swan's paper in 1928, with details of the foundation of pier 2, appeared to eliminate this pier or any extension of it, as one of the supports for a long lift span with high towers and heavy counterweights. With the wreck of the 300-foot span in 1930 conditions appeared to be in favour of a swing span for the suggested reconstruction.

Mr. Pratley in his discussion of Mr. Swan's paper stated:

> "The reasons leading to the selection of a bascule of that type and at that point in the stream would, if available, be of considerable interest. Economy in first cost and in operation would appear to lie with the horizontal swinging type."

Or as stated by a well known authority on movable bridges:

> "When the conditions at the site are favourable and there are no restricting circumstances, a swing bridge is the simplest, best and most economical type in first cost and maintenance."

In the study of the different schemes for the reconstruction of the bridge was a swing span considered? A span north of pier 2, slightly longer than, but not as heavy as the 581-foot 6-inch swing span proposed by Sir John Wolfe Barry, Lyster and Partners for the structure in 1914, would have provided two openings each practically equal to the one provided by the present lift span. The vertical clearance would not have been restricted to 140 feet above high water, the load on pier 2 would have been less than what it originally carried and the obstruction in the waterway would have been considerably less than with the present structure. The trusses are only 20 feet centre to centre but the full width of the deck would have been available for lateral stability over pier 1, which could have been strengthened at a reasonable cost, to provide adequately for the loads it would have had to carry as a pivot pier. The two north 150-foot spans would have been strengthened to serve as the ends of the swing span. The saving in the cost of reconstruction and maintenance would have meant earlier relief of the north shore municipalities from the carrying charges on the bridge bonds they guaranteed.

Footwalks could have been provided on both sides to permit the span to swing through 180 degrees. Over the Harlem river, New York City, where heavy traffic and navigation require quick operation, swing spans have turned through 180 degrees without a stop, the one arm of the span following the boat as it passed through the channel.

Some engineers have a prejudice against the swing bridge and favour the bascule or lift span even for locations where the horizontal swinging type is the logical structure. This prejudice is sometimes due to a comparison of a modern bascule or lift span with an ancient swing bridge. Good salesmanship frequently sold a bascule bridge for a site where the needs of traffic and navigation, cost and æsthetics would have favoured the swing span.

Bascule and lift spans have an advantage when passing small craft as they have only to be lifted a short distance but the time required for the actual movement of the span is usually a small proportion of the total time traffic is delayed for the passage of a boat.

Timber fender piers would have been required for a swing span but should not all piers in channels used for navigation be provided with timber fenders for the protection of shipping? The Towboat Section of the Vancouver Merchants Exchange, in 1927 stressed the need of such protection to obviate the frequent breaking of log booms. The piers of the San Francisco-Oakland Bay bridge are to be provided with timber fenders although the two main spans are 2,310 feet. The long fender piers required for swing spans are frequently an aid to navigation.

It is unfortunate that the unsightly counterweight and counterweight trusses of the old bascule span have not been removed and that the original construction included the rock fill, extending from the south shore to pier 5, which undoubtedly increased the cross-current from the south shore to the north-east mentioned by the author.

P. B. Motley, m.e.i.c.[3]

There are a few remarks which occur to the writer in regard to the æsthetic side of bridge designing, which have been suggested by the details of the bridge.

A good appearance is an asset in connection with any structure, especially those which occupy such prominent places as bridges. Too many public works are not beautiful, and the engineer is usually looked upon as one who has not that quality which goes by the general term of "Art."

The designing engineer, on account of his desire to arrive at the stresses that will occur in a structure, often overlooks the æsthetic side. However, beautiful outlines can be obtained even in a steel framed structure just as in

[1] Paper presented at the Western Professional Meeting of The Engineering Institute of Canada, Vancouver, July 11th to 14th, 1934, and published in the August, 1934, issue of The Journal.

[2] Consulting engineer, Vancouver, B.C.

[3] Engineer of bridges, Canadian Pacific Railway Company, Montreal.

any other material, if the engineer combines in himself sufficient artistic instinct to correctly proportion his work. It is not sufficient for a mathematician to do his best—or worst—and hand the design over to an architect for beautification. What is required is the combination of the artist with the engineer in the same person, and while it may be a rare combination, it is not unreasonable that there should be some authority at Ottawa who shall have the power to veto designs which are likely to shock the artistic sense of the beholder.

In the case of the important work under discussion, the engineer for the construction company has admitted that the bridge was designed to suit a certain sum of money which was available. It seems that this, as a basis of bridge designing, is very undesirable, though far too common. A bridge should be built to suit the requirements of the case, and while true economy should always be kept in mind the cheapest design should not necessarily be approved.

In rebuilding this bridge, again cheapness has doubtless caused the engineers to leave in the old bascule and its counterweights. Would any architect have remodelled a building and left in so much of its original unused details for all to behold besides perpetuating the hazard to the structure should the span in question be struck by another ship, to say nothing of the cost of maintenance of the counterweight which is likely to be considerable. The cost of removing or redesigning the bascule bridge and the removal of the counterweight trusses would have been money well spent.

Mention has been made of the proposed glance booms to steer ships through the right span, and while no details of these are provided, they should be of such rugged construction that they can at all times be depended upon.

It is to be hoped that some day there will be an authority at Ottawa, who first of all shall have an æsthetic sense and then the power to say "No" to all cheap bridge designs, and thus avoid defacing the natural beauty of this country.

Otis E. Hovey[4]

The writer would refer to the wisdom of using fenders adjacent to the piers which support the lift span.

Near New York there was a Scherzer bascule span which was built over tide water. The rolling segment was supported on heavy plate girders between which was a double track open railway floor and heavy lateral bracing. A 10,000-ton steamer, out of control, struck the plate girder supporting span opposite the middle floor beam, and although the boat was moving very slowly, the force of the collision wrecked the floor system and laterals, and twisted the entire bascule span and its supporting girders on the piers so that the movement at one corner was nearly two feet. However, if each supporting pier had been provided with fenders of proper shape the steamer probably would have collided with one of them, and expended its energy in destroying the fender rather than in damaging the bridge. This bridge was out of service until extensive repairs could be made, while damaged fenders usually would not obstruct traffic.

Inadequate fenders may fail to protect a bridge superstructure as in the case where a steamer collided with the end of a centre pier fender of a swing bridge. The swing span was open and it struck the fender in the centre of its end. The fender was a little longer than the span and of light construction and the steamer cut through the fender, struck the end of the open span, also of light construction, and followed it endwise, causing a complete wreck of both the fender and the span. The damage to the boat was well above the water line and amounted to only a small fraction of that to the bridge.

When money is available for building a movable bridge, the additional amount required to protect the piers and the bridge by adequate fenders should prove to be a wise investment. If a vessel collided with a fender it would destroy a relatively cheap structure but probably would not damage the piers, or the bridge.

(4) Consulting engineer, 71 Broadway, New York, N.Y.

Wm. Smaill, m.e.i.c.[5]

There were originally proposals for a high level bridge, but only for highway traffic. Later a railway connection to the north shore was desired to develop the manufacturing sites there and it was also considered as an ideal place for a free port. An American firm of bridge builders stated they would build a bridge at this place for the amount of money and bonds which the bridge company had at that time, but after investigating, said that it could not be done for the amount available. The writer's company had just completed the Ballantyne pier and had equipment on the north shore for cylinder piers, and it was believed that a bridge might be built with these piers. The firm spent some $25,000 on soundings and meter readings, with the result that it was necessary to change the layout and use caissons.

Estimates were made for a swing span and finally a design was completed which it was felt could be built for the money and bonds available. It was decided to use air caissons on pier No. 2 and the bascule support. The writer was not proud of the layout, but it was the best that could be done with the funds available.

Seven different designs had been prepared, lift spans, 200-foot spans, 300-foot spans and a lift span with railway above it, and attempts were made to see if the Federal government would accept one of these. Any of these schemes would have cost less than the repairs cost on the bridge later. The government did promise to dredge the last span on the north, which would stop the cross-currents; however, they only dredged a short hole on the south side of the bridge. A bad cross-current comes down there, and would interfere with the up-traffic coming in at about high tide.

After the bridge was wrecked and six years after it was built, the Harbour Board brought in a regulation that boats were not to go through unless going against the tide. It is absolutely impossible for any boat going against the tide to hit a pier because the sheer of the water coming down would throw the vessel back away from the pier and keep it in the centre of the draw. There has not been a single accident at that bridge which has happened with a boat going against the tide.

R. K. Palmer, m.e.i.c.[6]

No accident has happened to the bascule span or in the operating channel but accidents have happened to the spans on both sides of the operating channel. It will certainly be unfortunate if a boat collides with the bascule under the new construction because the bascule is now supporting the back legs of one of the towers and as no boat would attempt passage unless the lift span were up, a wreck of the bascule span would crash the structure.

It is a curious thing that the old counterweight is left in place and is depended on to so modify the stresses in the bascule leaf as to partially take care of the new load coming in from the back legs of the lift bridge tower. Of course, with the bascule span not operating there are no reversals of stress in the counterweight framework and,

(5) Chief engineer, Northern Construction Company and J. W. Stewart Limited, Vancouver, B.C.

(6) Chief engineer and vice-president i/c operations, Hamilton Bridge Company, Hamilton, Ont.

therefore, little chance of trouble arising from the counterweight, although counterweights have given trouble in the past on operating spans.

JOHN PORTAS, M.E.I.C.[7]

The imposing list of accidents from which the Second Narrows bridge has suffered, draws attention to the grave responsibilities of the engineer in matters concerning choice of location and major features of design.

In the absence of any evidence justifying the original layout, the writer can only suppose that it was adopted in the interests of economy. Actually it has proved to be anything but economical, for the misplaced, undersized, movable span and the main pier situated in the middle of the shipping channel have occasioned heavy financial loss, caused serious inconvenience and damage to river traffic, and resulted in complete cessation of land traffic for a period of years. Because of its critical position at the intersection of land and water traffic, the case of the movable span calls for special attention. When, as in this case, the problem is complicated by extraordinary conditions of tide and current, the importance of preliminary studies cannot be magnified. The author's firm is to be congratulated on the care with which the preliminary work for the rehabilitation of the bridge was carried out and on the close estimate of cost which resulted.

The layout finally adopted, a lift span of 286 feet in the centre of the channel, should remove from the bridge, its well earned epithet, "a menace to navigation." Æsthetically also the structure must be considered satisfactory, in view of the limitations imposed by the original layout.

The writer has had occasion recently to make a preliminary design and estimate for a 300-foot double-deck lift span for combined highway and railway loading and is impressed by the economy of this type, in construction and operation. At the Second Narrows the choice of a vertical lift for this loading and span is obvious, but it would be interesting to hear if comparative estimates were made for other types.

The writer questions the desirability of making use of the old bascule leaf in the new structure. Was the saving effected by this means sufficient to justify such unconventional treatment of the problem? Has any thought been given to the possibility of strengthening this span by welding, and cutting away counterweights and supporting frame?

Of the many alternatives examined by the author's firm the one adopted—which involved the demolishing of the badly located pier No. 2—is the one which appeals to the cursory reader. If, as is suggested, the old 300-foot span was still serviceable it seems regrettable that it was mislaid. At very little cost it could have been converted into a lift span and the additional 14-foot span would have been by no means out of place on this difficult passage.

The account of the conditions of loading resulting in the maximum possible pressure at the base of the pier and of the effect of eccentricity of the shaft of pier No. 2 B, is most interesting. In view of the many accidents which have occurred in the past and the possibility of future collisions which may occur in spite of greatly improved conditions, it would be interesting to know if there are figures available showing the effect on a pier of a possible head-on collision by a ship of the maximum tonnage using this channel? Has any consideration been given to the necessity of providing fenders for pier protection?

[7] Chief engineer, J. W. Cumming Manufacturing Company, Ltd., New Glasgow, N.S.

P. L. PRATLEY, M.E.I.C.[8]

The author in replying to the discussion, wishes again to express his regret that he was unable to attend the meeting and to present in person his response to the observations offered and the questions raised. He is more than grateful to Colonel J. P. Mackenzie for reading the paper and is pleased that so many members found it interesting enough to comment upon.

Mr. Grant quotes from the author's own discussion on Mr. A. D. Swan's paper before The Institution regarding the need for remembering that the horizontally swinging span still has its place in the active service list of efficient movable bridges, and then adds a note to which the author heartily subscribes. The reference is to the fear that supersalesmanship has quite often been the controlling influence in displacing the non-patented swing span by the patented bascule.

Several gentlemen mentioned the retention of the old bascule in the completed work and enquired the reasons therefor. As pointed out, the removal of the bascule was found to be quite an expensive undertaking, the estimates made and received varying up to $60,000. Those responsible for financing the project could see no advantage in such an expenditure at this time, and under the governing circumstances no engineer could justifiably recommend it. Investigations were carried out regarding methods to be adopted if and when such a procedure could be undertaken, and as Mr. Portas surmises, the necessary strengthening of the flanking span was definitely considered as a welding job. The support and demolition of the concrete counterweight and its enclosed steel framework was naturally the most troublesome item in any removal scheme.

Whether the present ignominious position of the bascule is such as to evoke sympathy, commiseration or compassion, is a matter of opinion but there can be little doubt as to the negative value of the advertisement.

The author admits of no keener enthusiast for æsthetics in bridgework than himself, but, as Mr. Motley readily gathered, he was compelled to shut his eye to the old bascule and do the best he could with the new construction. As a matter of fact, viewed from the ferry boats or from Brockton Point, the new work has quite appropriate lines, and a satisfying appearance.

Mr. Grant also refers to the possibility of a 600-foot equal-arm span, using the old 150-foot spans as parts of its arms, resting on a huge pivot-pier, which would replace or absorb the existing pier No. 1, and using piers Nos. 2 and 00 as end rests. The swing-span possibility was not envisaged quite in this way by the author's firm, for reasons which seem sufficient to determine it as uneconomic. For instance, the pivot-pier would without doubt have to be entirely new, to avoid unequal settlements. The loads on its base would be enormous from consideration of its own weight and the weight of the totally supported swing-span above, even if cellular construction were adopted. The wind and current effects would probably prove quite important, quantitatively. To use the old 150-foot spans would remove the opportunity of lightening the swinging weight at essential points by adopting high-strength alloy steel. Pier No. 0 would have to be demolished and probably pier No. 00 would need extensions. Neither can it be agreed that pier No. 2 would necessarily be relieved of load, having regard to the specified conditions of swing-span loading and the resulting weight of materials. The bascule could have been retained in such a scheme as in several others illustrated in the paper, but no one wanted to retain it, and the re-use of its machinery was a desirable economic feature. Furthermore, it is at least questionable whether any saving in operation or maintenance could have been

[8] Monsarrat and Pratley, Montreal.

made, under the climatic and navigational conditions obtaining at the site. Finally, the matter of fenders arose as a serious additional cost, as fenders of some type would be absolutely necessary for a span extending 300 feet up and down the waterway. This question was also raised in the author's discussion of Mr. Swan's paper to which Mr. Grant made reference. Timber construction may be cheap in this neighbourhood, as Mr. Hovey suggests, but the amount of such timber work and the means for supporting it, without anchors in the waterway, would have added considerably to the cost of rehabilitation. Mr. Smaill points out the extreme improbability of a vessel striking a pier under present harbour regulations, and although it is recognized that rafts of logs may and do wrap themselves round the noses (of pier No. 1 especially), yet this type of occurrence involves no real danger to the superstructure, or even damage to the piers. Cutting such rafts loose is not a long or a hazardous job, and moreover the occurrence should become increasingly rare as the by-laws become better known and more strenuously enforced.

Mr. Palmer raises the question of collision between vessels and the old bascule span, now acting as south flanking span. Obviously such a collision cannot be dismissed as impossible, but the conditions of navigation are vastly improved, and no longer is a vessel asked to make for an unnatural 175-foot channel. Such conditions as may be imposed by regulation really constitute an engineering feature entering definitely into the design of the structure.

Answering Mr. Portas, it can be stated that various arrangements of bascule spans, single and double lift, were sketched and studied. Few of these advanced to the stage of being actually estimated because of physical or constructional problems which rendered them unsound or undesirable. No bascule arrangement giving equal lateral clearance seemed available without much greater cost, due largely of course to piers having to be placed in the deep channel without rock foundation. Mr. Portas raises a further point in attempting to appraise the effect of a possible head-on collision between a heavy ship and one of the piers. Mr. Smaill, as above mentioned, dealt with the general question, but the direct answer to Mr. Portas depends entirely upon the assumptions made regarding the rate of destruction of the ship's energy. The figures appearing in the calculation brief can be summarized as follows:—

If 1,000 tons dead weight moving at 10 feet per second strikes the east or west nose directly, head-on, and the energy is used up in one second, the equivalent blow is 313,000 pounds, and the lever arm from elevation 90 to the riprap level being 53 feet, the moment of this blow divided by the section modulus gives 1,200 pounds per square foot as the resulting extreme fibre stress. This unit obviously varies directly with the mass of the vessel and inversely with the time or space element allowed for the destruction of momentum or energy. Expressed in pounds per square inch the figure is apparently not excessive for ships of moderate tonnage, and no additional quantitative provision was made for such an eventuality.

# FORTY-NINTH
# ANNUAL GENERAL MEETING

AT

## TORONTO

## February 7th and 8th, 1935

The Annual General and General Professional Meeting will be held at the Royal York Hotel, Toronto, Ontario, on Thursday and Friday, February 7th and 8th, 1935.

Details of the arrangements will be announced in the December number of The Journal.

THE
# ENGINEERING JOURNAL
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VOLUME XVII NOVEMBER 1934 No. 11

## Progress Towards Sound Public Finance

An encouraging sign of the times is to be found in the increased extent to which professional men, business men, and those occupying responsible positions in our main industries are concerning themselves with public affairs and taking a national rather than a local point of view in discussing public problems. This tendency is no less marked in the west than in the east; the employee as well as the employer is seeking for information on problems of the day. The public is at last beginning to realize that even though conditions are improving, the outlook in Canada is serious so long as there are no definite prospects of relief from the burden of taxation, or assurance that our present burden of debt will be dealt with on sound business principles, and that our national budget will be balanced.

The only way in which the community can control taxation and enforce economy in public expenditure is through the vote, and the building up of an informed public opinion regarding these matters is therefore an essential preliminary to any constructive action. Among the organizations whose efforts are contributing to this very desirable end, the Canadian Chamber of Commerce stands high. Its campaign for sound public finance, directed by a committee of sixty business leaders under the chairmanship of Sir Henry Drayton, is now in its second year of activity. That committee is making studies of provincial as well as federal finance and taxation, and results beneficial to national economy have already been secured. Other activities of the Chamber include the consideration of such questions as immigration, extra-provincial taxation, fire-prevention in its national aspect, the encouragement of the younger men in studying public questions, the trade relations of Canada with Great Britain and the United States, and many other important topics.

The influence of the Chamber is further extended through articles on public questions contributed to the press and published in the Chamber's monthly magazine. An outstanding example of these is a recent discussion* of the debt situation in Canada, which may well be read in conjunction with the address on "Recovery by Construction,"† published in the last number of The Engineering Journal. Like Professor Jackson, Mr. McDonald points out that the Dominion has not yet faced the situation in the decisive manner adopted in Great Britain by clearing up government debts, by cutting down expenditure on all social services which are not indispensable, and by generally setting its financial house in order.

War debts, private speculative debts incurred during the boom, and governmental debts, are our chief obstacles to progress. The first two classes are no longer represented by any assets capable of providing means of repayment and are gradually being wiped out by the ordinary business processes of voluntary or forced concession. Debts of the third class, however, are due to the capitalization of federal, provincial and municipal government deficits, and to the failure to pay off debts incurred by our numerous governments for capital expenditure. Little, if any, progress is being made in regard to them.

In examining the way in which these government debts have grown in Canada, Mr. McDonald observes that most of our federal debt, and a large part of the debt of some of the provinces, has been the result of the conduct of business enterprises (including railway transportation) by governments. As regards governmental expenditure on social and educational work, he thinks the function of government should have been rather to see that such work is properly provided for, than to furnish the funds for it. A tendency is now becoming manifest for municipalities to lean on provincial governments, and for these in turn to rely on the Dominion government for support. "Looking at this situation," Mr. McDonald continues, "it must be obvious to everyone that Canadians must take a more intelligent and active interest in their governments and in the people chosen as their representatives. The functions of the different governments should be re-defined so that a situation where everybody seemed to be leaning on the central government might never occur again. In the definition of these functions the federal government should keep out of purely provincial and municipal affairs, retire entirely from the field of business and restrict its functions to those of a regulatory nature . . . It should be remembered that when a private business fails, the shareholders and creditors bear the loss, but when a government enterprise gets into difficulties the taxpayers must assume the burden of debt."

As regards the amount and incidence of taxation, we are in a very difficult position in this country. One fundamental difficulty in our present system of taxation is that it does not "bring home to every citizen of the community his responsibility to contribute to the cost of government." How can governments be expected to function efficiently while the general public displays little or no active interest as to what is really going on?

It happens that the burden of present financial conditions presses severely on the professional and salaried classes, to which The Institute's members belong. They have, therefore, a special interest in trying to bring about sounder conditions in government finance. The widespread organization of our branches, and the representative character of their membership in each locality, would seem to afford a special opportunity for constructive work on their part. Would it not be helpful if our members would occasionally turn from the consideration of engineering topics and technical papers to direct their individual and collective thought and effort towards arousing a local

*"The Challenge of Debts," Geo. C. McDonald, Canadian Business, April 1934, p. 18.

†"Recovery by Construction," Gilbert E. Jackson, Engineering Journal, October 1934, p. 460.

public opinion which will demand constructive progress in public finance, whether federal, provincial or municipal?

As one of the organizations affiliated with the Chamber, The Engineering Institute of Canada was recently asked to aid in the work of the Chamber's National Committee on Sound Public Finance, by submitting recommendations as to the conditions which it is desirable to observe in obtaining tenders and letting contracts for public works, this with a view of insuring efficiency and economy in carrying out these expensive undertakings. Gladly complying with the request, Council at once appointed a committee of prominent members, including two contractors, two government engineers, and a consulting engineer, and the committee's report, embodying the results of the wide experience of its members, will shortly be presented to Council for approval and transmission to the Chamber. It is a duty as well as a privilege for The Institute to assist in this way in the work of a body one of whose main purposes is to bring about much-needed improvement in our financial situation.

## Meeting of Council

A meeting of the Council of The Institute was held at the Royal York Hotel, Toronto, on Friday, October 19th, 1934, at seven thirty p.m., with President F. P. Shearwood, M.E.I.C., in the chair, and fourteen other members of Council present.

The membership of the Plummer Medal Committee for the year 1934 was approved as follows:

L. F. Goodwin, M.E.I.C., *Chairman.*
L. M. Arkley, M.E.I.C.
A. G. Fleming, M.E.I.C.
H. J. Roast, M.E.I.C.
N. C. Sherman, M.E.I.C.

Communications from the Winnipeg Branch were considered suggesting certain changes in the organization of the Branch Executive committee which it is hoped will facilitate the Branch's co-operation with the Association of Professional Engineers of Manitoba. The proposals were received with marked interest, and Council expressed its approval of the experiment, the results of which it will watch with great interest.

During the western journey of the President this year a number of questions regarding organization and policy were raised by the various branches. These having been placed before councillors by correspondence, the Secretary presented written opinions received in reply. It was found that some of the suggestions made had already been put in practice; one or two were not considered advisable, and in the case of the remainder it was decided to take no action at the present time.

The Council learned with sincere regret of the death of Calvin W. Rice, Secretary of the American Society of Mechanical Engineers, and a resolution of condolence was unanimously passed, the Secretary being directed to send a copy to the Society and to Mr. Rice's family.

One resignation was accepted, one member was placed on the Non-Active List, and two special cases were dealt with.

A number of applications for admission and for transfer were considered, and the following elections and transfers were effected:

| *Elections* | | *Transfers* | |
|---|---|---|---|
| Member | 1 | Assoc. Member to Member | 1 |
| Assoc. Members | 4 | Junior to Assoc. Member | 3 |
| Students admitted | 7 | Student to Assoc. Member | 1 |
| | | Student to Junior | 5 |
| | | Junior to Affiliate | 1 |

The Council rose at 12.03 a.m.

# OBITUARIES

## Calvin Winsor Rice

The death on October 2nd, 1934, of Calvin Winsor Rice, for nearly twenty-eight years Secretary of the American Society of Mechanical Engineers, ended the career of a man who has rendered distinguished services to the engineering profession.

He was remarkable for leadership, vision, enthusiasm and organizing ability, and for a genius for co-operation, gifts which enabled him to take a leading part in the movement which resulted in housing the activities of the great American engineering organizations in their monumental Engineering Societies Building in New York.

During his Secretaryship the Society developed greatly in prestige as well as membership, which grew from some three thousand in 1906 to over nineteen thousand in 1930 when the Society celebrated its fiftieth anniversary. His work in connection with professional-society organization and policies brought him into contact with a host of engineers of all nations; his many active international relationships were largely the result of his magnetic personality, his thoughtfulness, and his unfailing kindness and consideration. His activities in connection with the Kelvin memorial form an illustration of the spirit in which Dr. Rice seized every opportunity of promoting international comity. It is not generally realized that following the visit of the American Society of Mechanical Engineers to England in 1910, it was at his suggestion that through the efforts of British and American engineering societies a window in Westminster Abbey was provided, and the well-known Kelvin medal was established, as a memorial to his friend Lord Kelvin.

Dr. Rice was born at Winchester, Massachusetts, on November 4th 1868, and after attending school in his native town and at Boston and New Haven, was for four years at the Massachusetts Institute of Technology, graduating from that institution in 1890 with the degree of B.Sc. in electrical engineering.

Soon after graduation he became assistant engineer with the Thomson-Houston Company at Lynn, and later entered the service of the General Electric Company, and was stationed at Schenectady and Cincinnati. Subsequently he turned his attention to mining and obtained a position with the Silver Lake Mines in Colorado and the Anaconda Copper Mining Company of Montana. Later appointments were with the King's County Electric Light and Power Company, the New York Edison Company, the Consolidated Subway Company, the Nernst Lamp Company, and the General Electric Company in New York. In 1906 he became Secretary of the American Society of Mechanical Engineers.

Dr. Rice became a member of the American Institute of Electrical Engineers in 1897 and in 1900 joined the American Society of Mechanical Engineers. In addition he was a member of many other engineering and professional societies including the association of members in Argentina of the National Engineering Societies, the Koninklijk Instituut van Ingenieurs of Holland, the Club de Engenharia, of Rio de Janeiro, the Masaryk Academy, Czechoslovakia, the Deutsches Museum, Munich, Germany, the Instituto de Engenieros de Chile, the Technisches Museum, Vienna, and the Institution of Electrical Engineers of London.

Among other honours in Germany he received the honorary degree of Doctor of Engineering (Dr.-Ing.E.h.) from the Technische Hochschule of Darmstadt, in 1926.

The many courtesies shown by Dr. Rice to officers and members of The Institute will long be remembered. He was a welcome visitor to Canada on many occasions and his friends here will join in the regrets which the Council of The Institute has conveyed to the American Society of Mechanical Engineers and to Dr. Rice's family.

### Walter Charles Treanor, A.M.E.I.C.

Deep regret is expressed in placing on record the death at Ottawa, Ont., on September 11th, 1934, of Walter Charles Treanor, A.M.E.I.C.

Mr. Treanor was born at Roscrea, county Tipperary, Ireland, on September 12th, 1879, and received his technical education at the Great Southern and Western Railway Technical Institute and the City of Dublin Technical College, graduating from the latter institution in 1900. Mr. Treanor served an apprenticeship at the Great Southern and Western Railway works from 1895 to 1900. From 1900 to 1901 he was in the drawing office of the North Wall Marine and Engine Works, Dublin, and in 1901-1903 was junior engineer on the construction of the Fastnet Rock lighthouse, south of Ireland, in the Commissioners of Irish Lights' service. From 1903 until 1905 he was with the White Star Line as marine engineer, and coming to Canada in 1905 occupied the same position with the Canada Steamship Company on the Great Lakes. In 1906-1907 Mr. Treanor was engaged on the installation of the power plant and the erection of mechanical equipment of the Royal Mint at Ottawa, and in 1908, on the opening of the Mint, he was placed in charge of all the coining presses and remained in that position until the end of July 1913, when he was appointed by the Civil Service Commission, Canada, to the position of mechanical engineer in the Commissioner of Lights' Branch of the Department of Marine, Ottawa. Mr. Treanor was attached to the same Branch until the time of his death.

Mr. Treanor joined The Institute as an Associate Member on November 23rd, 1920.

### J. Emile Vanier, A.M.E.I.C.

With the death of J. Emile Vanier, A.M.E.I.C., at his home in Montreal on October 11th, 1934, The Institute loses one of its oldest members.

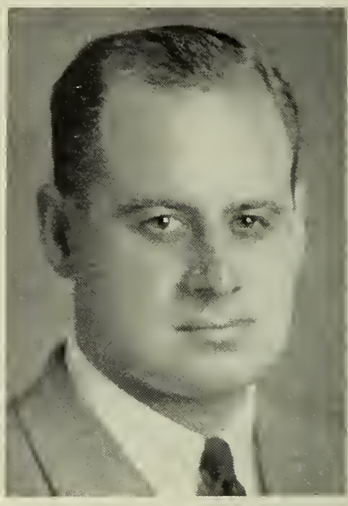
Mr. Vanier was born at Terrebonne, Que., on January 20th, 1858, and graduated from the Ecole Polytechnique, Montreal, in 1877. Following graduation he was assistant engineer on the Hochelaga sewers, and in 1878-1879 held a similar position on the irrigation works of the Lake Vineyard Land and Water Company, and the San Raphael Rancho tunnel at Los Angeles, California. In 1880-1881 and 1882 he was engaged on the preparation of plans, and superintending construction for various works, and in 1884 had charge of several hydrographic works, amongst these being one on the Riviere des Mille Isles in Terrebonne county. In 1885-1886 Mr. Vanier was chief engineer of the Valleyfield Water Works and of the Montreal and Western Railway, and in 1887 he held the same office with the Valleyfield Electric Light Company, later being chief engineer on the construction of a large highway bridge over the Yamaska river at St. Hyacinthe, Que. Later in the same year Mr. Vanier became chief engineer of the Cote St. Louis sewerage work, and in 1888 and 1889 was chief engineer of the St. Henry sewers also the Beauharnois and Lachine Water Works. Mr. Vanier later entered private practice as a consulting engineer and architect in the city of Montreal and at the time of his death was president of the Laurin and Leitch Engineering Company Ltd., and director of the Montreal Crushed Stone Company Limited.

Mr. Vanier was a prominent member of the profession and in 1927 was awarded the degree of D.A.Sc. by the University of Montreal. He was a member of the Royal Architectural Institute of Canada, and was a Past-President, and for many years Honorary Secretary, of the Architects Association of the Province of Quebec.

Mr. Vanier was a charter member of The Institute, joining on January 20th, 1887. He was made a life member on April 28th, 1933.

## PERSONALS

H. M. Black, A.M.E.I.C., has been appointed Ontario sales manager of the English Electric Company of Canada Limited, with headquarters in Toronto. Mr. Black graduated from McGill University in 1923 with the degree of B.Sc., and subsequently joined the staff of the Allis Chalmers Manufacturing Company, being engaged until 1924 on general design and checking, in 1924-1925 on engineering design and estimating, and in 1925-1927 as assistant to the engineer in charge of the steel mill division of the electrical department. In June 1927 Mr. Black became associated with the English Electric Company of Canada as representative in the Northern Ontario mining districts, which position he retained until 1931 when he became power apparatus salesman for the Northern Electric Company Limited at Toronto, Ont.



H. M. BLACK, A.M.E.I.C.

Richard Thorn, S.E.I.C., has joined the staff of Imperial Oil Refineries at Dartmouth, N.S.

W. M. Reynolds, A.M.E.I.C., has accepted the position of engineer with the God's Lake Gold Mines Company and is located at God's Lake, Man.

J. Y. Stanfield, S.E.I.C., who graduated from the Nova Scotia Technical College in 1933 with the degree of B.Sc., has joined the staff of the Consolidated Paper Corporation at Shawinigan Falls, Que.

G. A. Frecker, Jr.E.I.C., has been appointed lecturer in engineering at Memorial University College, St. John's, Newfoundland. Mr. Frecker graduated from the Nova Scotia Technical College in 1932 with the degree of B.Sc.

J. C. Kemp, A.M.E.I.C., has been appointed assistant to the president of Dominion Stores Limited, with headquarters at Montreal. Major Kemp, who was for some time in private practice as a consulting engineer, had been examining engineer with the National City Company at Montreal since 1926.

F. E. Palmer, Jr.E.I.C. is now designing engineer with Sherbrooke Machineries Limited, Sherbrooke, Que. From 1926 until 1931 Mr. Palmer was on the staff of Price Brothers and Company at Quebec and Riverbend, Que., and in 1932-1933 he was designing engineer with the Plessisville Foundry Company, Plessisville, Que. From that time until May of the current year Mr. Palmer was connected with Canadian Copper Refiners Limited at Montreal East, Que.

E. V. Moore, M.E.I.C., formerly district manager of coal sales for the Dominion Steel and Coal Corporation, Ltd., for New Brunswick and Prince Edward Island, with headquarters at Moncton, N.B., has been transferred to Toronto, where he is sales manager for the Ontario Dock and Forwarding Company. Mr. Moore was for many years closely associated with research work in connection with the manufacture of peat fuel, having been attached to the Division of Fuels and Fuel Testing, Department of Mines, Canada, and was responsible for the design and installation of the government peat plant at Port Alfred, Ontario.

Donald A. Gray, S.E.I.C., has joined the staff of the English Electric Company of Canada, Limited, Montreal, as sales engineer in the industrial field. Mr. Gray graduated from McGill University in 1925 with the degree of B.Sc., and was subsequently for two years with the Westinghouse Electric and Manufacturing Company at East Pittsburgh and Grand Rapids, Mich. He was later for a year and a half in the plant engineering department of the Bell Telephone Company of Canada Limited, following which Mr. Gray was for four years sales engineer in the compression department of the Canadian Ingersoll-Rand Company Limited, Montreal. He was more recently with Messrs. Laurie and Lamb, of Montreal, specializing in the sale of Diesel engines.

W. A. Mather, M.E.I.C., has been appointed general manager of Western Lines of the Canadian Pacific Railway Company, at Winnipeg, Man. Prior to graduation from McGill University in 1908 with the degree of B.Sc., Mr. Mather served with the Canadian Pacific Railway Company during the summer months as axeman, tapeman, rodman and instrumentman at Rush Lake and Deception, Ontario. In 1909 he was instrumentman at Kenora, Ont., and transitman at Laggan, B.C. In 1910-1912 Mr. Mather was resident engineer at Winnipeg and Portage La Prairie, Man., and in 1912 became acting superintendent at Kenora, Ont. From January 1913 until December 1914 he was superintendent at Kenora. For the first six months of 1915 Mr. Mather was superintendent of district 1, Alberta Division, at Medicine Hat, Alta., and from June 1915 until October 1918 he was assistant general superintendent of the British Columbia District, being located at Vancouver, B.C. From then until November 1922 he was general superintendent of the Saskatchewan district at Saskatoon, and in December 1932 Mr. Mather was appointed general superintendent of the Alberta district at Calgary. In May 1933 he was brought to Montreal as assistant to the vice-president of the company.

Graham Kearney, M.E.I.C., has been appointed district manager of the English Electric Company of Canada, Limited, and its subsidiary, the Canadian Crocker-Wheeler Company Limited, at Montreal, Que. Mr. Kearney graduated from McGill University in 1911 with the degree of B.Sc., and was subsequently, until 1917, connected with the Canadian General Electric Company successively as apparatus salesman, agent at Prince Rupert and Victoria, and district sales engineer at Vancouver. Mr. Kearney then went to China as professor of electrical engineering at the Tangshan College of the Chiao Tung University, which position he held until 1919, when he joined the staff of Andersen Meyer and Company Limited, remaining with them until 1926 and holding the following appointments: 1919-1921, engineering sales work; 1921-1923, in charge of engineering sales Tientsin Branch office; 1923-1925, manager of Canton branch office, and 1925-1926, manager of Hongkong and Canton branch offices. Returning to Canada, Mr. Kearney joined the staff of the Canadian General Electric Company Limited, Montreal, being engaged on engineering sales. In 1932 Mr. Kearney was engaged in private practice in Montreal, and in April of the present year he went to Vancouver, B.C., as a member of the firm of Sawford and Kearney, electrical and mechanical engineers.

## ELECTIONS AND TRANSFERS

At the meeting of Council held on October 19th, 1934, the following elections and transfers were effected:

*Member*

STEWART, Frederick Choate, B.A.Sc., C.E., (Univ. of B.C.), asst. engr., Greater Vancouver Water District, Vancouver, B.C.

*Associate Members*

BLAIR, Donald, (McGill Univ.), struct'l. designing engr., Department of National Defence, Ottawa, Ont.

CASTLEDEN, Geoffrey Percy, B.Sc., (Univ. of Sask.), asst. mechanic, Beattie Gold Mines, Duparquet, Que.

CLARK, George, dftsman., C.N.R. Winnipeg, Man.

DICKSON, Archibald, chief dftsman., Dominion Bridge Company, Calgary, Alta.

*Transferred from the class of Associate Member to that of Member*

LOVE, Alexander, B.Sc. (Eng.), (Glasgow Univ.), plant engr., Hamilton Bridge Company, Hamilton, Ont.

*Transferred from the class of Junior to that of Associate Member*

FRY, John Dawson, B.Sc., (McGill Univ.), engr., McDougall and Friedman, consltg. engrs., Montreal, Que.

GOODALL, Ernest Lorne, B.Sc., (McGill Univ.), res. engr., Provincial Paper Ltd., Port Arthur, Ont.

LAZENBY, Thomas William, sub-foreman, Project 37, Dept. National Defence, Kingston, Ont.

*Transferred from the class of Student to that of Associate Member*

BLACK, John Alfred, B.Sc., (N.S. Tech. Coll.), mill supt., Perron Gold Mines, Ltd., Amos, Que.

*Transferred from the class of Student to that of Junior*

ACHESON, Harry Ross Macdougall, B.Sc., (Univ. of Alta.), dftsman., Dept. Lands and Mines, Prov. of Alberta, Edmonton, Alta.

ADAMS, Eric G., B.Sc., (McGill Univ.), M.B.A., (Harvard Univ.), account executive, Cockfield Brown & Co., Montreal, Que.

BOWEN, John Alfred Clarke, (Univ. of Toronto), P.O. Box 294, Long Branch, Ont.

DOULL, Robert Morse, B.Sc., (McGill Univ.), asst. mgr., Construction Equipment Co. Ltd., and mgr., Gunite and Waterproofing Ltd., Montreal, Que.

SVARICH, John Paul, B.Sc., (Univ. of Alta.), 10564-98th St., Edmonton, Alta.

*Transferred from the class of Junior to that of Affiliate*

CHAUSSEE, Pierre Maurice, engr., elect'l. dept., Montreal Water Board, Montreal, Que.

*Students Admitted*

BLAIR-McGUFFIE, Malcolm Hugh, (McGill Univ.), 517 Pine Ave., Montreal, Que.

LOCHHEAD, John Starley, (McGill Univ.), 345 Ballantyne Ave. North, Montreal West, Que.

ROSE, Alexander, (McGill Univ.), 3806 Wilson Ave., Montreal, Que.

RULE, Albert Edward, B.A.Sc., (Univ. of Toronto), 100 Humbercrest Blvd., Toronto, Ont.

SMITH, Wilfrid Ewart, (Univ. of N.B.), 852 George St., Fredericton, N.B.

WIGDOR, Edward Irving, (McGill Univ.), 510 Wiseman Ave., Outremont, Que.

WONG, Henry G., (McGill Univ.), 1090 Chenneville St., Montreal, Que.

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### Exposition of Power and Mechanical Engineering

The eleventh National Exposition of Power and Mechanical Engineering is to be held at Grand Central Palace, New York, on December 3rd to 8th, 1934, occurring simultaneously with the Fifty-Fifth Annual Meeting of the American Society of Mechanical Engineers. It is stated that the latest developments in power economy and machine efficiency will be revealed. From the generation of power, through its transmission, up to the final machines which manufacture the products, literally in every phase of mechanical industry, the pageant of mechanical engineering progress will be complete.

## Nominations

The report of the Nominating Committee was presented to and accepted by Council at the meeting held on September 21st, 1934. The following is the list of nominees for officers as prepared by the Nominating Committee and published for the information of all corporate members as provided by Sections 68 and 74 of the By-laws.

List of Nominees for Officers for 1935 as Proposed by the Nominating Committee

| | | |
|---|---|---|
| President: | Frederick A. Gaby, M.E.I.C. | Toronto. |
| Vice-Presidents: | | |
| *Zone "A" | E. V. Caton, M.E.I.C. | Winnipeg. |
| *Zone "C" | P. L. Pratley, M.E.I.C. | Montreal. |
| Councillors: | | |
| ‡Halifax Branch | H. S. Johnston, M.E.I.C. | Halifax. |
| ‡Saint John Branch | G. A. Vandervoort, A.M.E.I.C. | Saint John. |
| ‡Saguenay Branch | G. H. Kirby, A.M.E.I.C. | Riverbend. |
| ‡St. Maurice Valley Branch | B. Grandmont, A.M.E.I.C. | Three Rivers. |
| ††Montreal Branch | A. Frigon, M.E.I.C. | Montreal. |
| | E. A. Ryan, M.E.I.C. | Montreal. |
| ‡Ottawa Branch | A. K. Hay, A.M.E.I.C. | Ottawa. |
| | E. W. Stedman, M.E.I.C. | Ottawa. |
| ‡Kingston Branch | L. F. Goodwin, M.E.I.C. | Kingston. |
| †Toronto Branch | A. B. Crealock, A.M.E.I.C. | Toronto. |
| ‡London Branch | J. A. Vance, A.M.E.I.C. | Woodstock, Ont. |
| ‡Border Cities Branch | C. G. R. Armstrong, A.M.E.I.C. | Windsor. |
| | R. C. Leslie, A.M.E.I.C. | Windsor. |
| ‡Lakehead Branch | G. H. Burbidge, M.E.I.C. | Port Arthur. |
| ‡Saskatchewan Branch | R. A. Spencer, A.M.E.I.C. | Saskatoon. |
| | S. Young, A.M.E.I.C. | Regina |
| ‡Edmonton Branch | R. M. Dingwall, A.M.E.I.C. | Edmonton. |
| | H. R. Webb, A.M.E.I.C. | Edmonton. |
| ‡Vancouver Branch | A. S. Wootton, M.E.I.C. | Vancouver. |

*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.

*Additional Nominations*

Section 68 provides also that "Additional nominations for the list of nominees for officers signed by ten or more corporate members and accompanied by written acceptances of those nominated, if received by the Secretary on or before the first day of December, shall be accepted by the Council and shall be placed on the officers' ballot."

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### Activities for Younger Members

The following notice received recently from the Calgary Branch of The Institute serves as an example of the manner in which many of the branches of The Institute are striving to interest the younger members. It is also in line with the thought expressed in the Editorial appearing in the October, 1934, issue of The Journal.

NOTICE

Calgary Branch

Younger members are invited to prepare short talks to be delivered in small groups at several of the General Meetings of the Branch during the coming season.

These talks will be in competition for a small prize or prizes, donated by a Member whose desire is to encourage contributions by the younger members.

The following rules govern:

1. Open to Corporate, Junior and Student members under the age of 30 years.
2. Competitors may choose any subject—preferably concerning work, research or hobby on which they have been personally engaged—not essentially technical, but desirably of an engineering nature.
3. Time of delivery not to exceed 10 minutes.
4. Notes permitted, but papers must not be read.
5. Notice of intention to compete to be in the hands of the Secretary not later than September 30th.

## RECENT ADDITIONS TO THE LIBRARY

**Proceedings, Transactions, etc.**

*Institution of Water Engineers:*
Transactions, 1933.
*North East Coast Institution of Engineers and Ship Builders:*
Transactions, 1933-1934.
*Institution of Mechanical Engineers:*
Proceedings, Vol. 126, 1934.
*Canadian Electrical Association:*
Proceedings of the 44th Annual Convention, 1934.
*Punjab Engineering Congress:*
Proceedings, Vol. 21, 1933.
*Society of Naval Architects and Marine Engineers:*
Transactions ,Vol. 39, 1931, and Vol. 40, 1932.
*Liverpool Engineering Society:*
Transactions, 1934.

**Reports, etc.**

*Federation of British Industries:*
Fuel Economy Review, 1934.
*Association of Ontario Land Surveyors:*
Annual Report, 1934.
*Royal Technical College, Glasgow:*
Calendar, 1934-1935.
*American Society for Testing Materials:*
1934 Supplement to Book of Standards.
*American Society for Testing Materials:*
Year Book, 1934.
*Canada, Dominion Bureau of Statistics:*
The Highway and the Motor Vehicle in Canada, 1933.
*Society of Naval Architects and Marine Engineers:*
Year Book, 1934.
*British Standards Institution:*
Engineering Symbols and Abbreviations, No. 560—1934.
*The Institution of Engineers, Australia:*
List of Members, 1934.

**Technical Books, etc., Received**

Analysis of Continuous Frames, by E. B. Russell. (*Ellison and Russell.*)
Principles of Mechanism, by C. E. Pearce. (*John Wiley and Sons, New York.*)
Die Castings, by H. L. Chase. (*John Wiley and Sons, New York.*)
Lighting Calculations, by H. H. Higbie. (*John Wiley and Sons, New York.*)
Design and Construction of Concrete Roads, by R. A. B. Smith. (*Concrete Publications Limited.*)

## BULLETINS

*Cut Gears*—A 12-page booklet received from the Hamilton Gear and Machine Company, Toronto, Ont., contains gear data required on enquiries or orders for cut gears and includes the recommended practice of the American Gear Manufacturers' Association.

*Packings*—The Canadian Johns-Manville Co., Limited, Toronto, have issued a 48-page booklet containing particulars regarding the various packings made by that company, and including a detailed list of packing recommendations for various services.

*Water Meters*—A series of five eight-page folders received from the Worthington-Gamon Meter Company, Harrison, N.J., gives information regarding their "watch dog" disc meters of the following types: Frost-proof model with open gear train and enclosed gear train; split case model with open gear train and enclosed gear train, and Model R disc meter. These water meters are made in ⅝, ¾ and 1 inch sizes.

*Gas Engines.*—The Worthington Pump and Machinery Corporation, Harrison, N.J., have issued a 6-page folder outlining the features, specifications and arrangement of type CG vertical gas engine.

*Packing.*—A 16-page booklet received from The Garlock Packing Company, Palmyra, N.Y., contains particulars of the Garlock Klozure used to retain oil and grease within a bearing and to exclude dust and dirt. A list of standard sizes is included.

*Concrete.*—The Portland Cement Association, Chicago, Ill., have issued a 48-page bulletin which contains a discussion of concrete bridge details, some of the subjects dealt with being abutment movements; wingwalls; bridge seats; bearings; expansion joints; prevention of seepage; wearing surfaces, etc.

*Gauging.*—A 28-page booklet received from Adam Hilger Limited, London, England, gives particulars and application of the Angle Dekkor and other optical tools for mechanical and engineering gauging and inspection.

*High Intensity Mercury Lamps*—A 4-page bulletin received from the Canadian Westinghouse Company contains particulars regarding the company's high intensity mercury lamp. The lamp is 12¾ inches long, 2 inches in diameter, consumes 400 watts, has an efficiency of approximately 35 to 40 lumens per watt, and is designed for an average of fifteen hundred hours. 240 volts are required in starting and 155 in operating.

## New Books of Interest to the Engineer

Building an Engineering Career, by C. C. Williams. McGraw-Hill, New York, 247 pp., $2.00. Primarily for college students. Describes what engineering is; the education necessary for and objective of engineering. The historical background and achievements in engineering.

The Design and Use of Instruments and Accurate Mechanism, by T. N. Whitehead. MacMillan Company, New York, 285 pp., $3.50. For those who use or design instruments such as clocks, precision lathes, carburetors and magnetos. Components of machinery for many industries. Treats with the theory of errors and general principles of design.

Engineers Sketch Book of Mechanical Movements, by T. W. Barber. E. and F. N. Spon Ltd., London, 6th edition, 355 pp., $4.50. Contains almost three thousand sketches of machines and machine elements of all kinds classified and indexed.

The Design and Construction of High Pressure Chemical Plant, by Harold Tongue. Chapman, Hall Ltd., London, 420 pp., 30s. Present status of high pressure commercial processes with details of the design and construction of major pieces of apparatus such as compressors, pipes, valves and fittings, etc.

Applied Acoustics, by H. F. Olson and Frank Wassa. Blakeston's Son and Co., Philadelphia, 430 pp., $4.50. Current practice in the field of electro-acoustics with the fundamental equations of sound developed and a description of microphones, telephone receivers and loud speakers, also a discussion of methods of calibration and fields of use.

Short Wave Wireless Communication, by A. W. Ladner and C. R. Stoner. Wiley and Sons Inc., New York, 384 pp., $3.75. Development of short waves, propagation, modulation and details of practical equipment used in modern practice. A final chapter on the ultra short wave field.

The Kinetic Theory of Gases, by L. B. Lock. McGraw-Hill, New York, 2nd edition, 687 pp., $6.00. Provides students and investigators with the classical and more modern aspects of the Kinetic theory. Suitable for text book or reference work.

Manufacture of Seamless Tubes, Ferrous and Non-Ferrous, by G. Evans. H. F. and G. Witherby, London, 187 pp., 40s. Concise description of the methods for making seamless tubing by rolling, drawing, extending and casting. Various processes and equipment also described.

Mathematical Treatise on Vibrations in Railway Bridges, by C. E. Inglis. MacMillan Company, New York, 203 pp., $7.50. Simple yet scientific formulae whereby the dynamic effects on bridges may be predicted with sufficient accuracy for practical requirements.

Heat, by J. M. Cork. Wiley and Sons Inc., New York, 279 pp., $3.00. Provides the advanced student with a survey of recent developments. Brief but complete with references to original papers.

Industrial Furnaces, vol. I, by W. Trinks. Wiley and Sons Inc., New York, 3rd edition, 456 pp., $6.00. Comprehensive exposition of the principles which underlie the design and operation of furnaces for heating and annealing metals. Discussed theoretically and practically.

Principles and Practice of Surveying, vol. II. Higher Surveying, by C. B. Breed and G. L. Hosmer. Wiley and Sons, New York, 4th edition, 603 pp., $3.50. Chiefly the conducting of topographic and hydrographic surveys, their control and details of methods used.

Cost Accounting and Control, by T. H. Sanders. McGraw-Hill, New York, 2nd edition, 517 pp., $4.00. Revised edition of "Industrial Accounting" brought up to date and including new problems introduced by government control of industry.

Loud Speakers (Theory, Performance, Testing and Design), by N. W. McLachlan. Oxford University Press, New York, 399 pp., $13.50. An aid to development and research in improving loud speaker design.

Mechanical Engineering Practice, by C. F. Shoop and G. L. Tuve. McGraw-Hill, New York, 2nd edition, 477 pp., $4.00. Reference text on experimental engineering. Discusses methods of mechanical measurement and the instruments used.

Power Plant Testing, by J. A. Moyer. McGraw-Hill, New York, 4th edition, 614 pp., $5.00. Details of approved methods of testing engines, turbines, boilers and power plant auxiliary machinery with descriptions of the apparatus used.

Design, Construction and Maintenance of Docks, Wharves and Piers, by F. M. DuPlat-Taylor. Ernest Benn, London, 2nd edition, 521 pp., 45s. The engineering commercial and managerial aspects of port works considered in a practical way.

Civil Engineering Handbook, by L. C. Urquhart. McGraw-Hill, New York, 885 pp., $5.00. Provides practising engineer with comprehensive book for reference. Divided into ten sections and pays particular attention to fundamental theory.

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*Canadian Johns-Manville Co. Ltd.*, Toronto, have announced in a new 16-page booklet a new type of electrical conduit "Transite Conduit" which is made of asbestos fibre and Portland cement combined under high pressure. Particulars and dimensions of various sizes are listed, ranging from 2 inches to 6 inches in diameter and 5 and 10 foot lengths.

## A Statistical Study of the Power Equipment in Canada

*H. E. M. Kensit, M.E.I.C.,*
*Ottawa, Ontario*

Estimates of the total amount of power installed in Canada usually contain only certain standard items for manufactures, mines, public utilities and sometimes steam railroads. These practically covered the field up to say twenty-five years ago—they have covered it less completely every year since and they no longer cover more than a fraction of it. A statement of the total power installed in Canada should include the total equipment necessary to the nation for at least all major uses and if it does not it is incomplete. Let us consider the case for making such a statement inclusive of all uses.

First take motor traction, by far the largest use of all. The first impulse is to think that this should not be included in such a list, but since we include steam and electric railroads without question and motor traction has now gained so large a part of the freight and passenger traffic of both classes of railroads that these are severely affected, it is surely illogical to exclude a use that has now become an essential in modern business and conditions of life.

Next consider agriculture. Few people realize the immense amount of power required for this and no previous estimate appears to have been made. The greatest demand for power in agriculture is for tractors for drawing harvesters, combines, binders, threshing machines, etc., and for motor trucks and automobiles for transport, all of which are just as necessary to the farmer as stationary power is to the manufacturer.

Then there is the power equipment of the army, navy and air force —a small matter in Canada but a large one in many countries and in view of the growing mechanization of military and naval forces, an essential part of the national existence.

Similar remarks apply to the smaller but growing field of commercial aircraft. This has been providing regular passenger and mail services for some years and giving immeasurable assistance in the development of our northern areas by both these and freight service. As Lord Londonderry, Secretary of State in Great Britain, recently put it: "Flying, which so short a time ago seemed almost miraculous, has become a common and necessary part of the equipment of civilization." In Canada, in spite of our very high railroad mileage, it is claimed that seventy-five per cent of the area of the Dominion is not yet served by either rail or road.

Lastly we may speak of shipping—that is the equipment of power-operated ships and boats; shipping creates large land industries and is an essential part of the national life—much of it is occupied in internal and coast-wise traffic and in Canada in particular there is the large and entirely internal traffic on the Great Lakes, and on the principal rivers, where water routes frequently form an alternative to the more expensive railroad haul; the power of the ocean-going ships of 1,000 h.p. or more constitutes only about 16 per cent of the total Canadian registration.

These last four important uses of power, in addition to what has been termed above the standard items or uses, are all essential to our business and prosperity—they furnish extensive employment and make large demands on our fuel resources, and it is submitted that there is no logical reason to exclude them from any statement of the national power equipment.

There are also several other minor uses that are not included in any census but reach a considerable aggregate, such as building and construction; municipal power for pumping, road machinery, etc.; hand industries and repair shops; dredging; drilling for oil and water; plants in railway stations and yards; private plants in office and apartment buildings, institutions, colleges, hospitals, etc., which may be termed non-industrial power. Buildings and construction and municipal power are considerable items that should be stated separately; the remainder of the above items may be put together under the heading of "miscellaneous."

The only country that appears to have so far attempted any complete estimates on the above lines is the United States, where several have been published. The most complete are two papers by C. R. Daugherty* that may well be referred to by those interested in the subject. It is now desired to form, as nearly as possible, a complete or "all-in" estimate of the total power required for all applications in Canada.

On the above defined bases an estimate, prepared from official sources on all main items and agreed therewith as to minor items, of the total power installed for all purposes in Canada is shown in Table I below. This table is divided into two sections, the first including all the subjects or uses covered by census and the allied applications not included in any census, and the second showing the additional national uses, which constitute a much larger aggregate.

Throughout the following matter we are speaking entirely of installed horsepower, that is of the primary horsepower as rated by

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*"Power Capacity and Production in the United States." Water Supply Paper 579, U.S. Geological Survey, 1928.

"Horsepower Equipment in the U.S." American Economic Review. September, 1933.

the manufacturer, not of actual use. The official censuses of manufactures, mineral industries and public utilities show the rated horsepower installed, that is the necessary equipment irrespective of the amount actually in use at any particular time, and it has been endeavoured to put all the other items on as nearly as possible the same basis.

Table I
Total Power Installed in Canada, 1932
(An "All-In" Table)

| | Census and allied uses | Primary horsepower | Per cent | |
|---|---|---|---|---|
| 1. | Manufactures | 1,463,000 | 8.0 | |
| 2. | Mineral industries | 195,000 | 1.1 | |
| 3. | Central electric stations | 6,529,000 | 36.1 | |
| 4. | Steam and electric railroads | 5,750,000 | 31.8 | |
| 5. | Agriculture | 3,453,000 | 19.1 | |
| 6. | Building and construction | 500,000 | 2.8 | |
| 7. | Municipal | 73,000 | .4 | |
| 8. | Miscellaneous | 125,000 | .7 | |
| | Sub-total | 18,088,000 | 100.0 | 21.8 |
| | Other Uses | | | |
| 9. | Army, navy and air force | 193,000 | | .2 |
| 10. | Commercial aircraft | 58,000 | | .1 |
| 11. | Ships and boats | 715,000 | | .9 |
| 12. | Motor traction | 64,000,000 | | 77.0 |
| | Grand-total | 83,054,000 | | 100.0 |

In the above table the items commonly included in statements of the "total power installation," viz. manufactures, mines and central stations, constitute only 10 per cent, or with the addition of railroads only 17 per cent, of the inclusive total, that is of the entire equipment required by the Dominion.

To make Table I of value, to make it satisfying, it is desirable to set forth the basis of each item therein, some because they seem so small and some because they seem so large, as follows:—

(1) *Manufactures.* The census of 1932 shows that excluding central stations, the total amount installed was 4,157,000 h.p. Of this electric motors operated by central station energy totalled 2,694,000 h.p. and this is included under central stations, so that the net primary power was 1,463,000 h.p.

(2) *Mineral industries.* The census of 1932 shows that the total amount was 924,000 h.p. Of this 637,000 h.p. was purchased from central stations, leaving 287,000 primary horsepower; 92,000 h.p. of this, used in manufacturing processes, was included in "Manufactures." The net primary horsepower was therefore 195,000.

(3) *Central electric power stations.* This is the total shown by the census for 1932.

(4) *Steam and electric railroads.* The annual reports of the Bureau of Statistics show the number of steam locomotives and the average tractive force in pounds, but do not give the horsepower. The formula used by the United States Bureau of Locomotive Inspection has been used for this purpose. To this there has been added 10,000 h.p. for electric railroads not included in the census of electric power stations. There is also a small amount for oil-electric locomotives.

(5) *Agriculture.* This item is so large that it will be well to describe the method of estimating it somewhat fully. The Census of Farm Facilities, 1931, lists the number of power producing units of each kind (including farmers' automobiles and trucks) but not the power rating thereof. The numbers of portable units as given by the census and the average horsepower as estimated by leading manufacturers are thus:—

| | Number | Average horsepower | Total horsepower |
|---|---|---|---|
| Automobiles | 321,276 | 58.4 | 18,750,000 |
| Motor trucks | 48,402 | 47.8 | 2,315,000 |
| Tractors | 105,269 | 27.0 | 2,840,000 |
| | | | 23,905,000 |

In addition to this there is estimated to be 24,000 h.p. in automotive combines and power equipment on harvesters and 682,000 h.p. in gasoline engines and electric motors, giving a grand total of 24,611,000 h.p. Some farmers have also developed small water powers but the amount of this is not known. This figure of nearly 25,000,000 h.p. for agriculture seems surprisingly high but except possibly to a small extent in the average horsepower per unit there appears no room for error. As regards the entry in Table I, to avoid duplication there has been deducted from this total the amount for automobiles and motor trucks, as these are included in registration returns and are therefore in the item for "Motor Traction," but not farm tractors which are not included in the registration, and there has also been deducted the amount for farmers' electric motors operated on purchased power and therefore included in the item for "Central Stations." The net amount shown in Table I is, therefore, made up of farm tractors, of automotive combines and harvesters and of gasoline engines, and totals 3,453,000 h.p., but the complete total is restated under the later heading for: "The Total Power in Separate Industries."

(6) *Building and Construction.* In Canada the Census collects no statistics of this and not even an estimate of the horsepower of plant employed therein is available. The Monthly Letter of the Canadian Bank of Commerce in June 1927 said:

> "In recent years building operations, the construction of roads and of power transmission lines and other work of similar character, have rightly been regarded as comprising a distinct industry, the importance of which cannot be over-emphasized. In 1926 construction of all classes exceeded in value of production every other industry except agriculture; it afforded employment for a great number of men—it provided for extensive use of mechanical equipment and it created a wide market for materials."

Many items might be added to the above extract; the construction of railroads and hydro-electric works with their power shovels, construction locomotives, cranes, stonebreakers, cement mixers, pile drivers, etc.—for example the vast equipment for the Queenston-Chippawa and Beauharnois Canals did not find its way into any census; construction of harbours, docks and wharves; contractors' woodworking and other shops, etc., etc. It is certainly too large and important an item to be omitted. The United States does not take a census of this either, but weighty estimates were from 6 to 10 million horsepower in 1929—say 8 million. Estimating for Canada pro-rata to population gives 660,000 h.p.—pro-rata to manufactures 585,000 h.p., and it appears that the figure may reasonably be taken at 500,000 h.p. Only a small part of this could be in use at the present time but it represents the equipment that is available for such work and that will be made use of as the business recovery gains momentum. It may be added that this figure represents only two per cent on the total of the first section of Table I.

(7) *Municipal.* Here again is a considerable amount of power that is not included in any census and for which there are no definite data—waterworks and sewage pumping (over 150 cities and towns use steam plants for this), road machinery, stone crushers, street sweepers and sprinklers, snow-plows, etc. It has been estimated at 5 per cent of the primary power for manufactures.

(8) *Miscellaneous.* A list of the principal items included under this heading was given in the introduction and it has been estimated at 110,000 horsepower.

Summing up regarding the first section of Table I, the only doubtful items, Building and Construction, Municipal, and Miscellaneous taken together amount to only 3.8 per cent of the total, and to only 0.8 per cent of the grand total—a trifling matter, but it is the aim to make this statement as nearly inclusive and correct as possible.

(9) *Army, Navy and Air Force.* The particulars for this item were obtained from the Department of National Defence. They include motor traction used by the defensive forces as this is not covered in the provincial registration of motor vehicles, but do not include purchased power as this is covered by the figure for central electric stations.

(10) *Commercial Aircraft.* This figure covers commercial and private aircraft and those lent by the Royal Canadian Air Force for commercial purposes. The record thereof is kept by the Department of National Defence.

(11) *Shipping.* This figure is obtained by summarizing the data in the Registry of Shipping of the Marine Department. About 94 per cent of the ships and boats registered therein were built in Canada and the great majority are clearly for local traffic.

(12) *Motor Traction.* The summary of registration figures issued by the Bureau of Statistics is the basis for number of vehicles, but this source does not give the horsepower. An approximate figure was obtained from manufacturers for the average horsepower of each class of vehicle such as passenger and taxi cars, trucks, motor-cycles, etc., and the total horsepower was obtained by the weighted average. It is thought that this must give quite a close approximation to the actual total.

### The Total Power Equipment in Separate Industries

As set forth in the foregoing explanatory notes to Table I, since that table shows the total installation in electric power stations and the total amount for motor traction in accordance with the registration records, to avoid duplication the figures for the leading industries do not show the total power equipment of each industry. To clarify this point as far as possible the total equipment for the three leading productive industries may be restated as follows. The first column includes purchased power in each case and for agriculture it includes power driven field machinery, which is equivalent to the stationary power for manufactures. The second column shows for agriculture the total power equipment including automobiles and trucks for transport, but no similar particulars are available for manufactures or mineral industries.

Total Equipment in Horsepower

| | Excluding Automobiles and trucks | Including Automobiles and trucks |
|---|---|---|
| Agriculture | 3,453,000 | 24,611,000 |
| Manufactures | 4,157,000 | ......... |
| Mineral industries | 924,000 | ......... |

Horsepower Per Capita

The population of the Dominion in 1932 was 10,506,000. Referring to Table I, items 1 to 4, which may be termed the regular or standard items, show an installation equivalent to 1.32 horsepower per capita—adding items 5 to 8, which are allied to and should be included with the regular items, the horsepower per capita rises to 1.72.

On the grand total for all items, including defensive forces, commercial aircraft, ships and motor traction, the figure becomes 7.9 h.p. per capita.

*The conclusion as to total power equipment is, therefore, that a modern nation such as Canada requires an installation of 8 h.p. per head of population to meet its normal requirements.* This, be it noted, is per head of population, not per "wage earner," these being less than 25 per cent of the total.

The foregoing has dealt entirely with the installed horsepower as classified by nature of use, and we may now consider the proportions of the various types of prime movers as set forth in the following Table II:

Table II
Types of Prime Movers, 1932

| | Installed horsepower in 1000's | | | |
|---|---|---|---|---|
| | Steam | Water power | Internal combustion | Total |
| 1. Manufacturing | 741 | 653 | 69 | 1,463 |
| 2. Mineral industries | 103 | 70 | 22 | 195 |
| 3. Central stations | 457 | 6,036 | 36 | 6,529 |
| 4. Steam and electric railroads | 5,740 | 10 | Small | 5,750 |
| 5. Agriculture | 57 | | 3,396 | 3,453 |
| 6, 7 and 8. (See Table I) | 413 | 147 | 138 | 698 |
| Sub-total | 7,511 | 6,916 | 3,661 | 18,088 |
| 9. Army, navy and air force | 129 | | 64 | 193 |
| 10. Commercial aircraft | | | 58 | 58 |
| 11. Shipping | 692 | | 23 | 715 |
| 12. Motor traction | | | 64,000 | 64,000 |
| Grand Total | 8,332 | 6,916 | 67,806 | 83,054 |

In the foregoing Table II, the sum of the water power used in the separate industries comes out a little less than the official figure at that date, so the latter will be substituted in the following summary for obtaining the percentages:

Summary of Table II

| Type of prime mover | Horsepower | Per cent |
|---|---|---|
| Steam | 8,332,000 | 10.0 |
| Water power | 7,045,000 | 8.5 |
| Internal combustion | 67,806,000 | 81.5 |
| | 83,183,000 | 100.0 |

In surveying the results shown in Table II, we should remember that they are for a country that is possessed of abundant water power and that has made exceptionally good use thereof—yet the water power plant is only 8½ per cent of the total for all purposes, and steam power, including railroads, accounts for only 10 per cent. It is the internal combustion engine, so little referred to in general discussions on the use of power, that supplies the vast majority of the indispensable power requirements of the nation—adding together all uses of these engines the total is nearly 68,000,000 installed horsepower or over 82 per cent of the grand total of power in Canada.

*The conclusion as to types of prime movers is therefore that in 1932 fuel plant (steam and internal combustion) constituted 92 per cent of the total installed in the Dominion.*

It is of course the case that if we consider the actual production and use of energy the situation is largely altered. If however we assume an average load factor of 70 per cent for water power (and with pulp and paper, electrochemical, electric steam boilers and other long hour uses it is about that), and an average load factor of only 15 per cent for fuel (including steam railways, motor traction, etc.), the energy produced by fuel plant in Canada would still be nearly two and a half times that produced by water power. It may be added that the assumed load factor of 15 per cent for fuel power covers all such plant in manufactures, mineral industries and central stations and that the "productive" or long hour portion of the traction load, such as taxis, buses, trucks and tractors, must possess quite a good load factor.

# BRANCH NEWS

## Border Cities Branch

*C. F. Davidson, A.M.E.I.C., Secretary-Treasurer.*
*F. J. Ryder, S.E.I.C., Branch News Editor.*

The regular monthly meeting of the Border Cities Branch was held the evening of May 18th, 1934, in the Prince Edward hotel.

Mr. Sheppard, of the firm of Sheppard & Masson, architects for Windsor's new Federal building, was the guest speaker.

He gave a very interesting picture of the points that were given special consideration in the construction of the new Post Office, a part of the government's employment programme.

Prior to the letting of the contract, test borings were taken to a depth of 40 feet and concrete piles were chosen for the foundation. However, the contractor after driving a test pile with considerable difficulty took further borings to an approximate depth of 127 feet. This uncovered subsoil conditions that were not expected and after consultation it was decided to put in a concrete mat foundation. Another point that had to be taken into consideration was the difference in bearing values of the soil at one end of the building to that at the other.

Mr. Sheppard then went into details regarding the sources of the Canadian materials and how well they compare with imported material.

Heating, ventilation, lighting and power were all considered. Special mention of the network system (3-4 wire) being made, as this is the first use of this type of wiring in the Border Cities.

The structure is built with the idea of future floors being added. In this connection, the elevator penthouse is designed of steel so that it may be knocked down and reassembled at the new elevation.

Mr. Sheppard extended an invitation to visit the building in a body, which was heartily accepted.

The following Friday evening the group reassembled at the new Post Office, where they became acquainted with the mechanical brains in the penthouse which controls the elevator, the up-to-date details in the boiler room, and the modern heating and ventilating devices.

## Calgary Branch

*J. Dow, M.E.I.C., Secretary-Treasurer.*
*H. W. Tooker, A.M.E.I.C., Branch News Editor.*

Through the courtesy of the management of the Earl Grey Golf Club, the members of the Calgary Branch of The Institute were on Saturday afternoon, September 15th, 1934, privileged to hold their annual golf tournament, which consisted of a nine hole competition and putting contest for both ladies and gentlemen.

The day was fine and quite a good number of the members turned out to enjoy this ancient out-of-door sport.

The prizes, presented by Mrs. G. P. F. Boese, were won by the following members and ladies:

| | | |
|---|---|---|
| Best Gross Score (Nine Holes) | 1st | F. Hughes. |
| | 2nd | R. L. Bonham, A.M.E.I.C. |
| Best Net Score Men (Nine Holes) | 1st | R. S. Stockton, M.E.I.C. |
| | 2nd | B. Fessenden |
| Ladies | 1st | Mrs. F. Peel. |
| | 2nd | Mrs. R. L. Bonham. |
| Hidden Hole (Handicap) | | B. P. Townsend. |
| Putting (Men) | 1st | G. P. F. Boese, A.M.E.I.C. |
| | 2nd | G. H. Patrick, A.M.E.I.C. |
| (Ladies) | 1st | Mrs. H. B. Sherman. |
| | 2nd | Mrs. T. Lees. |

Following the completion of the contests, tea, provided by the kindness of the ladies, was enjoyed by all, and presided over by Mrs. G. P. F. Boese, assisted by Mrs. J. Hadden.

## Halifax Branch

*R. R. Murray, A.M.E.I.C., Secretary-Treasurer.*
*C. Scrymgeour, A.M.E.I.C., Branch News Editor.*

The first meeting of the 1934-1935 winter season activities of the Halifax Branch of The Institute was held on Friday evening, October 12th, 1934, at the Nova Scotia Technical College, when the members of that Branch had as their guests the engineering students who had graduated from Dalhousie and St. Mary's College, and were commencing their training at the Technical College.

The chairman, R. L. Dunsmore, A.M.E.I.C., addressed the meeting and outlined the proposals for the season's activities, and also expressed pleasure at the large attendance of the members of the local Branch at the first meeting of the season.

Included in the regular business which was brought up for the attention of the members, was a resolution which was passed, and which endorsed the amalgamation of the Association of Professional Engineers and the Branches of The Institute in each province. This was as follows:

> "That whereas the members of the Halifax Branch of The Engineering Institute of Canada consider it to be in the interest of all members of The Institute that renewed steps should be taken to effect the amalgamation of the associations of Professional Engineers in the various provinces, with the Branches of The Institute

in each province, linking these organizations into one provincial body in each case, with the ultimate object of the formation of a Dominion-wide body formed from the provincial units.

Be it therefore resolved that the Halifax Branch of The Engineering Institute of Canada go on record as supporting any movement toward uniting the engineering organizations in each province and ultimately throughout the Dominion of Canada, and that the Secretary of the Halifax Branch be instructed to convey by letter to the General Secretary an expression of support of the Halifax Branch to any movement with these objectives and further that the General Secretary be requested to present this letter to Council at their next meeting."

At the conclusion of the regular business, Professor F. R. Faulkner, M.E.I.C., welcomed the students of the Technical College as guests of The Engineering Institute of Canada at this meeting, and expressed the hope that the students in their progress through college and into the engineering world, would become members of The Institute and thereby gain much benefit to themselves and also strengthen the membership of The Institute.

At the conclusion of these addresses, motion pictures were shown relative to the manufacture of aeroplanes, shipbuilding and the manufacture of steel, all of which were both highly instructive and interesting, and were appreciated by both the members of The Institute and their guests.

An informal social gathering concluded what was unanimously voted a very successful meeting.

## Hamilton Branch

*Alex. Love, A.M.E.I.C., Secretary-Treasurer.*
*Reported by A. B. Dove, S.E.I.C.*

A meeting of the Hamilton Branch was held at McMaster University on the evening of September 18th, 1934. The speaker of the evening, Dr. L. R. Hess, M.B., F.C.A.P., is one of Canada's foremost X-ray practitioners, and has gained an international reputation in the science. The meeting was the first of the fall series and members of the Hamilton Chemical Association were the guests of the Branch. The lecture room was admirably suited for this lecture and demonstration and the seating accommodation was taxed to its limit, about one hundred and fifty being present.

Dr. Hess was introduced by Professor C. E. Burke, Dean of the Faculty of Science at McMaster.

Dr. Hess stated that in the early days of X-ray, due in the most part to the frailty of the equipment, the science was adaptable only to medicine. Moreover the possibility of exposure of the operator's person to the rays, and the attendant dangers, made the equipment most unsatisfactory for use in other than medical lines. The science has so advanced, however, that apart from its great use in medicine, the X-ray may be applied to spectoscopy, examinations of welds, castings, determination of plate thickness, and even in the examination of sealed boxes with the use of the photographic film or the fluoroscopic screen.

Using the projector, Dr. Hess explained by sketches and pictures the construction of the main types of X-ray tubes and the method of the generation of the rays. From a frail, high vacuum glass tube, dangerous to handle, and uncertain in its work and constancy, there had been evolved a perfectly shielded air or water cooled tube, practically leak proof, and comparatively easy to handle, operating at 200,000 volts. These tubes have a life up to one thousand hours under normal conditions.

Dr. Hess confined the lecture principally to industrial applications of X-rays. Defects which do not appear on the surface are readily visible on the X-ray photograph, and in welded pressure vessels, when the weld is under examination, it is quite often possible to determine the cause of the defect as well as the defect itself. Dr. Hess showed a number of slides illustrating many of the industrial applications of X-rays. In the field of archeology it was also playing an important part, for the Egyptologist had found that the precious mummies which fall apart on exposure to the atmosphere, could be safely studied by the assistance of X-rays without any damage to the ancient corpse.

The speaker demonstrated the use of the fluoroscopic screen for the examination of a great variety of objects such as steel, rubber, wood, glass, leather, soap, and even sealed packages.

He also explained the action of a very interesting machine called the "dosimeter" which measures the quantity or "dosage" of X-rays being given to a patient, and has means of giving warning to the operator when a certain quantity has been given. This machine, of course, is not an X-ray machine but it is the meter used in this particular science.

Professor Walker, of the Chemistry Department at McMaster University, and this year president of the Hamilton Chemical Association, thanked The Engineering Institute of Canada for the opportunity of hearing Dr. Hess speak and proposed a vote of thanks to the speaker. This was enthusiastically endorsed by those present.

H. B. Stuart, A.M.E.I.C., chairman of the Branch, who presided at the meeting, expressed his gratification at the large attendance. He invited all to partake of coffee and sandwiches served in an adjoining room

*V. S. Thompson, A.M.E.I.C., Branch News Editor.*

The Hamilton Branch met in the Science Hall, McMaster University, on Tuesday evening, October 9th, 1934, about seventy-five members and friends being present. H. B. Stuart, A.M.E.I.C., chairman of the Branch, opened the proceedings with a message of welcome to visitors, pointing out that the Branch at all times gladly shared its privileges with any who were interested in its work.

Professor W. H. McNairn, Professor of Geology at McMaster, introduced the speaker of the evening, Rev. Dr. E. M. Burwash, geologist of the Provincial Department of Mines. Dr. E. M. Burwash is a man of great versatility, holding degrees in Arts, Divinity and Philosophy. He is a distinguished geologist, and has published many articles on that subject; he has also written a book on theology. Under the Department of Mines he made surveys during the summer and in the winter conducted courses of lectures for prospectors.

In introducing the subject, "The Geology of the Gold Fields of Ontario," Dr. Burwash showed on a slide the extent of the Pre-Cambrian rocks in North America, and detailed the strata that go to make up this system. He explained the sequence of events that left the rocks as we find them to-day, describing the sedimentary, intrusive, metamorphic, granitic and other rocks. It was in the quartz dykes of the Pre-Cambrian system that gold was found. Early prospecting, and in fact that done to-day for the most part, was on the outcrops. Where mining had been successful on the surface, dykes were sometimes followed down to great depths, the well known Hollinger being sometimes described as five hundred mines in one, as that number of veins were worked from the one shaft.

Dr. Burwash showed many slides prepared from recent geological maps, showing the geological structure at the most important mining areas. He also pointed out that some areas were not producing gold in spite of the fact that their geology would indicate that they should. Unfortunately the dykes did not always bear gold or they had it in such small quantity that it did not pay to work. Much of the north land was overlain with boulder clay which prevented examination for gold bearing quartz, and a great amount of the precious metal was thus possibly hidden from us.

E. G. MacKay, A.M.E.I.C., moved a vote of thanks to the speaker for his address, the audience warmly endorsing this, and the meeting adjourned to a neighbouring room, where refreshments were served.

## Lethbridge Branch

*E. A. Lawrence, S.E.I.C., Secretary-Treasurer.*
*J. E. Hawkins, S.E.I.C., Branch News Editor.*

The first meeting of the 1934-35 season of the Lethbridge Branch was held in the Marquis hotel on October 13th, 1934. This meeting, which took the form of a ladies night, was preceded by a dinner. During the dinner Mr. and Mrs. George Brown and their orchestra rendered several delightful musical numbers, while Messrs. R. S. Lawrence and Tom Smith rendered excellent solos.

At the conclusion of the musical numbers, chairman C. S. Donaldson, A.M.E.I.C., called upon Wm. Meldrum, A.M.E.I.C., chairman of the programme committee, to outline the programme that had been arranged for the season, which met with the hearty approval of the members.

The chairman having introduced the guests and visitors, who included Dr. Wyatt of the University of Alberta, then introduced the guest speaker of the evening, J. M. Wardle, M.E.I.C., Superintendent of the National Parks. As his lecture, Mr. Wardle gave a very interesting talk on the "Big Bend Highway" in British Columbia. The lecture was illustrated throughout with lantern slides and motion pictures, made by the National Parks Branch. The speaker stated that only about seven miles of the Big Bend highway remained to be constructed to complete the British Columbia portion of the Trans-Canada highway. The illustrations showed the difficulties under which construction is being carried out, and the manner in which these are being overcome.

At the conclusion of the lecture, and after questions had been asked and answered, N. H. Bradley, A.M.E.I.C., voiced the sentiments of the members as well as the ladies when he moved a hearty vote of thanks to Mr. Wardle.

After a short business meeting, all adjourned to the mezzanine floor where Mr. and Mrs. Donaldson were host and hostess for bridge for the remainder of the evening. While refreshments were being served the winners were announced, prizes being awarded to Mrs. C. Watson and Mr. H. W. Meech.

## Montreal Branch

*C. K. McLeod, A.M.E.I.C., Secretary-Treasurer.*

The first meeting of the season was held at Headquarters on Thursday evening, October 4th, 1934, when through the kindness of Vickers Limited, the members of the Branch were privileged to witness a series of six films.

Two showed operations at the steel making works of the English Steel Corporation, two the trials of the Vickers supermarine "Sea Gull V" and the "Scapa" twin engine flying boat and the "Vildebeest" torpedo-carrying plane. Another two showed the construction and trials of the P. and O. steamer "Strathaird" and "Strathnaver" at the works of Vickers-Armstrong Limited at Barrow-in-Furness.

Problems Facing The Institute

On Thursday, October 11th, F. P. Shearwood, M.E.I.C., the President of The Institute, was the principal speaker, the subject of his address being "Some Problems Facing The Institute," in which he discussed various subjects of interest to the members such as administration, employment, membership and technical activities.

He also referred to his attendance at the Western Professional Meeting of The Institute and the Annual Convention of the American Society of Civil Engineers held in Vancouver this year, and his visit to the western Branches of The Institute.

The meeting closed with a short talk on "Important Details of Machinery and Structures Fabricated by Welding" by R. H. Findlay, A.M.E.I.C., mechanical engineer for the Dominion Bridge Company Limited., Lachine, after which refreshments were served.

Meeting of the Junior Section

The first autumn meeting of the Junior Section of the Montreal Branch was held on Monday evening, October 15th, at which the programme for the Fall session was outlined, after which Mr. C. E. Frost, assistant engineer with the Montreal Harbour Commissioners, gave a short talk on his impressions of Mr. Hurst's book "The Technical Man Sells His Services." This proved to be most interesting and provoked a lengthy discussion. Light refreshments were served at the close of the meeting.

Construction Equipment of the Hoist Operated Type

On Thursday evening, October 18th, C. C. Langstroth, A.M.E.I.C., of the Dominion Hoist and Shovel Company Limited, gave a paper on "Construction Equipment of the Hoist Operated Type," which dealt with features of design and their effect on the operation of full revolving cranes, locomotive cranes and continuous chain crawler shovel cranes.

Electrical Section Meeting

Wednesday evening, October 24th, saw the first meeting of the Electrical Section of the Montreal Branch under the new arrangement whereby this section would hold separate meetings of a highly technical nature on nights other than the regular Thursday meeting night.

The paper prsented on this occasion was "Grounds and Grounding," by S. H. Cunha, A.M.E.I.C., which proved to be very interesting and led to considerable discussion.

## Niagara Peninsula Branch

*P. A. Dewey, A.M.E.I.C., Secretary-Treasurer.*
*C. G. Moon, A.M.E.I.C., Branch News Editor.*

Some fifty members of the Branch with their wives, friends and guests from the St. Catharine's Chemical Society visited Old Fort Niagara on September 28th, 1934, to view the restoration work which has been in progress for the last few years.

The "Old Fort" stands on the United States side at the mouth of the Niagara river, directly across from the little town of Niagara-on-the-Lake on the Canadian side, and undoubtedly many shots were exchanged between it and Fort George, which was General Brock's stronghold during the war of 1812.

Built in 1678 by LaSalle, under the name of "Fort Conti," it was the scene of alternate trading and fighting with the Indians and became important as the northerly end of the portage leading around the falls to the upper lakes. This portage route is now paved with concrete and may be followed by automobile to the southerly end at the town of LaSalle on the upper Niagara river.

The fort went through many vicissitudes under the French regime, being destroyed and re-built several times until, in 1759, the British captured it after the battle of LaForella. At that time, new stone block-houses and a central tower were constructed. The Treaty of Paris, in 1783, gave title to the United Colonies but it was not until thirteen years later that the British troops were finally withdrawn.

Since the battles of 1812, the old fort has been of little consequence and gradually fell into disuse and decay, with erosion from the river and lake Ontario threatening to destroy a major part of the property.

In the year 1924, the Men's Club of Youngstown with the assistance of William Wallace Kincaid obtained a grant of $22,000 from the War Department for restoration work. By 1927, twenty different local societies had banded together under the name of "The Old Fort Niagara Association" and since then, more than $500,000 has been expended in sea-walls and repairs to the buildings as well as replicas of many of the old-fashioned fittings.

Mr. Claude Hultzen, who has been in charge of the restoration, gave a most interesting address after dinner in which he told of the difficulties encountered in getting accurate information and in raising the necessary funds.

In the unavoidable absence of chairman W. R. Manock, A.M.E.I.C., the meeting was conducted by Paul Buss, A.M.E.I.C., our vice-president and councillor. E. G. Cameron, A.M.E.I.C., conveyed the thanks of the meeting to the speaker.

## Ottawa Branch

*F. C. C. Lynch, A.M.E.I.C., Secretary-Treasurer.*

The first noon luncheon of the Ottawa Branch was held at the Chateau Laurier on October 4th, 1934, with J. Grove Smith, Dominion Fire Commissioner, as the speaker. Alan K. Hay, A.M.E.I.C., chairman, presided, and in addition head table guests included His Worship the Mayor of Ottawa, P. J. Nolan, Tom Moore, R. E. Wodehouse, William Dickson, C. A. Bowman, A.M.E.I.C., T. J. Clark Reilly, Group Captain E. W. Stedman, M.E.I.C., J. Albert Ewart, A.M.E.I.C., J. E. N. Cauchon, A.M.E.I.C., and C. McL. Pitts, A.M.E.I.C.

Re-Housing a Nation

Mr. Smith spoke upon the subject "Re-Housing a Nation," and told the story of England's national housing policy. His address was illustrated with lantern slides.

Mr. Smith traced the history of national housing from the time of Charles the Second down to the present day. In 1858 the first Act was passed as a government measure dealing with the housing of the labouring classes.

The change in living conditions in Great Britain was exemplified by the statement that whereas in 1846 about 45 per cent of the population were urban in 1890 the proportion had increased to 80 per cent. As a result overcrowding had become a serious problem in all the larger industrial centres.

From the years 1900 to 1912 there were successive parliamentary inquiries into the housing problem. The Housing and Town Planning Act was enacted in 1909 and immediately twenty-three counties took steps to inaugurate town planning schemes. In 1912 a voluminous report was issued which has formed the basis of later action looking toward the betterment of conditions.

The Great War intervened but subsequently in 1919 the Housing Act was passed and further acts and amendments were passed later. A large number of houses were built under various schemes doing a great deal to alleviate slum conditions.

However, the very poor man has not been entirely provided for up to the present, as the type of houses generally built ranged in cost from about £286 to £350, with a rental value of from 9s to 13s per week. These houses were therefore available to the higher paid clerical and workingmen but not to those who were lower in the financial scale or who were on the "dole." It is estimated that about 6s 6d per week rental would be the limit for over a million people in Great Britain. It was hoped that these people would occupy the quarters vacated by those who would move into the new houses, but this has not developed.

In 1933 an Act was passed permitting local authorities to undertake a census of dilapidated slum districts in order to either effect repairs when such were advisable or to tear them down if it were not. The British people are, therefore, hopeful that within the next five years at least five millions of those people will be re-housed.

The problem was one which existed elsewhere than in England and the case of Poland was cited where there were probably more houses erected per capita in recent years than in any other country of the world. It was a problem that might have more adequately been dealt with in Canada, was the opinion of Mr. Smith.

## Peterborough Branch

*H. R. Sills, Jr.E.I.C., Secretary.*
*E. J. Davies, Jr.E.I.C., Branch News Editor.*

Annual Fall Outing

On Saturday, September 8th, 1934, about thirty brave and hardy members and friends of the Peterborough Branch ploughed through the mud and rain to the Rotary Boys' Camp on Clear Lake for the annual fall outing.

The rain spoiled the outdoor sports, so the afternoon was spent on indoor games and bridge. To compensate for the rain, poor partners and weak opponents, a very splendid dinner was prepared under the supervision of the camp director, Rotarian Doug. Loomis, to which all did ample justice.

After several speeches, and would-be speeches, we again attacked the mud and rain, and on arriving home decided that we had had a real jolly time.

## Sault Ste. Marie Branch

*H. O. Brown, A.M.E.I.C., Secretary-Treasurer.*

On Friday evening, September 28th, 1934. the fall opening meeting of the Sault Ste. Marie Branch of The Institute was held at the Windsor hotel. It was in the form of a dinner meeting with the chairman, E. M. MacQuarrie, A.M.E.I.C., in the chair.

Following the dinner and the usual general business, the evening was devoted to a discussion of some of The Institute problems as outlined in the President's address before the Branch on August 3rd.

A special committee with H. F. Bennett, A.M.E.I.C., as chairman lead the discussion. Three particular subjects were selected and each subject was introduced by a chosen member. These subjects were:

1. Relation of The Institute with Provincial Associations.
2. Administration.
3. Membership.

After a period of discussion on each subject a motion was presented and voted on by the members. From these motions the recommendations of the Sault Ste. Marie Branch was drafted and submitted to Headquarters in accordance with the wishes of the President.

# Preliminary Notice

## of Applications for Admission and for Transfer

October 24th, 1934

The By-laws provide that the Council of The Institute shall approve, classify and elect candidates to membership and transfer from one grade of membership to a higher.

It is also provided that there shall be issued to all corporate members a list of the new applicants for admission and for transfer, containing a concise statement of the record of each applicant and the names of his references.

In order that the Council may determine justly the eligibility of each candidate, every member is asked to read carefully the list submitted herewith and to report promptly to the Secretary any facts which may affect the classification and selection of any of the candidates. In cases where the professional career of an applicant is known to any member, such member is specially invited to make a definite recommendation as to the proper classification of the candidate.*

If to your knowledge facts exist which are derogatory to the personal reputation of any applicant, they should be promptly communicated.

**Communications relating to applicants are considered by the Council as strictly confidential.**

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The Council will consider the applications herein described in December, 1934.

R. J. Durley, Secretary.

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* The professional requirements are as follows:—

**A Member** shall be at least thirty-five years of age, and shall have been engaged in some branch of engineering for at least twelve years, which period may include apprenticeship or pupilage in a qualified engineer's office, or a term of instruction in a school of engineering recognized by the Council. The term of twelve years may, at the discretion of the Council, be reduced to ten years in the case of a candidate for election who has graduated from a school of engineering recognized by the Council. In every case the candidate shall have held a position in which he had responsible charge for at least five years as an engineer qualified to design, direct or report on engineering projects. The occupancy of a chair as a professor in a faculty of applied science of engineering, after the candidate has attained the age of thirty years, shall be considered as responsible charge.

**An Associate Member** shall be at least twenty-seven years of age, and shall have been engaged in some branch of engineering for at least six years, which period may include apprenticeship or pupilage in a qualified engineer's office or a term of instruction in a school of engineering recognized by the Council. In every case a candidate for election shall have held a position of professional responsibility, in charge of work as principal or assistant, for at least two years. The occupancy of a chair as an assistant professor or associate professor in a faculty of applied science of engineering, after the candidate has attained the age of twenty-seven years, shall be considered as professional responsibility.

Every candidate who has not graduated from a school of engineering recognized by the Council shall be required to pass an examination before a board of examiners appointed by the Council. The candidate shall be examined on the theory and practice of engineering, with special reference to the branch of engineering in which he has been engaged, as set forth in Schedule C of the Rules and Regulations relating to Examinations for Admission. He must also pass the examinations specified in Sections 9 and 10, if not already passed, or else present evidence satisfactory to the examiners that he has attained an equivalent standard. Any or all of these examinations may be waived at the discretion of the Council if the candidate has held a position of professional responsibility for five or more years.

**A Junior** shall be at least twenty-one years of age, and shall have been engaged in some branch of engineering for at least four years. This period may be reduced to one year at the discretion of the Council if the candidate for election has graduated from a school of engineering recognized by the Council. He shall not remain in the class of Junior after he has attained the age of thirty-three years, unless in the opinion of Council special circumstances warrant the extension of this age limit.

Every candidate who has not graduated from a school of engineering recognized by the Council, or has not passed the examinations of the third year in such a course, shall be required to pass an examination in engineering science as set forth in Schedule B of the Rules and Regulations relating to Examinations for Admission. He must also pass the examinations specified in Section 10, if not already passed, or else present evidence satisfactory to the examiners that he has attained an equivalent standard.

**A Student** shall be at least seventeen years of age, and shall present a certificate of having passed an examination equivalent to the final examination of a high school, or the matriculation of an arts or science course in a school of engineering recognized by the Council.

He shall either be pursuing a course of instruction in a school of engineering recognized by the Council, in which case he shall not remain in the class of Student for more than two years after graduation; or he shall be receiving a practical training in the profession, in which case he shall pass an examination in such of the subjects set forth in Schedule A of the Rules and Regulations relating to Examinations for Admission as were not included in the high school or matriculation examination which he has already passed; he shall not remain in the class of Student after he has attained the age of twenty-seven years, unless in the opinion of Council special circumstances warrant the extension of this age limit.

**An Affiliate** shall be one who is not an engineer by profession but whose pursuits, scientific attainments or practical experience qualify him to co-operate with engineers in the advancement of professional knowledge.

> The fact that candidates give the names of certain members as reference does not necessarily mean that their applications are endorsed by such members.

### FOR ADMISSION

BERRY—THEODORE VICTOR, of 3007 West 36th Ave., Vancouver, B.C., Born at Clacton-on-Sea, England, Feb. 12th, 1897; Educ., B.A.Sc., Univ. of B.C., 1923. R.P.E. (Civil) of B.C.; Summers 1920 and 1922, asst. to supt., Dominion Construction Co.; Summer 1921, asst. on topographic survey, City of Vancouver; 1923-24, calculator and dftsman. on hydro-electric surveys and investigations made by J. G. G. Kerry, M.E.I.C., for the City of Vancouver; 1924-26, asst. in municipal engrg. dept., City of Vancouver. Varied experience in design and constrn. of various projects; 1926-30, asst. to W. H. Powell, M.E.I.C., engr., Greater Vancouver Water District. On location, design and constrn. of various projects, including Burwell, Palisade and Loch Lomond storage projects, Seymour Falls Dam, Vancouver Heights Reservoir, Boundary Road Supply Main, Vancouver to Westminster Supply Main, etc., and Aug. to Nov. 1930, asst. to G. M. Gilbert, A.M.E.I.C., on constrn. of English Bay Interceptor; Jan. 1931 to date, secretary-treasurer, Vancouver and Districts Joint Sewerage and Drainage Board, Vancouver, B.C.

References: E. A. Cleveland, W. H. Powell, J. R. Grant, G. M. Gilbert, F. V. P. Cowley, W. O. Scott.

NORTON—JOHN ARTHUR, of 21 Harvie Ave., Toronto, Ont., Born at Toronto, March 16th, 1909; Educ., Evening classes, Advanced Maths., Toronto Technical School. I.C.S. Mech. Engrg. Course; 1926 to date, with H. Griffiths & Company, Toronto—1926-1928 as estimator and designer, from 1928 in charge of all designing and engrg. on work undertaken by the company, including power house and steam distributor at the Can. Gen. Elec. plant at Peterborough. From June 1934 mech'l. supt. or supervising engr. at the North Toronto Sewage Treatment plant, in sole charge of this contract.

References: W. Storrie, J. F. MacLaren, I. H. Nevitt, F. M. Byam, D. Shepherd, D. Cameron.

TREMBLAY—SOLYME NEREE, of Montreal, Que. Born at Les Eboulements, Que., May 11th, 1889; Educ., 2 years, Laval University (surveying); Member by examination of the Corpn. of Prof. Engrs. of Quebec, May 1934; 1911-13, chainman, 1913-14, instr'man., twp. subdivision in Alta.; 1914-19, war service; 1919-21, asst., twp. subdivision in Abitibi, Que.;1 924-26, field engr. on constrn., Port Alfred Pulp and Paper Mill, Mercier Dam, for the Foundation Company; 1926-30, field engr., topographical surveys, location of transmission lines, expropriations, estimates, costs, etc., Gatineau Power Co.; 1930 to date, engr. for the Quebec Streams Commission, topog'l. surveys, ice studies, precise levelling, investigation on property damaged by flooding, etc.

References: O. O. Lefebvre, W. E. Blue, P. E. Bourbonnais, G. J. Dodd, G. G. Gale, S. F. Rutherford.

WINDER—JOHN, of 5400 Waverley St., Montreal, Que., Born at Roanoke, Va., U.S.A., June 27th, 1889; Educ., Evening classes, and Amer. Corres. Schools; 1905-15, with the C.P.R., 1909-15, elect'l. constrn. and mtce., testing and inspection, and 1910-13, telephone equipment mtce. and inspection; 1915 to date, with Molson's Brewery Ltd., 1916-20, elect'l. constrn. and buying of materials, 1920-34, elect'l. constrn. and laying out of new work, mtce. of elect'l. equipment, at present chief electrician and elect'l. engr.

References: J. A. Shaw, J. W. Hughes, G. S. Clark, W. R. Bunting, S. G. Macdermott, C. P. Creighton, G. K. McDougall.

### FOR TRANSFER FROM THE CLASS OF ASSOCIATE MEMBER TO THAT OF MEMBER

BERRY—ALBERT EDWARD, of 235 Gainsborough Road, Toronto, Ont., Born at St. Mary's, Ont., Oct. 6th, 1894; Educ., B.A.Sc. 1917, M.A.Sc., 1921, C.E. 1923, Ph.D. 1926, Univ. of Toronto; 1915-16 (summers), gen. engrg. and contracting; 1917 (6 mos.), Ontario Department of Health; 2 years, overseas. Lieut., R.E.; 1919-26, sanitary engrg. asst., and 1926 to date, director, sanitary engrg. divn., Ontario Department ofHealth. (*A.M. 1921.*)

References: C. R. Young, R. E. Smythe, W. B. Redfern, R. O. Wynne-Roberts, G. G. Powell, W. Storrie.

COLHOUN—GEORGE A., of 84 Dalewood Crescent, Hamilton, Ont., Born at Sparta, Elgin Co., Ont., Dec. 23rd, 1881; Educ., Grad., S.P.S., Univ. of Toronto, 1906; 1906 to date, with the Hamilton Bridge Company as follows: 1906-10, dftsman., 1910-14, checker, 1914-21, designer, 1921-29, asst. to designing engr., and 1929 to date, designing engr., in charge of designing and estimating department. (*A.M. 1919.*)

References: R. K. Palmer, E. H. Darling, H. B. Stuart, A. Love, F. W. Paulin, W. G. Milne.

MOUNT—WILFRED ROWLAND, of 11408-100th Ave., Edmonton, Alta., Born at Reading, England, Dec. 5th, 1888; Educ., 1905-08, Camborne School of Metalliferous Mining, Cornwall, England (Certs. in all subjects); 1908-10, practical experience in several mines in Cornwall in the various branches of mining, metallurgy, surveying, assaying, etc ; 1910-11, surveyor and assayor, Broomassie Mines Ltd., Gold Coast Colony, West Africa; 1911-13, office and Instruments, etc., Can. Nor. Rly. (Alberta), Dom. Land Survey, Alberta Land Survey; 1913-14, instruments, engrg. dept., City of Edmonton; 1914-19, overseas, Royal Engrs. Major, M.C.; 1919 to date, general asst. and res. engr., City of Edmonton, Alberta. (*A.M. 1921.*)

References: D. Lyell, R. J. Gibb, E. Stansfield, C. A. Robb, A. W. Haddow.

### FOR TRANSFER FROM THE CLASS OF JUNIOR

HALL—STEWART WILLIAM SHERIDAN, of 393 Montrose Ave., Toronto, Ont., Born at Toronto, Nov. 10th, 1900; Educ., B.A.Sc., Univ. of Toronto, 1928; Summer work, carpenter foreman and transitman; 1927 (summer), engr's inspr., C. D. Howe & Co. Ltd., Port Arthur, Ont.; 1928 to date, plan examiner, city bldg. dept., Toronto, Ont., checking the design of various bldgs., architecturally and structurally. (*Jr. 1929.*)

References: L. A. Badgley, L. A. C. Lee, A. H. Harkness, G. L. Wallace, W. S. Wilson, R. E. Smythe.

### FOR TRANSFER FROM THE CLASS OF STUDENT

CARVER—STANLEY COX, of Victoria, B.C., Born at Leeds, England, Jan. 25th, 1907; Educ., B.A.Sc. (C.E.), Univ. of B.C., 1929; 1927, asst. instr'man., 1928, chief asst. instr'man., Topog'l. Dept., Ottawa; 1929-32, designing dftsman and checker, Western Bridge Co. Ltd., Vancouver, B.C., detailing, checking, designing and estimating, rly. and highway bridges, steel framed bldgs., hydro-electric equipment, piers, warehouses and gen. struct'l. work; 1933 to date, asst. designing engr., Fleming Bros., Struct'l. Engrs., Glasgow, Scotland, and London, England. (*St. 1927.*)

References: J. A. McFarlane, W. H. Powell, F. S. Gumley, R. W. Brock, A. E. Foreman, A. S. Gentles.

WISHART—WILLIAM DONALD, of Camp Borden, Ont., Born at Portage la Prairie, Man., Jan. 19th, 1907; Educ., B.Sc. (E.E.), Univ. of Manitoba, 1931; 1931 to date, Lieut., Royal Canadian Corps of Signals. (*St. 1932.*)

References: W. L. Laurie, E. P. Fetherstonhaugh, J. N. Finlayson.

## EMPLOYMENT SERVICE BUREAU

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*All correspondence should be addressed to*

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**2050 Mansfield Street, Montreal**

## Situations Wanted

ESTABLISHED SALES ENGINEER. Univ of Toronto '24, with plant and manufacturing experience, wishes to represent manufacturers of technical equipment. Connections witb automobile and electrical equipment dealers, throughout Canada. Will make small investment if necessary. Apply to Box No. 1-W.

MECHANICAL ENGINEER, Canadian, witb technical training and executive experience in hoth Canadian and American industries, particularly plant layout, equipment, planning and production control methods, is open for employment with company desirous of improving manufacturing methods, lowering costs and preparing for husiness expansion. Apply to Box No. 35-W.

MECHANICAL ENGINEER, A.M.E.I.C. Married. Experience in machine shops, erection and maintenance of industrial plant mechanical and structural design. Reads German, Frencb, Dutch and Spanish. Seeks any suitable position. Apply to Box No. 84-W.

MECHANICAL ENGINEER, graduate McGill Univ. Experience on hydro-electric power construction and design and installation of equipment of pulp and paper mills. Desires position as mechanical engineer in an industrial plant or pulp and paper mill, or as representative on tbe sale of beavy machinery. Apply to Box No. 142-W.

REINFORCED CONCRETE ENGINEER, B.Sc., P.E.Q., eight years experience in construction design of industrial huildings, office huildings, apartment houses, etc. Age 30. Married. Apply to Box No. 257 W.

DESIGNING DRAUGHTSMAN, experience in layout of steam power bouse equipment and piping. Wide experience in mechanical drive and details of machinery, gearing, and hoists. Accustomed to layout of small mill buildings of steel and timber, structural design and details. Good references. Present location Montreal. Apply to Box No. 329-W.

ELECTRICAL ENGINEER, B.Sc., A.M.E.I.C., Am.A.I.E.E., age 30, single. Eight years experience H.E. and steam power plants, substations, etc., shop layouts, steel and concrete design. Location immaterial. Available immediately. Apply to Box No. 435-W.

CIVIL ENGINEER, B.A.Sc. and C.E.; A.M.E.I.C., Jun. A.S.C.E., age 32, married. Experience over twelve years as assistant and resident engineer on the construction of bydro-electric, railway, and aerodrome works. Also office and teaching work on bydraulic designs and investigations, reinforced concrete, bridge foundations and caissons. Location immaterial. Available at once. Apply to Box No. 447-W.

SALES ENGINEER, M.A.Sc. Univ. of Toronto, wishes to represent firm selling building products or other engineering commodities, as their representative in Western Canada. Located in Winnipeg. Apply to Box No. 467-W.

MECHANICAL ENGINEER, B.Sc. Age 28, married. Four and a half years on industrial plant maintenance and construction, including shop production work and pulp and paper mill control. Also two and a balf years on structural steel and reinforced concrete design. Available at once. Apply to Box No. 521-W.

CIVIL ENGINEER, Canadian, married, twenty-five years' tecbnical and executive experience, specialized knowledge of industrial housing problems and the administration of industrial towns, also town planning and municipal engineering, desires new connection. Available on reasonable notice. Personal interview sought. Apply to Box No. 544-W.

ELECTRICAL AND MECHANICAL ENGINEER, B.Sc., A.M.E.I.C. Experience includes C.G.E. Students' Test Course and six years in engineering dept. of same company on design of electrical equipment. Four summers as instrumentman on surveying and bighway construction. Several years experience in accounting previous to attending university. Desires position with industrial concern wbere the combination of tecbnical and business experience will he of value. Apply to Box No. 564-W.

MECHANICAL ENGINEER, A.M.E.I.C. Experienced on plant maintenance, steel plant, cement plant and mining plants. Available on short notice. Apply to Box No. 571-W.

## Situations Wanted

DOMINION LAND SURVEYOR, and graduate engineer with extensive experience on legal, topographic and plane-table surveys and field and office use of aero-photographs, desires employment either in Canada or abroad. Available at once. Apply to Box No. 589-W.

CHEMICAL ENGINEER, S.E.I.C., B.Sc., University of Alberta, '30. Age 31. Single. Six seasons' practical laboratory experience, three as chief chemist and three as assistant chemist in cement plant; one year's p.g. work in physical cbemistry; three years' experience teaching. Desires position in any industry witb chemical control. Available immediately. Apply to Box No. 609-W.

DESIGNING ENGINEER AND ESTIMATOR, grad. Univ. of Toronto in C.E., A.M.E.I.C., twenty years experience in structural steel, construction and municipal work. Available at once. Apply to Box No. 613-W.

CIVIL ENGINEER, A.M.E.I.C., R.P.E., Ontario; three years construction engineer on industrial plants; fourteen years in charge of construction of bydraulic power developments, tower lines, sub-stations, etc.; four years as executive in charge of construction and development of harbours, including railways, docks, warehouses, hydraulic dredging, land reclamation, etc. Apply to Box No. 647-W.

### Time Study Work

Enquiries are received from time to time for engineers, particularly young men with mechanical training, experienced in, or having a knowledge of, time study methods and procedure.

If you have qualifications of this nature you should not neglect to forward details to The Institute Employment Service Bureau.

ELECTRICAL ENGINEER, B.Sc. in E.E. (Univ. of Man., '30). Age 25. Two year Can. Westinghouse Apprentice Course. Depts.—Switchboard assembly, general draughting office, switchboard engineering, test office. One year's experience since then designing and rewinding small motors and transformers. Location immaterial. Apply to Box No. 651-W.

ELECTRICAL AND RADIO ENGINEER, B.Sc. '30. Variously engaged on receiver development work, testing, and transformer development, under direction. More recent experience includes transmitter test room procedure and short wave heam transmission engineering. For further information apply to Box No. 680-V.

DIESEL ENGINEER. Erection and industrial engineer, A.M.E.I.C., technically trained mechanical engineer with English and Canadian experience in erection and operation of steam and Diesel equipment in power bouse and mines, pumping, rock drilling, air compressors. Experienced in industrial and steel works operations including rolling mills, quarries, sales. Open for position on maintenance, operation or sales engineer. Location immaterial. Apply to Box No. 682-W.

MECHANICAL AND STRUCTURAL ENGINEER. Six years experience with prominent manufacturer, designing, beating and power boilers, hoiler installations, coal and ash handling equipment. Good practical knowledge of steel plate work welding. Also wide experience in designing, estimating and detailing structural steel for buildings and bridges. Good education. Have held position of responsibility. Above can be verified by best of references. Available at once. Apply to Box No. 692-W.

## Situations Wanted

ELECTRICAL AND CIVIL ENGINEER, B.Sc., Elec., 29, B.Sc., Civil '33. Age 27. Jr.E.I.C. Undergraduate experience in surveying and concrete foundations; also four months with Canadian General Electric Co. Thirty-three months in engineering office of a large electrical manufacturing company since graduation. Good experience in layouts, switching diagrams, specifications and pricing. Best of references. Availahle immediately. Apply to Box No. 693-W.

MECHANICAL ENGINEER, B.Sc., '27, Jr.E.I.C. Four years maintenance of high speed Diesel engines units, 200 to 1,300 h.p. Also maintenance of D.C. and A.C. electrical systems and machinery. Draughting experience. Westinghouse apprenticeship course. Practical mechanical and electrical engineer with a special study of high speed Diesel engine design, application and operation. Location in western or eastern Canada immaterial. Apply to Box No. 703-W.

COMBUSTION ENGINEER, R.P.E., Manitoha, A.M.E.I.C. Wide experience with all classes of fuels. Expert designer and draughtsman on modern steam power plants. Experienced in publicity work. Well known throughout the west. Location, Winnipeg or tbe west. Available at once. Apply to Box No. 713-W.

ELECTRICAL ENGINEER, B.Sc., University of N.B., '31. Experience includes three months field work with Saint John Harhour Reconstruction. Apply to Box No. 722-W.

MECHANICAL ENGINEER, age 41, married. Eleven years designing experience with project of outstanding magnitude. Machinery layouts, checking, estimating and inspecting. Twelve years previous engineering, including draughting, machine shop and two years chemical laboratory. Higbest references. Apply to Box No. 723-W.

CIVIL ENGINEER, B.Sc. (Alta. '31), S.E.I.C. Experience includes three seasons in charge of survey party. Transitman on railway maintenance, and concrete bridge designing Nature of work and location immaterial. Apply to Box No. 724-W.

YOUNG CIVIL ENGINEER, B.Sc. (Univ. of N.B. '31), witb experience as rodman and checker on railroad construction, is open for a position. Apply to Box No. 728-W.

DESIGNING ENGINEER, M.Sc. (McGill Univ.), D.L.S., A.M.E.I.C., P.E.Q. Experience in design and construction of water power plants, transmission lines, field investigations of storage, hydraulic calculations and reports. Also paper mill construction, railways, highways, and in design and construction of hridges and huildings. Available at once. Apply to Box No. 729-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.Sc., Univ. of B.C. '30. Single, age 24. Sixteen months with the Allis-Chalmers Mfg. Co. as student engineer. Experience includes foundry production, erection and operation of steam turhines, erection of hydraulic machinery, and testing texropes and centrifugal pumps. Location immaterial. Available at once. Apply to Box No. 735-W.

CIVIL ENGINEER, M.Sc., A.M.E.I.C., R.P.E. (Ont.), ten years experience in municipal and highway engineering Read, write and talk French. Married. Served in France. Will go anywhere at any time. Experienced journalist. Apply to Box No. 737-W.

RADIO AND ELECTRICAL ENGINEER, B.Sc. '31, S.E.I.C. Age 27. Experience in installation of power and ligbting equipment. Temporary operator in radio station; studio experience with part time announcing. Two summers in switchboard and installation department of telephone company, eight months on extensive survey layouts. Interested in sales work of electrical or radio equipment. Available on short notice. Location immaterial. Apply to Box No. 740-W.

CIVIL ENGINEER, B.Sc. '29, A.M.E.I.C. Married. One year huilding construction, one year hydro-electric construction in South America, eighteen months resident engineer on highway construction, one year on barbour design and construction. Working knowledge of Spanish. Apply to Box No. 744-W.

SALES ENGINEER, B.Sc., McGill, 1923, A.M.E.I.C. Age 33. Married. Extensive experience in building construction. Thoroughly familiar with steel building products; last five years in cbarge of structural and reinforcing steel sales for company in New York state. Available at once. Located in Canada. Apply to Box No 749-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. Queen's Univ. '29. Age 25. Married. Three years experience as construction supt. and estimator for contracting firm. Experience includes general huilding, bridges, sewer work, concrete, boiler settings, sand blasting of bridges and spray painting. Available at once. Apply to Box No. 776-W.

CIVIL ENGINEER, B.Sc., '25, Jr.E.I.C., P.E.Q., married. Desires position, preferably witb construction firm. Experience includes railway, monument and mill building construction. Available immediately. Apply to Box No. 780-W.

## Situations Wanted

DRAUGHTSMAN, experience in civil engineering, forestry engineering, land surveying and house construction. Good references. Apply to Box No. 781-W.

ELECTRICAL AND SALES ENGINEER, S.E.I.C., grad. '28. Experience includes one year test course, one year switchboard design and two years switchboard and switching equipment sales with large electrical manufacturing company. Three summers Pilot Officer with R.C.A.F. Available at once. Apply to Box No. 788-W.

ELECTRICAL ENGINEER desires position as engineer or manager for industrial plant or factory. Over ten years diversified electrical and mechanical experience in the industrial field. Apply to Box No 795-W.

CIVIL ENGINEER, S.E.I.C., graduate '30, age 23, single. Experience includes mining surveys, assistant on highway location and construction, and assistant on large construction work. Steel and concrete layout and design. Apply to Box No. 809-W.

CIVIL ENGINEER, college graduate, age 27, single. Experience includes surveying, draughting concrete construction and design, street paving both asphalt and concrete. Available at once; will consider anything and go anywhere. Apply to Box No. 816-W.

CIVIL ENGINEER, B.E. (Sask. Univ. '32), S.E.I.C. Single. Experience in city street improvement; sewer and water extensions. Good draughtsman. References. Available at once. Location immaterial. Apply to Box No. 818-W.

CIVIL ENGINEER, B.SC., A.M.E.I.C., with fifteen years experience mostly in pulp and paper mill work, reinforced concrete and structural steel design, field surveys, layout of mechanical equipment, piping. Available at once. Apply to Box No. 825-W.

CIVIL ENGINEER, B.A.SC., D.L.S., O.L.S., A.M.E.I.C., age 46, married. Twelve years experience in charge of legal field surveys. Owns own surveying equipment. Eight years on technical, administrative, and editorial office work. Experienced in writing. Desires position on survey work, assisting in or in charge of preparation of house organ, on staff of technical or semi-technical magazine, or on publicity, editorial or administrative office work. Available at once. Will consider any salary, and any location. Apply to Box No. 831-W.

CIVIL ENGINEER, S.E.I.C., B.SC. '32 (Univ. of N.B.). Age 25. married. Two years experience in power line construction and maintenance; one year of highway construction; one summer surveying for power plant site, location and spur railway line construction. Available at once. Location immaterial. Apply to Box No. 840-W.

CIVIL ENGINEER, B.SC. '15, A.M.E.I.C., married, extensive experience in responsible position on railway construction, also highways, bridges and water supplies. Position desired as engineer or superintendent Available at once. Apply to Box No. 841-W.

CIVIL ENGINEER, B.SC. (Alta. '31), S.E.I.C., age 24. Experience, three summers on railroad maintenance, and seven months on highway location as instrumentman. Willing to do anything, anywhere, but would prefer connection with designing or construction firm on structural works. Available immediately. Apply to Box No. 846-W

MECHANICAL ENGINEER, JR E.I.C., Technical graduate, bilingual, age 32. Eight years experience in design of boiler plants; steam, water and gas piping; heating, ventilating, air conditioning and plumbing systems; writing of specifications and technical translation. Experience includes: two years in engineering department of large company, five years with consulting engineers and one year on large piping and construction projects Available at once. Apply to Box No. 850-W.

BRIDGE AND STRUCTURAL ENGINEER, A.M.E.I.C., McGill. Twenty-five years' experience on bridge and structural staffs Until recently employed. Familiar with all late designs, construction, and practices in all Canadian fabricating plants. Desirous of employment in any responsible position, sales, fabrication or construction. Apply to Box No. 851-W.

STRUCTURAL ENGINEER, B.A.SC., A.M.E.I.C. Twenty-two years experience in design of bridges and all types of buildings in structural steel and reinforced concrete. Three years experience in railway construction and land surveying. Apply to Box No. 856-W.

MECHANICAL ENGINEER, B.SC. '32, S.E.I.C. Good draughtsman. Undergraduate experience:—One year moulding shop practice; two years pipe fitting and sheet metal work; one year draughting and tracing on paper mill layout; six months machine shop practice; and eight months fuel investigation and power heating plant testing. Desires position offering experience in steam power plants or heating and ventilating design. Will go anywhere Apply to Box No 858-W.

MECHANICAL ENGINEER, age 31, graduate Sheffield (England) 1921; apprenticeship with firm manufacturing steam turbine generators and auxiliaries and subsequent experience in design, erection, operation and inspection of same. Marine experience B.O.T certificate thoroughly conversant with Canadian plants and equipment. Available on short notice. Any location. Box No. 860-W.

CHEMICAL ENGINEER, B.SC. (McGill '21), A.M.E.I.C., age 36, married; three years since graduation with pulp and paper mills; eight years in shops, estimating and sales divisions of well-known gas engineering and construction companies in the United States. Excellent references. Available on short notice. Apply to Box No. 866-W.

CONSTRUCTION ENGINEER (Toronto Univ. of '07). Experience includes hydro-electric, municipal and railroad work. Available immediately. Location immaterial. Apply to Box No. 886-W.

ELECTRICAL ENGINEER, graduate 1929, S.E.I.C. Single. Experience includes two years with electrical manufacturing concern and one on highway construction work. Available at once. Will go anywhere. Apply to Box No. 887-W.

AGENCIES WANTED, Young engineer, B.A.SC. in C.E., with business and sales experience, speaking fluent French, would consider representing a firm as agent for Montreal or the province of Quebec. Apply to Box No. 891-W.

ELECTRICAL ENGINEER, grad. Univ. of N.B. '31. Experienced in surveying and draughting, requires position. Available at once. Will go anywhere. Apply to Box No. 893-W.

CIVIL ENGINEER, B.A.SC., JR.E.I.C., age 29, single. Experience includes two years in pulp mill as draughtsman and designer on additions, maintenance and plant layout. Three and a half years in the Toronto Buildings Department checking steel, reinforced concrete, and architectural plans. Available at once. Location immaterial. At present in Toronto. Apply to Box No. 899-W.

DESIGNING ENGINEER, A.M.E.I.C. Permanent and executive position preferred but not essential. Fifteen years experience in designing power plants, engine and fan rooms, kitchens and laundries. Thoroughly familiar with plumbing and ventilating work, pneumatic tubes, and refrigeration, also heating, electrical work, and specifications. Apply to Box No. 913-W.

ELECTRICAL ENGINEER, Dipl. of Eng., B.SC. (Dalhousie Univ.), S.B. and S.M. in E.E. (Mass. Inst. of Tech.), Canadian. Married. Seven and a half years' experience in design, construction and operation of hydro, steam and industrial plants. For past sixteen months field office electrical engineer on 510,000 h.p. hydro-electric project. Available at once. Apply to Box No. 936-W.

CIVIL ENGINEER, B.SC., O.P.E. Experience includes several years on municipal work-design and construction of sewers, steel and concrete bridges, watermains and pavements. Available at once. Apply to Box No. 950-W.

CIVIL ENGINEER, B.SC. (Univ. of Sask. '33), S.E.I.C., age 28, single. Experience in testing hydro-electric equipment, draughting, surveying, city street, improvements, technical photography. Available at once. Location immaterial. Apply to Box No. 986-W.

ELECTRICAL ENGINEER, S.E.I.C., B.SC., (N.S. Tech. Coll., '33), desires work. Experience in transmission line construction. Location or class of work immaterial. Apply to Box No 1010-W.

ENGINEER SUPERINTENDENT, age 44. Engineering and business training, executive ability, tactful, energetic. Had charge of several large projects. Intimate knowledge of costs and prices, reports and estimates. Available immediately. Any location. Apply to Box No. 1021-W.

CIVIL ENGINEER, B.SC. (Queen's 14), A.M.E.I.C., Dominion Land Surveyor, 5 months' special course at the University of London, England, in municipal hygiene and reinforced concrete construction. Experience covers legal and topographic surveys, plane tabling and stadia surveying, railway and highway construction, drainage and excavation work. Available at once. Apply Box No. 1035-W.

ELECTRICAL ENGINEER AND GEOPHYSICIST. Age 36. Married. Seven years experience in geophysical exploration using seismic, magnetic and electrical methods. Two years experience with the Western Electric Company of Chicago, working on equipment and magnetic materials research. Experienced in radio and telephone work, also specializing in precise electrical measurements, resistance determinations, ground potentials and similar problems of ground current distribution. Apply to Box No. 1063-W.

ELECTRICAL ENGINEER, B.A.SC. Univ. Toronto '28. Experience includes Can. Gen. Elec. Co. Test Course. Also more than two years in the engineering dept. of the same company. Available on short notice. Preferred location central or eastern Canada. Apply to Box No. 1075-W.

ELECTRICAL ENGINEER, B.SC. Married. Eight years electrical experience, including operation, maintenance and construction work, electrical design work on large power development, mechanical ability, experienced photographer, employed in electrical capacity at present. Available on reasonable notice. Apply to Box No. 1076-W.

GRADUATE IN MECHANICAL ENGINEERING, 1927, desires opportunity in Diesel engine field, preferably in design and development work. Skilled draughtsman and clever in design. Familiar with basic theories of the Diesel engine and in touch with recent developments and applications. Anxious to obtain a foothold with up-to-date company. No objection to shopwork or other duties as a start but would prefer shopwork and assembly if possible. Apply to Box No. 1081-W.

CIVIL ENGINEER, age 27, graduate 1930, single. Experience includes detailing, designing and estimating structural steel, plate work and pressure vessels; also hydrographic surveying. Available at once. Apply to Box No. 1111-W.

ELECTRICAL ENGINEER, B.SC., in E.E. (Univ. of N.B. '34), S.E.I.C. Experience in bridge and road construction and auto repairing, desires position in industrial or power plant. Any locality. References on request. Apply to Box No. 1114-W.

CIVIL ENGINEER, B.SC., Sask. '30. S.E.I.C. Age 24 years. Experience in municipal engineering, including sewer and water construction, sidewalk construction, paving, storm sewer design, draughting, precise levelling, and reinforced concrete bridge construction. Unmarried. Available at once. Will go anywhere. Apply to Box No. 1115-W.

ELECTRICAL ENGINEER, B.SC.E.E. (Univ. of N.B. '31). C.G.E. Test Course included industrial control, induction motors and transformers; the transformer test included desk work for two months on computing losses, efficiencies, etc. Available at once. Apply to Box No. 1119-W.

GEODETIC AND TOPOGRAPHICAL ENGINEER, D.L.S., M.E.I.C. Experience in all kinds of geodetic and topographical surveys, especially photo-topography, well versed in all kinds of air photo surveys; Canadian and U.S. patent method of determining position and elevations of points from air photographs. Available at once anywhere in Canada or the United States. Apply to Box No. 1127-W.

PETROLEUM CHEMIST, B.SC. in Chem. Eng. Age 25, Single. One and a half years experience as assistant chemist. Capable of taking charge in small refinery. Wishes position anywhere in Canada. Apply to Box No. 1130-W.

ELECTRICAL ENGINEER. B.SC., Queen's '33. Single, age 23. Anxious to gain experience. Present experience installing small private hydro-electric plant. Location immaterial. Available at once. Apply to Box No. 1137-W.

CIVIL ENGINEER, A.M.E.I.C., with over twenty years experience in field and office on construction, maintenance, surveying, location, etc., desires position preferably of a permanent nature. At present near Montreal. but willing to locate anywhere. Apply to Box No. 1168-W.

CIVIL ENGINEER, B.A.SC., S.E.I.C., age 26, single. Experience includes one year in bridge construction, plain and reinforced concrete, pneumatic caissons and surveying. Available at once. Any location. Apply to Box No. 1204-W.

PHYSICIST ENGINEER, B.Sc.Mech. (Queen's 1913), M.Sc., Ph.D.Physics (McGill 1929, '30). Experience in municipal engineering, producer gas installation and operation, university plant maintenance. Experienced teacher of college physics. Industrial and pure physical research experience. Age 42. Married. Apply to Box No 1207-W.

MECHANICAL ENGINEER, B.SC. (Queen's Univ. '28), age 36, married, desires position of trust and responsibility. Experience includes fitting and assembly of machine tools, production, draughting, and maintenance. Five years teaching draughting and mathematics. Available on reasonable notice. Location immaterial. Apply to Box No. 1210-W.

# Purchasers' Classified Directory

*A Selected List of Equipment, Apparatus and Supplies*

For Alphabetical List of Advertisers see page 22.

A

**Acids:**
Canadian Industries Limited.
**Aerial Survey:**
Canadian Airways Ltd.
**Ammeters and Voltmeters:**
Bepco Canada Ltd
Crompton Parkinson (Canada) Ltd
**Angles, Steel:**
Bethlehem Steel Export Corp.
**Ash Handling Equipment:**
Babcock-Wilcox & Goldie McCulloch Ltd.
Combustion Engineering Corp. Ltd.
**Asphalt:**
Barrett Co. Ltd.
**Axles, Steel, Forged:**
Dominion Foundries & Steel Ltd.
Dominion Steel & Coal Corpn. Ltd.

B

**Ball Mills:**
Dominion Engineering Works Limited.
Wm. Kennedy & Sons Ltd.
Foster Wheeler Ltd.
Wm. Hamilton Div. Canadian Vickers Ltd.
**Balls, Steel and Bronze:**
Can. S.K.F. Co. Ltd.
Wm Kennedy & Sons Ltd.
**Barking Drums:**
Canadian Ingersoll-Rand Company, Limited.
**Bars, Steel and Iron:**
Bethlehem Steel Export Corp.
Dominion Foundries & Steel Ltd.
Dominion Steel & Coal Corpn. Ltd.
**Bearings, Ball and Roller:**
Can. S.K.F. Co. Ltd.
**Billets, Blooms, Slabs:**
Bethlehem Steel Export Corp.
Dominion Foundries & Steel Ltd.
**Bins:**
Canada Cement Co. Ltd.
**Blasting Materials:**
Canadian Industries Limited.
**Blowers, Centrifugal:**
Can. Ingersoll-Rand Co. Ltd.
B. F. Sturtevant Co. of Can. Ltd.
**Blue Print Machinery:**
Montreal Blue Print Co.
**Boilers:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Canadian Vickers Ltd.
Combustion Engineering Corp. Ltd.
Foster Wheeler Limited.
E. Leonard & Sons Ltd.
Vulcan Iron Wks. Ltd.
**Boilers Electric:**
Can. General Electric Co. Ltd.
Dominion Engineering Works Limited.
Northern Electric Co. Ltd.
**Boilers, Portable:**
Foster Wheeler Ltd.
E. Leonard & Sons Ltd.
**Boxes, Cable Junction:**
Northern Electric Co. Ltd.
**Braces, Cross Arm, Steel, Plain or Galvanized:**
Northern Electric Co. Ltd.
**Brackets, Ball Bearing:**
Can. S.K.F. Co. Ltd.
**Brakes, Air:**
Can. General Elec. Co. Ltd.
**Brakes, Magnetic Clutch:**
Northern Electric Co. Ltd.
**Bridge-Meggers:**
Northern Electric Co. Ltd.
**Bridges:**
Canada Cement Co. Ltd.
Canadian Vickers Ltd.
Dominion Bridge Co. Ltd
**Bucket Elevators:**
Jeffrey Mfg Co. Ltd.
**Buildings, Steel:**
Dominion Bridge Co. Ltd.

C

**Cables, Copper and Galvanized:**
Northern Electric Co. Ltd
**Cables, Electric, Bare and Insulated:**
Can. Westinghouse Co. Ltd.
Can. General Electric Co. Ltd.
Northern Electric Co. Ltd.
**Caissons, Barges:**
Dominion Bridge Co. Ltd.
**Cameras:**
Associated Screen News Ltd.
**Capacitors:**
Bepco Canada Ltd.
Can. Westinghouse Co. Ltd.
Lancashire Dynamo & Crypto Co. of Can. Ltd.
**Castings, Brass:**
The Superheater Co. Ltd.
**Castings, Iron:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Dominion Engineering Works.
Foster Wheeler Ltd.
Wm. Kennedy & Sons Ltd.
E. Leonard & Sons Ltd.
The Superheater Co. Ltd.
Vulcan Iron Wks Ltd.
**Castings, Alloy Steel:**
Dominion Foundries & Steel Ltd.
**Castings, Steel:**
Dominion Foundries & Steel Ltd.
Wm. Kennedy & Sons Ltd.
Vulcan Iron Wks. Ltd.
**Catenary Materials:**
Can. Ohio Brass Co. Ltd.
**Cement Manufacturers:**
Canada Cement Co. Ltd.
**Chains, Silent and Roller:**
Hamilton Gear & Machine Co.
Jeffrey Mfg. Co Ltd
**Channels:**
Bethlehem Steel Export Corp.
**Chemicals:**
Canadian Industries Limited.
**Chemists:**
Milton Hersey Co. Ltd.
Roast Laboratories Reg'd.
**Chippers, Pneumatic:**
Canadian Ingersoll-Rand Company, Limited.
**Choke Coils:**
Ferranti Electric Co.
**Circuit Breakers:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.
**Clarifiers, Filter:**
Bepco Canada Ltd.
Crompton Parkinson (Canada) Ltd.
**Clutches, Ball Bearing Friction:**
Can S.K.F. Co. Ltd.
**Clutches, Magnetic**
Northern Electric Co. Ltd.
**Coal Handling Equipment:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Combustion Engineering Corp. Ltd.
**Combustion Control Equipment:**
Bailey Meter Co. Ltd.
**Compressors, Air and Gas:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Canadian Ingersoll-Rand Company, Limited.
**Concrete:**
Canada Cement Co. Ltd.
**Condensers, Steam:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Canadian Ingersoll-Rand Company, Limited.
Foster Wheeler Limited.
**Condensers, Synchronous and Static:**
Bepco Canada Ltd.
Can General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Crompton Parkinson (Canada) Ltd.
Harland Eng. Co. of Can. Ltd.
Lancashire Dynamo & Crypto Co. of Cau. Ltd.
Northern Electric Co. Ltd.
Bruce Peebles (Canada) Ltd.
**Conditioning Systems, Air:**
B F Sturtevant Co. of Can. Ltd.
**Conduit:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co Ltd.
**Conduit, Underground Fibre, and Underfloor Duct:**
Northern Electric Co. Ltd.
**Controllers, Electric:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.
**Couplings:**
Dart Union Co. Ltd.
Dresser Mfg. Co. Ltd.
**Couplings, Flexible;**
Dominion Engineering Works Limited
Dresser Mfg. Co. Ltd.
**Couplings, Flexible:**
Wm. Hamilton Div. Canadian Vickers Ltd.
Hamilton Gear & Machine Co.
Wm. Kennedy & Sons Ltd.
**Cranes, Hand and Power:**
Dominion Bridge Co.
**Cranes, Locomotive:**
Dominion Hoist & Shovel Co. Ltd.
**Cranes, Shovel, Gasoline Crawler, Pillar:**
Canadian Vickers Ltd.
Dominion Hoist & Shovel Co. Ltd.
**Crowbars:**
B. J. Coghlin Co. Ltd.
**Crushers, Coal and Stone:**
Canadian Ingersoll-Rand Company, Limited.
Jeffrey Mfg Co. Ltd.
Wm. Kennedy & Sons Ltd.

D

**Dimmers:**
Northern Electric Co. Ltd.
**Disposal Plants, Sewage:**
W J. Westaway Co Ltd.
**Ditchers:**
Dominion Hoist & Shovel Co. Ltd.
**Drills, Pneumatic:**
Canadian Ingersoll-Rand Company, Limited.
**Dynamite:**
Canadian Industries Limited.

E

**Economizers, Fuel:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Combustion Engineering Corp. Ltd.
Foster Wheeler Limited.
B. F Sturtevant Co. of Can. Ltd.
**Elbows:**
Dart Union Co. Ltd.
**Electric Blasting Caps:**
Canadian Industries Limited.
**Electric Railway Car Couplers:**
Can Ohio Brass Co Ltd.
**Electrical Repair Work:**
Montreal Armature Works.
**Electrical Supplies:**
Can. General Elec. Co. Ltd.
Can. Ohio Brass Co Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.
**Electrification Materials, Steam Road:**
Can. Ohio Brass Co. Ltd.
**Engines, Diesel and Semi-Diesel:**
Canadian Ingersoll-Rand Company, Limited.
Harland Eng. Co. of Can. Ltd.
Waterous Limited
**Engines, Gas and Oil:**
Canadian Ingersoll-Rand Company, Limited.
Waterous Limited
**Engines, Steam:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Canadian Vickers Ltd.
Harland Eng. Co. of Can. Ltd.
E Leonard & Sons Ltd.
Waterous Limited
**Evaporators:**
Foster Wheeler Limited.
**Expansion Joints:**
Foster Wheeler Limited.
**Explosives:**
Canadian Industries Limited.

F

**Feed Water Heaters, Locomotive:**
The Superheater Co Ltd.
**Filtration Plants, Water:**
W. J. Westaway Co. Ltd.
**Finishes:**
Canadian Industries Limited.
**Fire Alarm Apparatus:**
Northern Electric Co. Ltd.
**Floodlights:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.
**Floor Stands:**
Jenkins Bros. Ltd.
**Floors:**
Canada Cement Co. Ltd.
**Forcite:**
Canadian Industries Limited
**Forgings:**
Bethlehem Steel Export Corp.
Dominion Steel & Coal Corpn. Ltd.
**Foundations:**
Canada Cement Co. Ltd.

G

**Gaskets, Asbestos, Fibrous, Metallic, Rubber:**
The Garlock Packing Co. of Can Ltd.
**Gasoline Recovery Systems:**
Foster Wheeler Limited.
**Gates, Hydraulic Regulating:**
Canadian Vickers Ltd.
Dominion Bridge Co. Ltd.
**Gauges, Draft:**
Bailey Meter Co. Ltd.
Bristol Co. of Can. Ltd.
**Gear Reductions:**
Hamilton Gear & Machine Co.
**Gears:**
Dominion Bridge Co. Ltd.
Dominion Engineering Works Limited.
Hamilton Gear & Machine Co.
Wm. Kennedy & Sons Ltd.
**Generators:**
Bepco Canada Ltd.
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Crompton Parkinson (Canada) Ltd.
Harland Eng. Co. of Can. Ltd.
Lancashire Dynamo & Crypto Co. of Can. Ltd.
Northern Electric Co. Ltd.
Bruce Peebles (Canada) Ltd.
**Governors, Pump:**
Bailey Meter Co. Ltd.
**Governors, Turbine:**
Dominion Engineering Works Limited.
**Gratings, M. & M. Safety:**
Dominion Bridge Co. Ltd.

H

**Hangers, Ball and Roller Bearing:**
Can. S.K.F. Co. Ltd.
**Headlights, Electric Railway:**
Can. General Elec. Co. Ltd.
Can. Ohio Brass Co. Ltd.
Can. Westinghouse Co. Ltd.
**Heat Exchange Equipment:**
Foster Wheeler Limited.
**Heating Systems:**
C. A. Dunham Co. Ltd.
**Hoists, Air, Steam and Electric:**
Canadian Ingersoll-Rand Company, Limited.
Dominion Hoist & Shovel Co. Ltd.
Wm. Hamilton Div. Canadian Vickers Ltd.
**Humidifying Equipment:**
W. J. Westaway Co. Ltd.

I

**Indicator Posts:**
Jenkins Bros. Ltd.
**Industrial Electric Control:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.
**Injectors, Locomotive, Exhaust Steam:**
The Superheater Co Ltd.
**Inspection of Materials:**
J. T. Donald & Co. Ltd.
Milton Hersey Co. Ltd.
**Instruments, Electric:**
Bepco Canada Ltd.
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Crompton Parkinson (Canada) Ltd.
Ferranti Electric Ltd.
Moloney Electric Co. of Canada, Ltd
Northern Electric Co. Ltd.
**Insulating Materials:**
Canadian Industries Limited.
**Insulators, Porcelain:**
Can. Ohio Brass Co Ltd.
Northern Electric Co. Ltd.
**Intercoolers:**
Foster Wheeler Limited.

J

**Journal Bearings and Boxes, Railway:**
Can. S.K.F. Co. Ltd.

L

**Lacquers:**
Canadian Industries Limited.
**Lantern Slides:**
Associated Screen News Ltd.
**Leading Wire:**
Canadian Industries Limited.

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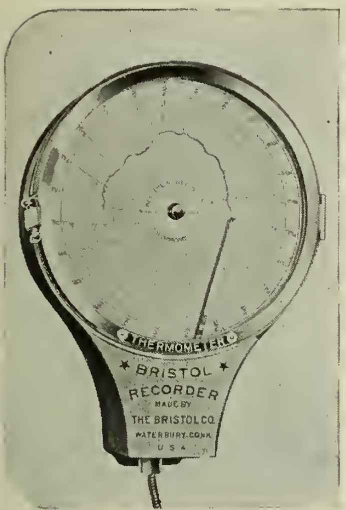


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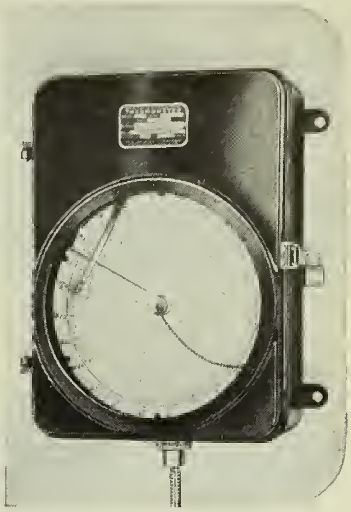
*Distributors: Montreal & Toronto: Powerlite Devices Ltd. Edmonton, Alta.: Gorman's Ltd. Winnipeg, Man.: Filer Smith Mach. Co.*



*Improved Recording Thermometer, Model 240M*

**BRISTOL'S**
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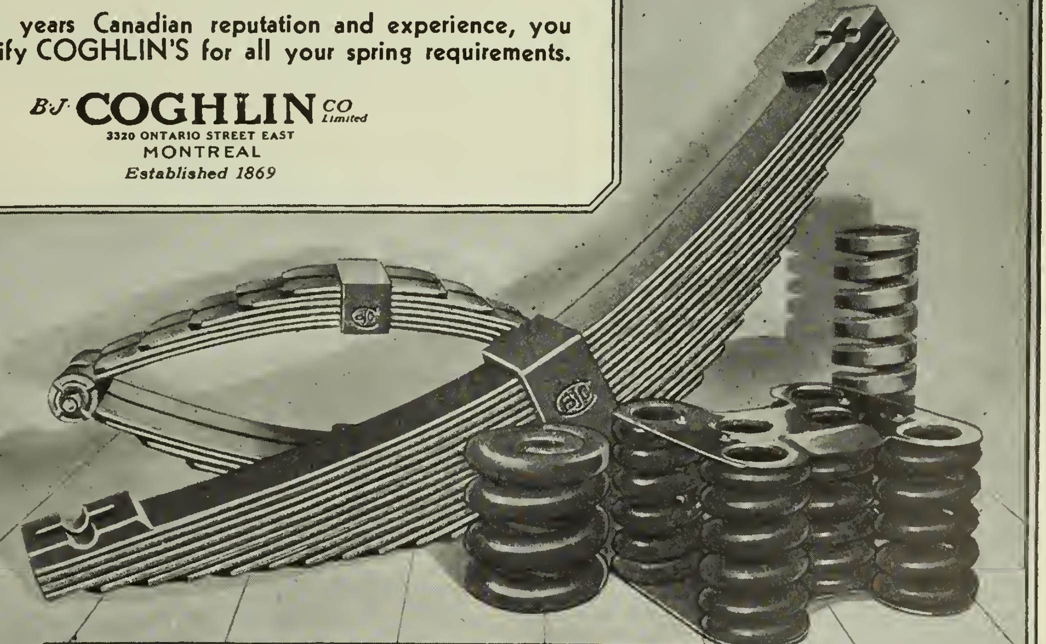
*Established 1869*



Agents: Harvard Turnbull & Co., Toronto
Filer Smith Machinery Co., Ltd., Winnipeg Gordon & Belyea, Ltd., Vancouver

## Purchasers' Classified Directory

**Library Films:**
Associated Screen News Ltd.
**Lighting Equipment, Industrial and Street:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd
Northern Electric Co. Ltd.
**Lightning Arresters:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd
Ferranti Electric Ltd.
Northern Electric Co. Ltd.
**Line Materials:**
Can. Ohio Brass Co. Ltd.
Northern Electric Co. Ltd.
**Locomotives, Electric:**
Can. General Elec. Co. Ltd.
Can Westinghouse Co. Ltd.

M

**Machinery, Hydraulic:**
Dominion Engineering Works Limited.
**Machinery, Metal and Wood-Working:**
Dominion Engineering Works Limited.
**Magnetic Separators:**
Northern Electric Co Ltd
**Material Handling Equipment:**
Jeffrey Mfg. Co. Ltd.
**Metallurgists:**
Roast Laboratories Reg'd.
**Meters, Boiler, and Coal:**
Bailey Meter Co. Ltd.
**Meters, Electric:**
Bristol Co. of Can. Ltd.
Can General Elec. Co Ltd
Can Westinghouse Co. Ltd.
Ferranti Electric Ltd
Northern Electric Co. Ltd.
**Meters, Flow:**
Bailey Meter Co. Ltd.
Neptune-National Meters Ltd.
**Meters, Liquid (Hot or Cold):**
Bailey Meter Co. Ltd
Neptune-National Meters Ltd.
**Mine Cars:**
Canadian Vickers Ltd.
**Mining Machinery:**
Canadian Ingersoll-Rand Company, Limited.
Canadian Vickers Ltd.
Dominion Engineering Works Limited.
**Motion Pictures:**
Associated Screen News Ltd
**Motors, Electric:**
Bepco Canada Ltd.
The Can. Fairbanks-Morse Co. Ltd.
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Crompton Parkinson (Canada) Ltd.
Harland Eng. Co. of Can. Ltd.
Lancashire Dynamo & Crypto Co. of Can. Ltd.
Northern Electric Co. Ltd.
Bruce Peebles (Canada) Ltd.
**Moulded Goods, Rubber and Asbestos:**
The Garlock Packing Co. of Can. Ltd.

O

**Oil Burning Equipment:**
Bethlehem Steel Export Corp.
**Oil Refining Equipment:**
Foster Wheeler Limited.
**Ornamental Iron:**
Vulcan Iron Wks. Ltd.

P

**Packings, Asbestos, Cotton and Flax, Metal, Rubber:**
The Garlock Packing Co of Can. Ltd.
**Paints, all purposes:**
Canadian Industries Limited.
**Paving Materials:**
Barrett Co. Ltd
**Penstocks:**
Canadian Vickers Ltd.
**Phase Rotation Indicators:**
Ferranti Electric Ltd.
**Photographs, Commercial and Portrait:**
Associated Screen News Ltd.
**Piling, Steel Sheet:**
Bethlehem Steel Export Corp.
**Pillow Blocks, Plain, Ball and Roller Bearing:**
Can. S.K.F. Co. Ltd.
**Pinions:**
Hamilton Gear & Machine Co.
**Pipe, Wood Stave:**
Canadian Wood Pipe & Tanks Ltd.
**Pipe Coils:**
The Superheater Co. Ltd.
**Pipe Couplings and Nipples:**
Dart Union Co. Ltd.
**Plates, Steel:**
Bethlehem Steel Export Corp
Dominion Foundries & Steel Ltd
**Pneumatic Tools:**
Canadian Ingersoll-Rand Company Ltd.
**Pole Line Hardware:**
Can. Ohio Brass Co. Ltd.
Northern Electric Co. Ltd.
**Polishes:**
Canadian Industries Limited.
**Powder, Black and Sporting:**
Canadian Industries Limited.
**Power Switchboards:**
Bepco Canada Ltd.
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Crompton Parkinson (Canada) Ltd.
Harland Eng. Co. of Can. Ltd
Northern Electric Co. Ltd.
**Preheaters, Air:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Combustion Engineering Corp.
Foster Wheeler Limited.
**Projectors:**
Associated Screen News Ltd.
**Pulleys:**
Plessisville Foundry.
**Pulleys, Ball Bearings, Loose:**
Can S.K.F Co Ltd.
**Pulp and Paper Mill Machinery:**
Can General Elec. Co Ltd.
Canadian Ingersoll-Rand Company, Limited
Can. Westinghouse Co. Ltd
Dominion Engineering Works Limited.
Wm. Hamilton Div. Canadian Vickers Ltd
Harland Eng. Co. of Can. Ltd.
**Pulverized Fuel Systems:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Bethlehem Steel Export Corpn
Combustion Engineering Corp Ltd.
Foster Wheeler Limited.
Wm Kennedy & Sons Ltd.
**Pump Valves, Rubber:**
The Garlock Packing Co. of Can. Ltd.
**Pumps:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Canadian Ingersoll-Rand Company, Limited.
Foster Wheeler Limited.
Wm. Hamilton Div Canadian Vickers Ltd
Harland Eng. Co. of Can Ltd.
Waterous Limited
**Purifiers, Water:**
W J. Westaway Co. Ltd

R

**Radiator Air Vents and Traps:**
Jenkins Bros. Ltd.
**Radiator Valves:**
Can. Ohio Brass Co. Ltd.
Jenkins Bros. Ltd.
**Radio Receiving Sets:**
Can. General Elec. Co Ltd
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.
**Radio Transformers:**
Ferranti Electric Ltd.
**Rail Bonds:**
Can. Ohio Brass Co. Ltd
U.S. Steel Products Co.
**Rail Braces and Joints:**
B. J. Coghlin Co.
**Railway Equipment:**
Can. General Elec. Co. Ltd.
Canadian Ingersoll-Rand Company, Limited.
Can Ohio Brass Co. Ltd.
**Receivers, Air:**
Canadian Ingersoll-Rand Company, Limited.
E. Leonard & Sons Ltd.
**Recorders**
Bailey Meter Co. Ltd.
Bristol Co of Can Ltd.
**Refrigerating Machinery:**
Canadian Ingersoll-Rand Company, Limited.
**Regulators, Feed Water:**
Bailey Meter Co. Ltd.
**Reservoirs:**
Canada Cement Co. Ltd

## Purchasers' Classified Directory

**Riveted Pipe:**
Dominion Bridge Co. Ltd.
**Roads:**
Canada Cement Co. Ltd.
**Road Machinery:**
Plessisville Foundry.
**Rods:**
Bethlehem Steel Export Corp.
**Rolls, Paper Machine:**
Dominion Engineering Works Limited.
**Roofing, Prepared:**
The Barrett Co. Ltd.
**Roofs, Built-up:**
The Barrett Co. Ltd.
**Rope, Wire:**
Dom. Wire Rope Co. Ltd.

S

**Screening Equipment:**
Canadian, Ingersoll-Rand Company, Limited.
Foster Wheeler Ltd.
**Separators, Electric:**
Northern Electric Co. Ltd.
**Sewers:**
Canada Cement Co. Ltd.
**Shingles, Prepared Asphalt:**
The Barrett Co. Ltd.
**Shovels — Powered Electric or Gasoline:**
Canadian Vickers Ltd.
**Smokestacks:**
Canada Cement Co. Ltd.
Canadian Vickers Ltd.
Foster Wheeler Ltd.
E. Leonard & Sons Ltd.
**Softeners, Water:**
W. J Westaway Co. Ltd.
**Sporting Powder:**
Canadian Industries Limited.
**Springs — Automobile, Railway, Wire:**
B. J. Coghlin Co. Ltd.
**Stains:**
Canadian Industries Limited.
**Steam Plant Equipment:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Combustion Engineering Corp. Ltd.
Foster Wheeler Limited.
Harland Eng. Co. of Can. Ltd.
**Steel Plate Construction:**
Canadian Vickers Ltd.
Dominion Bridge Co. Ltd.
Foster Wheeler Ltd.
E. Leonard & Sons Ltd.
**Stokers:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Combustion Engineering Corp Ltd.
**Structural Iron and Steel:**
Canadian Vickers Ltd.
Dominion Bridge Co. Ltd
Vulcan Iron Works Ltd.
**Superheaters:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Foster Wheeler Limited.
The Superheater Co. Ltd.
**Surge Absorbers:**
Ferranti Electric Ltd.
**Switchboards, Power Lighting:**
Bepco Canada Ltd.
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Crompton Parkinson (Canada) Ltd.
Harland Eng. Co. of Can. Ltd.
Northern Electric Co. Ltd.

T

**Tanks:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Braithwaite & Co. Engineers Ltd.
Canada Cement Co. Ltd.
Canadian Vickers Ldt.
Dominion Bridge Co. Ltd.
Foster Wheeler Ltd.
E. Leonard & Sons Ltd.
Vulcan Iron Wks. Ltd.
**Tanks, Wood:**
Canadian Wood Pipe & Tanks Ltd.
**Tees:**
Dart Union Co. Ltd.
**Telegraph Line Material:**
Northern Electric Co. Ltd.
**Testing Sets:**
Moloney Electric Co. of Can., Ltd.
**Thermometers, Recording:**
Bailey Meter Co. Ltd.
Bristol Co. of Can. Ltd.
**Tiles:**
Canada Cement Co. Ltd.
**Tinplate:**
Bethlehem Steel Export Corp.
**Towers, Cooling, Fractionating:**
Foster Wheeler Limited.
**Track Tools:**
B. J. Coghlin Co. Ltd.
**Transformers, Instrument, Testing, Distribution:**
Bepco Canada Ltd.
Ferranti Electric Ltd.
Moloney Electric Co. of Can., Ltd.
**Transformers, Lighting and Power:**
Bepco Canada Ltd.
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Crompton Parkinson (Canada) Ltd.
Ferranti Electric Ltd.
Moloney Electric Co. of Can., Ltd.
Northern Electric Co. Ltd.
Bruce Peebles (Canada) Ltd.
**Transmission Poles and Towers:**
Dominion Bridge Co. Ltd.
**Trolley Materials:**
Can. Ohio Brass Co. Ltd.
**Tubes, Boiler, Lapwelded Steel, and Iron:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Canadian Vickers Ltd.
E. Leonard & Sons Ltd.
**Turbines, Hydraulic:**
Dominion Engineering Works Limited.
Wm. Hamilton Div. Canadian Vickers Ltd
Wm. Kennedy & Sons Ltd.
**Turbines, Steam:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Harland Eng. Co. of Can. Ltd.
**Turbo Generators:**
Bepco Canada Ltd
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Lancashire Dynamo & Crypto Co. of Can. Ltd.
**Turntables:**
Dominion Bridge Co. Ltd

U

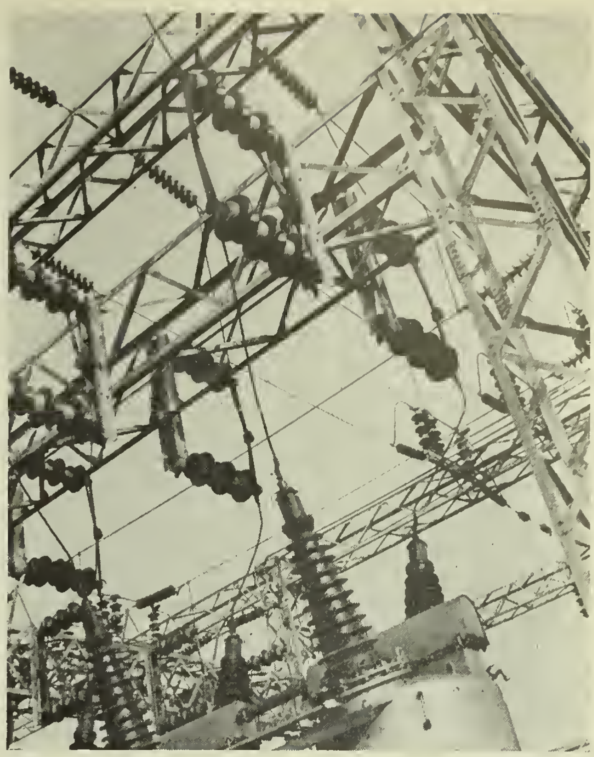
**Unions:**
Dart Union Co. Ltd.

V

**Valve Controls:**
Northern Electric Co. Ltd.
**Valve Discs, Rubber:**
The Garlock Packing Co. of Can. Ltd.
Jenkins Bros. Ltd.
**Valves:**
Can. Ohio Brass Co. Ltd.
Dominion Engineering Works Limited.
Jenkins Bros. Ltd.
**Valves, Relief:**
Neptune-National Meters Ltd.
**Varnishes:**
Canadian Industries Limited.
**Ventube:**
Canadian Industries Limited.

W

**Washers, Air:**
Canadian Ingersoll-Rand Company Limited.
**Water Cooled Furnaces:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Combustion Engineering Corp. Ltd.
Foster Wheeler Limited.
**Waterproofing:**
The Barrett Co. Ltd.
**Welding Machines, Electric and Accessories:**
Can. General Elec. Co. Ltd.
Can. Ohio Brass Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.
**Wheels, Fly and Gear:**
Hamilton Gear & Machine Co.
**Winches, Stop-log and Headgate**
Canadian Vickers Ltd.
**Wire:**
Bethlehem Steel Export Corp.
**Wire, Electric, Bare and Insulated:**
Can. General Elec. Co. Ltd.
Northern Electric Co. Ltd.
**Wire Rope:**
Dom. Wire Rope Co. Ltd.
**Wire Springs:**
B. J. Coghlin Co. Ltd.
**Worm Gears:**
Hamilton Gear & Machine Co.





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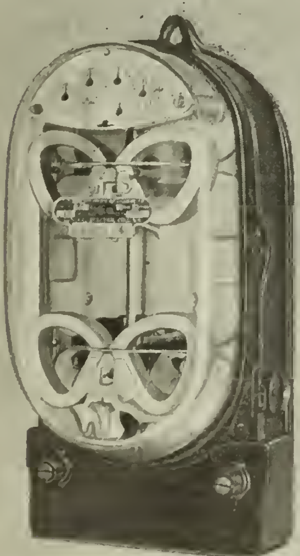

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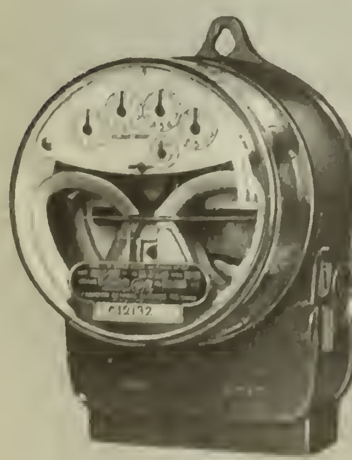

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DECEMBER 1934

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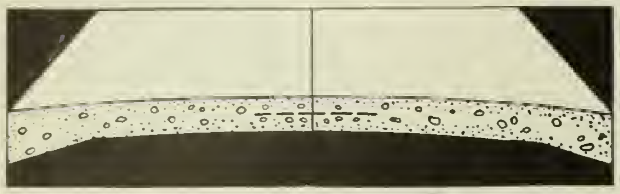

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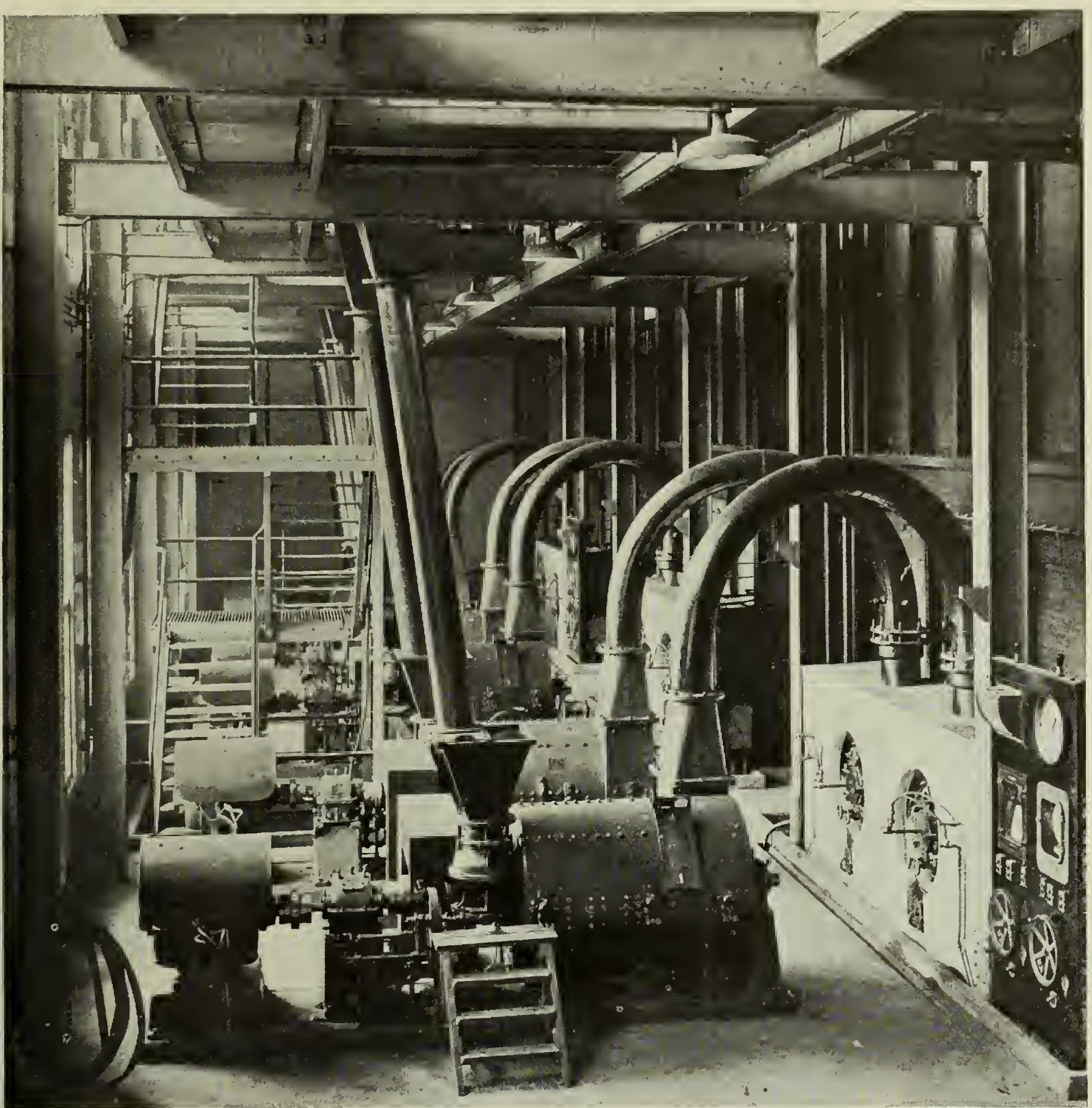

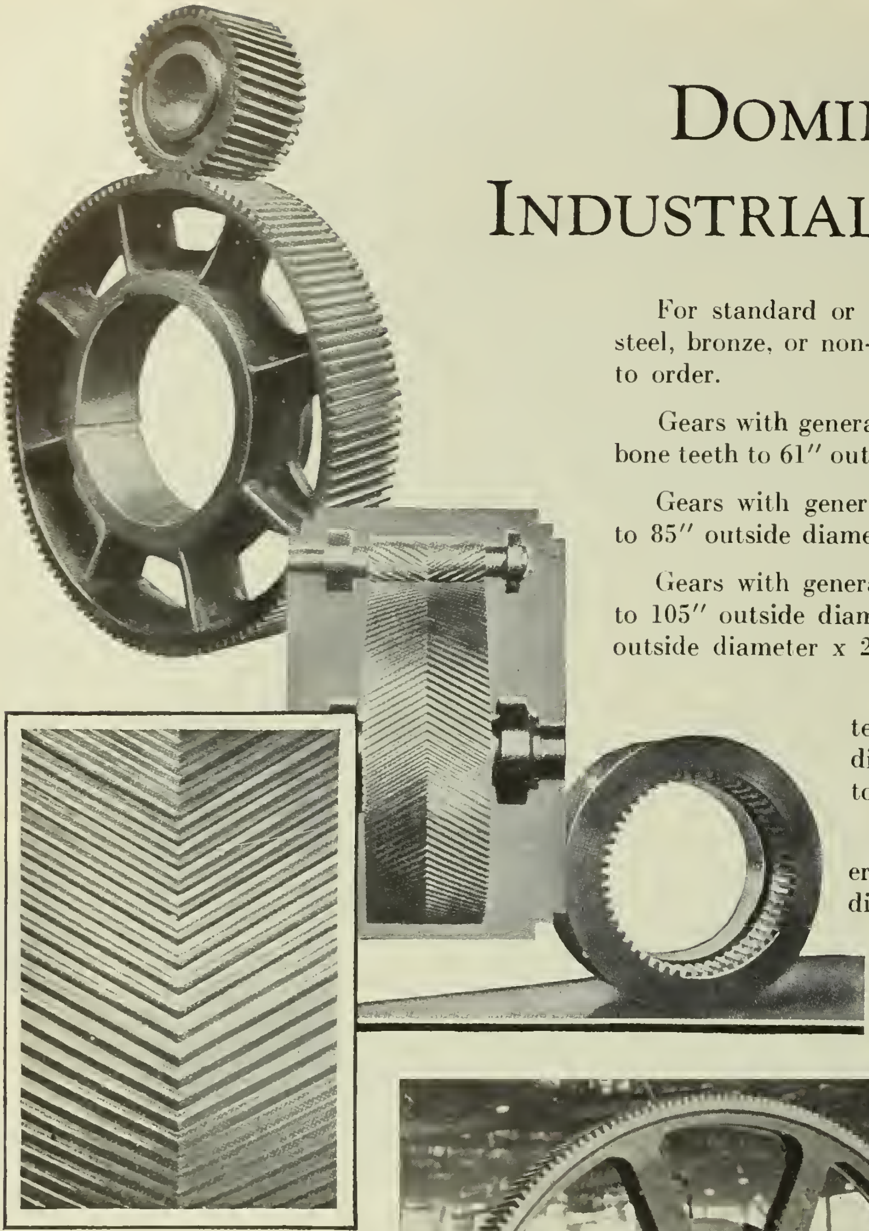

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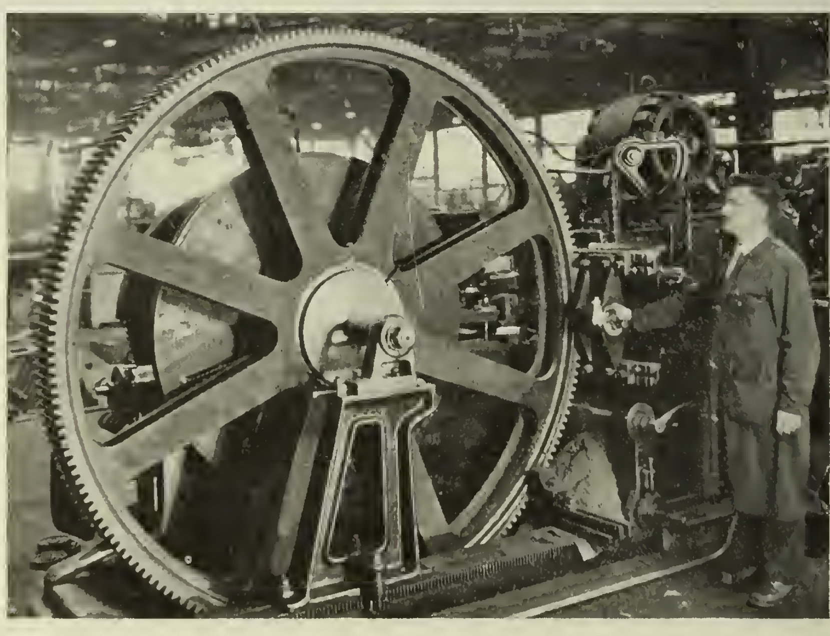

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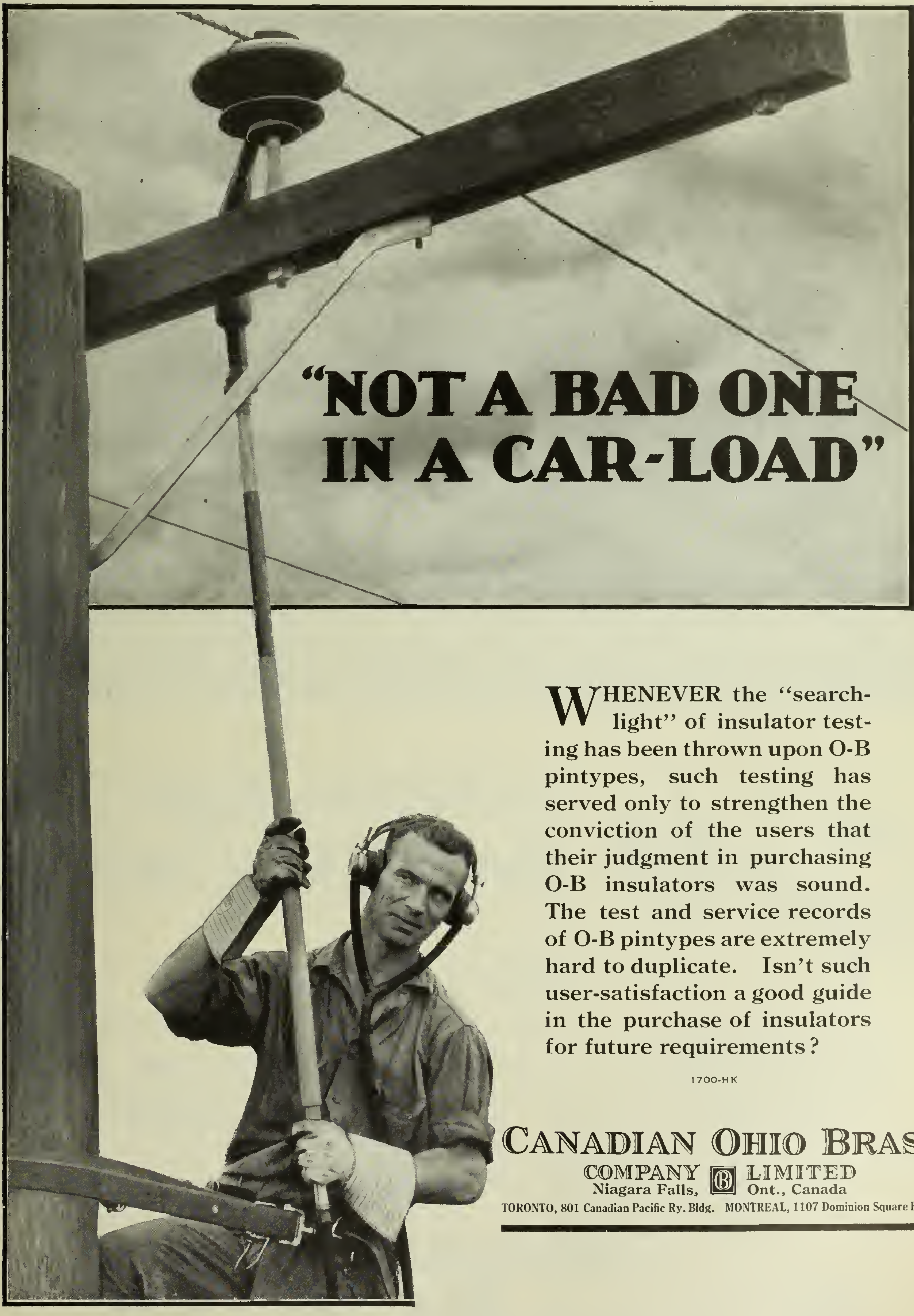
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VOLUME XVII | MONTREAL, DECEMBER, 1934 | NUMBER 12


# Photoelastic Determination of Temperature Stresses in an Arch Bridge Model


*Z. Levinton, S.E.I.C.,*

*University of Saskatchewan, Saskatoon, Sask.*



SUMMARY.—After a brief account of the photoelastic method of determining stress by polarized light, the paper describes a series of tests on a bakelite model of an arch of the Broadway bridge at Saskatoon, made to ascertain the stresses in the arch ribs and columns due to change of temperature. The experimental results are compared with those obtained by calculation.


During the past few years experimental methods of stress analysis have become prominent in the solution of many engineering problems. Among these methods photoelasticity has been developed as a powerful tool in determining stress concentration in structural members and machine parts of a complicated character which cannot be readily treated theoretically, such as plates with holes, notches and other discontinuities, hooks, chain links, gears and screw threads.

In the field of concrete construction many indeterminate structural forms are being introduced which present difficulties in stress analysis, and in important structures it is highly desirable that theoretical stress analysis be supplemented by some experimental method for determining the validity of the theoretical assumptions involved, as well as for a check on the accuracy of the voluminous computations.

It was with this view in mind that the author undertook the solution of temperature stresses in the new Broadway bridge at Saskatoon, when the problem was suggested to him by the designer, Dean C. J. MacKenzie, M.E.I.C., of the University of Saskatchewan. The characteristics of the design and construction of the bridge are described in an article published in the January 1934 issue of The Engineering Journal.

Among the peculiar features in the design was the consideration of the effect of temperature changes on the structure. To relieve the excessive temperature stresses the deck of the structure was cut over each pier, and each arch with its superstructure of columns and deck considered separately and analysed by means of the elastic theory. The temperature stresses in the arch rib were calculated by first considering the rib alone, then allowing for the effect of the superstructure. The latter effect was estimated with the aid of the experimental results obtained by Professor W. Wilson of the University of Illinois from a series of experiments on models of arch bridges with various degrees of rigidity and of various geometrical proportions.

The temperature stresses in the end columns directly supported by the piers were readily calculated by assuming that the expansion of the deck deflected the tops of the end columns horizontally, the stresses in which were obtained by then treating the columns as deflected cantilevers with both ends restrained from rotation. In the case of the spandrel columns, however, the conditions are too complex for satisfactory theoretical treatment. The top of a spandrel column is deflected and rotated due to the expansion and warping of the deck and its base is rotated due to the rise and rotation of the arch rib. Certain assumptions could be made as to the combined effect of the deck and the arch rib upon the spandrel columns, but the validity of those assumptions could not be well proved.

To solve the problem the author proposed to make a bakelite model of one span, to subject it to temperature stresses by heating it in a chamber with heating elements and to determine the stresses by the photoelastic method. The largest arch, of 186-foot span and 47-foot rise, was selected for this purpose.

### THE PHOTOELASTIC METHOD

Photoelasticity, as the name implies, is the correlation of the laws of optics and elasticity and their application to problems of stress analysis. The basic phenomenon of photoelasticity is that of double refraction produced by stress. It was discovered by Brewster, in 1816, that when a ray of polarized light passes through a glass plate under stress, the ray breaks up into two rays vibrating in the directions of the principal stresses in the plate. The two rays propagate in the plate with different velocities and emerge as an elliptically polarized ray with a phase difference proportional to the difference between the two principal stresses at the point of passage of the ray and to the thickness of the plate. The law is expressed by the equation $R = C\,(p - q)\,t$, where $R$ = phase difference, or relative retardation of the rays, $p$ and $q$ = principal stresses, $t$ = thickness of the plate, and $C$ = constant depending on the material of the plate and the wave length of the light. When the elliptical light issuing from the stressed specimen is passed through an analysing Nicol prism, which transmits vibrations in one plane, the emerging light is made up of two coplanar waves which interfere. The effect of interference is that of colours when white light is used and dark bands when monochromatic light is used. With increasing stress the colours change, following approximately Newton's scale of colours, and repeat themselves in higher orders. Thus there are yellow, red and green of the first order; yellow, red and green of the second order, etc. Points in the stressed plate where the stress difference $(p - q)$ is the same will form a band of colour, or "isochromatic," corresponding to that stress difference. Both tension and compression give the same colours for equal numerical values of stress.

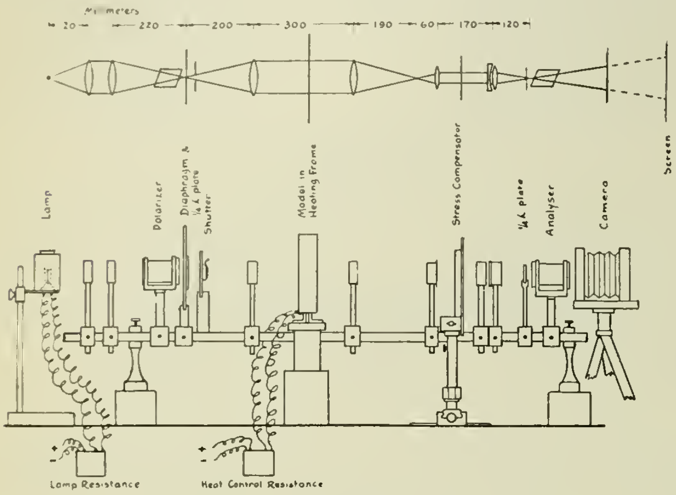


**Fig. 1—The Optical Set.**

The stress values of the isochromatics can be determined by comparison with the isochromatics of a simple specimen, such as a beam, where the stress distribution is thoroughly understood.

The stress difference at a point in the plate can be also determined by the "method of compensation" which consists in introducing the comparison beam or tension piece in series with the stressed plate and applying stresses until the total effect is zero and a dark spot occurs at the point. This is the "point of compensation" and the value of $p - q$ in the plate is equal to the known stress in the compensating piece. By proper orientation of the latter with respect to the directions of the principal stresses in the plate, it is possible to determine the sign of $(p - q)$, i.e. to distinguish between tension and compression.

To find the directions of the principal stresses in a plate, a "method of isoclinics" has been proposed by Clerk Maxwell and later developed by Filon, Coker and others. To obtain the separate values of $p$ and $q$, Coker (1)* devised a lateral extensometer and Filon (3) developed a mathematical method of graphical integration.

In many instances, such as in the present problem, it is obvious that the maximum stresses are at the extreme fibres, or boundaries. In such cases there is no necessity for stress separation, since at a free boundary there can be only one stress tangential to it, i.e. either $p$ or $q$ is zero.

From the discovery of the photoelastic law by Brewster until the beginning of the present century, glass was the only material available for the study of photoelasticity. The discovery of celluloid, bakelite and phenolite gave a new impetus to research. The ease of shaping into models and the higher stress-optical sensitivity of the new materials made possible the application of the method to many problems and greatly increased its accuracy. Ziro Tuzi (5) used phenolite in his photographic and kinematographic "fringe method." Frocht (11) further developed kinematography with monochromatic light and bakelite models. Solakian (7) successfully used the photographic method with white light. A commercial method is described by Baud (8). A new optical method of stress separation is due to Favre (6). The petrological microscope has been adapted to photoelastic work by Hall (12).

*Numbers refer to bibliography at end of paper.

### The Optical Apparatus

The optical set shown in Fig. 1 was assembled by the author from Nicol prisms, lenses and quarter wave plates supplied by the Physics Department of the University of Saskatchewan. Two ¾-inch steel shafts for the optical bench. The lenses, diaphragms, Nicols, etc., are attached to iron bars riding on the shafts. The various parts can be moved along the bench and clamped in positions determined by the focal lengths and diameters of the lenses and by the apertures of the Nicol prisms.

In the arrangement in Fig. 1 the Nicols are set with their axes crossed and the axes of the quarter wave plates are at right angles to each other and at 45 degrees to the axes of the Nicols. The light from a tungsten ribbon projection lamp is converged through the polarizer, the plane polarized beam passes through a diaphragm with a ⅛-inch hole and through a quarter wave plate. The emerging light is circularly polarized. The stressed model is placed in the path of parallel beam of circular light. The circular light becomes elliptically polarized due to the stresses in the model. The light further passes through the second quarter wave plate which cancels the effect of the first plate and the phase difference of the light passing through the analyser is entirely due to the stress difference in the model. The interference colours are projected on the glass screen where the isochromatics can be observed and traced on paper. For photographic work a camera with its lenses removed is placed close to the analyser. The shutter of the camera is placed in a convenient place in the system as shown in the figure.

The stress compensator shown in Fig. 2 is a dynamometer by means of which a known stress can be applied to a beam made of the same material as the model. This compensator is capable of horizontal and vertical motion and rotation about a vertical and horizontal axis, which enables one to place the compensating beam in various positions corresponding to the stress directions at the points of the model studied.

### The Model

The material used for the model was bakelite C-25 in sheets 7 by 12 by ¼ inches. The sheet was ground on both sides with emery powders and polished with white rouge. This treatment gave a sheet of good transparency and quite uniform thickness.

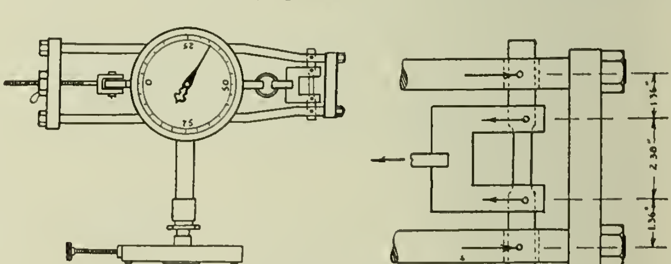

**Fig. 2—The Stress Compensator.**

In calculating the dimensions of the model the following principle of similarity had to be considered. The distortion of the model under stress must be similar to that of the structure. To obtain the above condition it is necessary (1) to have the centre lines of the model form a figure geometrically similar to that of the gravity axes of the members of the structure, and (2) the relative stiffness of the members of the model must be proportional to the relative stiffness of the members of the structure. The stiffness of a member is measured by the ratio $I/l$ where $I$ = moment of inertia of its cross section and $l$ = its length. With the thickness of the model of 0.240 inch throughout, it was necessary to adjust the widths of the arch ring, the columns and the deck to give moments of inertia in accordance with the requirements of similarity. The dimensions of the model, shown in Fig. 3, are 6 by 12 inches including the piers.

**Fig. 3—The Model.**

The centre lines and boundaries of the model were scratched on the bakelite sheet by means of a scriber attached to a micrometer vernier reading to 1/1000 of an inch. The model was first cut roughly to shape leaving about 3/32 of an inch of material around the boundaries. From the same sheet as the model, tension pieces and a beam were cut and filed roughly to shape.

The model and the accessory pieces, when examined in the polariscope, exhibited considerable initial stresses and annealing was necessary. Accordingly, they were placed between two glass plates with sheets of paper between the glass and bakelite. The glass plates with the model between were buried in fine silica sand in a pan, with about 2 inches of sand on all sides of the plates. The pan was placed in a hot air constant temperature oven. The temperature was raised to 175 degrees F. and kept constant for one and a half hours to ensure penetration of the heat through the sand and glass. The oven was then allowed to cool to room temperature for a period of sixteen hours. After the annealing, the examination in polarized light revealed very slight initial stresses left in the material. After annealing the model was finished with fine files to the boundaries and carefully measured with micrometer calipers. The variation in width of the members when finished was about 2/1000 inch.

The model was placed in the heating frame and the piers protruding below the frame were firmly bolted to two iron bars with serrated surfaces, as shown in Fig. 4. While the iron bars were at constant room temperature and held the piers in place, the superstructure could expand and undergo distortion due to the rise of temperature in the frame. The latter was heated by three heating elements in which the current was controlled by means of a resistance. Direct radiation from the elements was prevented by tin baffles and the temperature inside the frame was equalized by convection currents induced by stirring the air in the frame. A thermometer inserted at various depths into the frame gave a fairly uniform reading of the temperature.

### The Procedure of the Tests

The stresses corresponding to the various colours were determined by applying a load to the bakelite beam in the compensator and projecting the isochromatics on the screen. The neutral axis, the zone of zero stress, of the beam is shown as a dark band. In Fig. 5 the boundaries

Table I
Temperature Stresses in the Arch Rib

| Section | | Model | Conversion Factor | Structure | |
|---|---|---|---|---|---|
| | | Temp. Stress | | Temperature Stress | |
| | | 45° F. Rise | | 45° F. Rise | 90° F. Fall |
| 1 | Extrados...... | −550 | .322 | −177 | +350 |
| | Intrados...... | +350 | " | +112 | −220 |
| 2 | Extrados...... | −100 | .357 | − 36 | + 70 |
| | Intrados...... | +100 | " | + 36 | − 70 |
| 3 | Extrados...... | + 50 | .353 | + 18 | − 40 |
| | Intrados...... | −250 | " | − 88 | +180 |
| 4 | Extrados...... | + 50 | .346 | + 17 | − 30 |
| | Intrados...... | −250 | " | − 86 | +170 |
| 5 | Extrados...... | + 50 | .363 | + 18 | − 40 |
| | Intrados...... | −300 | " | −109 | +220 |
| Crown | Extrados...... | + 50 | .360 | + 18 | − 40 |
| | Intrados...... | −300 | " | −108 | +220 |

Tension = +.

of the colour bands are shown, the lengths of the lines being proportional to the stresses.

The initial stresses left in the edges of the model after annealing were determined by compensation with the beam compensator. These stresses were recorded and used for correcting the values of the temperature stresses.

To study the temperature stresses the air in the frame was heated from room temperature of 75 to 120 degrees F., a rise of 45 degrees F. It took about an hour for the heat to penetrate the model and give a condition of equilibrium.

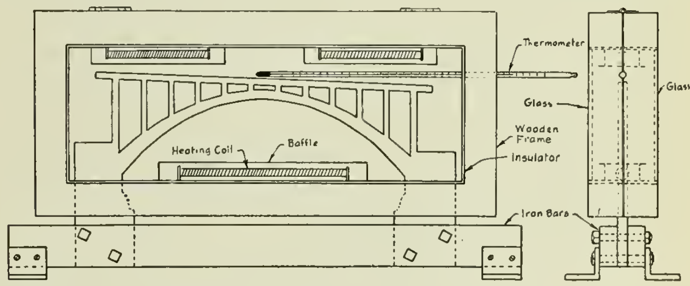


**Fig. 4—Model in Heating Frame.**

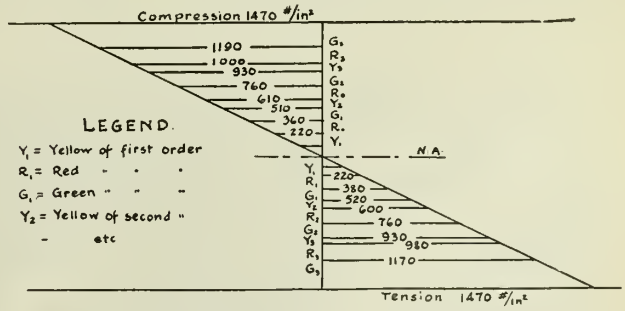


**Fig. 5—Bakelite Beam Calibration.**

At the end of the hour the isochromatics became stable and could be traced and photographed. The heating was repeated several times with different parts of the model in the path of the polarized light. The magnitudes of the stresses at the edges (extreme fibres) were determined by comparison with the colours of the calibrating beam pro-

Table II
Columns
Maximum Stress at Extreme Fibres

| Column | Model | Conversion Factor | Structure | |
|---|---|---|---|---|
| | Temperature Stress | | Temperature Stress | |
| | 45° F. Rise | | 45° F. Rise | 90° F. Fall |
| $C_1$ | −300 | .833 | −250 | +500 |
| $C_3$ | −300 | .925 | −280 | +560 |
| $C_4$ | −400 | " | −370 | +740 |
| $C_5$ | −400 | " | −370 | +740 |
| $C_8$ | −400 | " | −370 | +740 |
| $C_9$ | −400 | " | −370 | +740 |
| $C_{12}$ | −250 | .908 | −230 | +460 |

jected on the screen side by side with the portion of the model under examination, and the signs of the stresses (tension or compression) were determined by compensating or overlapping the model with the compressive or tensile side of the beam.

The stresses due to 45 degrees rise in temperature were small and only colours of the first order were observed. The author considered it unsafe to raise the temperature higher for fear of approaching the annealing or plastic state of bakelite.

### Results of Tests

In the second column of Tables I and II the observed temperature stresses, corrected for initial stresses, are given. In case of the columns the maximum stress due to a rise in temperature is compression. Columns 4, 5, 8 and 9 are under the highest stress, with 400 pounds per square inch compression at the extreme fibres at their bases. The section of highest stress in the arch rib is at the springing line, with 550 pounds per square inch compression on the extrados side and 350 pounds per square inch tension on the intrados side.

To convert the stresses in the model to those in the prototype structure, conversion factors had to be calculated for each section, taking into account the scale of the model, the coefficients of expansion of bakelite and concrete and their respective elastic moduli.

The stresses observed for a 45 degree F. rise in temperature will be doubled for a 90 degree rise and their signs reversed for a 90 degree drop. In the last columns of Tables I and II the stresses are converted for a 90 degree drop for purposes of comparison with the designers' theoretical computations in which such range of temperature had been assumed.

The thermal coefficient of bakelite for the range of temperature used in the experiments was determined to be .000026 inch per inch per degree F.

The elastic modulus was taken as 600,000 pounds per square inch.

### Comparison of Experimental Results with Theoretical Calculations

With the elastic modulus of concrete taken as 2,500,000 pounds per square inch and a coefficient of thermal expansion = .0000065, the theoretical temperature stress at the crown of the arch due to a 90 degree drop is 240 pounds per square inch. This compares well with 220 pounds per square inch as derived from the tests. (See Table I.)

While the thrust at the crown was not considered to be affected by the superstructure, the theoretical thrust and moment at the springing were corrected for the effect of the deck by empirical factors 2.5 and 1.75 respectively. These factors are based on those derived by W. Wilson of the University of Illinois from tests on a span of similar proportions. The theoretical stress at the springing, thus corrected, is 403 pounds per square inch, as compared with the photoelastic value of 350 pounds per square inch.

Table III
Comparison of Experiments with Theory

| Member | Maximum Stress | |
|---|---|---|
| | Theoretical | Experimental |
| Arch Crown | 240 lbs./in.² | 220 lbs./in.² |
| Arch Springing | 403 " | 350 " |
| Base of Column 1 | 480 " | 500 " |
| Base of Column 12 | 370 " | 460 " |

At the base of column 1 the theoretical stress of 480 pounds per square inch is closely checked by the experimental value of 500 pounds per square inch, while for column 12 the theoretical and photoelastic stresses are 370 and 460 pounds per square inch respectively. This latter discrepancy is indicative of the probable degree of accuracy to be expected from the experimental method. Table III summarizes the comparison of theory with the experiments.

### The Rise of the Arch Crown Due to Temperature

A novel use of the polariscope was made in measuring the rise of the crown of the model due to temperature. The quarter wave plates were removed and the Nicols were set parallel, the screen was moved back to give a large image of the model. The magnification thus obtained

Fig. 6 Photograph of Arch Springing and Base of Column 1.

Fig. 7 Detail of Isochromatics of Base of Column 1.

Fig. 8. Arch Rib at Column 9. Photograph of Isochromatics.

was 29. A cross engraved on the crown of the arch axis gave a dark image on the screen and its positions before and after heating were marked. The observed magnified movement of the arch was 0.33 inch corresponding to a true rise of the model arch of 0.0114 inch for a 45 degree rise in temperature. This corresponds to a 1.37-inch rise for the prototype structure with a 90 degree rise in temperature, which compares well with the theoretical value of 1.31 inches. Levels taken in the field gave a movement

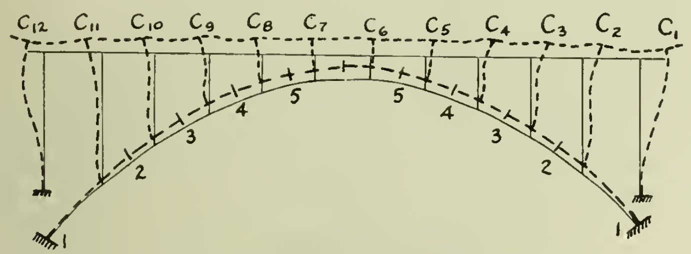


Fig. 9—Distortion with Rise of Temperature.

of crown of 1.47 inches for a temperature range of 92 degrees. (See Engineering Journal, January, 1934.) The agreement of the three values is a good check on the model showing that it is proportioned correctly and is representative of the actual structure.

### Conclusions

A question will undoubtedly arise in the mind of the critical reader as to the degree of accuracy obtained in the results of the experiment on the model, and as to the reliability of the conclusions with regard to the stresses in the structure itself.

The inherent error of the photoelastic method is the inaccuracy in determining the stress values of the isochromatics. This error may easily reach 5 per cent and where initial stresses are present the error is obviously doubled. In the present case a second annealing might have eliminated all initial stress in the material and increased the accuracy.

As to the error of "optical creep," or variation of optical effect with time after application of the load, this is quite negligible at low stresses.

An interesting problem is the possibility of variation of the stress-optical constant ($C$) with temperature. It is cited by Filon who found that glass changes slightly its optical coefficient when heated from 18 to 90 degrees C. With the small range of temperature used in his work the author considers it unlikely that the optical characteristics of the bakelite model were changed appreciably, but definite proof must be obtained experimentally. Another determination is necessary as to the possibility of variation of the elastic modulus for the same range of temperature. The uncertainty of the modulus of the material in the model, however, is not greater than the uncertainty of the modulus of concrete in the structure itself.

The author considered that the method of heating the model in a chamber more nearly approximates the conditions in the actual structure than the method of horizontal displacement of a pier, such as is used in the mechanical stress analysis. In the latter method a horizontal thrust is produced by displacing one pier horizontally, the arch is shortened and rises, transmitting the pressure to the deck through the spandrel columns and the deck acts as a beam tied to the piers by the end columns. With heating, however, an expansion of the deck takes place as well as a rise of the arch, and it is the combined effect of the two movements on the stresses in the spandrel columns that is of special interest in the present case.

The method of pier movement may have its advantage in enabling the formation of higher stresses with colours of higher order and consequently, greater accuracy. The author intends to try this method on the same model.

On the whole, the total error in determining the temperature stresses in the short columns is probably less than 20 per cent, which is quite satisfactory in a problem of this nature. In converting the model stresses into the structure more errors are introduced due to the fact that the reinforced concrete is not homogeneous. It was assumed in the calculation of the conversion factors that the stress distribution across a section in the structure is similar to that in the model. Since the columns are under dead load in compression, it was further assumed that the concrete may take temperature tension to the full amount of this initial compression. Where the temperature tension exceeds the dead load compression, cracks will form and the concrete will open up, changing the character of the section and the stress distribution.

With all the above mentioned uncertainties and difficulties, it is felt that the problem of temperature stress has been clarified to a great extent by the photoelastic method. The compressive and tensile stresses at the extreme fibres give a general idea of the dangerous sections and permit one to visualize the shape of the distorted frame. Figure 9 gives such a qualitative picture of the distortion of the span under a rise in temperature. The quantitative results, though by no means exact, give sufficient indication that the temperature stresses in the spandrel columns are serious and are to be considered in the design and construction of structures of this nature.

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# Notes on the Operation of a Lobnitz Rockbreaker

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Paper presented before the Saint John Branch of The Engineering Institute of Canada, March 27th, 1934.

SUMMARY.—Effective work has been done in the harbour of Saint John N.B., by a rockbreaker dropping a 15-ton chisel thus shattering the rock at the bottom of the channel. The advantages and limitations of the method are described together with the procedure for fixing the position of the cut and allowing for variations of tidal level during operation.

The Lobnitz rockbreaker *Glenbuckie* operated by the Saint John Dry Dock and Shipbuilding Company Limited, on the contract with the Department of Public Works of Canada for the main channel improvements in Saint John harbour is a device which possesses some interesting features. Its outstanding characteristics are ruggedness and simplicity and within its limits it does effective work very cheaply. Figure 1 is a plan of part of the harbour at Saint John, N.B., and the hatched areas indicate where the Lobnitz rockbreaker worked.

The apparatus was developed by Lobnitz and Company Limited, of Renfrew, Scotland, and consists essentially of a heavy chisel that is lifted and dropped on the rock, chopping pieces off the face of the cut. The chisel of the *Glenbuckie* consists of a steel cylinder 27 feet long by 22½ inches diameter and weighing 15 long tons, with an alloy

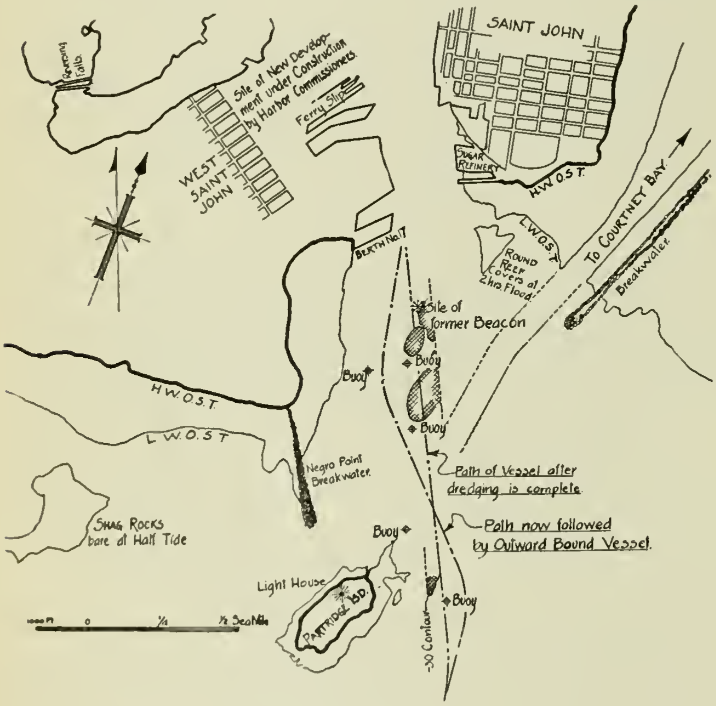


Fig. 1—Portion of Harbour Saint John, N.B.

steel point with a shank fitting into a hole in the end of the body. This point is renewable when worn; the body being heated in a portable oil furnace until it expands enough to allow the shank to enter, and a number of setscrews are set up after it is cooled and shrunk onto the shank. The chisel works in a tube of heavy plate, lined with a wooden bushing that serves to guide and restrain it, and through which the descending chisel expels the water with a force sufficient to wash away the broken rock at the spot being worked. The apparatus is mounted on a steel hull 160 feet long by 45 feet beam and steam is furnished by a Scotch marine boiler to the main winch, the manœuvering winch, a winch to handle the tube, and to the auxiliary apparatus. (See Figs. 2 and 3.)

The main winch, which operates the chisel, has a rather unusual clutch. This clutch consists of a helical spring of tapering rectangular section, attached to the hoisting drum, free to rotate with it when not engaged. (See Fig. 4.) The spring is coiled about another drum driven through double reduction gears by the engine. To engage the clutch, a collar, sliding on a feather on the shaft of the driven drum, is made to push against a bell-crank (moving it to a position as shown by the dotted line) which in turn communicates its motion to the free end of the spring at *A*, tightening it around the driven drum. This locks the

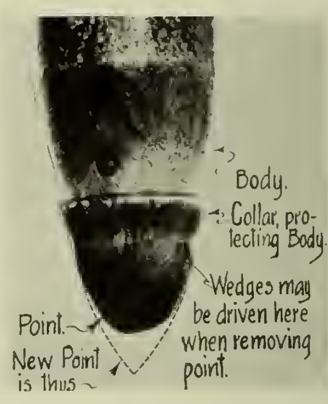


Fig. 2—Worn Chisel Point.

driven drum, spring, and hoisting drum together. When the collar is withdrawn the spring immediately lets go allowing the cable to run out and the chisel drops. The crank has a set screw at *A* for adjustment as the length of the spring varies with temperature changes. The clutch is all metal, there is no appreciable wear; clearances are small and only a small motion of the collar is needed. Except for occasional adjustment and lubrication it has worked without attention since August 1st, 1931. The collar is worked by a hand lever whose effect is reinforced by a steam ram with whose valve gear the hand lever is interconnected.

In operation three blows per minute may be struck, the chisel being hoisted and dropped 15 feet each time.

The vessel is manœuvred from six anchors, one ahead, one astern, and two on each side. The cables are brought through fairleads to a winch amidships. The six drums of this winch, each holding 1,000 feet of seven-eighths wire cable, are fitted with jaw clutches and brakes, three on each of two parallel shafts driven through worm gearing by an engine. The vessel swings to the bow anchor upstream, which is heavier than the others; and is moved across the cut by slacking the brakes and paying out the required amount of cable on one side, while the same amount is taken in on the two drums on the opposite side that are in gear. A swing of over two hundred feet can be made if the anchors are placed correctly.

To break rock, the face of the cut is pounded with the chisel until the chisel descends to the elevation to which it is desired to dredge, at points spaced three to five feet apart. In shaley rock, which shatters easily, four-foot spacing breaks it into pieces the size of a finger. In rock of a denser structure, four-foot spacing is apt to leave the fragments too big for convenient dredging, especially if the rock has well-defined bedding planes that are horizontal, and in that case it breaks off in four-foot square blocks. Three and a half foot spacing breaks it into pieces, the largest of which would go into a barrel, and that is generally used.

The rate of penetration depends upon the hardness of the rock, and upon the depth to be broken down—as dredgemen say "on the amount to come off." Under the same conditions the time required for one hole, so-called, increases about as the square of the amount to come off. When this becomes considerable, it is economical to do the work in two or more lifts, breaking first to a depth such that the rate of penetration begins to be slow in proportion to the amount of rock broken; then dredging the broken rock and repeating the process until the desired grade is attained. (See Fig. 5.)

Fig. 3—Replacing Chisel Point.

In some kinds of rock, the dredge *Leconfield* could dig to an elevation one or two feet below that to which the chisel was worked; elsewhere this has not been found possible.

Presumably the process is similar to cutting off the end of a wide board with a narrow carpenter's chisel. "Presumably"—because attempts by a diver to find out what had gone on below gave no results. He could only work at high water when the current was slack; and since the depth of water was then about 55 feet it was too dark to see and he could not tell by feeling. But if the analogy of the carpenter's chisel holds true, it is evident that the chisel must be spotted very exactly along the face of the cut. If the chisel is too far ahead of the face it only punches a dent in the solid rock; if behind, it only mashes up rock already broken. If correctly spaced at the face of the cut pieces are split off; and the chisel penetrates with each blow. Material already broken cushions the blow completely and penetration through it is slower than into solid rock. When the chisel hits on clean solid rock, the first few blows make a characteristic noise heard below decks, and causes a distinct quiver in the hull. But some arrangement must be provided whereby the vessel can be lined in and swung squarely across the cut precisely on that line. Attempts to operate by estimating the spacing of the holes either along or across the channel by mooring cables only ended in confusion. With six or eight hundred feet of cable to each anchor, rising and falling tides, swift currents, and occasional dragging anchors, the face of the cut could not be maintained.

### Range Guides

The shores are too far away in most cases to admit of satisfactory ranges being placed there, and they are often hidden by weather or smoke for long periods. Sometimes for weeks Fort Howe and its elaborate targets could not be seen and this difficulty, which at one time seemed serious, was overcome by erecting working ranges of weir-poles such as fishermen use. The forest of sticks that appeared between the main channel and Courtenay bay was composed of the dolphins used in this connection. One big dolphin was of large piles driven by a pile-driver, the many others were weir-pole dolphins. They are comparatively cheap and easily erected; and can in most cases be located close enough to be seen in any but the thickest weather. (See Fig. 6.)

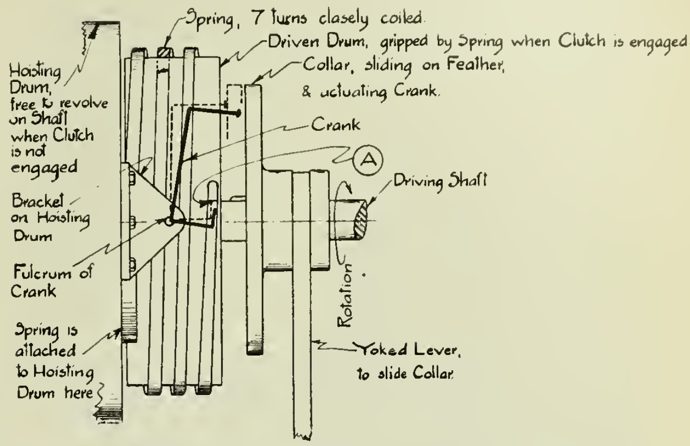


Fig. 4—Diagram showing action of Clutch on Main Winch.

These ranges guide the vessel across the cut but it is also necessary to be able to locate the distance from the side-line of the channel. After considerable experiment with a three-point fix by double angles with station-pointers, stadia, angles to a known point from a base-line on the deck, and a measuring line or tag line, the range-and-angle method was found most satisfactory. At first sight a tag line run out to a mooring would seem the simplest and most positive; but it is carried off by the current, requires shifting often as the vessel moves, is always in the way, and gets foul of drifting trash.

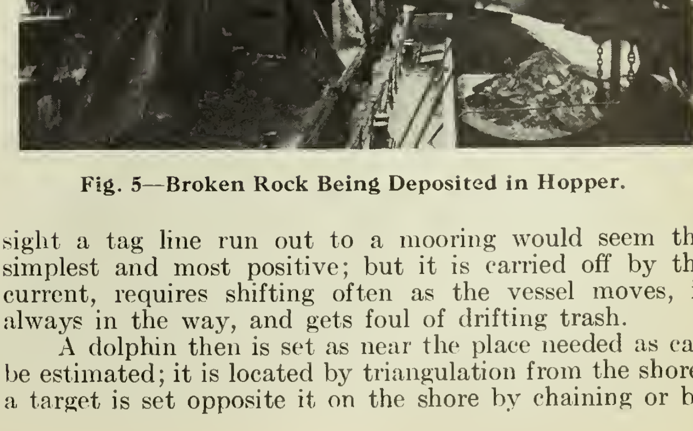

Fig. 5—Broken Rock Being Deposited in Hopper.

A dolphin then is set as near the place needed as can be estimated; it is located by triangulation from the shore; a target is set opposite it on the shore by chaining or by transits so that the range formed is at right angles to the channel; another dolphin can now be set on that line near enough to be seen from the channel. Sometimes the pile-driver can be lined in from the shore by a transit or by cross-bearings but often it is difficult to signal from the distant shore with vessels coming between. When one good range is obtained, others can be located from the deck of the rockbreaker. Three stakes, about eight inches

Fig. 6—Pile Dolphin—Weir Pole Dolphin in Background.

diameter at the butt, and long enough to bare at half tide, are driven, braced and tied together with smaller stock nailed to them. A top-stake of smaller diameter is fixed to the top of this structure and reaches to about 32 feet above low water. A fisherman's weir-pole driver having a hammer made from a large block of birch is used. (Fig. 6.)

A measuring frame of angle iron is placed along each side of the rockbreaker and marked in feet scaled off from the chisel. Plumb-bobs are hung from corresponding points on these frames and the range poles are lined in with them across the deck. A third dolphin is set ahead, or behind this range by an amount that may be determined by any convenient method. Then taking the angle between the range and the third dolphin with a sextant, a right angled triangle is obtained whose solution gives the distance to this third dolphin, and so the distance from the side line of the channel. If the dolphins are not too far away, say within 700 feet, and with a convenient range of values for the angle, results to the nearest 6 inches may be obtained with one setting of a 10-inch slide-rule. The whole operation of obtaining the chainage along the channel and the offset from the side line can be done with a sextant and slide-rule in one minute.

The greatest difficulty was encountered near the site of the old beacon because the rocky bottom did not allow driving poles near the channel and also here the most difficult rock was found. At Partridge island there is a glassy volcanic formation, very hard but brittle and further up the channel, about half way to No. 17 berth, red sandstone, laid down in carboniferous times, occurs. This gives place to slatey shales in which the fossil remains of cordaites, a carboniferous era tree, are found. Then there is a hard but brittle quartzite that breaks along the joint and bedding planes and is intersected by veins of white quartz crystals as much as one inch wide. However the rock near the old beacon site is a homogeneous quartzite apparently without any definite cleavage planes. It is very hard, and exceedingly tough and abrasive. The point of the chisel, that would last for a month elsewhere, was worn so as to require replacement in three days. It has been suggested that this rock, rising from deeper water and with different formations all around, may have been a sandy beach in pre-Cambrian times, and was formed from the disintegration of still older quartz rock. It has become solid through the infiltration of silicon dioxide in solution in hot waters acting as a cementing agent. Its great hardness has preserved it while later rocks have been formed on and about it, and have since disappeared. (Fig. 1.)

### Ideal Conditions for Short Periods Only

Delays in the work were caused by tide, storms, fog, and undertow. Of these the undertow is the most serious obstacle in the outer harbour and is the local name for the swell that runs in from the southwest and is due to causes at work beyond the harbour and beyond the Bay of Fundy itself. During September 1933 the local weather was not severe, but there was a succession of hurricanes in the West Indies. Many of these did not reach beyond the Caribbean, and no storm nor even strong wind blew in Saint John; yet the undertow ran all month. It would be interesting to know its origin and propagation.

An easterly storm in the Bay of Fundy raises a short sharp sea that soon dies away if the wind falls or shifts to the north. If however the wind hangs in the southwest or west, the waves lengthen from about 30 feet to 70 or 125 feet, and persist for perhaps a week. Days of fine clear weather, with only the gentlest southwest airs, pass; still the long smooth waves come rolling in in endless succession. They may die out at low water, but as the flood makes they are there again. The fog seems to encourage it, as do spring tides. North-north-west to east-south-east winds, or a heavy rain, and the ebb tide, run it down. The actual amplitude of the wave is small, only a few inches, except that every now and then three big waves in succession occur; they cause no inconvenience to shipping, but if breaking rock is attempted the chisel is set swinging like a pendulum and severe strains are imposed on the gear. Even when it is not bad enough to stop work this swing causes the chisel to hit incorrectly, dissipating its energy; thus progress is slow while the undertow lasts.

As a sample of favourable winter conditions, between December 9th, 1931, and January 16th, 1932, the rock-breaker was delayed 15 percent of the total possible working hours by a number of storms, 17 percent by tidal currents, and 28 percent by undertow; and this at a comparatively sheltered spot inside the Negro Point breakwater. During the winter it is seldom altogether absent outside of No. 17 berth.

When the velocity of the current exceeds two and a half knots it affects the chisel and tube so much that work must be stopped. August and September of 1933 were the first times in two years that the river was so low the *Glenbuckie* could be operated during low water. Schemes have been suggested for holding the tube against the current to permit working while the current was swift, but the writer doubts the efficacy of any of them.

### Tide Gauges

It was often difficult to set a tide gauge where it could be seen from the vessel. Sometimes the nearest pier or dolphin that could be used was 1,000 feet away and the divisions of a gauge could hardly be distinguished at night in the beam of a searchlight, and of course not at all in fog. It is necessary to know the height of the tide at all times when working, for the elevation to which the rock is broken is found by measuring from the point of the chisel, by means of marks on the cable, to the surface of the water. As it is the last few inches of penetration that take the most time, it is considered necessary to know the height of the tide to the nearest quarter of a foot.

The analysis of the rise and fall of the tide is exceedingly complex. It was thought it might be possible to predict the height of the tide at any time between high and low water by having the tide tables of the Hydrographic Service of the Department of Marine to go by; but this has not proved easy. The reason is discussed at length in various references and in particular by Dr. W. Bell Dawson, M.E.I.C., who was formerly Superintendent

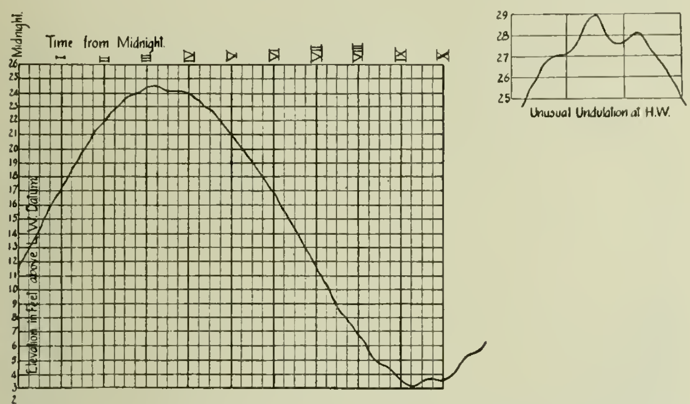


**Fig. 7—Typical Secondary Undulation at High and Low Water.**

of Tidal Surveys at Ottawa. Dr. Dawson contributed many papers to the Royal Society of Canada, containing the results of his researches; as well as his publications issued by the Tidal Survey, of which H. W. Jones, M.E.I.C., is now in charge.

THE TIDES AT SAINT JOHN

Where the tide is greatest in the Bay of Fundy, it rises and falls as a symmetrical curve when the height is plotted against time. This seems to be very nearly a sine (or cosine) curve; on the assumption that the rise or fall varies as the cosine of that angle which is that proportion of 180 degrees that the elapsed time since high or low water bears to the duration of the flood or ebb, an estimate can be made with the help of the tide tables. Sometimes this is satisfactory, agreeing with observed values for several days. But a difference may enter which can hardly be predicted. This is the "Secondary Undulation," due probably to barometric differences over wide areas of the open sea. This is said to be greatest where the range of the tide is least* and it is very pronounced at the Mag-

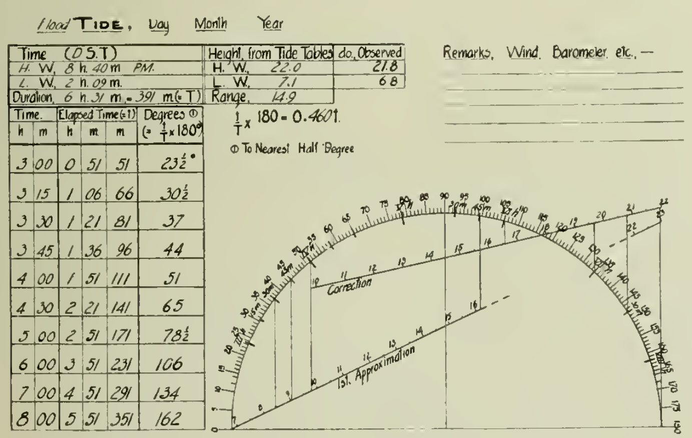


**Fig. 8—Chart for Estimating Elevation of Tide.**

dalens, in the Gulf of St. Lawrence, and at Halifax, N.S., where it is almost continuously present. At Yarmouth, N.S., there was a secondary undulation amounting to 45 percent of the range of 10.4 feet on a certain date; on the same date it amounted to 11 percent of the range of 18.0 feet at Saint John. It disappears as the tide progresses up the bay †and is present in about half of the tides at Saint John. Its period at Saint John is in the neighbourhood of forty minutes; the mean period of the true tidal undulation is twelve hours and twenty-five minutes. (See Fig. 7.)

So although this irregularity seldom amounts to 10 percent of the range of the tide at Saint John, 10 percent of a 20-foot tide may make a great difference when trying to break down 8 feet of rock with a Lobnitz apparatus.

Since the tide enters so largely into the life of the harbour it is essential that pilots and mariners, as well as engineering enterprise, should know in advance when high and low water occur, and what the depth will be at these times. This information is supplied in the daily Tide Tables issued annually for a year in advance by the Hydrographic Service of Canada.

Low Water Datum or Chart Datum is a local plane of reference established by the Tidal Surveys and from this the height of the tide is measured upward and the depth of water downward. It is an arbitrary plane and is chosen so as to be most convenient for tide calculations and to best represent the depth of water when the tide is out. It is different in different places, as the range of the tides differs. The elevation of a point half way between high and low water differs a little from tide to tide, but the mean from year to year is constant except in estuaries

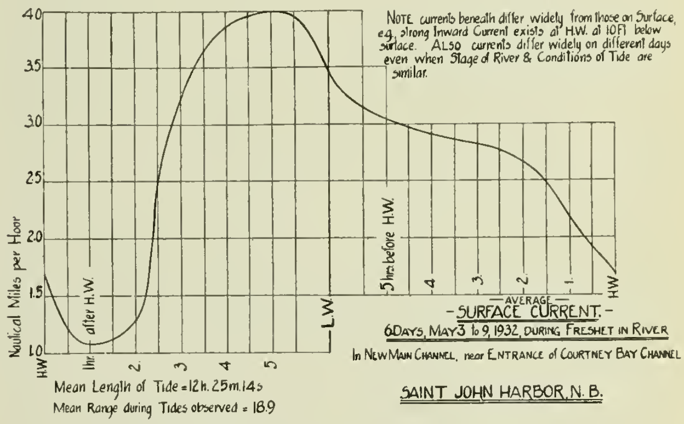


**Fig. 9—Chart of Surface Current.**

and rivers where the slope does not allow the water to fall to a true low water. This mean is Mean Sea Level and the Canadian and United States systems of precise levels show it to be the same for the whole Atlantic coast. Except for a possible secular change it is the most stable datum there is.

High or "spring" tides occur twice a month, at the full and change of the moon, but the elevations between which they rise and fall depend on the distance of the moon and the extreme range is seldom attained. At these times the tide is high between eleven o'clock in the morning and noon. Then a week later the tide is not high until evening and the range is very much less. For a precise discussion of these features the reader is referred to the pamphlets listed in the catalogue of publications of the Department of Marine, which not only contain exact information but present it in a most interesting form; and a recent paper by H. F. Bennett, A.M.E.I.C.‡

The tidal undulation is transmitted up river to Fredericton, about eighty-four miles, where it is high water some eight hours after Saint John. A few miles above Fredericton the effect of the tide disappears in the swifter water there. It is stated on the river chart that low water datum there is two and a half feet above Mean Sea Level. The tide there may rise about three quarters of a foot above

*Dr. Bell Dawson, Trans. Royal Soc. of Can.

†"Tides at the Head of the Bay of Fundy," Tidal Service of Canada.
‡The Engineering Journal, July 1934.

this datum. The surface of the water in the harbour at high tide may thus be considerably above the water level at Fredericton since at Saint John the tide may rise 14 feet above Mean Sea Level.

There are tables and charts for estimating the height of the tide during ebb or flood, based on the assumption that the fall or rise is harmonic. This arrangement has been used by the author; for it is often necessary to make (Fig. 8) a guess at the tide over an hour or so while a gauge is temporarily hidden. The form with the protractor on it is printed from a tracing on a blue line or ozalid print and the data, which are obtained from the tide tables, can be arrived at and filled in in a few minutes. Then if the gauge can be seen occasionally and if the tide is not rising or falling as expected, the curve of rise or fall will at least be nearly parallel to a sine curve, and a correction can be made on the form. In the example shown the times were calculated and spaced off on the protractor, any intervening time to the nearest five minutes being readily interpolated mentally or with a pair of dividers. Low water was observed to be 6.8 feet, and the height at four o'clock, p.m., d.s.t., twelve hour notation, was 9.8 feet. Choosing a suitable scale, it was placed on the diagrams so that 6.8 fell on the low water and 9.8 on a perpendicular through four o'clock. This line is the "first approximation" and the tide was read from this by dropping a perpendicular upon it from the time, until at half tide a chance to see the gauge seemed to show the tide was not rising as fast as this line would indicate. The fact that it showed that high water would be nearly 23, instead of 22 as predicted in the tables, would lead one to expect that the rate of rise had become less. Accordingly steps were taken to obtain a good reading of the tide gauge and at five hours and forty-five minutes it was found to be 15.7, instead of 16.2 as the curve showed. A new line, the "correction" was drawn, having 9.8 at four o'clock as before and 15.7 at five forty-five. This was found to agree with the gauge as closely as it could be read when visible, for the remainder of the flood; and showed high water 21.9 whereas 21.8 was observed (the average of several readings obtained during the high water stand) and 22.0 was predicted. But this or any other device may fall one and a half feet in error within twenty minutes of having verified a value by gauge when the secondary undulation is well developed.

Contrary to the firm convictions of many, the wind does not seem to affect the tides greatly, or at any rate regularly. It hardly seems possible but that a strong south-west wind should cause the tide to rise higher than it otherwise would for it can be seen to affect the surface filaments of current; and probably anyone can recall a high south-west wind accompanied by a high tide. But a high wind accompanied by a tide lower than would be expected from astronomical arguments does not attract much attention; nor does a tide higher than would be expected, with no wind at all, especially at neaps, and these often occur. Dr. Dawson has stated that the more he investigated currents, the less he found to attribute to wind. Perhaps the same applies to the elevation that the tide attains in Saint John harbour.

The currents vary greatly from day to day in both direction and velocity. The maximum outward current runs during the latter part of the ebb, and appears uniform from surface to bottom until a short time before low water, when it slackens. Its direction is nearly straight outward along the line of the new channel; but at other stages of the tide it takes different directions at different distances beneath the surface. Seldom if ever does it run inward on the surface, but at high water a strong inward current may occur below the surface, swinging a 45-pound sounding lead out of plumb. A study of the currents over a time long enough to show their different phases would be interesting. The curve (Fig. 9) is an attempt to show what might be expected at a depth of about five feet below the surface during the height of the freshet of 1932, at a point half way between No. 17 berth and Partridge island. A surface velocity of five and a half knots was noted for a short while each day during the height of the freshet of 1933. During September 1933 the surface velocity did not rise above 2.3 knots.

During the first part of the ebb the surface velocity is small, until a streak of broken water appears, drifting out of the harbour. As soon as this passes the surface velocity increases to a maximum and becomes strong and uniform as noted above. It is to be regretted that men and equipment were not available for a precise and detailed study of the current while the rockbreaker was moored in the harbour during 1932 and 1933, as apart from the interest in a research of this nature the results should be of value to the port.

Figure 10 shows a series of curves plotted from actual records obtained from an automatic tide gauge at Saint John.

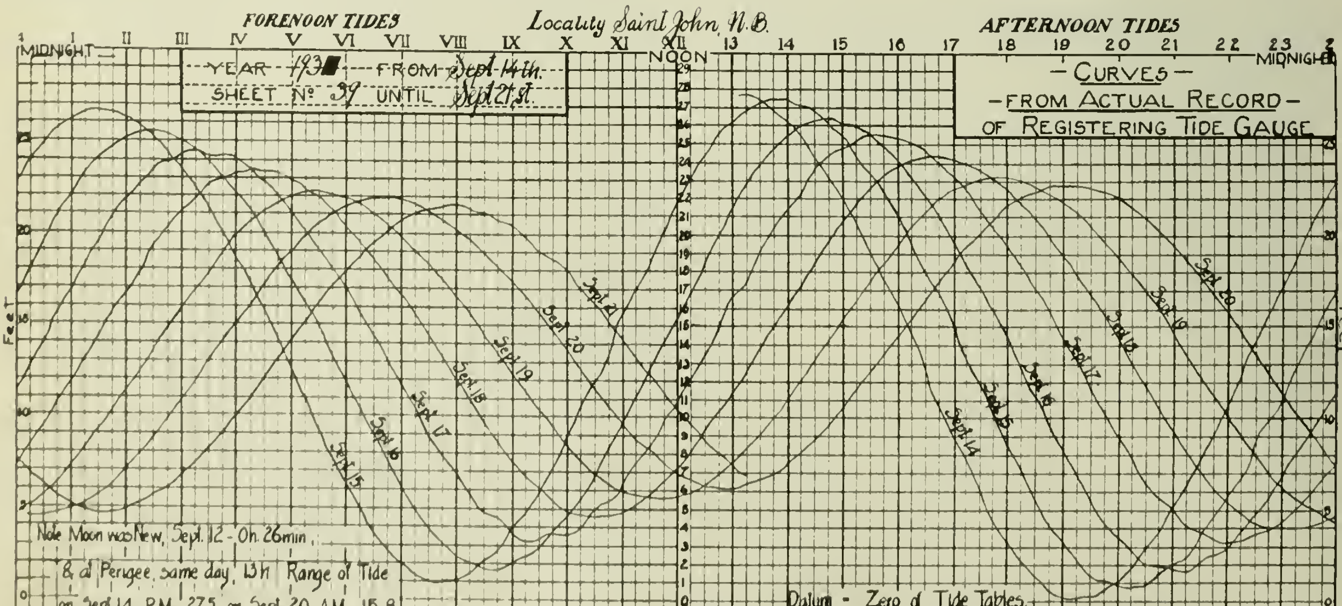


Fig. 10 Actual Record of Registering Tide Gauge.

# Maintenance of Substructure of the Lethbridge Viaduct

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**SUMMARY.—The author describes the difficulties experienced in maintaining the foundations of the western end of the Lethbridge viaduct, and the remedial measures employed in carrying foundations down to rock and in providing for drainage.**

The purpose of this paper is to describe the unusual maintenance work that has been carried out on the railway viaduct crossing the Belly river at Lethbridge, Alberta. The maintenance period covers an elapsed time of some twenty-two years. Ordinary operations, such as tie renewals, painting, etc., will not be described as they are common to all bridges irrespective of size. In the case referred to the unusual maintenance work is due to the immense size of the structure, coupled with adverse natural conditions at the bridge site.

**Fig. 1—St. Mary's River Crossing.**

Before taking up the subject of the paper, it will be of interest to outline the events leading to the construction of this bridge. Subsequent to the completion of the main line of the Canadian Pacific Railway the Alberta Coal and Navigation Company secured a charter and in 1885 built a narrow gauge line from Dunmore, on the Canadian Pacific main line, to Lethbridge. This narrow gauge line was primarily built to haul coal from mines located at Lethbridge to eastern markets. The track was widened to standard gauge in 1893 and later a charter was secured and during 1897 and 1898 a railway was built from Lethbridge to the west, through the Crow's Nest Pass. The west end of the Alberta Coal and Navigation Company's railway was on top of the east bank of the Belly river and immediately west of this was a valley over 300 feet in depth and 1¼ miles wide. A high level bridge at this point was too expensive to be undertaken at that date and the alternative was to develop a longer line and work down to a low level crossing. A junction was made about one mile east of Lethbridge and a line turning to the southwest was located on a 1.2 grade, working down the banks of the Belly and St. Mary's rivers to a low level crossing. This line along the river banks crossed numerous deep coulees, necessitating an aggregate length of 2.8 miles of bridge in a distance of 37 miles. All of these bridges were built of timber.

As the large timber bridges are getting to be a thing of the past two views are shown of these interesting old structures. The St. Mary's river crossing (Fig. 1) was 2,933 feet long and 65 feet in height and was built entirely of piles except for the two Howe truss spans over the river. Figure 2 shows another typical structure over a creek adjoining the St. Mary's river.

In addition to fire hazard and the usual maintenance of timber bridges there was very heavy maintenance at practically all of these structures due to sliding banks. In Fig. 2 the ground bracing between the towers should be noted. The pressure on the end of these 12 by 12 braces was so great that in many instances the timbers bearing on the end of the braces were completely crushed or sheared off.

Prior to the time it became necessary to replace or abandon these bridges, a study was made of a scheme to build directly west from Lethbridge. Information showed this line would be about six miles shorter, the grade would be .4 instead of 1.2, and only two bridges would be necessary —one over the Old Man river, 1,892 feet in length and 145 feet high, and the other over the Belly river, 5,327 feet long and 312 feet above the bed of the river.

Figure 3 shows a map of the territory giving the location of the new and the abandoned lines. The bridge over the Belly river is the subject of this paper and here the slope on the east bank was clay, reasonably flat and offering no serious handicap or apprehension as to stability. There were, however, a number of old mine workings in the bank directly under the bridge site. Plans and other records were available for some of these and the old workings were, as far as possible, located and filled in. One pedestal, which came directly over an old tunnel, was carried down to the solid ground below. The west bank, however, was a different proposition as it was of clay, very steep, being almost perpendicular in places. The formation showed that an old land slip occupied at least a part of the site selected for the bridge location. Before construction

**Fig. 2—Structure over Creek Adjoining the St. Mary's River.**

started the bank was sloped as well as possible and, in order to keep the foundations off the steepest part of the slope, one special length deck truss span was introduced. The foundations were concrete pedestals constructed on short concrete piles, the only exception being the pedestals in the river which were on shale, making piles unnecessary. This bridge was completed and turned over for operation during the fall of 1909 and Fig. 4 is a general view of the completed structure looking east along the north side.

A short time after the bridge was placed in operation it was noticed that the deck was going out of line and surface and a complete line of check levels was run in July 1913. At that time it was found that pedestal No. 53 South was down 2½ inches, 53 North 1⅜ inches, 54 South down 1⅜ inches, and 59 South 1⅜ inches. There were other differences but 53 South was the cause of immediate concern. Figure 5, on which is shown a general elevation, gives the location of these pedestals and it will be noted that bent 53 is the first bent west of the river and under one of the highest towers.

A study of conditions on the ground, and records of this foundation, led to the conclusion that the water saturated ground from below the pedestal was being squeezed out towards the river. In order to counteract this and retain ground in position, it was decided to build a row of heavy concrete buttresses along the river bank. These were tied into the light reinforced wall that was built during the construction of the bridge, and riprap was also added to prevent erosion below and above the bridge site. There were many gopher holes in this bank and some of these showed up as the usual small round burrows, others showed as cracks. This latter peculiarity led to an investigation of the whole bank. Men with pointed steel rods sounded the entire area searching for cavities and those found were usually cracks covered on the top with loose soil or sage brush. Some of the cracks could be traced for a length of 6 feet to 8 feet, and when uncovered showed widths up to 8 inches. The usual width was 3 to 5 inches but the depths were not determinable as the sides were irregular. Some holes of considerable size were found; one of them was 7 feet deep and opened into a large crack. All cavities were carefully uncovered and then filled with clay, which was tightly rammed into place. After this filling was completed shallow concrete lined ditches were constructed. These followed small natural depressions along the hillside and were designed to quickly collect and carry away all surface water. Observations had disclosed that during rain storms large quantities of water

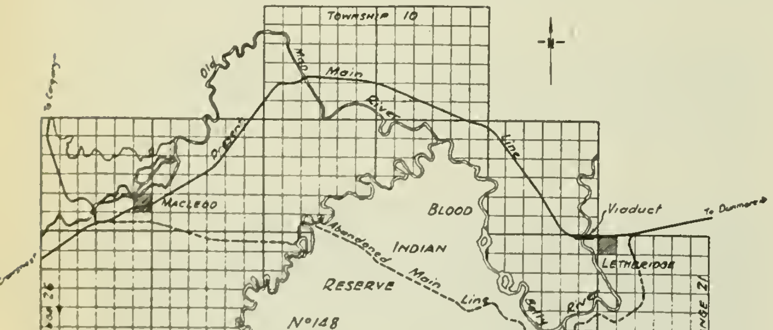


Fig. 3—Present and Abandoned Main Lines Between Lethbridge and MacLeod.

were collected by the exposed area of the long tower legs. This water ran down the leg and off the top of the pedestal, softening the ground in the immediate vicinity. Galvanized iron pans were fitted around the bottom of the long legs to collect this water and spouts were arranged to carry it to the above-mentioned concrete lined ditches. This completed every possible scheme that could be thought of to quickly dispose of surface water.

Levels on the foundations continued to be run at different periods, and it was noted with considerable satisfaction that pedestals 53 and 54 South had come to rest with a maximum settlement of about 4 inches and 2½ inches respectively. Pedestal 59 South, which is one of the pedestals supporting the tower at the east end of the long span, continued to give trouble. Records of this foundation showed a concrete pedestal 25 feet high on fourteen concrete piles approximately 10 feet long. The material below the foundation was yellow clay. During an inspection in February 1922, both anchor bolts of this pedestal were found in place in the steelwork but broken off close to the top of the concrete and from their appearance

Fig. 4—Lethbridge Viaduct from North West.

they had been broken for some time. Levels at this time showed this pedestal had settled about 2½ inches and that it had also moved towards the river. An examination of the steel superstructure did not show any damage either to rivets or bracing, although the track on the top of this tower was low and out of line.

For the following four or five years the movement was very slow and it was hoped that it would come to rest before it was necessary to undertake major repairs. This turned out to be a vain hope, however, as during an inspection in March 1930, it was noticed that a passing train caused an up and down movement of the leg at the top of the pedestal. Examination showed that when the bridge was unloaded there was a space of approximately ⅜ of an inch between bearings. Steel shims, in the form of wedges, were immediately driven (to a height of 1⅛ inches) under the shoe. These wedges not only took up the visible slack but also raised the steelwork stopping all movement due to loading. By jacking up steel depth of shims were increased to 1⅞ inches. Levels disclosed a total settlement of 4¾ inches, an increase of 1⅝ inches since the last levels were taken and probably within a short period immediately preceding discovery of the slackness at this foundation.

Steps were immediately taken to get information as to conditions below the old pedestal and the chance, if any, for a solid foundation. A drilling rig, equipped to drill 6-inch holes and extract cores, was put to work and six holes were put down at different points surrounding the pedestal. The material encountered was principally a wet clay, one seam of gravel and a general mixture of various kinds. Shale was struck at a depth of approximately 50 feet below the ground surface and 33 feet below the bottom of the pedestal. The only way to secure a solid foundation was to go down to this shale and the problem was how to support the steel while foundations were being carried down to this depth below the pedestal without starting a disturbance that would accelerate movement and perhaps cause trouble to the foundation next on the bank above. One scheme considered was to drive piles on each side of 53 South, cross cap these pile towers and support the steelwork on this cross capping. The old pedestal would then be removed and excavation carried down inside sheet piling to shale. Another was to drive sheet piling on either side of pedestal, excavate inside this piling down to shale and fill with concrete, cut away the top of the old pedestal and support the leg on I beams resting on the two new supports. These schemes presented objections, the principal one being the chance of disturbing the ground and aggravating existing conditions.

The procedure finally adopted was to sink two round reinforced concrete caissons, one on the upper and one on the lower side, fill these with concrete, cross cap with steel beams after cutting away the old pedestal and take the weight of the tower leg on the top of the new construction. In deciding the size for the caissons, consideration was given to working space for men and room for a bucket for hoisting material. The height of the form was governed by what was considered a maximum day's work in sinking the excavation. The clear inside dimension was set at 6 feet with an 8-inch reinforced wall. The height of the form was set as 5 feet and above this angle irons were left projecting for the purpose of suspending the inside form and for general handling.

In starting the work a shallow pit was made; in this was cast, in a wood form, a reinforced concrete cutting edge or shoe. This shoe was very carefully made. On the east cylinder, which was the first one put down, the diameter of shoe was 1¼ inches in excess of the diameter of the main caisson. The shoe on the second cylinder was reduced in size to ½ inch in excess of the main cylinder. Above this shoe the outer steel form was placed on cross timbers very carefully levelled and firmly braced to prevent movement. This was very important as it was the only means to insure the caisson being sunk plumb. The inside form was suspended from an overhead framework and this framework also carried a sheave for a line used in hoisting material. The programme called for the excavation, the building and the sinking of the form to proceed simultaneously. Ciment Fondu was used in the caisson in order to insure against delays while waiting for concrete to set. The caisson form, as first designed and used, had channel iron fillers as connections in the inside form and it was necessary to slack off the inside form to allow the concrete to settle. Later a slightly tapered hardwood filler was used and this tapered filler eased off the friction on the sides of the form, and as soon as the concrete caisson was well started its own weight pulled it down (without any slacking off of form) as fast as the material was excavated below the cutting edge.

Figure 6 gives a general plan of an elevation of the form, together with a section of the concrete caisson, also the new and old foundation. The excavation inside the open caisson was carried down to shale by ordinary pick and shovel methods. The excavated material was loaded in a cylindrical bucket 18 inches in diameter which had a capacity of 3½ cubic feet. A single line was run from this bucket to the sheave attached to the overhead frame and a horse on the other end of the line provided the power for hoisting. A 3-inch plank platform, leaving room for the hoisting bucket, was securely suspended for protection above the workmen inside the caisson. A storage battery with a single light for illuminating the work was attached to this platform.

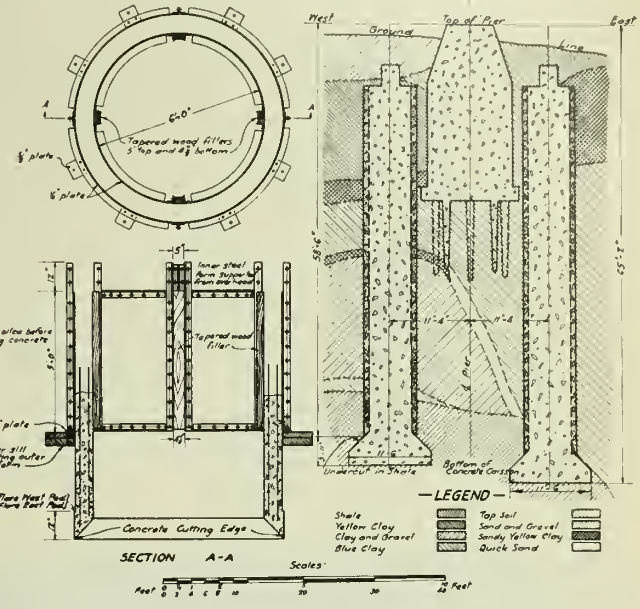


**Fig. 6—Steel Form for Concrete Caissons and New and Old Foundation for Pier 59 South.**

A gang of nine men sunk these caissons at an average of 3 feet 10 inches in an eight-hour day and the maximum day's work was 4 feet 6 inches. The downhill or east caisson was first put down and shale was encountered at an average depth of 58 feet below the top of the old pedestal. The excavation was carried to a total depth of 65½ feet and while the top of the shale was on a considerable slope towards the east, the shale bedding was practically level. The material through which the excavation passed above the shale was principally a wet clay, some gravel and a little sand. There was sufficient water to collect in small pools in the bottom of this excavation. After the caisson was well landed in the shale, the excavation was carried below the cutting edge and enlarged for extra bearing. The size of the enlarged footing was 11 feet 6 inches in diameter.

The steel form was now moved to the upper side, where a site had already been prepared, and the cutting shoe cast. After the experience gained with the first caisson, this shoe was only given a clearance of one quarter

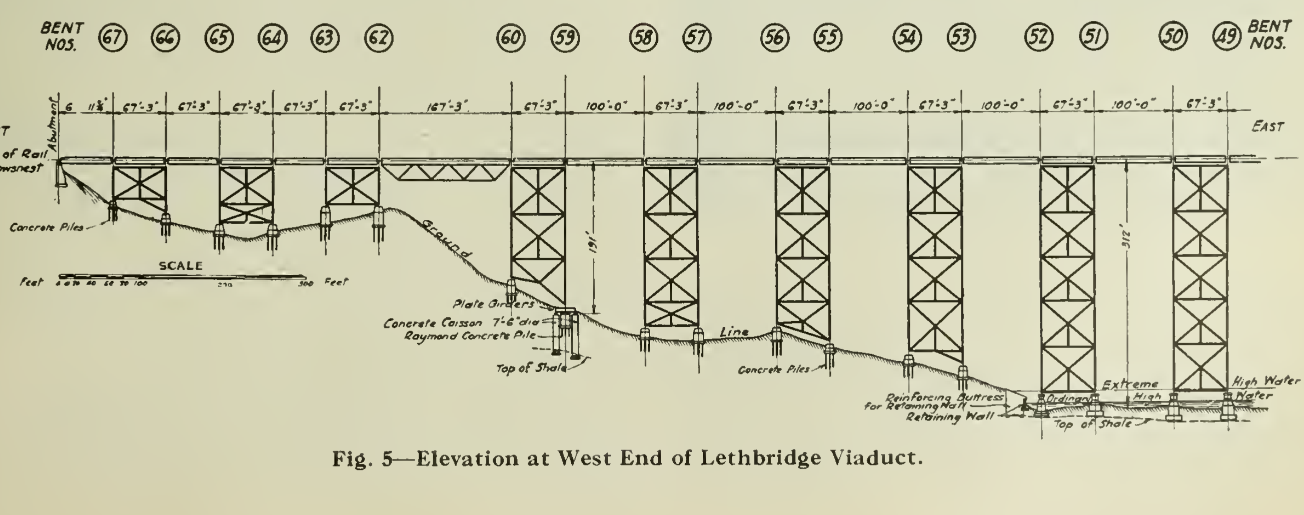


**Fig. 5—Elevation at West End of Lethbridge Viaduct.**

of an inch. While the second excavation was underway the inside of the first caisson was filled and capped with a concrete block. The material encountered in the second excavation was much the same as the first, with the exception of a seam of water-bearing gravel just above the shale and there was sufficient water at this point to collect to a depth of 4 or 5 feet during the night. This caisson was landed in the shale at a depth of 52 feet and the excavation was carried below this and undercut to give the extra bearing. The next procedure was to cut away the top of the old pedestal. In order to do this the two outside girders were placed first and the inside was then worked out by alternate cutting and blocking, after which the blocking was removed between trains and the two inside girders placed. Figure 7 shows the pedestal being cut away and Fig. 8 illustrates the completed job.

It will be recalled that the cutting edges were slightly larger than the barrel of the caisson. Dry sand, to the amount of forty cubic feet, was poured into the visible space between the outside of the barrel and the ground and this sand was firmly rodded into place. The top of the sand was kept about 5 feet below ground level and above this the space was filled with thin concrete. The idea was to leave no space to start a re-adjustment of the ground in this vicinity. The amount of dry sand and concrete introduced outside the caisson almost exactly made up for the difference in area between the cutting edge and the barrel, which was a very satisfactory condition. Levels

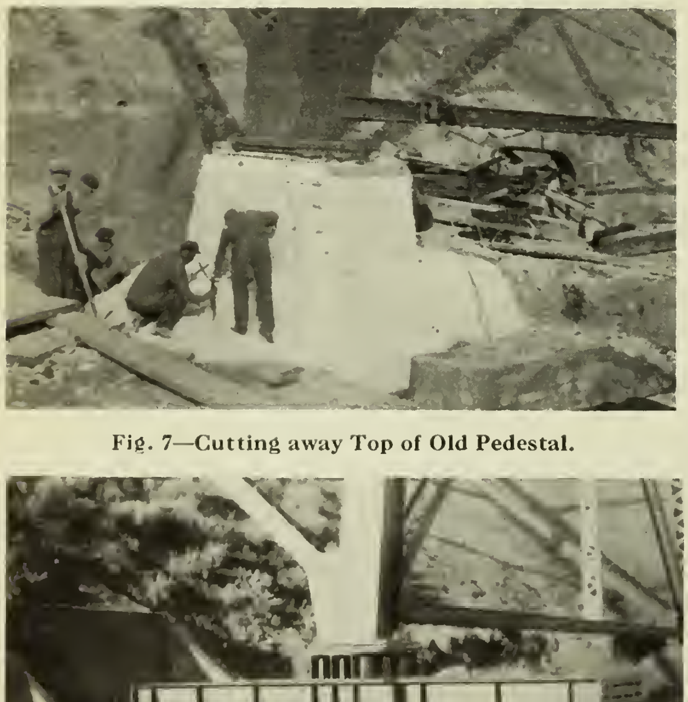

Fig. 7—Cutting away Top of Old Pedestal.

Fig. 8—Completed Job with Girders in Position.

had been taken on the old pedestal every few days while the work was going on and due to precautions taken there was no extra settlement during the time caissons were being placed and filled. This made pedestal 59 South safe from settlement though there was still the uncertainty of the bank sliding and overturning the new foundations. The total cost of the work, as outlined above, was $10,502.00, which included $2,146.00 for the steel beams used in cross capping.

As previously mentioned, water in considerable quantities had been found in the excavation for No. 2 caisson. This water-bearing stratum was about 50 feet below ground level and too deep to drain by ordinary methods. It was thought that local relief could be secured by jacking a drain pipe into the bank and a location was selected north of the bridge and below the level of the area which it was proposed to drain. A 6-inch wrought iron pipe was lined up and jacked into the bank, however to be of use this had to land on, or very close, to the top of the shale. Jacking was rather slow but not expensive as only a few men were engaged. The necessary distance was about 154 feet and as pipe was pushed into the bank the inside was cleaned out with a water jet. After reaching the objective it was found that there was no flow of water so the pipe was withdrawn a few feet and after working with it for some time it started to discharge at the rate of twenty-two gallons per hour and continued at this rate for a long period, when the flow gradually dropped to fifteen gallons per hour. The relief offered by this drain was very material but limited in area so consideration was then given as to what other remedies might be applied and it was decided to drill the river bank to see if the flow of water could be found and cut off before it reached the bridge site. The bank south of the bridge seemed to offer greater possibilities for water than the north side so it was selected for prospecting with the same drill as used around pedestal 59 South. Seven holes in all were put down, as shown in Fig. 9, which also shows the location of the drain pipe described above and the location of the tunnel which will be described later.

The hole marked No. 2 showed a heavy flow at a point about 204 feet below the ground surface and just on top of the shale. Other holes showed water at various levels but no large quantities at any point. It will be noted from the profile on Fig. 10 that hole No. 2 indicates a depression or valley in the shale surface which appears to offer a reasonable explanation for encountering the most water at this location.

After studying the information obtained by this drilling it was decided to drive a tunnel from a point in the bank about 450 feet south of the bridge in a line through holes 7, 1, 2 and 3. The tunnel was to be located in the shale (except for a distance of approximately 120 feet at the entrance) the top being kept just even with the top of the shale at its lowest point as located at hole No. 2. There was considerable discussion as to size and method of lining and it was decided that there should be a clear inside height of 4 feet 10 inches and a width of 4 feet with a lining of cedar. Cedar lining gave promise of a life of twenty-five years or more, and the size gave room for men to work comfortably and to use a good sized mucking car. The tunnel was started in January 1932 and the first 120 feet was driven through clay. At this point shale was encountered in the bottom of the excavation and also a flow of water which was estimated to be at a rate of 35 gallons per hour. The shale now started to raise and at a point 175 feet from the portal, the excavation was entirely in shale and here an additional flow of 25 gallons of water per hour was encountered.

The tunneling through the shale went forward in a routine manner at a rate of about eight feet a day. Air drills of various types were tried but in the end an auger similar to the ordinary bridge auger was used as it was found that this gave the best results.

On May 17th, 1932, the tunnel had reached drill hole No. 2 and when the heading was shot, the shale over the roof caved in. Water and gravel poured into the tunnel, filling about fifty feet with debris and the water ran from

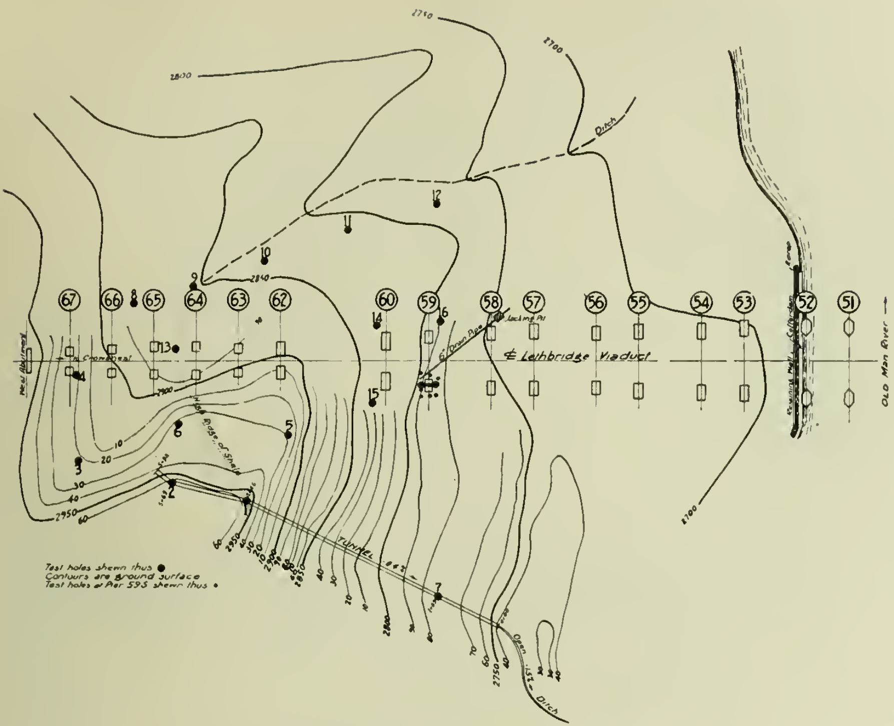


Fig. 9—Plan of Drainage Tunnel.

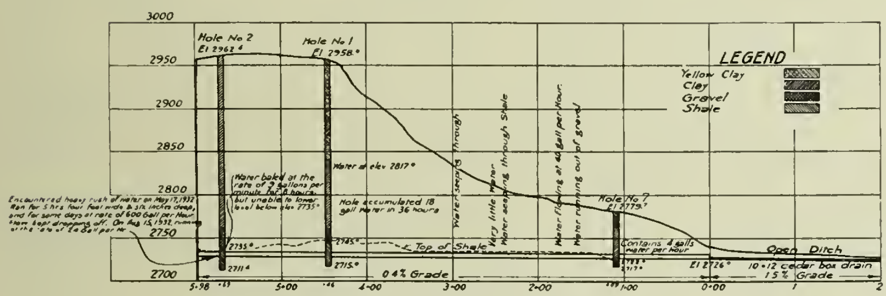


Fig. 10—Section of Drainage Tunnel.

the tunnel for five hours in a stream five inches deep and four feet wide on a four-tenths grade. After this first rush, the water eased off but still continued to flow in a large volume. On the morning of May 28th the flow was at the rate of 480 gallons per hour and an attempt was made to continue the tunneling; however there was so much trouble with water that as soon as the heading was made safe, work was temporarily abandoned. In August the flow of water had dropped to 20 gallons per hour and the tunnel was advanced to station 5 plus 94, where it was all in dry shale and the work was then closed down for an indefinite period. The flow from the drain pipe and tunnel was measured from time to time and although there was a continued reduction at each point, it was thought best to continue investigations by drilling on the north side of bridge with the idea of driving a second tunnel in that location if investigations disclosed any water pockets.

Drilling was started on this investigation on May 1st, 1933, and holes 8 to 16 inclusive were put down in selected locations. The material in all the holes was quite similar, consisting of a surface layer of yellow clay fairly dry varying from 20 to 40 feet thick; then 40 to 70 feet of blue clay mixed with sand and gravel; and below this about 25 feet of gravel overlying shale. In holes 8, 9 and 13 the blue clay carried water; in the others it was only moist. The shale at hole 8 was encountered at elevation 2735.8, practically the same as at hole 2, where the large body of water was encountered in the tunnel on the south side. At hole 9, the surface of shale was 2742.7 or about 7 feet higher and hole 13 was drilled with the idea of proving whether or not the ridge in the shale was continuous. If this was the case water could not flow out the valley as located by holes 2 and 8; except by way of the drainage tunnel. Hole 13 showed shale at an elevation of 2744 and definitely established a dyke or ridge in the shale cutting off the flow of water to the east. Holes 14, 15 and 16 were put down to secure additional information as to the elevation of the shale in the vicinity of pedestals 59 and 60. The results obtained were all similar: 5 to 10 feet of fairly dry yellow clay on top, then about 50 feet of moist blue clay with about 20 feet of gravel overlying the shale.

The information as disclosed by this drilling showed no accumulation of water and due to the slope of the shale no chance for an accumulation such as had been tapped by the tunnel already driven on the south side. The question of driving another tunnel was therefore abandoned. However a perforated casing filled with gravel was installed in holes 8, 9 and 13 to drain as much water as possible from the wet blue clay to the gravel overlying the shale where it would eventually make its way to the drainage tunnel already built.

A measurement of the flow of water in August 1933 showed 9.2 gallons per hour from the tunnel and 4.3 gallons per hour from the drain pipe. In October 1933 the flow was 4.0 gallons from the tunnel and 2.9 in the drain pipe and on January 20th, 1934, following a long mild spell after a fall of snow, the tunnel flow was 7 gallons per hour and the pipe flow 3.46 gallons. By May 9th the tunnel flow fell off to 4.0 gallons and the pipe flow was 3.4 gallons per hour. On October 19th, 1934, the tunnel gave 4.6 gallons per hour; the pipe 3.5 gallons per hour.

Therefore from present indications it would appear as if the drainage problem has been solved. If so, the trouble with settlement of foundations should also be about ended, much to the relief of all those responsible for the maintenance of this structure.

# The Hydrostatic Cord

*J. B. Macphail, A.M.E.I.C.,*
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The problem of the hydrostatic cord is an interesting mathematical byway leading to the determination of the shape of a flexible weightless cord, hung from two supports in the same horizontal plane, when subjected to a loading similar to hydrostatic pressure. It is briefly mentioned in some of the older English text-books on elasticity but never to the extent of a complete treatment of the many possible cases which can occur.

The curve which the cord takes is a portion of a more general curve representing the several shapes into which a thin springy metallic spline can be bent, including a variety of loops and bends shown in Love's "Mathematical Theory of Elasticity." Another portion of the curve was used by R. D. Johnson in designing a large conduit with the wall in tension only, and later by H. H. Burness in England with a much fuller mathematical development.* Yet another portion of the curve was used by Rankine in his treatment of the hydrostatic arch.†

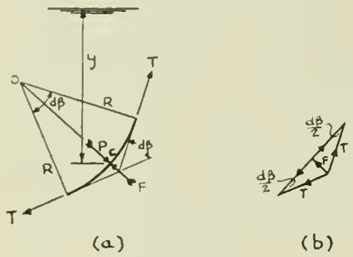


Fig. 1

The hydrostatic cord is not exactly the mathematical equivalent of a cross-word puzzle, as some might suspect. The present writer became interested in the matter in the course of a routine investigation of shapes and stresses in a certain steel plating problem. The equations which were found or which were developed in the course of the work suggested that they might be particular forms of a more general case, and their extension seemed to be of sufficient interest to justify this presentation. They appear also to have a real application to the design of bunker bottoms, troughs and flumes.

Consider in Fig. 1 (*a*) a flexible weightless cord of unit width, hung from two supports in the same horizontal plane, and subjected to a fluid loading which produces a tension $T$. Since there are no tangential forces, this tension is constant over the length of the cord. Take an element of length $ds$ about a point at depth $y$, and let $R$ be the radius of curvature and $d\beta$ the included angle. Since the element is in equilibrium, the resultant of the tensions on it must equal the normal force of the fluid pressure and be collinear therewith. Resolving the tensions along and perpendicular to the radius $OC$ as shown in Fig. 1 (*b*), the perpendicular components cancel and the unbalanced elements are $F = 2\,T \sin (d\beta/2) = T\,d\beta$. The internal force $P = wyds$ where $w$ is the unit weight of the fluid. Equating these and putting $ds = R\,d\beta$ we have $T = wy\,R$ or $R = a^2/y$ where $T/w = a^2$, the parameter $a$ having the dimensions of a length.

The complete curve has several possible shapes, shown in Fig. 2, but to assist in the subsequent analysis the one shown in Fig. 3 will be taken to illustrate the most general case.

*"Engineering," Vol. 124, page 632, 11th November 1927.
†"Applied Mechanics," 10th Edition, page 190.

We have then, taking $y$ positive downwards,

$$ds = R\,d\beta = a^2 d\beta/y \quad\text{and}\quad ds = -\,dy/\sin\beta.$$

Hence $\quad \sin\beta\,d\beta = -\,(y/a^2)\,dy$

which on integration becomes

$$y^2 = 2\,a^2\cos\beta + c^2 \quad\ldots\ldots\ldots\ldots(1)$$

where $c^2$ is the constant of integration having dimensions of $(\text{length})^2$.

At $\quad y = h \quad \beta = 0 \quad \therefore h^2 = 2\,a^2 + c^2$

At $\quad y = eh \quad \beta = \alpha \quad \therefore e^2h^2 = 2\,a^2\cos\alpha + c^2$

Then $\quad h^2 = (1 - \cos\alpha)\,2\,a^2/1 - e^2$

$$c^2 = h^2 - 2\,a^2 = (e^2 - \cos\alpha)\,2\,a^2/(1 - e^2)\ldots(2)$$

$$\cos\alpha = 1 - (1 - e^2)\,h^2/2\,a^2\ldots\ldots\ldots\ldots(3)$$

This equation contains four quantities, and when any three are known from the physical circumstances of the case, the fourth can be found. If any of the known characteristics happen to be the length of the curve or the dimension $x_o$ the subsequent equations for their values must be solved by successive approximations to give the quantities in equation (3).

Values of $x$ are obtained by integrating the equation

$$dx = ds\cos\beta = (a^2/y)\cos\beta\,d\beta\ldots\ldots\ldots(4)$$

Substitute (2) in (3) and get after a little reduction

$$y^2 = 4\,a^2\left[-\sin^2\frac{\beta}{2} + \frac{1}{1 - e^2}\sin^2\frac{\alpha}{2}\right]\ldots\ldots\ldots(5)$$

The subsequent development proceeds by two paths, according as the second term in the bracket is greater or less than unity. First, putting $\left(\sin^2\frac{\alpha}{2}\right)\Big/(1 - e^2) = k^2$ where

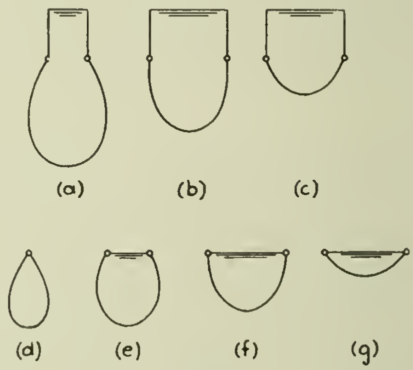


Fig. 2

$k \overline{\gtrless} 1$ and putting $\sin(\beta/2) = k\sin\phi$ we get $y = 2\,ak\cos\phi$ and (4) becomes

$$x = \int_o^\phi \frac{a\,(1 - 2\,k^2\sin^2\phi)}{\sqrt{(1 - k^2\sin^2\phi)}}\,d\phi$$

which gives on integration a result in terms of elliptic integrals

$$x = a\,[\,2\,E\,(k, \phi) - F\,(k, \phi)\,]\ldots\ldots\ldots\ldots(6)$$

Tables of elliptic integrals are readily available, and numerical results can be calculated with ease.

If $k > 1$ this procedure is not applicable, and we must put $k^2 = 1/f^2$ where $f < 1$ and put $\phi = \beta/2$. Then $y = (1 - f^2\sin^2\phi)^{\frac{1}{2}}\,2\,a/f$ and equation (4) becomes

$$x = af\int_o^\phi \frac{1 - 2\sin^2\phi}{\sqrt{(1 - f^2\sin^2\phi)}}\,d\phi$$

which on integration gives

$$x = af\left[F(f, \phi) - \frac{2}{f^2}\{F(f, \phi) - E(f, \phi)\}\right] \ldots\ldots (7)$$

The length of any arc, measured from the bottom point, is given by integration of the equation $ds = R\, d\beta$

$$s = afF(f, \phi) \ldots\ldots\ldots\ldots\ldots\ldots (8)$$

$$s = aF(k, \phi) \ldots\ldots\ldots\ldots\ldots\ldots (9)$$

according as $k$ is greater or less than unity.

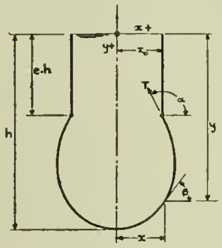

Fig. 3

The area bounded by the curve, the vertical boundaries and the water surface comes directly from consideration of the tension at the supports, since $wA/2 = T \sin \alpha$ and hence, if $A$ is this area,

$$A = 2a^2 \sin \alpha \ldots\ldots\ldots\ldots\ldots\ldots (10)$$

The general type of curve is shown by the following relations for the cases in Fig. 2:

$h^2(1 - e^2) > 2a^2$ Fig. 2 (*a*)
$= 2a^2$ Fig. 2 (*b*)
$< 2a^2$ Fig. 2 (*c*)

and when $e = 0$ the same relations apply respectively to Figs. 2 (*e*), 2 (*f*) and 2 (*g*). In Fig. 2 (*d*) there is the condition that $x_o = 0$.

The case of the fluid level below the points of support does not require consideration in detail because dimensions must then be referred to the plane of the water surface, and the cord will follow its tangents at the water surface to the points of support.

The curve can also be constructed graphically from the equation $R = a^2/y$.

In the particular case of Fig. 2 (*f*) when the tangents at the supports are vertical and $e = 0$ there are the simple relations $h^2 = 2a^2 = A$; $x_o = 0.847\, a$ and the length of the curve between supports is $3.708\, a$.

# Forty-Ninth Annual General Meeting

## Toronto, Ont.

OUTLINE OF PROGRAMME

(*Subject to Minor Change*)

Thursday, February 7th:—

*Morning*..... Registration and Business Session. Induction of incoming President and Council.

*Noon*......... Formal Luncheon.

*Afternoon*..... Discussion on the Status of the Engineer. Reception and Tea for Ladies.

*Evening*...... Annual Dinner of The Institute followed by a Dance.

Friday, February 8th:—

*Morning*...... Technical Sessions.

*Noon*......... Luncheon.

*Afternoon*..... Discussion on the Water Supply of the Prairie Provinces.

*Evening*...... Smoking Concert. Entertainment for Ladies.

Saturday, February 9th:—

*Morning*...... Visits to Engineering Works of Interest.

Toronto from the Harbour. (*By courtesy of Canadian Pacific Railway Co.*)

# The Rationalization of Load Factors for Aeroplane Wings

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*Technical Assistant, Hawker Aircraft Limited, Kingston-on-Thames, England.*

**From a thesis submitted to the Massachusetts Institute of Technology and reprinted by permission.**

SUMMARY.—In the past load factors for aeroplane wings have been decided on an empirical rather than on a rational basis. The author refers to previous investigations bearing on this subject and describes briefly the various methods for the determination of principal wing load factor for which data are available He discusses the results obtained by rational methods and suggests a new expression, based on the equations of motion and assuming an instantaneous pull up from horizontal flight at maximum velocity. Recommmendations are given with regard to the load factor to be assigned to aeroplanes both of the restricted and unrestricted classes.

When the art of flying was in its early stages of development, scientific investigation was largely directed toward the aerodynamic aspects of the problem of flight; when it had been demonstrated that mechanical flight was possible and feasible, the attention of experimenters was concentrated on the problem of building structures sufficiently light and strong to fly. Theory and experimental research produced satisfactory aerofoils, and for a number of years aeronautical engineering was chiefly concerned with aeroplane structures. During and since the World War, research and experience have solved the most pressing problems in structural design, and in the past few years more and more attention has been paid to aerodynamics, and there has been a decided tendency toward replacing empirical methods and formulae by more rational means. At the present time, the rationalization of load factors is occupying a prominent place in such discussions; a number of attempts have been made to put the specification of load factors on a rational basis: some of these have mingled a slight amount of theory with a large amount of empiricism; others have been based on pure theory, simplified as necessary by reasonable assumptions. In this work an attempt will be made to present a number of proposed solutions of the load factor problem, to correlate their results and to select what is thought to be the best method.

Before proceeding further it would be well to state clearly what is meant by the term "load factor." In general, in aeroplane structures, the stress is not proportional to the load, and it has long been the rule to design members to their ultimate strength, multiplying the normal load by a load factor. Throughout this work, we shall be concerned solely with wing load factors, and accordingly,

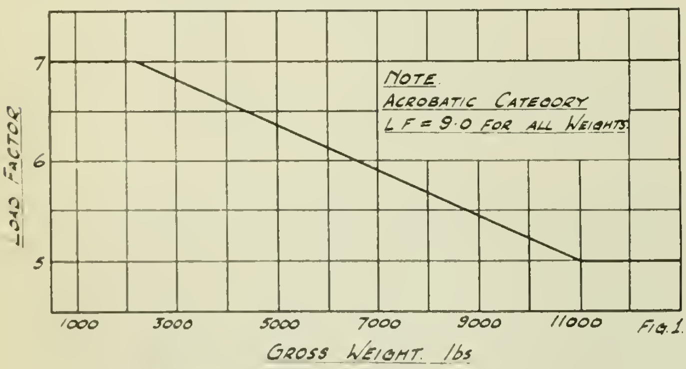


**Fig. 1—Current British Load Factors.**
**Factors for Centre of Pressure Forward Case**
**(High Angle of Incidence).**
**From Air Publication 1208—Airworthiness Handbook for Civil Aircraft.**

may define load factor as the ratio of the maximum load likely to be sustained by the wings of an aeroplane in flight, to the normal load. Further, we shall confine ourselves to wing load factors caused by curvature of the flight path, and not by changes in angle of attack due to atmospheric disturbances, which is an entirely separate field of study.

It goes without saying that an accurate knowledge of the maximum load occurring on the wings is of first importance; for if the aircraft is designed to too low a factor, the wing structure will fail when the machine is put through a violent manœuvre, or encounters a strong gust in "bumpy" air; while if the specified load factor is too high, a needless sacrifice of useful load is made, and the aircraft is thereby penalized. It is well known that it is impracticable to build an aeroplane of such strength that it cannot be broken in the air by a reckless and violent pilot, and there is no reason why this should be the aim, since skilful and careful handling, with due regard to the limitations of the aeroplane, is to be fairly expected of the pilot.

When governmental authority turned its attention to the need for uniformity and control in the specification of load factors, rules for future designs were based on existing aeroplanes which had shown evidence of satisfactory strength. the gross weight being the criterion. The British system of assigning load factors is still based on gross weight, while that employed in the United States is based on gross weight and power loading. This method is purely empirical, and while it is thought that the load factors given are high enough, due to the rarity of structural failures now occurring, it is not known whether they are too high, or higher for some aircraft than others, in respect to the actual load factors which may be experienced in flight. It is therefore considered that the method of assigning load factors should be put on a more rational basis, which would more closely approximate the factor actually sustained by the aircraft, and which would be less likely to be out-moded by changes in design.

The aim of the semi-rational methods has been to evolve a formula which would give results closely approximating those of the present method, for the majority of machines, but which would define the required load factor in terms of more rational variables than at present employed, take care of the increasing spread in the range of speeds, and make some allowance for manœuvrability. As shown in a "Preliminary Study of Load Factor Determination,"[1] the theoretical load factor is a function of the square of the speed range. The first attempts at rationalization were based on this factor. More rational methods attempted to set up the equations of motion in a specified manœuvre, and found the load factor by mathematical means. In some of these, sufficient assumptions were made that the equations could be solved; in others, step-by-step integrations were carried through. These methods will be considered in some detail in the following sections.

## Objections and Preliminary Suggestions

The principal objection to the present system of assigning load factors, is simply that it is too empirical, and therefore not as trustworthy as desired. It has proved reliable enough in the past, but with improvements in design and increase of power and speed, it could not be applied with full confidence. Any empirical method requires constant revision, and in the nature of things, such revision is bound to have a considerable time lag. It is well known that there are other factors besides the gross

[1] Air Commerce Bulletin, Nov. 2, 1931.

weight and power loading, which affect the load factor attainable in flight, but the system now in use completely ignores them, and therefore must be adjusted to suit designs which are the worst in this respect, thereby penalizing improved designs. The type of aircraft, the service for which it is intended, the degree of manœuvrability, the speeds at which the aeroplane will be manœuvred, and the manner in which it is handled, are major considerations which are not taken into account.

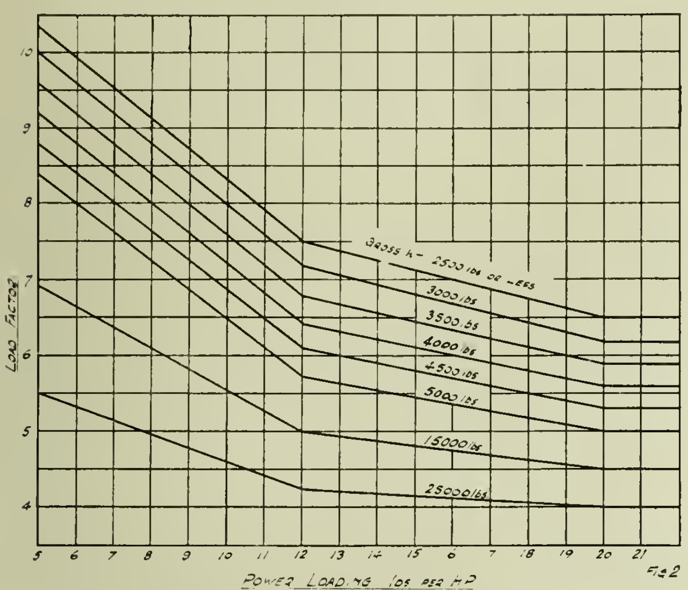


**Fig. 2—American Load Factors.**
**Factors for High Angle of Incidence (Recently Amended).**
**From Aeronautics Bulletin No. 7-A of the U.S. Dept. of Commerce—Airworthiness Requirements.**

One of the first remedies for this state of affairs, is the division of aeroplanes into classes, according to the type of service. The British Load Factors Sub-committee suggests division into two classes, viz.: General and Commercial (see R. & M. 673, 776); aeroplanes falling into the general class to be strong enough to allow stunting (acrobatic); and stunting to be prohibited in the commercial class. This is a step in the right direction, and could be carried further. For example, a private owner is likely to want an aeroplane in which a moderate amount of stunting would be permissible, but his machine need not be capable of the violent acrobatics which are demanded of fast military pursuit ships and diving bombers. Some limitation would have to be placed, and the best way would be to post a notice in the aeroplane, stating the maximum safe speed for manœuvring; this speed being that used in determining the design load factor. The pilot would thereby be warned to handle the machine with more than ordinary care at higher speeds. The pilot's skill is another variable, which could also be taken care of in fixing the maximum safe speed to be used in design.

The type of service for which an aeroplane is intended limits the manœuvres it should be able to withstand with safety. It is therefore necessary to discover, first, what type of manœuvre results in the greatest wing loads; second, whether the class of machine under consideration is to be handled in this manner; and third, which is the worst condition to be designed for in this class.

It is generally agreed that the worst condition is that of a sharp pull-out from a dive at terminal velocity; and it is also generally agreed that it is safe to assume that a commercial aeroplane will never be dived at its terminal speed. The opinion is held that the design condition should be, instead, a sharp pull-up from level flight at maximum speed. It is quite possible that a commercial machine would be subjected to this manœuvre, but it is only likely to occur in an emergency. Experiment shows that, excepting the pull-up from a dive, the pull-up from horizontal flight at maximum speed gives the greatest loads; and for machines of moderate size, it is also reasonable to assume that this condition is a fair representation of loads imposed by bumpy air. In the case of a large machine, such loads may be much greater than loads due to manœuvring, and will probably be the design condition.

The limitations upon attainable load factor are given by Edward P. Warner as follows[2]:

1. Physiological limitation of the maximum load factor that the pilot can sustain without losing consciousness.
2. Limits imposed by the manœuvrability characteristics of the airplane and the time taken for its attitude to change from that of diving to that corresponding to a high-lift coefficient.
3. Limit of rapidity with which the pilot can pull back the stick.
4. Limit upon the force that the pilot is physically able to exert on the stick.

The first, third and fourth limits are known with reasonable accuracy: it is, in part, the purpose of this study to shed some light on the second.

It has been recommended (R. & M. 706, see page 533) that the terminal velocity should be used as a basis for all design, and the load factor modified by a design factor of one-half, for all classes. The argument for this is, that the terminal speed depends on the design, whereas any other value depends on the engine installed. The objection that engine power might be increased without making allowance for the increased load factor, may be forestalled

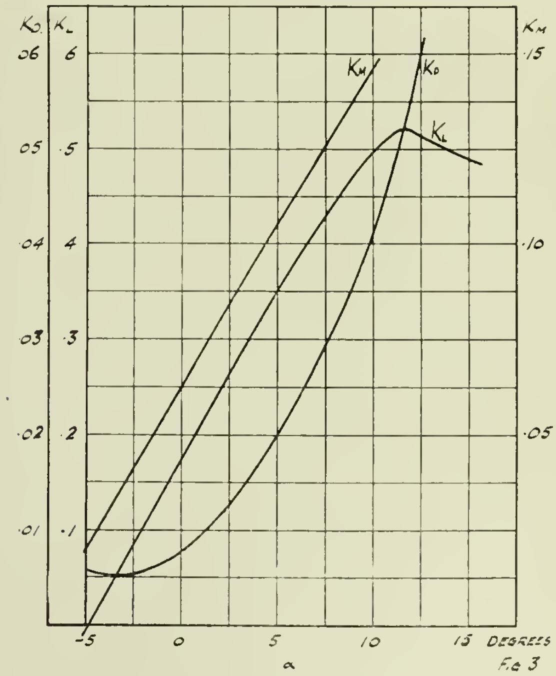


**Fig. 3—Curve of Lift ($K_L$), Drag ($K_D$), and Moment ($K_M$) coefficients vs. Angle of Incidence for R.A.F. 28 Aerofoil. (The Moment Coefficient is referred to the Leading Edge.)**

by governmental regulation. (See U.S. Department of Commerce regulations.) Approximate formulae exist for estimation of maximum level speed and minimum speed; these should be refined by further comparison with actual aeroplanes.

[2]"The Rationalization of Airplane Load Factors"—paper read at the Aeronautic meeting of the Society of Automotive Engineers, April 1932.

Summing up, it is recommended that:—

(*a*) Aeroplanes be classed as "restricted" or "unrestricted."

(*b*) Unrestricted aeroplanes to be designed to withstand manœuvres which they are specifically intended to carry out.

(*c*) Restricted aeroplanes to be designed to withstand a sharp pull-up from level flight at a speed to be decided on by the manufacturer, and posted in the cockpit, but not less than the maximum speed in level flight.

### General Experimental Conclusions

A report by J. H. Doolittle on "Accelerations in Flight"[3] was one of the earliest experimental investigations of load factors experienced in flight. The aeroplane used in these tests was a Fokker PW-7, with balanced control surfaces, and powered by a Curtiss D-12 engine. The results of this investigation were:—

1. The worst condition is in pulling out of a dive; in which case the accelerations go to within 3 or 4 per cent of the theoretically possible.

2. Accelerations due to rough air do not amount to more than 2.5 *g*.

3. The pilot can stand instantaneous accelerations of 7.8 *g*, but not more than 4.5 *g* if continued for several seconds.

4. The load depends on:

   (*a*) The ratio: $(V/V_{\min})^2$. (The speed of the manœuvre divided by the stalling speed.)

   (*b*) The longitudinal stability of the aeroplane.

   (*c*) The damping due to pitching.

   (*d*) The time required to pull back the stick.

In the case of a highly manœuvrable aeroplane of this type, especially one with balanced elevators, the results (1) and (4) above, are to be expected, since the damping is quite small. The accelerations due to rough air are questionable, since air conditions much worse than those experienced are sometimes encountered. In the discussion of Professor Newell's paper,[10] Lieutenant R. D. MacCart, U.S.N., is quoted as saying, "The maximum acceleration that can safely be sustained by what might be called the high-acceleration pilot may be nine, although the average pilot will not voluntarily accept, even momentarily, as high an acceleration..." It would appear from this that the maximum load factor to which any aeroplane need be designed would be about 15, leaving a substantial margin of safety.

In more recent experiments,[4] measurements were made of air speed, angular velocity, linear acceleration and position of the control surfaces, by instruments in the aeroplane, during loops, push-downs, pull-outs from dives, pull-ups from level flight, barrel rolls and spins. A camera obscura was used in obtaining flight path co-ordinates.

For the F6C-3, the maximum normal accelerations were obtained in a pull-up from a dive and a pull-up from horizontal flight, both with abrupt control; the accelerations in both cases being 6.65 *g*. The same manœuvres gave maximum accelerations for the F6C-4, the accelerations being, for the pull-up from a dive, 9.3 *g*; and for the pull-up from horizontal flight, 7.8 *g*. These tests showed that the reduction in velocity, and time taken to reach the maximum load, are negligibly small.

In a report by E. Finn and A. E. Woodward Nutt[5] a total of 340 manœuvres on 14 different types of aircraft were analyzed. Free flight tests showed that for manœuvres correctly performed by skilled pilots, the average maximum acceleration was of the order of 2 *g*.

These results do not seem to be significant. Evidently "correct" performance is taken to mean handling the aeroplane in such a manner as not to impose a high acceleration. However, it does show that manœuvres *can* be performed without imposing great loads.

The results of a number of accelerometer tests which were made by the U.S. Air Corps at McCook Field are tabulated in "Airplane Structures" by Niles and Newell, page 22. Tests were made on training, observation, pursuit, bombing and cargo aeroplanes. The last two classes gave quite low load factors, while the highest, 7.8, was reached by a PW-7 pursuit aeroplane, in a sharp pull-out at high speed.

The results of these tests are valuable for comparison, but suffer from lack of accurate knowledge of the speed during manœuvres; and it is probable also that higher load factors than those recorded could have been developed by these aeroplanes.

A report by Heinrich Hertel[6] covers a very complete series of tests. The maximum values are:—for two-hand pull—275 pounds belted in, 187 pounds free; for one-hand pull or push—143 pounds with belt, 187 pounds free. The maximum quickness of operation was found to be 6.56 feet per second, and was independent of the load; the stick movement being 7.87 inches.

Another report[7] covers similar tests to the above. The bulk of the motion was found to occur in 0.2 seconds, independently of resistance. The maximum speed was found to be 5.25 feet per second; the motion of the control stick being nearly twice as great as in the above tests. The usual maximum stick force was about 165 pounds, but one experimenter reached 200 pounds and another about 230 pounds; these were with the initial position of the stick 30 degrees forward. A ten-pound lead weight was placed on the stick to represent the inertia of the controls.

All these considerations lead to the following recommendations:—

(*a*) The maximum load factor for any aeroplane to be taken as 15 or thereabouts.

(*b*) The reduction in velocity during a sharp pull-up to be neglected.

(*c*) The maximum control column force to be taken as 200 pounds, applied instantaneously.

### Empirical and Semi-rational Methods

One of the first attempts to put the determination of load factors on a rational basis was that of Major F. H. Bramwell[8] in 1920. Working from certain theoretical considerations and considering a vertical bank, he obtains equations for the minimum radius of turn, the acceleration, and the load factor.

This determination is too familiar to require much discussion. It is invalidated by completely neglecting the damping due to pitching. The equations apply to the wing alone, and would represent approximately the case of a tailless aeroplane. This treatment represents the first elementary stage in the rationalization of load factors.

In another early and well-known attempt at rationalization,[9] manœuvrability is assumed to be a function of

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[3] U.S. National Advisory Committee for Aeronautics—T.R. 203—"Accelerations in Flight," by J. H. Doolittle.

[4] N.A.C.A. T.R.'s 369 and 386—"Maneuverability Investigation of the F6C-3 and F6C-4."

[5] R. & M. 1392—"Accelerations on Aircraft During Manœuvres," by E. Finn and A. E. Woodward Nutt, 1930.

[6] N.A.C.A. T.M. 583—"Determination of the Maximum Control Forces and Attainable Quickness of Operation of Airplane Controls," by Heinrich Hertel, 1930.

[7] R. & M. 282—"Experiments on the Possible Rate at which the Pilot Can Pull Back the Control Column in an Aeroplane. 1916,"

[8] R. & M. 670—"The Maximum Angular Velocity of Aeroplanes," by Major F. H. Bramwell, 1920.

[9] N.A.C.A. T.N. 263—"A Load Factor Formula," by Roy G. Miller, 1927.

gross weight and the speed range squared. Certain arbitrary constants are assumed, and the formula given as:

$$\text{Load factor, } N = 1.75 + (V_{\max}/V_{\min})^2 \frac{112}{\sqrt{5000 + W}}$$

where $W$ = weight of aeroplane, pounds
$V$ = speed, feet per second.

The formula is checked by comparison with aeroplanes which have experienced structural failure, and those which have not. The only points in favour of the formula are that it includes the speed range squared, and that it corresponds to experience up to that time, but this point is a very dubious one, as mentioned previously.

The treatment in a paper by Joseph S. Newell[10] is based on the fact that the load factor depends on the speed range of the aeroplane and its ability to manœuvre. It is further pointed out[11] that the increase in normal force coefficient, due to pitching, more than offsets the decrease in velocity during a pull-up. It is shown that the maximum loads will occur when the aeroplane is flown in the high angle of attack condition and at terminal velocity. It is proposed to base load factors on the speed range, i.e. the maximum level flight speed divided by the stalling speed, and a control surface constant that is the horizontal tail surface area divided by the wing area, times the length of the tail divided by the mean aerodynamic chord. An empirical constant of 3.5 is introduced, apparently in order to make the results agree as closely as possible with existing load factors.

In summing up, it is recommend that aeroplanes be divided into acrobatic and non-acrobatic classes (see page 531); the factors for the first class, in the high angle attitude, to be based on the maximum possible or endurable accelerations, and for the second class, in terms of the speed range and a manœuvrability factor. The tail loads would be determined in each case, from the maximum velocity for an abrupt pull-up, and the factors for the low angle attitude to be based on the loads possible in mild pull-outs at terminal speeds, and would be determined from the ratio of terminal velocity to the level flight velocity at the same angle of attack.

A number of bulletins,[12] published by the U.S. Department of Commerce, Aeronautics Branch, contain a series of articles dealing with load factors.

In the first of the series, a formula is presented which is based on the square of the speed range, and a constant which depends on gross weight, and is so chosen that the results will be the same as at present in use. The procedure is very similar to that of Roy G. Miller, reviewed above, and is subject to the same criticism. Coefficients are given which are to be used to modify the high speed formula suggested for different types of aeroplanes. Minimum values are proposed for the constant and speed range squared.

In the January 15th bulletin, the article, "A General System of Load Determination for Aircraft," presents a more rational method of attack, and, without developing a formula for load factor, indicates the salient points to be dealt with and their manner of treatment. It is continued in the last bulletin of the series, in which a formula is given, without derivation, for the design lift coefficient.

Examination of the formula shows that the damping of the tail due to pitching was neglected in the derivation, and it is accordingly "damned with faint praise," for if control is sufficient to get the tail down to make a three-point landing, as it should be, and there is no damping, there is nothing to prevent the aeroplane from reaching the maximum-lift attitude. Accordingly, if damping is to be neglected, the load factor is simply:

$$N = \left(\frac{V_{\max}}{V_{\min}}\right)^2$$

The damping of the tail is obviously an important factor, which cannot be neglected in a rational treatment of the load factor problem.

### Load Factor Determination by Rational Methods

The equations of motion following were step-integrated by Bryant[13] to find the flight paths during loops and pull-outs from loops and dives.

$$k_B^2\,\ddot{\theta} = M/m + M_q\dot{\theta} \qquad (1)$$
$$\dot{w} = u\dot{\theta} + Z - g\sin\theta + Z_q\dot{\theta} \qquad (2)$$
$$\dot{u} = -w\dot{\theta} + X - T/M - g\cos\theta \qquad (3)$$

where $k_B$ = longitudinal radius of gyration of aeroplane
$M$ = pitching moment
$M_q$ = pitching moment due to pitch
$m$ = mass of machine in slugs (32.2 lb. mass)
$\theta$ = angle between longitudinal axis and the vertical
whence $\dot{\theta}$ and $\ddot{\theta}$ = angular velocity and acceleration in pitch
$w$ = velocity along vertical axis
$u$ = velocity along longitudinal axis
$Z$ = force along vertical axis
$X$ = force along longitudinal axis
$T$ = airscrew thrust.

Curves showing the variation of $M$, $M_q$, $Z$ and $X$ with elevator setting and angle of incidence, were plotted from model test data. The flight paths are plotted; load factor, load on tail, angle of incidence and forward speed being indicated at points along the path.

Conclusions are drawn as follows:—"It appears that the maximum wing loading will occur at the critical angle of incidence and at a speed not more than 150 to 160 m.p.h.; and that for most modern machines with unbalanced elevators and the usual control leverages it is then probably about twelve to thirteen times normal load... The greatest load, therefore, will not in general occur after diving at the limiting speed, but when the pilot exerts his hardest pull for a second or two while the speed is considerably less than the limiting speed. In the course of a loop after a steep and prolonged nose dive the loading of the wings of a very fast machine should not exceed 5 times normal, even if the pilot initially exerts a pull approaching his greatest, provided that he slackens his pull again immediately. There is greater risk in pulling hard at lesser speeds, particularly when flattening out after looping. The maximum loading will usually occur in the second quadrant of a loop, but may occur near the top of a loop if the machine is looping at a very high forward speed."

A load factor of 8 to 10 is recommended for fast military machines. This report appears to be an excellent treatment of the load factor problem, but unfortunately, no general conclusions can be drawn from it, except possibly, for highly manœuvrable aeroplanes.

The method followed in an investigation by Professor Pippard[14] was as follows:—An aeroplane of the B. E. class was taken to be flying on a path inclined at 20 degrees downward to the horizon. The elevators were then con-

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[10] "The Rationalization of Load Factors for Aeroplanes in Flight," by Joseph S. Newell. Paper read at the Aeronautic meeting of the S.A.E., January 1932.

[11] N.A.C.A. T.R. 364—"Pressure Distribution over the Wings and Tail Surfaces of a PW-9 Pursuit Airplane in Flight," by R. V. Rhode.

[12] Air Commerce Bulletins, Vol. 3, Nos. 9, 11, 14 and 20; Nov. 2, Dec. 1, Jan. 15, and April 15, 1932.

[13] R. & M. 496—"On the Possible Loading of the Wings and Body of an Aeroplane in Flight," by L. W. Bryant, 1917.

[14] R. & M. 706—"An Analysis of the Conditions Governing the Requisite Strength of Aeroplane Structures," by A. J. Sutton Pippard, 1920.

sidered to be raised, the engine cut out, and the subsequent motion investigated. The equations of motion (given in "Applied Aerodynamics" by Bairstow) were step-integrated, varying the terms one at a time in order to determine to what extent each influenced the value of load factors. The terms varied were, velocity, mass of the aeroplane, longitudinal moment of inertia, pitching moment due to the inclination of the aeroplane to the relative wind, pitching moment due to pitching, and distance between the C.G. and the C.P. of the tail. It was found that the only terms which affect the loading in a pull-up are: velocity, mass, pitching moment due to inclination and pitching moment due to pitching. The formula for load factor is deduced from the results as:

$$N = 0.208\,(V/V_o)^{1.7}\,[1 - 3.32\,(M_1/M_q{}^1)^{7/15}]$$

where $V_o$ = stalling speed, feet per second

$M_1$ = pitching moment due to the inclination of the aeroplane to the relative wind.

$M_q{}^1$ = value of pitching moment due to pitching at a rate of one radian per second.

This formula is plotted as a family of curves and as a nomograph. The author points out that this result is obtained for one type of aeroplane only, and that further work is required to determine the effect of the wing section and the degree of longitudinal stability. $V$ is the terminal speed, a design factor of 1/2 being introduced.

The chief value of this report, or any similar treatment, is that it indicates the factors which are most important and must be included in any rational determination, and those for which approximations can be made, or which can be neglected. The most important terms are the speed range, the pitching moment, and the pitching moment due to pitching, i.e., the damping. The gross weight is implicitly included in the speed range, and the tail length in the moment terms.

In a report by H. Bolas and G. A. Allward,[15] step-by-step calculations were made of wing and tail loads for a machine of specified characteristics, in pulling out of a dive. Variations in gear ratio between elevator and control stick were assumed, as well as variations in the total time required to pull the stick back, and in the initial diving speed.

Conclusions were drawn as follows:—

(1) A variable gear ratio is of no great value in reducing the maximum loads.

(2) Increasing the time does not greatly reduce the wing loading, but the tail loading is considerably reduced. A device to prevent the stick from being pulled back too quickly would not reduce the loading appreciably.

(3) For a safe manœuvre low hand loads must be employed. "In the case considered, a maximum hand load of about 33 pounds produces a wing loading of 4 *g*."

"The incorporation of a means whereby only a limited load could be applied to the elevator, would produce the desired effect. This might for instance take the form of a control stick provided with a hinge at some convenient point—a strong spring being introduced which would insure a virtually rigid stick for all normal work, but which would allow the stick to 'break' when the pull back exceeded a certain predetermined load, say for instance, 50 pounds in the present case."

(4) The pull-out from a terminal velocity dive represents the worst possible case, and shows that increase of load factor as a means of overcoming the difficulty is out of the question.

This report does not produce a general formula for load factor, but like the previous one, it indicates the factors affecting the maximum loading. The recommendation of a spring device in the control column, to limit the hand load, seems impractical. Pilots would be likely to remove the device and replace it with the ordinary stick. Further, having the stick "break" when pulled up sharply in an emergency, would be most disconcerting. The conclusion to be drawn from the report is therefore that the maximum wing loading cannot be limited by mechanical appliances, and it is very doubtful if such a solution of the problem would even be considered, at least on this continent.

The static stability of the aeroplane is considered to have a predominating effect on the motion of recovery which follows a given change in the force exerted on the stick.[16] From calculation made during the war on the motion of S.E. 5 in pulling out from steep dives, by step integration, it was established that the variation in forward speed remains small until after the maximum aerodynamic load occurs. The forward speed was therefore assumed constant, and the equations of lift and pitching moment were integrated in terms of inclination of the flight path to the vertical and the angle of incidence, measured from zero lift.

An equation is set up which expresses a relation between the pilot's pull on the column and the lift coefficient at maximum load, and connects stick force with load factor.

The following points are noted:—

(1) Load factor ($N$) is independent of the longitudinal moment of inertia.

(2) For an aeroplane of given weight, tail volume, and C.G. position, $N$ is independent of the cleanness of design, i.e. of the speed in the dive, for a given pull.

(3) For a given pull, $N$ decreases as the weight increases, but this variation is a function of stability. In a neutrally stable aeroplane, $N$ is independent of the wing loading.

(4) $N$ increases with the height of the manœuvre.

(5) For geometrically similar aeroplanes of given normal loading, in which the gearing of the control is constant, $N$ for a given pull goes down rather faster than the inverse cube of the linear dimension.

The results show that load factor varies greatly with the type of aeroplane. The results on the whole are somewhat unconvincing. The conclusion that the load factor is independent of the speed in the dive is contradictory to the last report, and in fact, to the results of most, if not all investigations. In the writer's opinion it is preferable to base the load factor on elevator deflection instead of stick force, because the poor data available for hinge moments limits the practicability of the method, and hinge moments are very difficult to measure, especially with balanced control surfaces. A separate calculation can be made to take the stick force into account.

A good part of the work, and the last formula given, are of little use since they apply only to aeroplanes of neutral stability, whereas it is stated in the beginning that the static stability has a predominating effect on the motion of recovery, and therefore, it is to be inferred, on the load factor.

### A Proposed Rational Method of Load Factor Determination

This method is here presented for the first time. The method of treatment of the moment equations was suggested by Professor Otto Koppen of the Massachusetts Institute of Technology.

As the equations of motion cannot be integrated directly, during the recovery from a dive, it is necessary to make some simplifying assumptions, based on results found from experiment and step-by-step integration. The case considered is that of an instantaneous pull-up from

[15] R. & M. 1229—"Loads on the Main Planes and Tail of an Aeroplane when Recovering from a Dive," by H. Bolas and G. A. Allward, 1928.

[16] R. & M. 1232—"On the Maximum Loads in Pulling Out from Vertical Dives," by S. B. Gates and H. B. Howard, 1928.

horizontal flight at maximum velocity, with the following assumptions:—

1. The lift coefficient is a linear function of angle of incidence, the maximum point being neglected in the equations.
2. The aeroplane is trimmed at maximum level speed, with zero elevator deflection.
3. The reduction in forward speed during the pull-up is negligible. This is verified by experiment (page 532) and is also on the conservative side.
4. The control column is pulled back to the maximum elevator deflection, and the maximum load comes on the wings, all in a negligibly short time. The equations apply when equilibrium conditions have been attained.

The symbols used and their meanings, are as follows (see Handbook of Aeronautics R.Ae.S., and R. & M.):

$W$ = gross weight, pounds
$k_L$ = absolute lift coefficient = $L/S\rho V^2$
$a$ = distance of the C.G. behind the leading edge of the mean aerodynamic chord
$c$ = mean aerodynamic chord
$L$ = length from C.G. to C.P. of tailplane
$S_w$ = wing area, ft²
$S_t$ = horizontal tail area
$S_\eta$ = elevator area
$\alpha_w$ = angle of incidence of wing, degrees, measured from zero lift
$\alpha_t$ = angle of incidence of tail to relative wind, degrees
$\varepsilon$ = angle of downwash
$\alpha_{T_o}$ = angle between wing and tailplane = $(\alpha_T - \tau\eta)$
$\alpha_T$ = stabilizer setting
$\eta$ = angle of deflection of elevator
$A$ = equivalent monoplane aspect ratio
$M_{cg}$ = moment about centre of gravity
$\rho$ = air density
$s$ = wing area
$k_{mcg}$ = moment coefficient about centre of gravity
$q$ = angular velocity in pitch, radians per second
$K$ = $k_L/k_{L_{\max}} = (V_{\min}/V_{\max})^2$
$N$ = load factor
$k_m$ = pitching moment coefficient = $M/cS\rho V^2$

The equation of static equilibrium is:

$$M_{cg} = k_{m_o} c S_w \rho V^2 + k_L (a - .25\,c) S\rho V^2 - L S_t \rho V^2 (dk_L/d\alpha)_t \alpha_t$$

$$\alpha_t = \alpha_w - \varepsilon + \alpha_{T_o}$$

$$k_{m_{cg}} = k_{m_o} + k_L (a/c - .25) - \frac{L}{c}\frac{S_t}{S_w}\left(\frac{dk_L}{d\alpha}\right)_t (\alpha_w - \varepsilon + \alpha_{T_o})$$

$$= k_{m_o} + Bk_L - F(\alpha_w - \varepsilon + \alpha_{T_o}) \quad \ldots\ldots\ldots\ldots (1)$$

where $k_{m_o}$ = moment coefficient of the wing about the quarter-chord.

$$B = (a/c - .25)$$

$$F = \frac{L}{c}\frac{S_t}{S_w}\left(\frac{dk_L}{d\alpha}\right)_t$$

Differentiating (1):

$$\frac{dk_{m_{cg}}}{d\alpha_w} = \frac{dk_{m_o}}{d\alpha} + B\left(\frac{dk_L}{d\alpha}\right)_w - F(1 - d\varepsilon/d\alpha) = k \text{ (say)} \ldots\ldots (2)$$

$k$ may be called a "stability constant." Its value should be between $-0.0025$ and $-0.005$ for satisfactory stability. (See Göttingen tests.)

Now, $dk_{m_o}/d\alpha = 0$ (approximately, for all aerofoils)

$\varepsilon = k_1 k_L / A$ (Warner's "Aerodynamics" p. 342)

therefore $$\frac{d\varepsilon}{d\alpha} = \frac{k_1}{A}\left(\frac{dk_L}{d\alpha}\right)$$

Hence $$\frac{B}{F} = \frac{k}{F\left(\frac{dk_L}{d\alpha}\right)} + \frac{1}{\left(\frac{dk_L}{d\alpha}\right)} - \frac{k_1}{A} \ldots\ldots\ldots (3)$$

In curvilinear flight, the force on the wings,

$$L = \frac{WV^2}{gR} + W\cos\theta = k_L \rho S V^2$$

where $R$ = radius of curvature of flight path and $\theta$ = angle to the horizon.

Taking $\cos\theta = 1$, corresponding to the case of a sharp pull-up from level flight,

$$1/R = gk_L\rho\, S/W - g/V^2$$

In curvilinear flight, $V = qR$

therefore $$1/R = q/V = gk_L\rho\, S/W - g/V^2 \ldots\ldots (4)$$

The equation of equilibrium in curvilinear flight is:

$$k_{m_{cg}} = k_{m_o} + Bk_L - F(\alpha_w - \varepsilon + \alpha_{T_o}) - 57.3\, FLq/V = 0$$

$$k_{m_o} + Bk_L - F(\alpha_w - \varepsilon + \alpha_T - \tau\eta) - 57.3\, FLq/V = 0 \ldots\ldots\ldots (5)$$

where $\alpha_{T_o} = (\alpha_T - \tau\eta)$

Dividing through by $F$ and making the substitutions for

$$\alpha = \frac{k_L}{(dk_L/d\alpha)}$$

$$\varepsilon = k_1 k_L / A$$

$$q/V = gk_L\rho S/W - g/V^2$$

$$\frac{k_{m_o}}{F} + \frac{B}{F}k_L - \frac{k_L}{\frac{dk_L}{d\alpha}} + \frac{k_1 k_L}{A} - \alpha_T + \tau\eta - 57.3\, g\, k_L\rho LS/W + 57.3\, g\, L/V^2 = 0$$

Collecting $k_L$ terms,

$$\frac{k_{m_o}}{F} + k_L\left(\frac{B}{F} - \frac{1}{\left(\frac{dk_L}{d\alpha}\right)_w} + \frac{k_1}{A} - 57.3\, g\,\rho LS/W\right) - \alpha_T + \tau\eta + 57.3\, Lg/V^2 = 0$$

Substituting for $B/F$ from (3):

$$\frac{k_{m_o}}{F} + k_L\left(\frac{k}{F\left(\frac{dk_L}{d\alpha}\right)} + \frac{1}{\frac{dk_L}{d\alpha}} - \frac{k_1}{A} - \frac{1}{\frac{dk_L}{d\alpha}} + \frac{k_1}{A} - 57.3\, g\,\rho\frac{LS}{W}\right) - \alpha_T + \tau\eta + 57.3\, L\, g/V^2 = 0$$

$$k_L = \frac{-\frac{k_{m_o}}{F} + \alpha_T - \tau\eta - 57.3\, Lg/V^2}{\frac{k}{F\left(\frac{dk_L}{d\alpha}\right)} - 57.3\, g\,\rho\frac{LS}{W}}$$

Differentiating with respect to elevator angle:

$$\frac{dk_L}{d\eta} = \frac{-\tau}{\frac{k}{F\left(\frac{dk_L}{d\alpha}\right)} - 57.3\, g\,\rho\frac{LS}{W}} \ldots\ldots\ldots\ldots (6)$$

From equation (4):

$$V^2/R = g\, k_L\, \rho\, S\, V^2/W - g$$

$$\frac{d(V^2/R)}{dk_L} = g\,\rho S V^2/W \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

In level flight $W = K\, k_{L_{\max}}\, \rho\, S\, V^2$

or $V^2 = W/K\, k_{L_{\max}}\, \rho\, S$

where $K = (k_L/k_{L_{\max}}) = (V_{\min}/V_{\max})^2$

Substituting for $V^2$ in (7) and assuming speed remains constant,

$$\frac{d(V^2/R)}{dk_L} = g\,\rho\frac{S}{W} \times \frac{W}{K\, k_{L_{\max}}\, \rho S} = \frac{g}{K\, k_{L_{\max}}} \ldots\ldots (8)$$

From equations (6) and (8):

$$\frac{d(V^2/R)}{d\eta} = \frac{d(V^2/R)}{d\,k_L} \times \frac{d\,k_L}{d\eta}$$

$$= \frac{g}{K\,k_{L_{max}}} \times \frac{-\tau}{\dfrac{k}{F\left(\dfrac{d\,k_L}{d\alpha}\right)} - 57.3\,g\rho\dfrac{LS}{W}}$$

where $\frac{d(V^2/R)}{d\eta}$ is the rate of change of acceleration normal to the flight path, with elevator deflection.

Therefore, load factor,

$$N = \frac{-\tau\eta_{max}}{K\,k_{L_{max}}\left[\dfrac{k}{F\left(\dfrac{d\,k_L}{d\alpha}\right)} - 57.3\,g\rho\dfrac{LS}{W}\right]}$$

*Determination of the Elevator constant*

$\tau$ may be defined as the rate of change of effective tail angle of attack with elevator angle, which is seen from differentiating the expression for angle of attack of the tail:

$$\alpha_t = \alpha_w - \varepsilon + \alpha_{T_o} = \alpha_w - \varepsilon + \alpha_T - \tau\eta$$

$$d\alpha_t/d\eta = \tau$$

$\tau$ is a function of the ratio of elevator area to total tail area, and of elevator angle. Various expressions for $\tau$ are given by Diehl, Glauert, Bréguet and Toussaint. Curves were plotted from these formulae, as well as from tests made by the U.S. Army Air Corps and by the Göttingen Research Institute, and from comparison of the curves, it was decided to use the expression given by Diehl, for the purposes of this work. This is (see "Engineering Aerodynamics"):

$$\tau = (1.90 - 0.57\,t/c - 0.014\,\eta_o)\,t/c$$

where $t$ = mean chord of elevator
$c$ = mean chord of tail plane
$\eta$ = elevator angle.

*Simplification of the Load Factor Formula*

The following simplifying assumptions represent average values of the constants of the aeroplane, and are, in general, on the conservative side.

1. Wing aspect ratio, $A = 6$
whence[17] $(dk_L/d\alpha)_w = .037$
$(d\varepsilon/d\alpha) = 0.3$ (approx.)
2. Tail aspect ratio, $A = 3.5$
whence $(dk_L/d\alpha)_t = .0323$ (theoretical)
$= .0323 \times .87 = .0281$ (actual)[18]
3. Maximum elevator angle, $\eta = 30°$ (up)
4. $S\eta/S_t = t/c = 0.45$
whence $\tau = 0.545$
$\tau\eta = 16.35$
5. $k_{L_{max}} = 0.7$

From these it follows that:

$$k = .037\,B - .7\,F$$

$$N = \frac{-16.35}{.7\,K\left(\dfrac{.37B - .7F}{.37F} - 4.38\dfrac{LS}{W}\right)}$$

$$= \frac{-16.35}{.7\,K\,(B/F - 19.7 - 4.38\,LS/W)}$$

*or*

$$N = \frac{(V_{max}/V_{min})^2}{k_{L_{max}}} \times \frac{-16.35}{(B/F - 19.7 - 4.38\,LS/W)}$$

[17] See Warner—"Aerodynamics" p. 362, and $kL$ curves.

[18] See "Determination of the Slope of the Lift Curve of Horizontal Tail Surfaces," by Benjamin F. Ruffner, Jr., "Aviation Engineering," Vol. III, No. 10, Oct. 1930.

A simple nomograph may be constructed which will give a graphical solution of this equation, giving values of $N$ for known values of $B/F$, $LS/W$ and $K$, or speed range.

*Hinge Moments*

A relation between the pilot's pull on the control column and the elevator deflection, is as follows:

Hinge moment, $M_H = k_H S_\eta c_\eta \rho V^2$

where $k_H = b_1\alpha_T + b_2\eta$

therefore $M_H = (b_1\alpha_T + b_2\eta)\,S_\eta c_\eta \rho V^2$

$$\eta = \frac{M_H - b_1\alpha_T S_\eta c_\eta \rho V^2}{b_2 S_\eta c_\eta \rho V^2}$$

$\alpha_T$ is the angle between the stabilizer and the relative wind at the time the stick force is being applied and $= (\alpha_w - \varepsilon + \alpha_{T_o}) = \alpha_t$.

The hinge moment applied by the pilot,

$$M_H = kP$$

where $k$ = leverage ratio, given as 1.8 in R. & M. 1232
$P$ = pilot's pull on stick, maximum 165 to 200 pounds

therefore $M_{H_{max}} = 360$ ft-lbs., approximately.

Average values of $b_1$ and $b_2$ are:

$b_1 = .0082$; $b_2 = .014$.

See R. & M. 1095 and Göttingen Research Institute reports.

*Example*

Load factor calculations for a hypothetical aeroplane; and the effect upon load factor of changing the various physical constants of the aeroplane. Values of the various terms are assumed, and the load factor calculated.

Assumptions:

| | |
|---|---|
| $W/S = 12$ | $a/c = .35$ |
| $S_t/S_w = .12$ | $L = 16$ ft. |
| $S_\eta/S_t = .45$ | $c = 5$ ft. |
| $k_{L_{max}} = 0.7$ | $L/c = 3.2$ |
| $K = .25$ | $LS/W = 1.33$ |
| $\eta = 30°$ | |

Wing aspect ratio = 6, whence $(dk_L/d\alpha)_w = .037$

Tail aspect ratio = 3.5 " $(dk_L/d\alpha)_t = .0323 \times .87 = .0281$

$(d\varepsilon/d\alpha) = .3$

$B = .35 - .25 = .10$

$F = 3.2 \times .12 \times .0281 = .0108$

$k = .10 \times .037 - .0108\,(1 - .3)$

$= -.0039$ (retained constant)

$\tau = .545$

$$N = \frac{-16.35}{.25 \times .7\left(\dfrac{-.0039}{.0108 \times .037} - 4.38 \times 1.33\right)}$$

$$= \frac{-16.35}{.175\,(-9.76 - 5.83)}$$

$$= 6.00$$

Note that this result is greater than the speed range squared $(1/K)$, and therefore the correct load factor for this case is $1/K$, i.e. 4.

Effect of changing the constants. Variation in the constants of the aeroplane, one at a time, keeping the same degree of static stability ($k$), affect load factor as follows:

Load factor increases with increasing values of:

Centre of gravity location (moving backwards)
Wing aspect ratio
Wing loading
Ratio of elevator area to total tail area

Maximum elevator displacement
Speed range and
Tail constant ($F$),

and decreases with increasing values of:

Tail length and
Maximum lift coefficient.

These are for constant static stability. Load factor also decreases with increased static stability.

Effect of thrust of propellor. The equilibrium equations were modified to include the effects of thrust due to the propeller, slip-stream, and propellor downwash, and a sample calculation gone through, as above. These effects are somewhat doubtful, but do not appear to have much effect upon load factor. It was thought advisable to neglect them, as their inclusion makes the work too complicated to be practicable.

For highly manœuvrable aeroplanes the formula for load factor may be expected to give results which are too high; firstly, because the lift coefficient has been assumed to continue indefinitely as a linear function of angle of incidence, and secondly, because the load factor in such cases may be limited by the pilot's ability to pull the control stick full back and to withstand the resulting acceleration. The load factor given by the formula should be checked against the square of the speed range, the smaller value being the correct load factor. The maximum attainable elevator deflection may be found from the formula given under hinge moments.

In an unrestricted machine which is to be sufficiently strong to withstand a sudden pull-out from a dive at terminal velocity, a correction may be made by putting $K$ equal to the square of the ratio of stalling speed to terminal speed, instead of maximum horizontal speed. This is not exact but would probably be a sufficiently close approximation.

## Conclusion

In the preceding sections an attempt has been made to present in brief form, all the methods of determination of principal wing load factor for which data are available, except purely arbitrary rulings. We may now set down some general conclusions.

The exigencies of every-day use in designing aeroplanes require that any method of ascertaining load factors should be as simple and easy to apply as possible. From this point of view alone, the present British system of assigning load factors on a basis of gross weight alone, is ideal; but a certain minimum number of calculations are necessary in the design of an aeroplane: a balance diagram must be drawn, and a calculation for static stability, at least, should be made. It is therefore imposing no hardship on the designer to require him to perform these operations in order to determine the load factor, but a step-by-step integration for each design would not be a practical possibility.

We may now sum up the conclusions and recommendations made in previous sections, as follows:—

1. In general, it may be assumed that the pilot is capable of pulling back the control column instantaneously.

2. The load factor cannot be made sufficiently large to cover the worst condition of loading possible.

3. Any rational method of determination of load factor must include the damping moment caused by the tail plane in pitching.

4. The most important factors to be included in the determination are:

(*a*) Minimum speed, which is a function of gross weight and wing area,
(*b*) Maximum speed, which implicitly includes engine horsepower and the over-all cleanness of design,
(*c*) Pitching moment, or static stability,
(*d*) Damping moment, or dynamic stability.

5. General conclusions cannot be drawn from step-by-step calculations, at least until a very large number of such calculations have been made for widely varying types of aeroplanes.

6. Incorporation of any device to place a limitation on the maximum wing loads attainable, is not a practical solution of the problem.

7. The longitudinal moment of inertia is, at least, not an important factor.

## Recommendations

1. All aeroplanes to be divided into restricted and unrestricted classes.

(*a*) Restricted aeroplanes to be designed to withstand a sharp pull-up from level flight at a speed to be decided on by the manufacturer, and posted in the cockpit, but not less than the maximum speed attainable in level flight.
(*b*) Unrestricted aeroplanes to be designed to withstand manœuvres which they are specifically intended to carry out.

2. The maximum load factor in any case to be taken as 15.

3. The reduction in velocity during a pull-up to be neglected.

4. The maximum force which the pilot can exert on the control stick to be taken as 200 pounds.

In view of all these considerations, it is believed that the method presented on pages 535 and 536 is a satisfactory solution of the problem of principal wing load factors in the high angle of attack condition.

## WORKS CONSULTED

Warner—Aerodynamics.
Diehl—Engineering Aerodynamics.
Bairstow—Applied Aerodynamics.
Reports and Memoranda of the Aeronautical Research Committee (British).
Reports of the National Advisory Committee for Aeronautics (U.S.A.).
Journal of the Society of Automotive Engineers.
U.S. Army Air Corps Information Circulars.
U.S. Department of Commerce, Aeronautics Branch, Bulletins and Circulars.

## ABBREVIATIONS USED

N.A.C.A.—National Advisory Committee for Aeronautics.
R. & M.—Reports and Memoranda of the Aeronautical Research Committee (British).
T.M.—Technical Memorandum of the N.A.C.A.
T.R.—Technical Report of the N.A.C.A.
T.N.—Technical Note of the N.A.C.A.
S.A.E.—Society of Automotive Engineers.
C.G.—Centre of gravity.
C.P.—Centre of pressure.

THE
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VOLUME XVII DECEMBER 1934 No. 12

## The Forty-ninth Annual General Meeting

The formal Annual General Meeting for 1935 will be convened at Headquarters on Thursday, January 24th, 1935, at eight o'clock p.m. for the transaction of the prescribed routine business, and will be adjourned to reconvene at the Royal York Hotel, Toronto, at ten o'clock a.m. on Thursday, February 7th, 1935.

## Water for the Western Farmer

Those who have not seen for themselves the conditions existing in the so-called drought areas of the prairie provinces will find it difficult to realize the serious situation which exists in South-Eastern Alberta, Southern Saskatchewan, and South-Western Manitoba. Fortunately the districts at present affected are only a portion of Canada's grain producing territory; the stricken areas, moreover, have been productive in the past, and are favourably situated as regards transportation. The discouragement due to successive crop failures has nevertheless resulted in proposals for the wide-spread shifting of population from these areas to regions where conditions during the past five years have been more favourable.

It is reassuring to learn that the area is small over which conditions are such as to make abandonment actually necessary. There is, of course, land which never should have been cultivated, but should have retained its original prairie vegetation, but this condition only applies to restricted districts, and over the greater part of the region affected there is good reason to believe that remedial measures will prove effective.

It is important, therefore, that efforts should be directed towards discovering how to provide water for the dry areas rather than towards their abandonment.

The existing difficulty is not a new one; serious drought conditions existed in 1917 and 1921. They were succeeded by years of more normal precipitation, and long term records give no reason to suppose that a period of adequate rainfall will not follow the present dry cycle. In the past we have been in error in not realizing fully the possibility of so serious a condition as now exists. Too little attention has been given to the conservation of moisture and its utilization, and the farmer's efforts have rather been in the direction of drainage of his land in order to commence work earlier in the season, and draining the sloughs in order to get additional area under cultivation. The shortage of ground water is now such that in some districts, although the farmer has been able to grow wheat, he has not been self-supporting as regards stock and vegetables. An adequate water supply for each farmer's home, enabling him to raise practically all the food he requires, is a pressing need, and is just as important to the welfare of the west as an adequate supply for its cities and towns.

The problem is vital to the prosperity of Canada as a whole, as well as to the prairie provinces, and has naturally been a matter of particular anxiety to the western provincial governments. Speaking recently in Winnipeg, Premier Bracken laid stress on the fact that the question is truly a national one. He is familiar with conditions in Saskatchewan as well as in Manitoba, and has a thorough knowledge of western farming. He believes that the governments of the prairie provinces should co-operate in a complete study of the situation, for which the aid of the Dominion government should be secured, with the object of deciding upon a co-ordinated policy. Such a policy should not only provide for the fuller utilization of the scanty supplies of water now available, but should also be such as to insure the conservation and better use of the rainfall which will come when the present drought is broken.

Our drought problem in Canada is on a small scale as compared with that existing in the United States, where a stricken area extends over a wide belt of the mid-west from Texas in the south to North Dakota and Montana on the Canadian border. The Federal government has for some time been giving attention to the difficulties of this mid-western region, and it is therefore particularly desirable that there should be full consultation between the Canadian and American governmental authorities concerned before we adopt any definite policy involving the expenditure of a large sum of money. The government departments at Washington have always been generous in making their technical information available for the benefit of other nations, and the results of their experience in conservation and reclamation in the dry belt cannot fail to be of great benefit to us in Canada in considering what has to be done in this country.

Suggestions of all kinds have been made as to the course to be pursued. It seems now to be agreed, in Saskatchewan at least, that measures of reclamation and agricultural readjustment depending upon local soil and climatic conditions are the most promising. Farmers may have to co-operate by changing their methods of cultivation, planting drought resisting grasses, establishing hedges and other means to lessen soil drifting, and so on. But these efforts will have to be supplemented by a policy of water conservation on a wide scale, based on the co-ordination of all the reliable information that is available. Among the factors which must be considered are precipitation, run-off, the underground water supply as affected by geological structure, the effect of surface water areas, trees, and vegetation, the possibilities of further utilizing existing streams and rivers, and the conservation of run-off water by the construction of local ponds and reservoirs.

It is in connection with these portions of the programme that technical advice is necessary. Recognizing this fact, the Council of The Institute has approved a suggestion coming from our western members that one entire session at the forthcoming Annual Meeting of The Institute should be devoted to a discussion on "The

Water Supply of the Prairie Provinces and its Bearing on their Economic Development." Arrangements are being made accordingly, and it is intended to base the discussion on a series of papers dealing with separate aspects of the problem. It is expected that these will be supplemented by contributions from officers of the Dominion Meteorological Service, the Dominion Water Power and Hydrometric Bureau, the Geological Survey, and the provincial technical officers concerned.

The subject is not an entirely new one to members of The Institute, papers dealing with it having already been presented at western branch meetings. This will be the first time, however, that an attempt has been made to render available to all our members and to the public the collected views of engineers and technical officers who have made a study of this important question.

The ultimate solution of the many problems involved will no doubt require federal as well as provincial expenditure, a circumstance which gives all good Canadians a very personal interest in the methods to be adopted.

## Meeting of Council

A meeting of the Council of The Institute was held at Headquarters on Friday, November 16th, 1934, at eight o'clock p.m., with President F. P. Shearwood, M.E.I.C., in the chair, and eleven other members of Council present.

The Council gave further consideration to the communication from the Vancouver Branch, dated October 3rd, 1934, dealing with the future policy and lines of development of The Institute. This was one of the communications received from various branches in response to the President's request for an expression of branch opinions on problems now before The Institute, and will be available for consideration when the problem of re-organization comes up for consideration in detail.

It was noted that the revenue and expenditure of The Institute up to the end of October had been kept well within the budget estimates.

Letters were received from the Hamilton Branch pointing out that the work of The Institute Nominating Committee this year had not been carried out in exact accordance with the by-laws. The Secretary submitted explanatory statements received from the chairman of the Nominating Committee and was directed to transmit these to the branch.

Discussion took place with regard to the possible nomination of engineers on the directorate of the Bank of Canada, and Council received with appreciation and approval a report prepared by a committee of the Ottawa Branch with regard to the nomination of a suitable candidate in each of the three categories.

The Secretary submitted certain amendments to the Winnipeg Branch by-laws, which have been proposed by the Branch Executive Committee with a view of facilitating the co-operation of that Branch with the Association of Professional Engineers of Manitoba. These amendments were approved, and the Secretary was directed to publish in The Journal for the information of the membership of The Institute an account of the effort which is being made by the engineers in Manitoba to promote that object.

It was decided that the formal Annual General Meeting for 1935 should be convened at Headquarters on Thursday, January 24th, 1935, at eight o'clock p.m., for the transaction of the prescribed routine business, to be adjourned to reconvene at the Royal York Hotel, Toronto, at ten o'clock a.m. on Thursday, February, 7th, 1935.

It was noted that three candidates had sat for The Institute's examinations on November 6th, 1934, and that all had failed to satisfy the examiners.

Discussion took place on a suggestion received from the President of the Association of Professional Engineers of Alberta that The Institute general office might act as a clearing house in communications between the Associations of Professional Engineers and the Department of Immigration with regard to applications for the admission of foreign engineers to Canada. The suggestion was approved, provided the consent of all the Professional Associations to the arrangement could be secured.

Four members were replaced on the active list, and two Life Memberships were granted.

A number of applications for admission and for transfer were considered, and the following elections and transfers were effected:

| *Elections* | | *Transfers* | |
|---|---|---|---|
| Assoc. Member | 1 | Junior to Assoc. Member | 4 |
| Students admitted | 6 | Student to Assoc. Member | 2 |
| | | Student to Junior | 2 |

The Council rose at ten thirty-five p.m.

## OBITUARIES

### Paul Albert Nicolas Seurot, M.E.I.C.

Widespread regret will be felt at the death in Montreal on November 18th, 1934, of Paul Albert Nicolas Seurot, M.E.I.C.

Mr. Seurot was born in Paris, France, on August 26th, 1869, and was educated at the Ecole Turgot in that city, graduating as Ingénieur diplômé with the "certificat d'Etudes supérieures" and in 1887-1890 was engaged on post graduate work, and as tutor at the Ecole Fénelon.

In 1890 Mr. Seurot came to the United States, and until September of that year was employed by C. M. Jacobs, consulting engineer, as a rodman on triangulation on the New York harbour, and on various surveys for railway work. From that time until 1892 he was on the Long Island Railroad as rodman, instrumentman and chief of surveying corps and in 1892-1894 was assistant engineer in charge of the reconstruction of and double tracking of roadway and reconstruction of bridges on some of the Long Island Railway lines, and was also in charge of parties for preliminary and relocation surveys. From 1894 until

P. A. N. Seurot, M.E.I.C.

1898 he was with Jacobs and Davies, consulting engineers, and was associated with some important engineering achievements in and about New York, particularly on the construction of the East River gas tunnel and on the designs and reports of the proposed Brooklyn Rapid Transit system. During the years 1895-1901 he was also retained by the Panama Canal Company in their dealings with the Interstate Commerce committee at Washington. From 1901 to 1906 Mr. Seurot was engineer on the Atlantic Avenue improvement (Brooklyn Rapid Transit Company), engineer on the Pennsylvania tunnels under the North River (New York), on the Hudson tunnels and McAdoo underground and rapid transit systems in New York and New Jersey. In 1905 he was sent by Jacobs and Davies to Norfolk, Va., to make a study, report and estimate on a tunnel under the Elizabeth river, and during the summer of 1906 the same firm sent him to France to make on their behalf a complete study, estimate and report to the French Minister of Public Works on the construction of a tunnel under the estuary of the Seine. In 1906-1907 Mr. Seurot was office engineer on the Hudson Tunnels, and in 1907-1911 he was in Paris as representative of Jacobs and Davies, in charge of the work of construction of the Paris Metropolitan tunnel under the Seine, known as the Concord tunnel.

Coming to Canada in 1911, Mr. Seurot established his own practice, and was retained on many important projects in Montreal and Toronto and was in addition chief engineer to the Montreal Tunnel Company. The city of Montreal also retained his services to report on and design the proposed tunnels under the Lachine canal. He was also attached to the Canadian delegation sent to France by the Minister of Trade and Commerce. In 1918 he was appointed chief engineer of the Montreal Tramways Commission, and from 1927 until his death he was engineer of rapid transit of the Montreal Tramways Company.

During his active life Mr. Seurot wrote a number of important papers dealing with engineering problems and in 1914 was the recipient of the Gzowski medal awarded by The Institute (then the Canadian Society of Civil Engineers) for his paper on "Subaqueous Tunnelling." His services were recognized by France, which made him a Chevalier de la Légion d'Honneur, and Officier d'Académie, while he was also the holder of the Gold Medal of Honour of the French Humane Society.

Mr. Seurot was a member of the Institution of Civil Engineers (Great Britain), the American Society of Civil Engineers, and the Corporation of Professional Engineers of the Province of Quebec.

He became a Member of The Institute on May 11th, 1912.

### Kenneth Murray Chadwick, M.E.I.C.

It is with deep regret that we record the death of Kenneth Murray Chadwick, M.E.I.C., which occurred at Victoria, B.C., on October 21st, 1934.

Mr. Chadwick was born at Leeds, England, on August 11th, 1878, and in 1895-1899 served articles of apprenticeship with the city engineer of Leeds.

From that time until 1902 he was resident engineer for the city on the construction of bacteriological sewage filters and contact beds, and on the construction of a large water-main system. In 1903-1905 Mr. Chadwick was engaged on the design and construction of an addition to the main sewerage system of the city, and in 1906 he was assistant engineer of design on the city's sewage disposal scheme. In 1907, having come to this country, his work was at first in connection with building construction in Ontario and later in British Columbia. In 1916-1917, Mr. Chadwick was in the inspection service of the Imperial Munitions Board, and following this, in 1918, he became engineer of construction for the Victoria Gas Company, Victoria. At the time of his death Mr. Chadwick was not engaged in practice.

Mr. Chadwick joined The Institute (then the Canadian Society of Civil Engineers) as an Associate Member on March 12th, 1908, and on October 27th, 1925, became a full Member. For many years he took an active interest in Institute affairs, having served as secretary-treasurer of the Victoria Branch from 1927 until 1931, as vice-chairman of the Branch in 1932 and 1933, and as member of Council in 1931. He was elected an Associate Member of the Institution of Civil Engineers in 1904.

## PERSONALS

A. D. W. Fraser, S.E.I.C., who graduated from McGill University this year with the degree of B.Eng., has joined the staff of Siscoe Gold Mines, Limited, at Siscoe, Que.

Pierre Warren, S.E.I.C., a graduate of the Ecole Polytechnique of the year 1932, is now assistant engineer with the Department of Publics Works, Canada, at Rimouski, Que.

Gordon M. McLean, S.E.I.C., is now with the Perron Gold Mines Limited, at Pascalis, Que. Mr. McLean graduated from the Nova Scotia Technical College in 1932.

J. B. DeHart, M.E.I.C., District Inspector of Mines, Province of Alberta, Lethbridge, Alta., has been elected president of the Association of Professional Engineers of the Province of Alberta.

A. LeB. Ross, S.E.I.C., is now connected with the Railway and Power Engineer Corp., at Toronto, Ontario. Mr. Ross, who graduated from McGill University with the degree of B.Eng. in 1932, was formerly with Noranda Mines Limited, at Noranda, Que.

A. L. Graham, S.E.I.C., has become connected with Eastern Power Devices Limited, Toronto. Mr. Graham graduated from the University of Toronto in 1931 with the degree of B.A.Sc., and in 1932 he was with the Canadian General Electric Company at Peterborough, Ontario.

Wm. H. Hunt, S.E.I.C., who graduated from the Nova Scotia Technical College in 1933 with the degree of B.Sc., has joined the staff of the Maritime Telegraph and Telephone Company, at Halifax, as junior maintenance assistant in the general plant department.

O. Desjardins, A.M.E.I.C., formerly joint chief engineer of the Department of Public Works of the Province of Quebec, has been appointed chief engineer of the Department. Mr. Desjardins, who has been with the Department for many years, is a graduate of the Ecole Polytechnique, Montreal, having graduated from that institution in 1919 with the degree of B.A.Sc.

J. M. Breen, A.M.E.I.C., of the Canada Cement Company Limited, has been transferred from the Toronto office of the company to Montreal, where he has assumed the position of chief of the technical staff. Following graduation from the University of Toronto in 1921 with the degree of B.A.Sc., Mr. Breen was employed for a time with the Toronto Harbour Commission, and later with the Roads Department of the city of Toronto. In 1922 he entered the employ of the Canada Cement Company Limited as engineer in the Toronto office, and has been connected with that office up to the present time.

Eric G. Adams, Jr.E.I.C., has been appointed secretary of the Newsprint Export Manufacturers Association of Canada, at Montreal. Mr. Adams is a graduate of McGill University, having obtained the degree of B.Sc. in 1929, and was formerly with Messrs. Cockfield Brown and Company, Montreal. Mr. Adams will be remembered by the membership of The Institute as the winner of the Past-Presidents' Prize for the year 1932-1933 for his paper on "The Relations of Economics to Engineering." He also received the Phelps Johnson Prize for Students and Juniors in the province of Quebec for the year 1930-1931, for his paper entitled "Some Economic Problems Confronting the Wider Application of Railroad Electrification in America."

E. S. Mattice, M.E.I.C., has severed his connection with the National Bridge Company of Canada, of which he has been vice-president and manager since 1929, and has become vice-president and general manager of Farand and Delorme, structural miscellaneous steel work, Montreal. From 1923 until 1925 Mr. Mattice was chief engineer of Canadian Vickers Limited, at Montreal, and was later, for four years, manager and chief engineer of Steel Gates Company Limited, St. Catharines, Ontario, being in charge of the construction and erection of the steel gates of the Welland Ship canal. Following that he accepted the appointment from which he has recently resigned.

### T. C. MacNabb, M.E.I.C., Receives Appointment

T. C. MacNabb, M.E.I.C., has been appointed general superintendent for the New Brunswick district of the Canadian Pacific Railway Company.

Mr. MacNabb is a graduate of the University of Manitoba, having graduated with the degree of B.A. with honours, in 1902. Immediately following this he joined the staff of the Canadian Pacific Railway Company, and has been engaged on various works with that company throughout Canada ever since. He was first with the construction department, and in succession occupied various positions commencing as chainman and rodman in 1902, being promoted to topographer in 1903, and later draughtsman in the field office at Winnipeg; in the following year he was instrumentman, and in 1905 became resident engineer. In this capacity his work took him to Saskatoon, Lethbridge and Battle River. In 1908 Mr. MacNabb was made assistant engineer on construction, the following year, division engineer on maintenance, and in 1916, assistant engineer for Saskatchewan. In 1917 he became superintendent at Revelstoke. In 1926 Mr. MacNabb was appointed engineer of construction of the company's western lines with office at Winnipeg, Man., and has held that position up to the present time.

### Beaudry Leman, A.M.E.I.C., President of Banque Canadienne Nationale

Beaudry Leman, A.M.E.I.C., has been elected president and managing director of the Banque Canadienne Nationale. Mr. Leman, who was formerly vice-president and general manager of that institution, is a graduate of the University of Lille and of McGill University. He commenced his engineering career in the employ of the Shawinigan Water and Power Company, devoting six years to the development of hydro-electric enterprise. In 1906 he took an active part in the establishment and construction of the railway which connects the city of Three Rivers with the towns of Shawinigan Falls and Grand'Mere. For some years he represented a group of Belgian and French banks interested in Canadian enterprises, and in 1912 entered the service of the Banque d'Hochelaga, rising rapidly to the important position which he now holds with the Banque Canadienne Nationale. Mr. Leman who has served a term as President of the Canadian Bankers' Association, has also acted as a member of the Electric Service Commission of Montreal, and of the National Advisory Committee on the St. Lawrence Waterways project. He was a member of the Royal Commission appointed in 1931 to enquire into the Canadian Railway situation.

Mr. Leman became an Associate Member of The Institute (then the Canadian Society of Civil Engineers) on April 10th, 1902.

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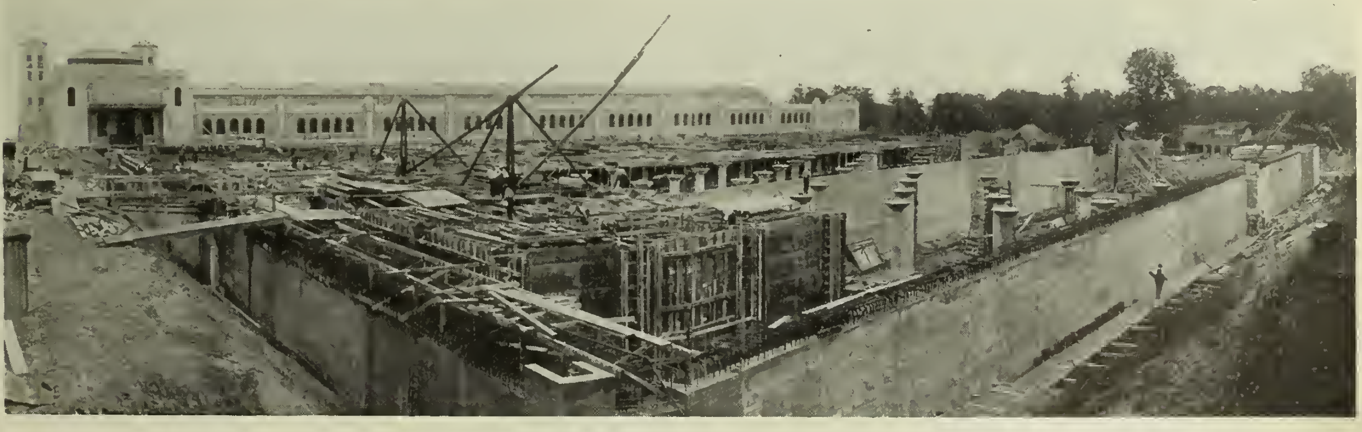
# Annual General and General Professional Meeting, Toronto,

## FEBRUARY 7TH AND 8TH, 1935

At the professional sessions on February 7th and 8th papers will be presented for discussion dealing with many topics of interest and of national importance, such as:

- The Status of the Engineer—(three papers).
- Electrical Inspection and Testing at the Laboratories of the Hydro-Electric Power Commission of Ontario.
- Gaseous Conductor Lamps and their Applications.
- Graphical Solutions for Pressure Rise in Pipe Lines.
- The Montreal Neurological Institute and its Service Equipment.
- The Toronto Waterworks Extensions.
- Bascule Bridges.
- The Water Supply of the Prairie Provinces and its Bearing on their Economic Development (eight papers).

The presentation of the papers on "The Status of the Engineer" and the "Water Supply of the Prairie Provinces" will be followed by discussions, which will occupy an entire afternoon session in each case.



Victoria Park Filtration Plant, Toronto.

## ELECTIONS AND TRANSFERS

At the meeting of Council held on November 16th, 1934, the following elections and transfers were effected:

*Associate Member*

DEMPSEY, Wesley Thomas, B.Sc. (Civil), (Univ. of Sask.), Dundurn Camp, Dundurn, Sask.

*Transferred from the class of Junior to that of Associate Member*

BANKS, Shewell Reginald, B.Eng., M.Eng., (Univ. of Liverpool), asst. engr., Monsarrat & Pratley, Montreal, Que.

CORNISH, Wilfred Ernest, B.Sc. (E.E.), (Univ. of Man.), M.Sc., (Univ. of Alta.), asst. professor, Dept. of Elect. Engrg., University of Alberta, Edmonton, Alta.

DOULL, Robert Morse, B.Sc. (Mech.), (McGill Univ.), asst. mgr., Construction Equipment Company, mgr., Gunite and Waterproofing Ltd., Montreal, Que.

TAYLOR, Andrew, B.Sc. (C.E.), (Univ. of Man.), technical dftsman., Surveys Branch, Dept. of Mines and Natural Resources, Winnipeg, Man.

*Transferred from the class of Student to that of Associate Member*

ORANGE, Frank A., B.Sc., (Queen's Univ.), designer, mech'l. engrg. office, International Nickel Co., Copper Cliff, Ont.

SAUER, George Douglas, B.Sc., (McGill Univ.), designer, Beauharnois Light Heat and Power Co., Beauharnois, Que.

*Transferred from the class of Student to that of Junior*

DOVE, Allan Burgess, B.Sc., (Queen's Univ.), chem. engr. and asst. to West Mill supt., Canada Works, Steel Company of Canada, Hamilton, Ont.

PORTEOUS, John Wardlaw, B.Sc., (Univ. of Alta.), lecturer, University of Alberta, Edmonton, Alta.

*Students Admitted*

DOW, Gordon Young, B.Sc. (E.E.), (Univ. of N.B.), Pacific Dairies Ltd., Saint John, N.B.

KIMPTON, Geoffrey H., (McGill Univ.), 71 Birch Ave., St. Lambert, Que.

L'ALLIER, Lucien, (McGill Univ.), 5022 de la Roche St., Montreal, Que.

REDMOND, William Lawson, (Univ. of Alta.), 9818-108th St., Edmonton, Alta.

SCHUYDER, Max, (McGill Univ.), 1477 Fort St., Montreal, Que.

WATTERS, Edgar Steen, B.Sc. (E.E.), (Univ. of N.B.), 83 Prince St., West Saint John, N.B.

## RECENT ADDITIONS TO THE LIBRARY

### Proceedings, Transactions, etc.

*Punjab Engineering Congress:*
Proceedings, 1934.

*American Railway Engineering Association:*
Proceedings 1930, 1931, 1932, 1933 and 1934. (*Presented by J. E. Armstrong, A.M.E.I.C.*)

*Society for the Promotion of Engineering Education:*
Proceedings of 40th Anniversary and 41st Annual Meeting, 1934.

### Reports, etc.

*Financial Post:*
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*Quebec Bureau of Mines:*
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*Province of Alberta, Geological Survey Division:*
Geology of Central Alberta, by J. A. Allan and R. L. Rutherford.

*American Institute of Steel Construction:*
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*Electrochemical Society Inc.:*
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*International Tin Research and Development Council:*
A Rapid Test of Thickness of Tin Coatings on Steel, by G. G. Clarke.

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67th Annual Report, 1933-1934

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*New Orleans Sewerage and Water Board:*
68th Semi-annual Report, December 31st, 1933.

*American Waterworks Association:*
Membership List, Constitution and By-laws, etc., 1934.

*City of New York, Board of Water Supply:*
Annual Report, 1933.

*Canada, Hydrographic Service, Tidal and Current Survey:*
Tide Tables for the Pacific Coast of Canada, 1935.

*American Society for Testing Materials:*
Symposium on the Outdoor Weathering of Metals and Metallic Coatings.

### Technical Books, etc., Received

Industrial Standardization, its Principles and Application, by John Gaillard. (*The H. W. Wilson Company.*)

History of Rensselaer Polytechnic Institute 1824–1934, by P. C. Ricketts. (*John Wiley and Sons.*)

Structural Design in Steel, by T. C. Shedd. (*John Wiley and Sons.*)

Handbook of Aeronautics, 2nd edition, Volumes I and II, by A. Swan. (Published under the authority of the Council of the Royal Aeronautical Society, by Sir Isaac Pitman and Sons.)

The Stone Industries, by O. Bowles. (*McGraw-Hill Book Company.*)

An Introduction to Practical Organic Chemistry, by W. A. Waters. (*Longmans Green and Company.*)

Explosives, by A. Marshall. (*Presented by Mr. R. J. Durley.*)

Handbook of Chemistry, by N. A. Lange. (*Handbook Publishers Inc.*)

## BOOK REVIEWS

### Design and Construction of Concrete Roads

*By R. A. B. Smith, Concrete Publications Limited, London, 1934. 5½ by 8¾ inches, 264 pp. 8s. 6d. Cloth.*

Reviewed by Professor R. de L. French, M.E.I.C.*

Although those on this side of the water interested in concrete highway design, construction and maintenance, will not agree entirely with the views expressed by the author of this book, they will do well to read it attentively. It leaves one with the impression that the British engineer is either not very favourably impressed by the results of American experience and research, or that he finds these results of little use under British conditions.

For example, Mr. Smith feels that there are other and better methods of securing the necessary strength at the edges of a road slab than that which has become practically standard practice here, the thickening of those edges. He also has some pretty definite views on joints, well worth study, as well as on finishing, curing and other matters.

The differences between American and British construction practices are brought out, incidentally. Much is still done by hand in Britain that we do by machine. Nowhere is there any mention of machine subgrade finishing, nor even of machine surface finishing, both common practices with us. The typical—and excellent—British attention to details is apparent throughout the text, and in the illustrations, which seem to this reviewer to be above the average both in selection and quality.

Some useful material with respect to colouring concrete, to the layout of junctions with curves, to "footpaths" (sidewalks) and to accessories, such as drainage inlets, traffic markings, fences, sign and lamp posts, and kiosks—the latter practically unknown here—with a good index, complete the body of a book of distinct usefulness.

One appendix deals with Professor H. M. Westergaard's development of the theory of the stresses in road slabs, the second contains suggested clauses for specifications, and a third outlines the British Standard tests for concrete and concrete materials. There is also a short bibliography of reports of the Ministry of Transport regarding concrete roads.

*Professor of Highway and Municipal Engineering, McGill University, Montreal.

### Principles of Mechanism

*By C. E. Pearce, John Wiley and Sons Inc., New York, 1934. 6 by 9¼ inches, 283 pages. $3.50. Cloth.*

Reviewed by Professor L. M. Arkley, M.E.I.C.*

As stated in the preface this book is designed especially as a text book for sophomore classes in college, and as such it should be satisfactory.

Chapter one treats of machines in general and touches on the different kinds of motion found in them.

Chapter two is on transmission by direct friction, and illustrations are given of such examples of this as grooved friction wheels, rolling cones with external and internal contact and speed variators.

There are three chapters devoted to transmission by toothed wheels and screw gears, chapters three and four are more or less decriptive with illustrations of the different types while in chapter fourteen methods of finding the true shape of involute and cyclodial curves for gear teeth are given.

The chapter on power transmission by flexible connectors which include belts, wire rope drives and chains is fairly comprehensive.

One of the best chapters in the book is number ten, dealing with vector representation of motion and in it is shown clearly the use of the instantaneous centre method of analysing the velocities of the links of different chains. Linear and angular velocity ratios are discussed and at the end of the chapter are many excellent illustrative mechanisms and problems.

The next chapter treats of the transmission of power by means of linkages and gives analyses of such well known mechanisms as the slider crank chain with its different inversions including quick return motions, the oscillating engine mechanism and universal couplings. In fact these two chapters contain so much that is necessary to the study of the fundamentals of mechanism that it seems they might have been placed nearer the beginning of the book.

There is little new in the treatment of the subject of cams, but an interesting chapter follows on the subject of mechanisms with some special geometrical properties, such as straight line motions.

In several of the chapters there does not appear to be a sufficient analysis of the principles treated to enable students to apply these to the solution of the problems given at the end of the chapter; and the reviewer believes the arrangement of the material in the book might be improved by placing some of the fundamental principles in the first chapters.

The book is well illustrated by excellent cuts and at the end of each chapter is an unusually long list of problems to be solved.

*Professor of Mechanical Engineering, Queen's University, Kingston, Ont.*

## Handbook of Aeronautics

*Published under the authority of the Council of the Royal Aeronautical Society by Sir Isaac Pitman and Sons Inc., London, 1934. 5¾ by 9 inches. 2nd edition. 2 volumes. 40s. Cloth.*

This handbook has been published under the authority of the Council of the Royal Aeronautical Society of Great Britain for the purpose of collecting in as accurate and authoritative a form as possible, information which will be of every day use to the designer and constructor of aircraft and the aeronautical engineer. It has been prepared by engineers of recognized standing in the various branches of the profession.

During the past twenty-five years a mass of scientific data dealing with aeronautics has been published, mainly in official reports, and a difficulty is experienced by young engineers not only in obtaining access to these reports, but also in sorting out the information which they contain.

The Handbook of Aeronautics has, therefore, a definite value, because not only does it give an indication of the problems which have to be faced and the method of attacking them, but also it gives a very valuable series of references to other published material. More experienced engineers will perhaps find that some sections are inadequately dealt with, particularly those dealing with aerodynamics, design data and formulae, but these engineers will already possess information with which to fill up the gaps.

In the section dealing with aerodynamics much recently published work done at high Reynolds numbers has been omitted, as also has reference to modern devices such as split flaps and servo gears.

The chapter on performance is well written and contains useful information.

Construction is perhaps an incorrect name for chapter III, because this chapter deals mainly with material specifications, dimensions of standard parts, tables of constants for various sections and similar data of assistance to the designer, without dealing in any way with the methods of construction, which one would expect to find under this heading.

The properties of materials have been successfully summarized in the fourth chapter.

Chapter V deals with meteorology in a very brief manner, but sufficiently for the purpose of this book.

Aircraft instruments, wireless and air survey are each dealt with rather briefly.

The chapter on design data and formulae cannot replace a text-book on aircraft design without becoming unduly long, and for this reason this section of the book seems to be incomplete, in that it does not give a beginner a good introduction to this important part of the work of an aircraft designer.

The second volume is devoted to aero engines and airscrews. It outlines the problem of aero engine design in a satisfactory manner, and gives data which should be of value not only to the aero engine designer, but also to other designers of internal combustion engines.

After dealing a little critically perhaps with the individual chapters, one is left with the impression that the authors have undertaken a very heavy task in attempting to combine in one book the many branches of a subject so wide in its scope as aeronautics, and that the result obtained is upon the whole very satisfactory. The book is one which should be possessed by every aircraft and aero engine designer and by students of aeronautics. E.W.S.

## Structural Design in Steel

*By Thomas Clark Shedd, John Wiley and Sons, New York, 1934. 6 by 9¼ inches, 560 pages. $5.00. Cloth.*

Reviewed by W. Chase Thomson, M.E.I.C.*

This work deals primarily with the details of design for steel structures, a subject which had not previously been adequately covered by available text-books. In it the student is assumed to be familiar with the principles involved in the strength of materials, and to have considerable skill in the calculation of the principal stresses in simple structures. The author has made a special feature of the numerous design sheets for actual structures, with calculations arranged in accordance with usual practice in the office of a designing engineer; and he is to be commended for this method of teaching by example as well as by precept.

Chapter I is introductory, and refers briefly to some of the problems treated in work. Chapter II discusses types of structure and of structural framing; it is illustrated by many photographic views of existing structures, also by line drawings.

The most important part of the book is contained in chapters III, IV and V. In chapter III, rolled beams and built-up girders are treated in great detail, giving particular attention to maximum shears, to splices and to riveting. Chapter IV treats of tension and compression members, including those which are also subject to bending moments, stresses in columns due to flexure, latticing and other details. Chapter V deals with connections of all kinds, including those for tension and compression, for shear only and for shear and bending moments combined. It also gives careful consideration to the stresses in and to the proportioning of gusset plates.

In chapter VI, treating with the design of structural steel for buildings, and in chapter VII, with that for bridges, the principles set forth in chapters III, IV and V are further illustrated by practical examples. Chapter VIII deals satisfactorily with the principles and present practice of structural welding.

The volume closes with three appendices, A, B and C.

Appendix A is a specification for the design of steel railway bridges, in general agreement with that prepared by the committees of the American Society of Civil Engineers and the American Railway Engineering Association, published in the Proceedings of the American Society of Civil Engineers, December 1929, but slightly modified by the author to suit his own views with respect to allowable intensities of stress, loading, provision for net section and in some other matters of minor importance.

Appendix B is a general specification for the design of steel highway bridges, generally in accordance with that prepared by representatives of the American Association of State Highway Officials, and the American Railway Engineering Association, printed in Bulletin 314, Vol. 30, of the latter organization, February 1927.

Appendix C is a specification for the design, fabrication and erection of structural steel for buildings, adopted by the American Institute of Steel Construction in 1923 and revised to January 1934.

The book is well written and the numerous illustrations distributed through the text, including the design sheets, are neat and clear. In addition to these illustrations there are nine folding plates which, for greater convenience are loose and are placed in a pocket provided in the back cover.

As a text-book this work should be valuable for use in colleges and of great assistance to the young structural engineer. As a book of reference it should also be found of much value to structural engineers of greater experience.

*Consulting engineer, Montreal.*

## Symposium on the Outdoor Weathering of Metals and Metallic Coatings

### American Society for Testing Materials

The above symposium which has been received in the library of The Institute evaluates the performance data obtained from extensive outdoor weathering tests carried out by two committees of the American Society for Testing Materials and is intended to illustrate applications of corrosion test data in solving materials problems.

The five papers included discuss outdoor test results on bare and metal-coated ferrous specimens; the harmony of outdoor weathering tests; influence of rainfall and smoke on the corrosion of iron and steel; early interpretation of test results in the atmospheric corrosion of non-ferrous metals and alloys, and galvanic corrosion by contact of dissimilar metals.

An interpretation of corrosion test results necessarily introduces various viewpoints and a portion of the publication is devoted to discussion. Extensive contributions from technologists in England indicate results of widespread test programmes conducted there and comparisons with conclusions reached in the United States.

Copies of this 113-page book can be obtained from the American Society for Testing Materials at 260 S. Broad Street, Philadelphia, Pa., at $1.25 a copy.

## Civil Aviation Map

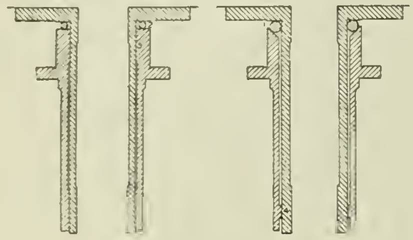
The Department of National Defence in co-operation with the Department of the Interior has issued a map of Canada showing the airports, intermediate aerodromes, and seaplane ports and anchorages. The various types of landing stations are designated by separate symbols.

Copies of the map may be obtained from the Topographical and Air Survey Bureau, Department of the Interior, Ottawa, at ten cents per copy.

# Testing and Improving the Performance of the Wild Precision Theodolite

*Professor James Weir, A.M.E.I.C.,*
*Assistant Professor of Geodesy, McGill University, Montreal.*

In the March 1934 number of the Canadian Journal of Research, National Research Council, Ottawa, there appear three papers by officers of the Geodetic Survey of Canada, Department of the Interior, and entitled: "Variable Personal Equation of Bisection in Primary Triangulation," by J. L. Rannie, M.E.I.C., and W. M. Dennis, M.E.I.C., 5 pages; "Improving the Performance of Primary Triangulation Theodolites as a Result of Laboratory Tests," by J. L. Rannie, M.E.I.C., and W. M. Dennis, M.E.I.C., 15 pages; "A Field Test of Primary Triangulation Theodolites," by J. L. Rannie, M.E.I.C., 11 pages.*



(a) (b)
**Fig. 1—(a) Original and (b) Modified Alidade Axis.**

These papers embody the results of an investigation—the first of its kind, so far as is known—into the causes and remedies for certain puzzling errors which were suspected to exist in the Wild precision theodolite designed for precise angle measurements. The results of the investigation apply also to smaller models of several makes which are in general use by engineers.

The investigation was carried on both outdoors and, mainly, in the collimator laboratories of the National Research Council by officers of the Geodetic Survey of Canada.

The Wild precision theodolite (a 5½-inch instrument slightly larger than the small 3¾-inch type used by a considerable number of Canadian engineers) was the instrument under investigation. Ten of these theodolites have been in use by the Geodetic Survey for primary triangulation, and, as one of the criteria of accuracy of this class of work is that the sum of the three measured angles of a triangle shall, on the average, be within one second of the true amount, it is seen that angles must be correctly measured within a fraction of a second. In many cases this precision was obtained without trouble with this new

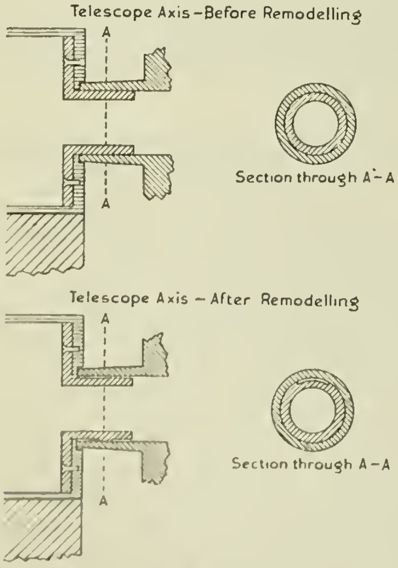



**Fig. 2—Original and Modified Telescope Axis.**

type of theodolite, but in a number of other cases errors as high as two to four seconds were indicated.

While angular errors of these magnitudes are occasionally caused by atmospheric disturbances, their occurrence with this instrument was rather too frequent to be attributable to this phenomenon, and it was decided to subject the instruments to a very comprehensive test to determine if any errors, hitherto undiscovered, really did exist in this type of theodolite.

*Reprints of these papers may be obtained from the Director of the Geodetic Survey of Canada, Ottawa.

One cause of trouble which had been noticed in some of the instruments (and this has also been found in a number of cases with the small model) was that the alidade axis, as well as the telescope axis, developed stiffness in service. Noticeable stiffness in the alidade or vertical axis can be removed by lapping, while that in the telescope axis is generally cured by adjustments to the bearing blocks at the ends of the telescope axis. This stiffness was later found to be an exaggeration of the trouble found with the Geodetic Survey theodolites.

These theodolites are constructed with the cylindrical alidade and telescope axes of hardened steel which are fitted with very small tolerances; it is well known that many metals are subject to dimensional changes for some years after machining and heating processes; due to these circumstances it was found that minute lacks of fit developed in the alidade and telescope axes, and these produced minute strains in the metal which changed as the telescope was swung in azimuth and changed in elevation. These strains were found to be transmitted through the instrument to the telescope and caused changing deflections of the line of collimation, thus producing errors in angular measurements varying from zero to about four seconds. A dangerous feature of these strains is that, unless excessive, they do not result in definite stiffness of motion of the axes. The method employed to measure these errors was to change the position of the footscrews between groups of measurements of the same angles, in this way changing the relation between the

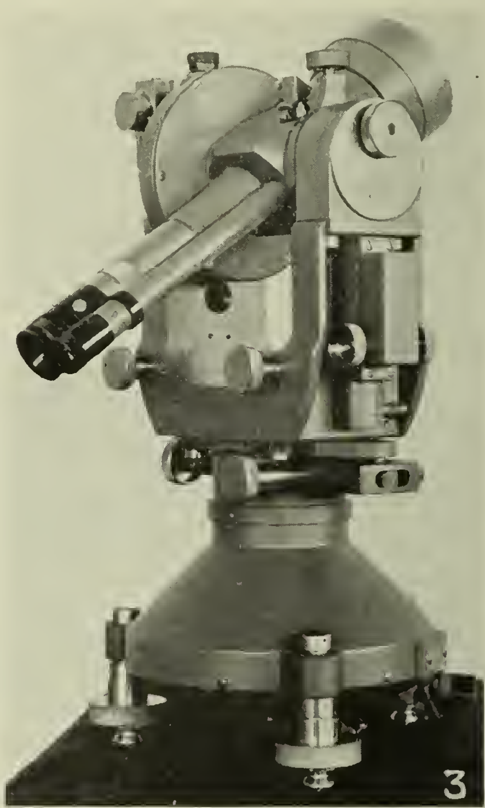


**Fig. 3—Wild Precision Theodolite 5½-inch Horizontal Circle.**

alidade axis and its socket and changing the strains which produced these errors.

Nine of the ten Wild precision theodolites examined were found to be affected by axis strain in varying degree.

The errors discovered in the alidade and telescope axes were eliminated by employing the principles of kinematical design so far as was found possible. The full application of these principles removes the necessity of precision fits, such as cylinders, which are expensive to manufacture and are seldom permanent; these advantages are bringing these principles into increasing use in the design of engineering mechanisms. The original and re-modelled alidade and telescope axes used on the Wild theodolites are illustrated in Figs. 1 and 2 respectively.

The remodeled instruments were subjected to the same extensive series of tests as before and gave very much improved results, as good as or better than those with older and larger theodolites which had given years of satisfactory service. The improved instruments were also used in the field with entirely satisfactory results.

Two other important results of the investigation were, the development of a method of testing geodetic theodolites out of doors, and the rediscovery that some observers consistently make very different pointings on bright and dim lights, resulting in angular errors which with certain observers may be as large as two or three seconds.

The results of this investigation are of real importance to the average engineer, since a considerable number of the small model of

Wild, Zeiss and Cooke (Tavistock) instruments are in use. These may not be kept in as perfect condition as those used by a geodetic survey so that, while errors of three or four seconds may appear trivial to the average engineer. it is evident that errors of several times this amount may be produced if there is any noticeable stiffness of movement of the alidade or telescope axes.

Several precautions and observational procedure suggested by this investigation are equally applicable to smaller types of theodolites, either those with cylindrical or conical axes:

1. The footscrews must be kept much tighter during observations than is necessary with heavier theodolites.
2. If there is any suggestion of stiffness in the action of the alidade axis it should be lapped to a loose fit. A slack centre is preferable to a tight one.
3. Meticulous care should be taken to avoid any stiffness in the telescope axis, by adjustments of the blocks at the tops of the standards (Wild type).
4. To minimize the effect of changing axis strain the levelling screws should be moved 120 degrees between each third of a programme of observation.

## Branch Unemployment Relief Activities

The activities of the various branch unemployment committees during the past two years, and the assistance given these committees by many members of The Institute, have not received the attention that they might have.

The following letter to corporate members and juniors of the Montreal Branch should, therefore, be of interest. Similar requests on the part of several of the other branches (notably Toronto and the Border Cities), have also received excellent support, which is the more appreciated as in many cases the donors are themselves in reduced circumstances.

October 29th, 1934.

Gentlemen:—

After due consideration your Executive deem it necessary to again ask for subscriptions to the Unemployment Relief Fund. Even if you subscribed previously it is trusted that you will send in your contribution with the enclosed card.

As a result of a survey on unemployment made two years ago the Unemployment Relief Fund was started to help members of the Branch who were in extreme need of assistance.

The first appeal went out in December 1932, when 240 members subscribed. The second appeal was made in December 1933 when 190 subscriptions were received and the situation now is as follows:

| | | |
|---|---|---|
| *Receipts* | | |
| 1932-3 Subscriptions | $1,577.88 | |
| 1933-4 Subscriptions | 872.50 | |
| Interest | 19.34 | |
| Amount repaid by 2 members | 43.83 | |
| | | $2,513.55 |
| *Disbursements* | | |
| 1932-3 Assistance | $1,625.93 | |
| 1933-4 Assistance | 1,079.24 | |
| Printing and postage | 28.85 | |
| | | $2,734.02 |

It is estimated $1,000 will be required to make up the deficit and enable the Committee to carry on during the coming winter.

Yours very truly,

(Sgd.) C. K. McLeod, A.M.E.I.C.,
*Secretary-Treasurer.*

*Note:*—It may be of interest to know that on November 30th the amount of the subscriptions received as a result of this letter amounted to $553.00.

## Salary Standardization and Administration

This report is the result of a survey that was made by the Policyholders Service Bureau of the Metropolitan Life Insurance Company to determine the details of such scientific methods as now are in effective use.

Although progress has been made in developing scientific control of the pay of wage earners, few organizations have attempted to evolve similar procedures with reference to salaried positions. The outstanding reasons for such control vary from that of obtaining a complete accurate and impersonal description of the work done by each employee, to the determination of fair minimum and maximum salaries for each position or kind of work done throughout the organization.

Positions up to the rank of department heads have been included but most of the companies co-operating in this study limit standardization to those positions paying up to a maximum of about $300 a month.

The report states that the success of salary standardization depends upon the intelligence with which jobs are evaluated and classified. The list of grades used by a number of organizations are given in detail in the report and the methods of making evaluations are discussed, also the determination of salary limits for each group.

Copies of the report may be obtained from the Policyholders Service Bureau, Metropolitan Life Insurance Company, 180 Wellington Street, Ottawa, Ont.

# BRANCH NEWS

## Border Cities

*C. E. Davison, A.M.E.I.C., Secretary-Treasurer.*
*F. J. Ryder, S.E.I.C., Branch News Editor.*

The Electronic Valve

At the regular meeting held October 11th, 1934, Mr. G. Chute, of the General Electric Company, Detroit, former industrial power engineer and now in charge of research work on the electronic valve, presented the members with a very interesting talk on the latter subject.

The electronic valve is evolved from the common electric light which is composed of a metal filament enclosed in a glass bulb. When the filament is heated by an electric current, electrons are given off in innumerable quantities. Remembering that all electrons are negative in character, the next step was to insert a metal plate into the bulb making it positive in character.

Now the electrons instead of just being thrown off and wandering around willy-nilly, as in the light bulb, are attracted to the positive plate. By varying the voltage on this plate the quantity and speed of the electrons is varied. Evacuation of the tube aids the travel of the electrons as there is nothing left to hinder their progress. This set-up corresponds to our first radio tube.

This was not satisfactory as it did not reproduce or amplify the impulses clearly, but left the tones hazy. This was due to the filament not cooling quickly enough after the original impulse had stopped. To offset this, a grid or screen was placed between the plate and the filament and charged negatively. By varying the charge on the grid, the electrons passing through it to the plate could be controlled. Further refinements were made by introducing a metal that was known to be a good electron producer into the valve and using the filament as a source of heat. Now the valve contains all the principles in our present day radio tubes.

There are two types of electronic valves; one like the radio tube which given a small impulse may be controlled or amplified gradually, the other called the thyratron tube in which an atmosphere of some gas is introduced.

Knowing that heat and light are the same thing acting at different frequencies produced the electric eye. Instead of electrical impulses being transformed into heat as in the radio tube, we have light impulses which have the same effect as heat on the electron producing plate within the tube.

The latter portion of the talk was on the use of the thyraton tube in the development of the thyratron motor. This will be of great advantage to power transmission for it would then be possible to transform alternating current to direct current and vice-versa. This would do away with the third wire in present day transmission lines and more than likely would save many of the other transmission line losses.

At the conclusion, Mr. Chute was heartily applauded by all, his home-made demonstrators and practical appliances creating much humour and adding a good deal of spice to an already interesting lecture.

## Calgary Branch

*J. Dow, M.E.I.C., Secretary-Treasurer.*
*H. W. Tooker, A.M.E.I.C., Branch News Editor.*

Thursday evening, October 18th, 1934, was the opening night for the Calgary Branch of The Institute. On this occasion over sixty-five members, their wives and friends, were present to witness five reels of motion pictures entitled "From the Ground Up," procured from Ottawa through the Director of Publicity, by the efforts of the chairman, G. P. F. Boese, A.M.E.I.C., and vice-chairman, J. Hadden, M.E.I.C.

The pictures illustrated the manufacture of the motor car in Canada from the raw materials to the finished article, and showed the many different types of machines employed to produce the various moving parts, and also the moving assembly table.

This proved to be most interesting and gave a very clear conception of the enormous amount of machinery required to construct a car in the short space of time that they are manufactured in to-day.

Following the pictures, through the kindness of the ladies, refreshments were served and they thus did their share in making the opening night a success.

Thursday evening, November 1st, 1934, was the occasion of an address given to forty members of the Calgary Branch and their friends by W. H. Greene, M.E.I.C., whose subject was "Timber for Structural Use, its Design, Working Stresses and Preservative Treatment." It was also the first evening for a series of ten-minute addresses, being a competition open to the younger members, for which a small cash prize is offered.

Following the announcement of the rules governing the competition, which are as follows:

1. Open to Students, Juniors and Corporate Members.
2. Subject to be chosen by themselves.
3. Subject to be preferably of a technical nature, but may relate to a hobby or research work.
4. The address must be delivered extemporaneously and not read. Notes permitted.

The chairman, G. P. F. Boese, A.M.E.I.C., called upon the first competitor, D. C. Fleming, S.E.I.C., whose subject was "Photo-electric Cells and some of their Applications." He explained that a photo-electric cell is one which changes light pulsations into electrical pulsations of which there were three types. He then went on to give particulars of these types and their applications.

The second competitor, James Blair, S.E.I.C., chose as his subject "Pressure Vessels for Oil Cracking," and went on to explain that the use of the cracking process is growing at an ever-increasing rate. Increasing operating temperatures and pressures for gasoline making has brought about an increase in manufacturing difficulties to produce large vessels to withstand the conditions desired.

The process of manufacture was described, stress relieving and the use of the X-ray in testing welds being also discussed.

The chairman then called upon the speaker of the evening, Mr. Greene, to deliver his address:

TIMBER FOR STRUCTURAL USE, ITS DESIGN, WORKING STRESSES AND PRESERVATIVE TREATMENT

Wood preservatives can be defined as the art of protecting structural timber from destructive agents, the most common of which are decay, insects, marine borers, mechanical abrasion and fire.

In the prairie provinces the greatest enemy in timber structures is a low form of plant life known as fungi. The spores are blown about by the wind and lodge on the surface or in cracks of the timber and can remain dormant for long periods. By injecting or impregnating wood with poisonous chemicals these enemies are deprived of nutrition and decay is prevented. Many chemicals have been advocated but only a few possess the necessary qualifications.

To date there are only two chemicals that have proved themselves in accordance with specifications, namely creosote oil and zinc chloride. Creosote is the best preservative discovered to date, and is injected into the wood by pressure and heat.

Modern timber technology considers it good practice to take the fibre stress at the elastic limit and not more than 56 per cent of the modulus of rupture and the working stress at 60 per cent of the fibre stress at the elastic limit, or in other words the working stress is 39 per cent of the modulus of rupture.

Consider a structure of untreated timber; the recommended working stresses are based on "green conditions" and these will also be reduced to provide for considerable loss of strength due to decay. The initial strength of the wood would be greater than that used in arriving at the working stresses and this is necessary for immediately after being built into the structure, or even before it, the timber will absorb moisture from the air, rain or melting snow and return to the green unseasoned condition. This is not the case with creosoted timber, and for structures not continuously immersed in water, will keep the moisture content at, or below, the fibre saturation point.

Mr. Greene illustrated his lecture with many interesting slides and graphs and by motion pictures graphically depicted the various methods of treating timber in a modern creosoting plant.

At the close of the lecture the following took part in the discussion: W. S. Fetherstonhaugh, M.E.I.C., A. Griffin, M.E.I.C., J. Dow, M.E.I.C., J. Blair, S.E.I.C., G. P. F. Boese, A.M.E.I.C., F. N. Rhodes, A.M.E.I.C., and R. S. Stockton, M.E.I.C.

A hearty vote of thanks was given the speaker.

## Hamilton Branch

*A. Love, A.M.E.I.C., Secretary-Treasurer.*
*V. S. Thompson, A.M.E.I.C., Branch News Editor.*

On the evening of October 26th, 1934, the Hamilton Branch of The Institute held a joint meeting with the Babcock-Wilcox and Goldie-McCulloch Engineering Society of Galt. The meeting was held in the Science Building of McMaster University, Hamilton, and the accommodation was taxed to the limit, two hundred and fifty being present, including more than one hundred from Galt.

Mr. H. B. Stuart, A.M.E.I.C., chairman of the Hamilton Branch, welcomed the audience and expressed his pleasure at seeing such an enthusiastic gathering. Mr. P. L. Evans, President of the Babcock-Wilcox and Goldie-McCulloch Engineering Society, then took charge of the proceedings. He referred to the past joint meetings which had been most enjoyable and was delighted to see that this one had proved such a drawing card. Mr. McCulloch, president of the Babcock-Wilcox and Goldie-McCulloch Company of Galt, brought felicitations from the company and hoped that the meetings would continue. The Galt Society acted as hosts and provided an illustrated description of the work being done at the Boulder dam on the Colorado river.

R. M. Dilly read a descriptive article concerning this great construction project which was illustrated by numerous lantern slides.

The Boulder dam construction was authorized by Act of Congress in 1928, is part of the scheme for control of the Colorado river, to provide flood storage, store water for irrigation and domestic use, and provide a settling basin for mud and silt. The project also includes the construction of a power plant to generate nearly two million horse power. The total estimated cost of the project is 165 million dollars. The reservoir created by the dam will have an area of 227 square miles and will take nearly two years to fill. The dam is 730 feet high, 650 feet thick at the base and 45 feet at the top, 4,400,000 cubic yards of concrete are being used in its construction. The river is temporarily diverted through four tunnels, cofferdams being constructed above and below the dam site to allow work to proceed.

The construction of the diversion tunnels, 50 feet in diameter and about 4,000 feet long, was the first part of the undertaking. According to the original plans, the tunnels were to be used directly as power tunnels, but it was later thought that there might be risk of trouble from rock slips, so it was decided to build a steel pipe, 30 feet in diameter, within the tunnel—this pipe being capable of withstanding the full head of water or a pressure of 300 pounds per square inch. These pipes are fabricated in a plant which has been erected at the dam site. Three plates 2¾ inches thick and weighing 23 tons each are rolled to diameter and welded together to form a 12-foot section of the 30-foot pipe. The welds are examined by an X-ray machine and the pipes are stress relieved in a specially designed oil-fired furnace.

The lecture illustrated the extent and equipment of the shop, the method of transporting the heavy section of the pipe from the shop to the site, and also the tests that were carried out to determine pipe sag, stress and reinforcing.

At the conclusion of the lecture films were shown, descriptive of of the work at Boulder dam, and it was learned that the successful bidders—six companies incorporated—had to build a fair sized city in the desert, to house their huge army of workers and their families.

F. W. Paulin, M.E.I.C., moved a hearty vote of thanks to the Babcock-Wilcox and Goldie-McCulloch Engineering Society for their enterprise in securing these pictures and bringing them to Hamilton, and also to Mr. Dilly for his reading of the descriptive article. At the conclusion of the meeting refreshments were served.

## London Branch

*H. A. McKay, A.M.E.I.C., Secretary-Treasurer.*
*Jno. R. Rostron, A.M.E.I.C., Branch News Editor.*

The regular monthly meeting of the Branch was held on October 31st, 1934, in the City Hall auditorium, the speaker being Mr. William Duffield, president of the City Gas Company.

The chairman of the Branch, Frank C. Ball, A.M.E.I.C., presided. The speaker was introduced by D. M. Bright, A.M.E.I.C., a member of the Papers committee, and in the course of his remarks he mentioned the fact that the City Gas Company were applying to the city council for permission to bring natural gas to the city of London and that it was proposed to submit the proposition to the electors for approval or otherwise at the municipal election in December next.

The speaker first pointed out that the City Gas Company had been producing and distributing artificial gas to the city of London since 1864 and that in 1914 a proposition to introduce natural gas from the Tilbury field was defeated by the electorate owing to the disagreeable and sulphur-laden gas then produced in that area. Since that time the Tilbury gas had been greatly purified by filtration and the sulphur content rendered almost negligible.

However the present proposition was to draw gas from the "Dawn Field" about 55 miles south west of London. This is a new field and the gas from it is absolutely odourless and gives about twice the heat value of artificial gas.

Mr. Duffield went on to show that the new gas would be supplied at a much cheaper rate than the present manufactured gas, effecting a saving of from 37 to 48 per cent (according to quantity used) and owing to greater heat content (1,050 B.t.u. compared to 520 B.t.u. per cubic foot of the present artificial gas) only about half the quantity would be required to obtain the same heat value.

Re-arrangement of the pipe lines in the city would be undertaken so as to ensure an even pressure to all consumers. This together with the pipe line from Dawn would involve an outlay of $1,000,000 which would provide employment for a large number of local men. All gas appliances would be adjusted free of cost to the consumer and all present employees of the Gas Company would be retained.

From careful investigations made by expert engineers and geologists over a long period the supply was found to be practically inexhaustible.

Mr. Duffield also gave a history of natural gas supplies and touched on the necessary legislation. Size of pipe lines and pressures were given. A map was also exhibited showing the proposed high pressure and feeder lines in the city.

Many questions were asked and satisfactorily answered by the speaker.

A vote of thanks was proposed by Colonel I. Leonard, M.E.I.C., and seconded by E. V. Buchanan, M.E.I.C., and unanimously carried.

## Montreal Branch

*C. K. McLeod, A.M.E.I.C., Secretary-Treasurer.*

CITY NOISES AND THEIR CONTROL

On October 25th, 1934, Professor H. E. Reilly of McGill University delivered an address on the above subject. He observed that noise regulation was an essential part of "air conditioning" which term should include "the provision of an adequate acoustic atmosphere." In this Professor Reilly also included smoke elimination. The speaker advanced several constructive suggestions as to the means of eliminating excessive noise which was a danger to health. H. J. Vennes, A.M.E.I.C., acted as chairman.

MODERN SEWAGE TREATMENT PRACTICE

On November 1st, Mr. E. B. Besselievre, sanitary engineer with the Dorr Company Inc., of New York, presented a paper dealing with the most modern methods of sewage treatment as distinct from sewage disposal. The speaker stressed the advantages of proper treatment and the revenue which might be obtained from the high calorific gas emanating from the decomposition of sewage which was suitable for power production and could also be sold to local gas companies or exchanged for electric power. Professor R. de L. French, M.E.I.C., presided.

JUNIOR SECTION MEETING

A meeting of the Junior Section was held at the Engineering Building, McGill University, on October 29th, at which two interesting papers were given, one on "Recent Trends in Small Heating Plants" by A. G. L. Atwood, A.M.E.I.C., engineer with the Iron Fireman Manufacturing Company, Montreal, and the other on "Disc Tumbler Locks and Key Fitting Devices" by Mr. A. Zion, a student in fourth year mechanical engineering at McGill University.

PLANT VISIT

On the evening of November 5th, through the courtesy of the Bell Telephone Company of Canada, one hundred members of the Junior Section paid a visit to the Toll Building of the company on Belmont street. Guides were provided and the visitors were given an opportunity to examine the power equipment and witness the arrangements for long distance operating, radio hook-ups, trans-Atlantic telephony, teletype and telegraph operations, etc.

STUDENT NIGHT

The semi-annual students night of the Branch was held on November 8th and two papers were presented: "Un nouveau gazogène pour l'industrie Canadienne" by Paul Vincent, S.E.I.C., who is a graduate of 1934 of the Ecole Polytechnique, and who is now undertaking post graduate studies at that university, and "A Small Power Plant for a Game Lodge" by Mr. E. S. Cooper, a fourth year student in electrical engineering at McGill University.

The President of The Institute, F. P. Shearwood, M.E.I.C., took this occasion to present the E.I.C. Student's Prize which was awarded to Yvon R. Tasse, S.E.I.C., by the Ecole Polytechnique.

ECONOMICS OF THE DURABLE GOODS INDUSTRY

On November 15th Dr. D. M. Marvin, economist of the Royal Bank of Canada, gave an exceptionally interesting talk in which he developed the argument that durable goods industries—notably construction—were greatly affected by the recent depression. He discussed unemployment in various groups of industries, the N.R.A., and contrasted the methods used by the United States and Great Britain to restore prosperity. The speaker prophesied that with the return of active business there will be a building boom in Canada on a much larger scale than most people realize. The future was bright and a real recovery had been achieved.

Professor R. E. Jamieson, M.E.I.C., acted as chairman.

## Niagara Peninsula

*P. A. Dewey, A.M.E.I.C., Secretary-Treasurer.*
*C. G. Moon, A.M.E.I.C., Branch News Editor.*

Through the kindness of Mr. Ellis Jones, manager of the Yale and Towne Manufacturing Company, the Branch was invited to visit the factory at St. Catharines on October 24th, 1934.

Meeting at 3 p.m., the members were guided through the extensive plant and explained the complicated process by which the materials pass from the raw state to the finished product.

Steel, iron, tin, copper and nickel are the principal metals used in the delicate castings and forgings which go into the modern locks, door closers and chain hoists. Lacquering, bronzing and the Bower-Barff process are also used as protective coverings.

At six o'clock the party adjourned to the Lincoln hotel for dinner and, afterwards, Mr. Jones gave a brief history of lockmaking with some examples of the modern lock to illustrate the strides which have been made in the last eighty years.

Locks are by no means a modern method of fastening, said Mr. Jones. A wooden lock with a key six feet long has been found in the ruins of Nineveh and the pin-tumbler principle was known to the early Egyptians in a crude form. Some of the hand-wrought iron locks of the middle ages are fine pieces of workmanship.

Locks may be classified roughly under three types: (1) the warded lock, 4 to 12 key changes, wherein the key is shaped to fit over fixed wards either at the ends or sides; (2) the lever-tumbler lock, 12 to 144 changes, where the obstacle is one or more pivoted flat tumblers which the key has to move into certain positions before it can be turned; (3) the cylinder pin-tumbler lock which is undoubtedly the safest and is capable of unlimited combinations. The series used in commercial practice consists of 30,000 changes and the probability of duplicates is therefore in that order.

Master key systems have many variations and Mr. Jones described one for a modern hotel installation, as follows:

1. Guest key—Good for only one room in the hotel.
2. Floormaid's key—Good for one floor only, except when locked from inside or when locked by keys No. 5 or No. 6.
3. Housekeeper's or Manager's key—Good for any lock in the hotel with the same exceptions as No. 2.
4. Emergency key—Good for any lock, with no exceptions.
5. Shut-out key—Used only to prevent keys No. 1, No. 2 or No. 3 from operating the lock.
6. Display key—An individual "shut-out" key for salesmen who wish to leave valuable property in certain rooms and will prevent keys No. 1, No. 2 and No. 3 from operating.

The safe deposit box is now protected by a recently developed lock which has 4,000 combinations and therefore each new customer may select an entirely new key to which, by an ingenious arrangement, the combination is adjusted to fit.

At the close of the meeting Mr. Jones presented to each member a souvenir in the form of a small "personal lock" which can be attached to the inside of any door for extra security. E. P. Johnson, A.M.E.I.C., and A. W. F. McQueen, A.M.E.I.C., proposed a vote of thanks to the speaker. Paul Buss, A.M.E.I.C., acted as chairman.

## Ottawa Branch

*F. C. C. Lynch, A.M.E.I.C., Secretary-Treasurer.*

STREAMLINING

At the second noon luncheon of the Ottawa Branch, held at the Chateau Laurier on October 18th, 1934, Dr. J. J. Green, of the National Research Laboratories, spoke upon the subject of "Streamlining." Head table guests, in addition to the speaker and the chairman, included: V. I. Smart, Deputy Minister of the Department of Railways and Canals; Major J. G. Parmelee, Deputy Minister of the Department of Trade and Commerce; J. Patterson, Director of the Meteorological Services of Canada; Dr. S. J. McLean, Acting Chief Commissioner of the Board of Railway Commissioners; G. J. Desbarats, M.E.I.C.; Squadron Leader A. T. Cowley, A.M.E.I.C.; A. E. MacRae, A.M.E.I.C.; Squadron Leader A. Ferrier, A.M.E.I.C., and C. McL. Pitts, A.M.E.I.C.

Dr. Green for the past four years has been engaged in aeronautical research and testing and gave a brief outline of the phenomena accompanying the passage of a body through a fluid, with particular reference to the types of resistance encountered and to the possibilities of minimizing it by attention to exterior design.

When a body is moving through a fluid, he stated, two types of resistance are encountered. One, due to the inertia of the fluid is called the "form drag." The other, due to its viscosity is known as the "skin friction."

Two distinct types of flow have been observed. At very low speed, the flow follows closely the contour of the body, the form drag is negligible, and the resistance is almost entirely made up of skin friction. As the velocity is increased, this ideal type of flow gives way to the second type. The flow now breaks away from the body at some point on the surface aft of the nose and a "wake or vorticity" is generated toward the rear of the body. This vortex wake is associated with a large form drag and, by comparison, a small skin friction. The breakaway of the flow in this type is explained by a failure of the viscous forces to restrain the fluid particles, and by the adverse pressure gradient around the body which opposes the motion of the fluid in the thin layer close to the surface of the body. This latter is known as the "boundary layer."

The principle involved in streamlining consists in so shaping the body on the downstream side that the sharpness of the angle through which the flow must turn in order to adhere to the surface is reduced.

The speaker then referred to the two types of flow possible in the boundary layer. These are, respectively, a "laminar" flow or one following closely and evenly along the exterior surface of the body, and a "turbulent" flow or one in agitation or commotion as it follows along the body surface.

The address was illustrated by lantern slides showing attempts at reducing air resistance in the design of airships, aeroplanes, automobiles, steam railway and electric trains, and even motorcycles. Much further investigation remains to be done in the way of streamlining for most efficient results, stated the speaker.

STEEL-MAKING, AEROPLANE AND MARINE CONSTRUCTION IN ENGLAND

A series of six films relating the steel-making, aviation, and steamship construction in England were shown at an evening meeting on October 25th, 1934, at the R.C.A.F. rooms of the Jackson Building. It was one of the most largely attended evening meetings in the history of the Branch, the projection room of the Photographic Section of the R.C.A.F. being taxed to its capacity. The chairman, A. K. Hay, A.M.E.I.C., presided. The films were supplied by the Vickers-Armstrong Company.

The first film depicted steel-making operations at the works of the English Steel Corporation, Sheffield, including electric furnace charging, pouring, stripping and forging. The full extent of these operations however could hardly be adequately shown by the limited medium of the film.

The next three films showed the naval construction works of the company at Barrow-in-Furness and followed the construction at that place of the P. and O. steamers *Strathaird* and *Strathnaver*.

The two remaining films presented respectively the launching and trial flights of the Vickers Supermarine *Seagull V.* with tests of a launching catapult; and the trials of the *Scapa* twin engine flying boat, erection and tests of *Vildebeest*, torpedo carrier, with torpedo dropping trials, and other types of aircraft.

At the conclusion of the showing, which took about an hour, a vote of thanks was passed to the Vickers-Armstrong Company for the use of the films, and to Group Captain G. M. Croil, A.M.E.I.C., the Senior Air Officer of the Photographic Section of the R.C.A.F., for the use of the projection room.

## Peterborough Branch

*H. R. Sills, Jr.E.I.C., Secretary.*
*E. J. Davies, Jr.E.I.C., Branch News Editor.*

Impressions of Soviet Russia

The first fall meeting of this Branch was held on October 11th, 1934, at which Mr. T. Fechney, of the Pratt and Whitney Company of Canada Limited, gave a most interesting address on his recent visit to Russia.

Mr. Fechney was one of a party of twenty-one engineers who went to Russia in 1930, under a three-year contract with the Soviet government to install steel mills. He gave many interesting anecdotes of their travelling, bringing out the wholly inadequate transportation system; the utter disregard of schedule or time tables; the importance of freight over passenger trains, as a result of which the latter were frequently side tracked for the former; and the difficulty of getting meals or hotel accommodation en route.

The Russians seemed to have had a penchant for doing things on a lavish scale and then overlooked or skimped on small but important items. They provided a splendid modern staff house for the visiting engineers, equipped with modern appliances and hot and cold plumbing, but overlooked a water heater. One hundred heavy duty machine tools, such as planers, boring mills, etc., which cost from $15,000 to $100,000 each, were bought for one plant and then the government would not provide proper cutting tools.

The Russians seemed determined to carry out the production as called for by the Five Year Plan, whether the product was satisfactorily produced or not, as frequently happened through stubbornness on the part of the officials, who did not always agree with the foreign engineers. Another reason for loss or damage was their desire to train their own young engineers and allow them to try their ideas. If these ideas proved wrong, it was considered part of the plan. The officials and particularly the foremen did not always have their own way with the men: for, since they were elected by the men, if their orders or methods did not please, the foremen were promptly removed by election.

Mr. Fechney explained that although most plants ran continuously in eight-hour shifts, each man worked four days and rested the fifth. There was no such thing as Sunday, Christmas, etc. The original idea of the same wage for all has been abandoned for a sliding scale, but the worker, i.e. factory producer, still was better off than the professional man who was not a producer.

He felt that some progress has been made, but a little more open-mindedness and co-operation would greatly assist the progress. Although many churches have been converted to clubs, museums and theatres, there were still some churches being used as such, and if fifty percent of the people in any community applied for a church, it would be established. The tendency in this direction seems to be becoming stronger.

The lengthy and animated discussion which followed the address indicated the interest with which the large audience had followed the address. The thanks of the branch was tendered, through the chairman, J. W. Pierce, M.E.I.C., by W. T. Fanjoy, Jr.E.I.C.

## Quebec Branch

*Jules Joyal, A.M.E.I.C., Secretary-Treasurer.*

Le 20 octobre dernier, les membres de la Section de Québec visitaient pour la seconde fois les travaux du Pont de l'Ile d'Orléans; tous ont pu constater les changements opérés durant les deux mois écoulés depuis la première visite et ceux qui ont pris part à cette réunion ont été vivement intéressés. Cette fois encore, M. Théo. M. Déchène, A.M.E.I.C., Ingénieur au Ministère des Travaux Publics de Québec, fut l'organisateur de cette excursion et sur les lieux les visiteurs furent cordialement accueillis par MM. J. W. Roland, M.E.I.C., et W. H. Smick, qui se prêtèrent volontiers à donner toutes les explications demandées.

Deux jours plus tard nos membres se réunissaient de nouveau au Palais Montcalm pour voir se dérouler des films très instructifs mis à la disposition des diverses sections de l'Institut par la compagnie Vickers-Armstrong Ltd.

## Saskatchewan Branch

*S. Young, A.M.E.I.C., Secretary-Treasurer.*

City Manager Form of Local Government

The regular monthly meeting of the Saskatchewan Branch, The Engineering Institute of Canada was held in the Parliament Buildings, Regina, at 7.45 p.m. October 19th, 1934, the attendance being twenty. H. C. Ritchie, A.M.E.I.C., occupied the chair.

S. R. Muirhead, A.M.E.I.C., reported for the Papers committee, stating that the next meeting of the Branch would be held in Regina on Friday evening, November 16th, 1934. The speaker of the evening would be Mr. Fawkes, his subject being "The City Manager Form of Local Government." Mr. Fawkes is a member of the Association of Professional Engineers, British Columbia, and formerly held the position of City Commissioner, Moose Jaw.

Mr. Muirhead also gave a brief resumé of the contents of the October number of The Journal, urging the members to read The Journal.

Moving pictures of the construction of that portion of the Big Bend highway in the National Park, British Columbia, were then shown, the films having been loaned by J. M. Wardle, M.E.I.C., chief engineer, National Parks of Canada, Banff, Alberta. The films indicated the various stages in the construction of the highway from its location and survey of right-of-way to the finally constructed highway.

The meeting concluded with a brief outline of Institute affairs, especially in the matter of Institute development, by P. C. Perry, A.M.E.I.C., and general discussion by those present. Mr. Perry, after pointing out the difficulties in the way of Dominion-wide amalgamation of The Institute with the several associations of professional engineers, suggested the desirability of local co-ordination of the activities of this Branch of The Institute with the Saskatchewan Association of Professional Engineers. The general conclusion was that in order to have an organization of engineers similar to the Royal Architectural Institute of Canada it would be necessary to build from the Provincial Associations.

The first of a series of meetings being sponsored by the Saskatoon Section, Saskatchewan Branch, Engineering Institute of Canada, was held in the Engineering Building, University of Saskatchewan, Saskatoon, on October 22nd, 1934.

Dr. J. B. Mawdsley, head of the University of Saskatchewan geology department, delivered a very able address upon "The Modern Prospector," in which he gave those present an insight into the work of these forerunners of mining operations as only one of his vast experience in this field is capable.

The address of the evening was preceded by the showing of "The Big Bend Highway" films, loaned by J. M. Wardle, M.E.I.C., chief engineer, National Parks Branch, Banff, Alberta, and shown through the kindness of Mr. Kerr, advertising manager of the International Harvester Company, Saskatoon.

Both features of the programme were highly enjoyed by over one hundred members of The Institute, the Graduate Engineers Club, practising engineers of the city and engineering and geology students of the university.

Chairman R. A. Spencer, A.M.E.I.C., presided.

## Winnipeg Branch

*E. W. M. James, A.M.E.I.C., Secretary-Treasurer.*
*E. V. Caton, M.E.I.C., Branch News Editor.*

The winter session of the Manitoba Branch of The Engineering Institute of Canada was opened on October 4th, 1934, with A. J. Taunton, A.M.E.I.C., in the chair. After the general business was completed the chairman gave a brief resume of the activities of the Branch during the summer and of the visit of the General Secretary and later on the President.

In discussing the summer activities the chairman mentioned that during the visit of the General Secretary the opportunity was taken to discuss many of the business affairs and the relation of the Branches to The Institute, and considerable benefit was derived by both parties due to the candid expression of opinion and the realization of the problems of Headquarters. At the meeting of the Branch called during Mr. Durley's visit, he gave an address on the responsibility of the engineer to his National Technical Association, which was greatly appreciated by the members.

During the time the Branch was honoured by the visit of the President, in addition to addressing the Branch on Institute affairs he also gave a most interesting paper on "Bridge Construction." Special meetings were arranged at which the Executive and other members of the Branch were able to discuss the many problems of the Branches and Headquarters. The President and Mrs. Shearwood were entertained at a dinner at the Lower Fort Garry Country Club. The general opinion of the Branch was expressed that visits of this sort should be more frequent, as they tend to much closer co-operation between the Branches and Headquarters.

Science in Naval Warfare

The speaker for the evening of October 4th was Professor J. F. T. Young, Professor of Physics, University of Manitoba, who gave an address on "Science in Naval Warfare."

The speaker indulged in some reminiscences of developments in the theory and practice of naval warfare which came to his notice during service in the Great War. Attention was given chiefly to the submarine campaign of the Germans which by its intensity and ruthlessness proved to be an almost decisive factor in 1917. The general method of protection of merchant ships by dazzle-painting and by the convoy system, a revival of Napoleonic times, proved efficient so far as they went but were purely defensive measures. More aggressive action followed from the development of new scientific devices based upon hitherto unused properties of ships. In addition to the improvements in contract mines, special mines based on the acoustic and magnetic properties of ships were proposed and those of the latter type proved very successful indeed. Incidental to these investigations with new mining methods, extensive researches on pressure waves in underwater explosions were carried out to determine the kind and amount of explosive most suitable for the destruction of ships, submarines in particular. Very interesting and important data resulted which added to the effectiveness of the later phases of the naval campaign. Blockade methods, such as used at Zeebrugge and as proposed for the English Channel with the famous "Mystery Towers," were discussed.

The lecture closed with a brief mention of the application of these new inventions to naval tactics and as aids to peace time navigation, in position plotting and depth sounding. Many lantern slides throughout the lecture illustrated the various phases treated.

# Preliminary Notice

## of Applications for Admission and for Transfer

November 26th, 1934

The By-laws provide that the Council of The Institute shall approve, classify and elect candidates to membership and transfer from one grade of membership to a higher.

It is also provided that there shall be issued to all corporate members a list of the new applicants for admission and for transfer, containing a concise statement of the record of each applicant and the names of his references.

In order that the Council may determine justly the eligibility of each candidate, every member is asked to read carefully the list submitted herewith and to report promptly to the Secretary any facts which may affect the classification and selection of any of the candidates. In cases where the professional career of an applicant is known to any member, such member is specially invited to make a definite recommendation as to the proper classification of the candidate.*

If to your knowledge facts exist which are derogatory to the personal reputation of any applicant, they should be promptly communicated.

**Communications relating to applicants are considered by the Council as strictly confidential.**

The Council will consider the applications herein described in January, 1935.

R. J. Durley, Secretary.

* The professional requirements are as follows:—

**A Member** shall be at least thirty-five years of age, and shall have been engaged in some branch of engineering for at least twelve years, which period may include apprenticeship or pupilage in a qualified engineer's office, or a term of instruction in a school of engineering recognized by the Council. The term of twelve years may, at the discretion of the Council, be reduced to ten years in the case of a candidate for election who has graduated from a school of engineering recognized by the Council. In every case the candidate shall have held a position in which he had responsible charge for at least five years as an engineer qualified to design, direct or report on engineering projects. The occupancy of a chair as a professor in a faculty of applied science of engineering, after the candidate has attained the age of thirty years, shall be considered as responsible charge.

**An Associate Member** shall be at least twenty-seven years of age, and shall have been engaged in some branch of engineering for at least six years, which period may include apprenticeship or pupilage in a qualified engineer's office or a term of instruction in a school of engineering recognized by the Council. In every case a candidate for election shall have held a position of professional responsibility, in charge of work as principal or assistant, for at least two years. The occupancy of a chair as an assistant professor or associate professor in a faculty of applied science of engineering, after the candidate has attained the age of twenty-seven years, shall be considered as professional responsibility.

Every candidate who has not graduated from a school of engineering recognized by the Council shall be required to pass an examination before a board of examiners appointed by the Council. The candidate shall be examined on the theory and practice of engineering, with special reference to the branch of engineering in which he has been engaged, as set forth in Schedule C of the Rules and Regulations relating to Examinations for Admission. He must also pass the examinations specified in Sections 9 and 10, if not already passed, or else present evidence satisfactory to the examiners that he has attained an equivalent standard. Any or all of these examinations may be waived at the discretion of the Council if the candidate has held a position of professional responsibility for five or more years.

**A Junior** shall be at least twenty-one years of age, and shall have been engaged in some branch of engineering for at least four years. This period may be reduced to one year at the discretion of the Council if the candidate for election has graduated from a school of engineering recognized by the Council. He shall not remain in the class of Junior after he has attained the age of thirty-three years, unless in the opinion of Council special circumstances warrant the extension of this age limit.

Every candidate who has not graduated from a school of engineering recognized by the Council, or has not passed the examinations of the third year in such a course, shall be required to pass an examination in engineering science as set forth in Schedule B of the Rules and Regulations relating to Examinations for Admission. He must also pass the examinations specified in Section 10, if not already passed, or else present evidence satisfactory to the examiners that he has attained an equivalent standard.

**A Student** shall be at least seventeen years of age, and shall present a certificate of having passed an examination equivalent to the final examination of a high school, or the matriculation of an arts or science course in a school of engineering recognized by the Council.

He shall either be pursuing a course of instruction in a school of engineering recognized by the Council, in which case he shall not remain in the class of Student for more than two years after graduation; or he shall be receiving a practical training in the profession, in which case he shall pass an examination in such of the subjects set forth in Schedule A of the Rules and Regulations relating to Examinations for Admission as were not included in the high school or matriculation examination which he has already passed; he shall not remain in the class of Student after he has attained the age of twenty-seven years, unless in the opinion of Council special circumstances warrant the extension of this age limit.

**An Affiliate** shall be one who is not an engineer by profession but whose pursuits, scientific attainments or practical experience qualify him to co-operate with engineers in the advancement of professional knowledge.

The fact that candidates give the names of certain members as reference does not necessarily mean that their applications are endorsed by such members.

### FOR ADMISSION

AVERY—ERIC, of 733 Alexander Crescent, Calgary, Alta., Born at London, England, Sept. 16th, 1902; Educ., Public Schools and St. Johns Technical School, Winnipeg, 1908-19; Private tuition over five years; 1919 to date, with the Dominion Bridge Company as follows: 1919-24, dftsman., 1924-25, field erection, 1925-29, designing and estimating, Winnipeg, and from 1929 to date, chief engr. at Calgary. Work includes designing, estimating, sales, shop production, drawing office production, supervn. of field erection.

References: F. P. Shearwood, H. M. White, A. Campbell, J. R. Wood, T. Lees, J. C. Trueman, R. Barnecut, R. C. Harris.

BAILEY—CHARLES DAVID, of 544 Notre Dame St., Lachine, Que., Born at Glasgow, Scotland, July 2nd, 1903; 1917-22, cert. for five year course in engrg., Clydebank Technical School (in affiliation with Royal Technical College, Glasgow); 1918-23, articled ap'ticeship with Beardmore Company, Engrs. and Shipbldrs., Dalmuir, Scotland; 1923-25, junior engr. with same firm, design of ship forms, powering of ships, and design of screw propellors. Experimental work on resistance of ship forms, on seaplane floats and on flying boat hulls. General estimator and stress engr.; 1925-29, with H.M. Air Ministry, Design and Research Dept., Cardington, England. Design of form of rigid airships. Analysis of model results. Assessment of loading systems from static and aerodynamic distributions. Strength of aircraft structures. Reduction and analysis of full scale experiments on aerodynamic pressure distribution on aircraft and on struct'l. strength of airship hulls. Stress checking of design and detail mech'l. drawings. Test trials on engines and experiments on water recovery from exhaust gases of internal combustion engines; 1929 to date, engr. and estimator with Dominion Bridge Company, Ltd., Montreal. Design of cranes and electric hoists, hydraulic regulating gates and hydro-electric auxiliary machinery. Design and experimental work on gearing and rollers. Stress analysis on braced structures.

References: F. P. Shearwood, F. Newell, R. H. Findlay, P. L. Pratley, R. S. Eadie, M. J. Berlyn, C. R. Whittemore.

BEATON—NEVILLE, of Powell River, B.C., Born at London, England, May 22nd, 1894; Educ., Guildford Technical School, England, 1909-14. Private study; Member, Assn. Prof. Engrs. B.C.; 1909-14, student ap'tice, Royal Aircraft Factory, Farnborough, England. Complete course in all depts. of shops, labs. and drawing office; 1915-18, mgr. of airship and kite balloon factory, of J. Mandleberg & Co. Ltd., Manchester, England; Charge of entire plant and all incidental depts., including dfting., planning, purchasing, and clerical; 1919, in business for self; 1920-24, asst. equipment engr., Dept. of Highways, Ontario; 1924, chief inspr., Brooks Steam Motors, Stratford, Ont.; 1925, plant engr., Gregory Tire Co., Coquitlam, B.C., charge of design, production and plant operation; 1925 to date, with Powell River Co. Ltd., Powell River, B.C., as dftsman., checker, chief dftsman., plant engr., and at present res. engr. In charge of all operations, plant equipment, hydraulic development and records; plant extensions, engrg. contracts, designs and records; field engrg. dept., etc.; reports and recommendations on development work.

References: W. Jamieson, E. Davis, E. A. Wheatley, A. C. R. Yuill, J. Robertson, W. G. Swan.

BECKER—DONALD FAY, of Calgary, Alta., Born at Vancouver, B.C., June 24th, 1912; Educ., B.A., 1931, B.Sc., 1933, Univ. of Alta.; 1933 to date, operation of plant for chemical treatment of gasoline, Calgary. Operation and design of plant for chemical treatment of gasoline, Southern Turner Valley; 1932 to date, supervision and mtce. of supplies at service and bulk stations of Richfield Distributors Ltd., being secretary-treasurer of this company. (Co-responsibility with H. W. Becker.)

References: R. S. L. Wilson, H. J. MacLeod, H. R. Webb, S. G. Coultis, J. Dow.

BECKER—HOWARD WARREN, of Calgary, Alta., Born at Springfield, Miss., U.S.A., March 10th, 1911; Educ., B.A., 1931, B.Sc., 1933, Univ. of Alta.; 1932 to date, supervision of and mtce. of supplies at service and bulk stations of Richfield Distributors Ltd., being vice-president of this company. 1933, operation of plant for chemical treatment of gasoline at Calgary. 1934, Operation and design of plant for chemical treatment of gasoline, Southern Turner Valley. (Co-responsibility with D. F. Becker.)

References: R. S. L. Wilson, H. J. MacLeod, H. R. Webb, S. G. Coultis, J. Dow.

BELANGER—RENE, of 53 Price St., Chicoutimi, Que., Born at Asbestos, Que., Sept. 11th, 1896; Educ., B.A.Sc., C.E., Laval Univ., Montreal, 1918; 1911-13 (two years) and 4 summers 1913-18, with Laurentide Paper Co., compiling technical data and operating reports; 1918, asst. engr., Town of Grand Mere, Que.; 1919-26, with Laurentide Paper Co., in constrn., materials and planning depts., also in several operating depts. of the plant; 1927 to date, engr. in charge and supt. of the plants of the Quebec Pulp and Paper Corpn., Société d'Eclairage et d'Energie Electrique du Saguenay and Chicoutimi Mills Ltd.

References: G. E. LaMothe, E. B. Wardle, O. O. Lefebvre, B. Pelletier, H. O. Keay, H. R. Wake, E. Lavoie.

JOHNSTON—ALEXANDER CHARLES, of Arvida, Que., Born at Dundee, Scotland, Feb. 7th, 1886; Educ., Public and Private Schools, Toronto. Private study and corres. course; 1904-09, asst. electr'n. and mechanic, Smart-Woods Ltd., Montreal; 1909-10, master mechanic and electr'n. with E. A. Wallberg, contractor, Matabitchewan power house; With Canadian Westinghouse Company as follows: 1910-11, constrn. electr'n., 1911-12, erecting engr., 1913-18, district engr., Toronto, 1918-19, sales engr., Toronto; 1919-22, technical asst., and 1922-27, asst. supt., Northern Aluminum Co.; 1927 to date, elect'l. supt., Aluminum Company of Canada, Arvida, Que.

References: N. D. Paine, A. W. Whitaker, Jr., J. Palmer, J. W. Ward, H. U. Hart.

PERRY—AUBREY HUFFMAN, of St. Catharines, Ont., Born at Port Hope, Ont., Oct. 7th, 1906; Educ., B.A.Sc., Univ. of Toronto, 1930; June 1930 to date, asst. sanitary engr., Public Health Engrg. Divn., Great Lakes District, Dept. of Pensions and National Health, St. Catharines, Ont. Supervision of drinking water supplies on all classes of common carriers engaged in interprovincial and international traffic; problems connected with the pollution of boundary waters; design of small structures connected with water supply; sewage disposal, garbage incineration, etc.; preparation of reports on various sanitary problems.

References: G. H. Ferguson, A. E. Berry, C. R. Young, W. S. Wilson, F. M. Brickenden.

RIGGS—HENRY EARLE, of 527 East Liberty St., Ann Arbor, Mich., U.S.A.; Born at Lawrence, Kansas, May 8th, 1865; Educ., B.A., Kansas Univ., 1886; Degree of Civil Engr. granted by Univ. of Mich., 1910; Member, A.S.C.E. (Director 1932 to date); 1890-96, chief engr., Toledo, Ann Arbor and North Mich. Rly.; 1896-1912, member of firm, The Riggs and Sherman Co., Toledo, Ohio, designed and built electric rlys., industrial lines for steam rlys., docks and wharves, waterworks, etc.; 1912-30, professor of civil engrg., and head of Dept. of Civil Engrg., Univ. of Michigan. Retired in 1930 with title of Honorary Professor of Civil Engrg.; From 1908 to date, engaged principally in valuation work, also as arbitrator and consltg. engr.

References: C. H. Mitchell, J. A. Heaman, F. C. McMath, J. M. R. Fairbairn, F. H. Kester, H. P. Eddy, J. L. Harrington.

SMITH—GEORGE HILLIER, of 3472 Van Horne Ave., Montreal, Que., Born at Hull, England, July 7th, 1887; Educ., 1901-07, Hull Technical School. 21 years private study, materials handling machinery (all branches). Assoc. Member, Amer. Soc. Mech. Engrs.; 1901-07, dftsman., Earles Shiphuilding Co., Hull, England; 1907-11, asst. to chief engr., Rohilkhand & Oudh Ry., Lucknow, U.P., India; 1915-25, conveyor divn., Dunlop Tire and Rubber Co.; 1911-15, sales engr., Federal Engrg. Co., Toronto; 1925-28, conveyor and transmission engr. (sales), Dodge Mfg. Co., Toronto; 1928-29, manager, Montreal Office, Stephens-Adamson Mfg. Co.; 1929 to date, engr. for design and layout, Materials-Handling Divn., Plessisville Foundry Ltd., Montreal, Que.

References: M. V. Sauer, R. W. Angus, A. P. Theuerkauf, M. Eaton, E. B. Wardle, H. L. Johnston.

STOBBART—WILLIAM MORLEY, of 4835 Patricia Ave., Montreal, Que., Born in Cumberland, England, June 22nd, 1896; Educ., High School, Carlisle, England, 1905-12; 3 years engrg. course, Carlisle Technical School; Advanced engrg. course, Northampton Polytechnic, London, England; 1912-20 (interrupted by war service), ap'ticed as mech'l. engr., passing through shops and drawing office, Cowans Sheldon & Co. Ltd., Carlyle, England; 1920-22, mech'l. designer, steel works, cranes, chargers and gen. steel works equipment, Wellman, Smith Owen Engrg. Corpn., London, England; 1922-24, asst. engr., design and production of cranes, hoists and materials handling equipment, Sociedad Espanola de Construc., Bilbao, Spain; 1924-26, designing engr., cranes, hoists and coal and ore bridges, Stohort & Pitt Ltd., Bath, England; 1926-29, designing engr., cranes, hoists, hydraulic regulating gates and equipment. Launching machines for seaplanes designed in collaboration with Admiralty. Ransome & Rapier Ltd., Ipswich, England; 1929-31, mech'l. designer, cranes, hoists, hydraulic regulating gates and equipment, and at present asst. engr., Dominion Bridge Company, Ltd., Montreal, Que.

References: F. P. Shearwood, F. Newell, M. V. Sauer, A. H. Cowie, R. H. Findlay.

FOR TRANSFER FROM THE CLASS OF ASSOCIATE MEMBER TO THAT OF MEMBER

ADDIE—GEORGE KYLE, of 148 St. Cyrille St., Quebec, Que., Born at Sherbrooke, Que., June 16th, 1868; Educ., B.Sc., McGill Univ., 1889; Q.L.S., 1889; 1886-89, articled ap'tice. to A. W. Elkins, C.E., Q.L.S.; 1889 to date, private practice as consltg. engr., employed by many railway, mining and lumber companies, municipalities and private individuals. Engaged as expert on many lawsuits. From 1906-12, Divisional Intell. Officer, M.D. No. 5, retiring in 1912 with rank of Lt.-Col., and long service decoration. (*St. 1887, A.M. 1898.*)

References: H. Cimon, A. Lariviere, A. B. Normandin, J. T. F. King, J. G. O'Donnell, R. B. McDunnough, P. Methe, L. Beaudry.

FOR TRANSFER FROM THE CLASS OF JUNIOR

KILLAM—DONALD ALEXANDER, of Montreal, Que., Born at Weymouth, N.S., June 16th, 1901; Educ., B.Sc., McGill Univ., 1927; 1925 (summer), instr'man., hydrographic survey; 1926 (summer), instr'man. and checker on constrn., Ste. Anne paper mill; 1927-28, dftsman., paper mill design; 1928-29, Canada Power & Paper Co., designing for Windsor Mills and Anticosti paper mill and wood handling equipment; 1929-30, International Power & Paper Co., chief dtfsman. in charge of design for mill extensions; 1930 to date, designing engr. for various plants, bldgs. or equipment. Involving investigation of processes, complete plant layout and details of same. Also requisitioning materials and equipment, and, on occasions, supervising erection and installn. of same. (*St. 1925, Jr. 1928.*)

References: C. C. Langstroth, G. R. Stephen, I. R. Tait, J. B. D'Aeth, A. B. McEwen.

FOR TRANSFER FROM THE CLASS OF STUDENT

ADDISON—JOHN HILLCOCK, of Noranda, Que., Born at Toronto, Ont., Feb. 25th, 1912; Educ., B.A.Sc. (Civil), Univ. of Toronto, 1933; 1928-29 (summers) on constrn. for Dominion Bridge Company; 1930 (summer), paving on Ferguson highway, Bituminous Spraying Co.; Sept. 1933 to date, civil engr. in charge of surveying with Minefinders Ltd., Toronto, Ont. (*St. 1932.*)

References: D. C. Tennant, C. R. Young, T. R. Loudon, C. H. Mitchell, W. J. Smither.

MILLER—CHARLES, of Arvida, Que., Born at Watford, Ont., July 16th, 1907; Educ., B.Sc. (Civil), Queen's Univ., 1930; 1928 (summer), dftsman., Aerial Survey Dept., and 1929 (summer), instr'man. on survey party in Manitoba, for Topog'l. Surveys, Ottawa; 1930 to date, on engrg. staff of Duke-Price Power Co. Ltd., Arvida, Que. Experience includes: layout of sewers, waterlines, streets, sidewalks, etc. for Town of Isle Maligne; design, layout and inspection for reinforced concrete bases for towers and transformers for 140 KV substation for electrical boiler installn. at Dolbeau, and concrete transformer fire cells in Isle Maligne power house; misc. topog'l. surveys for flooded lots, etc.; hydraulic studies of Lake St. John watershed; in charge of hydrographic survey at entrance of Grand Discharge from Lake St. John. (*St. 1928.*)

References: F. L. Lawton, G. H. Kirby, N. F. McCaghey, D. A. Evans, A. Macphail, W. P. Wilgar.

## List of New and Revised British Standard Specifications

(issued during July and August, 1934)

B.S.S. No.

110–1934. Air-Break Circuit-Breakers for Voltages not exceeding 660 Volts. (Revision.)

130–1934. Totally-Enclosed Air-Break Circuit-Breakers for Voltages not exceeding 660 Volts. (Revision.)
These two specifications cover circuit-breakers for use on both A.C. and D.C. circuits. The standard sizes have been reduced and the temperature limits revised.

560–1934. Engineering Symbols and Abbreviations.
A list of British Standard symbols and abbreviations recommended for the most commonly used terms in all branches of engineering. For authors of text books and technical papers.

561–1934. Alternating-Current Line Relays (2-Element, 3-Position) for Railway Signalling Purposes.
An addition to the series of specifications for railway signalling relays. This issue deals with A.C. line relays of the 2-element, 3-position, induction type, intended for use on railway signalling circuits, not exceeding 250 volts.

563–1934. Land Aerodrome and Airway Lighting.
The specification is based on the decisions of the International Commission on Illumination and deals with the characteristics of aerodrome and airway beacons, boundary lights, aerodrome, airway and air navigation obstruction lights, landing area obstruction lights, landing area floodlights and illuminated wind indicators.

564–1934. Nickel Ammonium Sulphate and Nickel Sulphate for Electroplating.
The use of material to this specification will obviate the danger of the solution being contaminated by impure salts in electroplating baths.

Copies of the new specifications may be obtained from the Publications Department, British Standards Institution, 28 Victoria Street, London, S.W.1, and from the Canadian Engineering Standards Association, 79, Sussex Street, Ottawa, Ont.

## Canadian Chemical Industries

The chemical industry of Canada ranks well among the chemical industries of the world. Canadian Industries Limited, developed from Canadian Explosives Limited, have expanded and diversified production until to-day they are the largest Canadian manufacturers of acids, alkalis, chlorines and fertilizers, and have also become an important factor in the paint industry. In addition, they are the principal manufacturers of artificial leathers and the only manufacturers of cellophane in Canada. Among their most interesting products are those derived from cellulose. Cellulose was first used chemically as a base for gun cotton. At the present time the chemist transforms it into cellophane, fabrikoid, or lacquers such as Duco, and in combination with resins, it is used in the manufacture of many other products.

In practice, chemical companies tend to produce a continually increasing variety of products from the same set of raw materials with which they have manufactured their first or primary product. In an exceptionally interesting article entitled "The Invisible Science" in a recent issue of Maclean's Magazine, there appeared a chart showing the use made of seven basic materials in the ten major divisions of Canadian Industries Limited. In six of the ten divisions, four or more of these seven basic materials are used and sulphuric acid in nine of them.

When one considers the widely varying forms into which cellulose may be transformed, it is not surprising that a chemical company usually makes use of comparatively few raw materials. Many chemical products are used almost entirely in the manufacture of more complex chemicals. Thus, from an industrial point of view, there are few chemicals of greater importance than sulphuric acid. At Coppercliff, Ont., the smoke from the smelter of the International Nickel Company contains a large proportion of sulphur. This smoke is now used by Canadian Industries for the manufacture of sulphuric acid at the rate of about one hundred and fifty tons per day.

At Shawinigan Falls, Que., a chemical industry is established which is essentially Canadian in character. It was developed by Canadian chemists and has utilized Canadian resources. It has found a world-wide market for its products and Shawinigan Chemicals Limited is one of the largest power consumers in the country. Even before the War this plant produced calcium carbide on a large scale; the calcium carbide in turn is used to produce acetylene gas which is of importance in modern welding. In 1915 these processes became of great importance in the production of acetone for cordite and acetic acid. To-day the plant has been much enlarged and its production greatly diversified. By the application of hydro-electric energy to lime and coke, carbide is made and from carbide a series of synthetic organic compounds. It is a peculiar fact that the physical properties of the different members of this group of organic chemicals, some of which are used in explosives, may be controlled in such a manner as to produce the resilient resins necessary for a chewing gum (now on the market) or transformed into a hard transparent resin which may eventually prove satisfactory as a substitute for shatter-proof glass. In the meantime, other forms and colourings of this same group are being used for new and attractive sets of brushes and combs, cups and various decorative containers. It has the advantage over the celluloid group of products in that it is relatively non-inflammable.

Perhaps the largest source of sulphuric acid in Canada is the plant of the Consolidated Mining and Smelting Company at Trail, B.C. The great stacks of this plant emitting huge volumes of sulphur smoke were considered a menace to vegetation in the surrounding country. When the wind carried this smoke over the international boundary, famous lawsuits ensued. Now that Smelters make use of this smoke for the production of sulphuric acid and then use the sulphuric acid for fertilizers, trouble from this source is a thing of the past.—*Royal Bank of Canada Letter.*

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The first figures published in connection with the Mersey tunnel, which connects the ports of Liverpool and Birkenhead, England, show that between July 18th when the tunnel was opened, and August 31st, no fewer than 527,347 vehicles and 819,585 paying passengers had passed through, paying £42,021 in tolls.

These figures greatly exceed the estimates of the traffic experts. It was estimated that 1,590,000 vehicles of all kinds would use the tunnel annually, or just over 209,000 for the period under review. The actual returns are more than two-and-a-half times this number.

—*Industrial Britain*

## EMPLOYMENT SERVICE BUREAU

**The Service is operated for the benefit of members of The Engineering Institute of Canada, and for industrial and other organizations employing technically trained men—without charge to either party.**

***All correspondence should be addressed to***

**The Employment Service Bureau, The Engineering Institute of Canada**

**2050 Mansfield Street, Montreal**

## Situations Vacant

MECHANICAL OR CHEMICAL ENGINEER, with experience in pulp and paper mill, preferably in the control dept. Must be unmarried. Apply giving full particulars of experience to Box No. 1086-V.

YOUNG ENGINEER WITH CAPITAL

Contracting engineer will sell part holdings in active company to young engineering graduate desirous of learning contracting business. Salary $65 to $75 per month. Capital needed $7,000 minimum to $10,000 maximum. Location eastern Canada. Apply to Box No. 1090-V.

CIVIL SERVICE OF CANADA
*List No. 608*

The Civil Service Commission announces an open competitive examination for the following position:

An Instructor (in Chemistry and Physics), Male, for the Royal Military College, Kingston, Ontario, Department of National Defence, at a salary of $2,460 per annum, less a deduction of 10 per cent, authorized by legislation for the fiscal year beginning April 1st, 1934.

*Duties.*—Under direction, to give instruction in Chemistry and Physics at the Royal Military College; on occasion, to give individual instruction to cadets; to correct and criticize exercises; to prepare, examine and rate examination papers; to give lectures; and to perform other related work as required.

*Qualifications required.*—Graduation from a University of recognized standing with specialization in Chemistry and in Physics; at least three years of experience in the teaching of Chemistry, Physics, or related subjects, in an institution of higher education, or two years of such experience together with professional training in pedagogy at a College of Education; thorough teaching ability, and ability to deal tactfully and firmly with cadets; good personality. As no definite age limit has been set for this competition, age may be a determining factor in the making of a selection.

Application forms properly filled in must be filed with the Civil Service Commission, Ottawa, NOT LATER THAN DECEMBER 13, 1934. Application forms may be obtained from the offices of the Employment Service of Canada, from the Postmasters at Prince Rupert, Vancouver, Victoria, Edmonton, Calgary, Regina, Saskatoon, Winnipeg, Quebec, Fredericton, St. John, Charlottetown, and Halifax, or from the Secretary of the Civil Service Commission or The Engineering Institute of Canada.

Candidates must be British subjects, and have resided in Canada for at least five years.

## Situations Wanted

ESTABLISHED SALES ENGINEER. Univ. of Toronto '24, with plant and manufacturing experience, wishes to represent manufacturers of technical equipment. Connections with automobile and electrical equipment dealers, throughout Canada. Will make small investment if necessary. Apply to Box No. 1-W.

MECHANICAL ENGINEER, Canadian, with technical training and executive experience in both Canadian and American industries, particularly plant layout, equipment, planning and production control methods, is open for employment with company desirous of improving manufacturing methods, lowering costs and preparing for business expansion. Apply to Box No. 35-W.

MECHANICAL ENGINEER, A.M.E.I.C. Married. Experience in machine shops, erection and maintenance of industrial plant mechanical and structural design. Reads German, French, Dutch and Spanish. Seeks any suitable position. Apply to Box No. 84-W.

MECHANICAL ENGINEER, graduate McGill Univ. Experience on hydro-electric power construction and design and installation of equipment of pulp and paper mills. Desires position as mechanical engineer in an industrial plant or pulp and paper mill, or as representative on the sale of heavy machinery. Apply to Box No. 142-W.

REINFORCED CONCRETE ENGINEER, B.SC., P.E.Q., eight years experience in construction design of industrial buildings, office buildings, apartment houses, etc. Age 30. Married. Apply to Box No. 257-W.

DESIGNING DRAUGHTSMAN, experience in layout of steam power house equipment and piping. Wide experience in mechanical drive and details of machinery, gearing, and hoists. Accustomed to layout of small mill buildings of steel and timber, structural design and details. Good references. Present location Montreal. Apply to Box No. 329-W.

## Situations Wanted

ELECTRICAL ENGINEER, B.SC., A.M.E.I.C., AM.A.I.E.E., age 30, single. Eight years experience H.E. and steam power plants, substations, etc., shop layouts, steel and concrete design. Location immaterial. Available immediately. Apply to Box No. 435-W.

CIVIL ENGINEER, B.A.SC. and C.E.; A.M.E.I.C., JUN. A.S.C.E., age 32, married. Experience over twelve years as assistant and resident engineer on the construction of hydro-electric, railway, and aerodrome works. Also office and teaching work on hydraulic designs and investigations, reinforced concrete, bridge foundations and caissons. Location immaterial. Available at once. Apply to Box No. 447-W.

SALES ENGINEER, M.A.SC. Univ. of Toronto, wishes to represent firm selling building products or other engineering commodities, as their representative in Western Canada. Located in Winnipeg. Apply to Box No. 467-W.

MECHANICAL ENGINEER, B.SC. Age 31. Married. Last ten years includes:—Mechanical structural and reinforced concrete design in pulp and paper mills, industrial plants, hydro-electric, mine, sewers and sewage disposal plant construction. My experience also includes shop production, steam plant combustion, fuel analysing, inspecting, supervising and instrument work on industrial construction. Permanent position preferred. Apply to Box No. 521-W.

### Finding Work

This is the title of a pamphlet just received from the American Society of Mechanical Engineers. It was prepared at the request of their Council by Mr. Samuel S. Board, placement specialist of New York, and deals in a practical way with the important problem of finding work.

The author outlines "a standard technique applied to the needs of engineers" and comments on such subjects as the types of work open to engineers, sales engineering, about which he disclaims many of the older ideas concerning this branch of engineering. Among other phases covered are engineers in business, where to look for a job, looking ahead while working, and professional advancement.

Copies of this booklet are available on request from the Employment Service Bureau of The Engineering Institute of Canada, 2050 Mansfield Street, Montreal.

CIVIL ENGINEER, Canadian, married, twenty-five years technical and executive experience, specialized knowledge of industrial housing problems and the administration of industrial towns, also town planning and municipal engineering, desires new connection. Available on reasonable notice. Personal interview sought. Apply to Box No. 544-W.

ELECTRICAL AND MECHANICAL ENGINEER, B.SC., A.M.E.I.C. Experience includes C.G.E. Students' Test Course and six years in engineering dept. of same company on design of electrical equipment. Four summers as instrumentman on surveying and highway construction. Several years experience in accounting previous to attending university. Desires position with industrial concern where the combination of technical and business experience will be of value. Apply to Box No. 564-W.

MECHANICAL ENGINEER, A.M.E.I.C. Experienced on plant maintenance, steel plant, cement plant and mining plants. Available on short notice. Apply to Box No. 571-W.

DOMINION LAND SURVEYOR, and graduate engineer with extensive experience on legal, topographic and plane-table surveys and field and office use of aero-photographs, desires employment either in Canada or abroad. Available at once. Apply to Box No. 589-W.

CHEMICAL ENGINEER, S.E.I.C., B.SC., University of Alberta, '30. Age 31. Single. Six seasons practical laboratory experience, three as chief chemist and three as assistant chemist in cement plant; one year's p.g. work in physical chemistry; three years experience teaching. Desires position in any industry with chemical control. Available immediately. Apply to Box. No. 609-W.

## Situations Wanted

DESIGNING ENGINEER AND ESTIMATOR, grad. Univ. of Toronto in C.E., A.M.E.I.C., twenty years experience in structural steel, construction and municipal work. Available at once. Apply to Box No. 613-W.

CIVIL ENGINEER, A.M.E.I.C., R.P.E., Ontario; three years construction engineer on industrial plants; fourteen years in charge of construction of hydraulic power developments, tower lines, sub-stations, etc.; four years as executive in charge of construction and development of harbours, including railways, docks, warehouses, hydraulic dredging, land reclamation, etc. Apply to Box No. 647-W.

ELECTRICAL ENGINEER, B.SC. in E.E. (Univ. of Man., '30). Age 25. Two year Can. Westinghouse Apprentice Course. Depts.—Switchboard assembly, general draughting office, switchboard engineering, test office. One year's experience since then designing and rewinding small motors and transformers. Location immaterial. Apply to Box. No. 651-W.

ELECTRICAL AND RADIO ENGINEER, B.SC. '30. Variously engaged on receiver development work, testing, and transformer development, under direction. More recent experience includes transmitter test room procedure and short wave beam transmission engineering. For further information apply to Box No. 680-W.

DIESEL ENGINEER. Erection and industrial engineer, A.M.E.I.C., technically trained mechanical engineer with English and Canadian experience in erection and operation of steam and Diesel equipment in power house and mines, pumping, rock drilling, air compressors. Experienced in industrial and steel works operations including rolling mills, quarries, sales. Open for position on maintenance, operation or sales engineer. Location immaterial. Apply to Box No. 682-W.

MECHANICAL AND STRUCTURAL ENGINEER. Six years experience with prominent manufacturer, designing, heating and power boilers, boiler installations, coal and ash handling equipment. Good practical knowledge of steel plate work welding. Also wide experience in designing, estimating and detailing structural steel for buildings and bridges. Good education. Have held position of responsibility. Above can be verified by best of references. Available at once. Apply to Box No. 692-W.

ELECTRICAL AND CIVIL ENGINEER, B.SC., Elec., '29, B.SC., Civil '33. Age 27. JR.E.I.C. Undergraduate experience in surveying and concrete foundations; also four months with Canadian General Electric Co. Thirty-three months in engineering office of a large electrical manufacturing company since graduation. Good experience in layouts, switching diagrams, specifications and pricing. Best of references. Available immediately. Apply to Box No. 693-W.

MECHANICAL ENGINEER, B.SC., '27, JR.E.I.C. Four years maintenance of high speed Diesel engines units, 200 to 1,300 h.p. Also maintenance of D.C. and A.C. electrical systems and machinery. Draughting experience. Westinghouse apprenticeship course. Practical mechanical and electrical engineer with a special study of high speed Diesel engine design, application and operation. Location in western or eastern Canada immaterial. Apply to Box No. 703-W.

COMBUSTION ENGINEER, R.P.E., Manitoba, A.M.E.I.C. Wide experience with all classes of fuels. Expert designer and draughtsman on modern steam power plants. Experienced in publicity work. Well known throughout the west. Location, Winnipeg or the west. Available at once. Apply to Box No. 713-W.

ELECTRICAL ENGINEER, B.SC., University of N.B., '31. Experience includes three months field work with Saint John Harbour Reconstruction. Apply to Box No. 722-W.

MECHANICAL ENGINEER, age 41, married. Eleven years designing experience with project of outstanding magnitude. Machinery layouts, checking, estimating and inspecting. Twelve years previous engineering, including draughting, machine shop and two years chemical laboratory. Highest references. Apply to Box No. 723-W.

CIVIL ENGINEER, B.SC. (Alta. '31), S.E.I.C. Experience includes three seasons in charge of survey party. Transitman on railway maintenance, and concrete bridge designing. Nature of work and location immaterial. Apply to Box No. 724-W.

YOUNG CIVIL ENGINEER, B.SC. (Univ. of N.B. '31), with experience as rodman and checker on railroad construction, is open for a position. Apply to Box No. 728-W.

DESIGNING ENGINEER, M.SC. (McGill Univ.), D.L.S., A.M.E.I.C., P.E.Q. Experience in design and construction of water power plants, transmission lines, field investigations of storage, hydraulic calculations and reports. Also paper mill construction, railways, highways, and in design and construction of bridges and buildings. Available at once. Apply to Box. No. 729-W.

## Situations Wanted

MECHANICAL ENGINEER, s.e.i.c., b.a.sc., Univ. of B.C. '30. Single, age 24. Sixteen months with the Allis-Chalmers Mfg. Co. as student engineer. Experience includes foundry production, erection and operation of steam turbines, erection of hydraulic machinery, and testing texropes and centrifugal pumps. Location immaterial. Available at once. Apply to Box No. 735-W.

RADIO AND ELECTRICAL ENGINEER, b.sc. '31, s.e.i.c. Age 27. Experience in installation of power and lighting equipment. Temporary operator in radio station; studio experience with part time announcing. Two summers in switchboard and installation department of telephone company, eight months on extensive survey layouts. Interested in sales work of electrical or radio equipment. Available on short notice. Location immaterial. Apply to Box No. 740-W.

CIVIL ENGINEER, b.sc. '29, a.m.e.i.c. Married. One year building construction. One year hydro-electric construction in South America, eighteen months resident engineer on highway construction, one year on harbour design and construction. Working knowledge of Spanish. Apply to Box No. 744-W.

CIVIL ENGINEER, s.e.i.c., b.sc. Queen's Univ. '29. Age 25. Married. Three years experience as construction supt. and estimator for contracting firm. Experience includes general building, bridges, sewer work, concrete, boiler settings, sand blasting of bridges and spray painting. Available at once. Apply to Box No. 776-W.

CIVIL ENGINEER, b.sc., '25, jr.e.i.c., p.e.q., married. Desires position, preferably with construction firm. Experience includes railway, monument and mill building construction. Available immediately. Apply to Box No. 780-W.

DRAUGHTSMAN, experience in civil engineering, forestry engineering, land surveying and house construction. Good references. Apply to Box No. 781-W.

ELECTRICAL AND SALES ENGINEER, s.e.i.c., grad. '28. Experience includes one year test course, one year switchboard design and two years switchboard and switching equipment sales with large electrical manufacturing company. Three summers Pilot Officer with R.C.A.F. Available at once. Apply to Box No. 788-W.

ELECTRICAL ENGINEER desires position as engineer or manager for industrial plant or factory. Over ten years diversified electrical and mechanical experience in the industrial field. Apply to Box No. 795-W.

CIVIL ENGINEER, s.e.i.c., graduate '30, age 23, single. Experience includes mining surveys, assistant on highway location and construction, and assistant on large construction work. Steel and concrete layout and design. Apply to Box No. 809-W.

CIVIL ENGINEER, college graduate, age 27, single. Experience includes surveying, draughting, concrete construction and design, street paving both asphalt and concrete. Available at once; will consider anything and go anywhere. Apply to Box No. 816-W.

CIVIL ENGINEER, b.e. (Sask. Univ. '32), s.e.i.c. Single. Experience in city street improvement; sewer and water extensions. Good draughtsman. References. Available at once. Location immaterial. Apply to Box No. 818-W.

CIVIL ENGINEER, b.sc., a.m.e.i.c., with fifteen years experience mostly in pulp and paper mill work, reinforced concrete and structural steel design, field surveys, layout of mechanical equipment, piping. Available at once. Apply to Box No. 825-W.

CIVIL ENGINEER, b.a.sc., d.l.s., o.l.s., a.m.e.i.c., age 46, married. Twelve years experience in charge of legal field surveys. Owns own surveying equipment. Eight years on technical, administrative, and editorial office work. Experienced in writing. Desires position on survey work, assisting in or in charge of preparation of house organ, on staff of technical or semi-technical magazine, or on publicity, editorial or administrative office work. Available at once. Will consider any salary, and any location. Apply to Box No. 831-W.

CIVIL ENGINEER, s.e.i.c., b.sc. '32 (Univ. of N.B.). Age 25. Married. Two years experience in power line construction and maintenance; one year of highway construction; one summer surveying for power plant site, location and spur railway line construction. Available at once. Location immaterial. Apply to Box No. 840-W.

CIVIL ENGINEER, b.sc. '15, a.m.e.i.c., married, extensive experience in responsible position on railway construction, also highways, bridges and water supplies. Position desired as engineer or superintendent. Available at once. Apply to Box No. 841-W.

CIVIL ENGINEER, b.sc. (Alta. '31), s.e.i.c., age 24. Experience, three summers on railroad maintenance, and seven months on highway location as instrumentman. Willing to do anything, anywhere, but would prefer connection with designing or construction firm on structural works. Available immediately. Apply to Box No. 846-W.

## Situations Wanted

MECHANICAL ENGINEER, jr.e.i.c., Technical graduate, bilingual, age 32. Eight years experience in design of boiler plants; steam, water and gas piping; heating, ventilating, air conditioning and plumbing systems; writing of specifications and technical translation. Experience includes: two years in engineering department of large company, five years with consulting engineers and one year on large piping and construction projects. Available at once. Apply to Box No. 850-W.

BRIDGE AND STRUCTURAL ENGINEER, a.m.e.i.c., McGill. Twenty-five years experience on bridge and structural staffs. Until recently employed. Familiar with all late designs, construction, and practices in all Canadian fabricating plants. Desirous of employment in any responsible position, sales, fabrication or construction. Apply to Box No. 851-W.

STRUCTURAL ENGINEER, b.a.sc., a.m.e.i.c. Twenty-two years experience in design of bridges and all types of buildings in structural steel and reinforced concrete. Three years experience in railway construction and land surveying. Apply to Box No. 856-W.

MECHANICAL ENGINEER, b.sc. '32, s.e.i.c. Good draughtsman. Undergraduate experience:—One year moulding shop practice; two years pipe fitting and sheet metal work; one year draughting and tracing on paper mill layout; six months machine shop practice; and eight months fuel investigation and power heating plant testing. Desires position offering experience in steam power plants or heating and ventilating design. Will go anywhere. Apply to Box No. 858-W.

MECHANICAL ENGINEER, age 31, graduate Sheffield (England) 1921; apprenticeship with firm manufacturing steam turbine generators and auxiliaries and subsequent experience in design, erection, operation and inspection of same. Marine experience b.o.t. certificate thoroughly conversant with Canadian plants and equipment. Available on short notice. Any location. Box No. 860-W.

CHEMICAL ENGINEER, b.sc. (McGill '21), a.m.e.i.c., age 36, married; three years since graduation with pulp and paper mills; eight years in shops, estimating and sales divisions of well-known gas engineering and construction companies in the United States. Excellent references. Available on short notice. Apply to Box No. 866-W.

CONSTRUCTION ENGINEER (Toronto Univ. of '07). Experience includes hydro-electric, municipal and railroad work. Available immediately. Location immaterial. Apply to Box. No. 886-W.

ELECTRICAL ENGINEER, graduate 1929, s.e.i.c. Single. Experience includes two years with electrical manufacturing concern and one on highway construction work. Available at once. Will go anywhere. Apply to Box No. 887-W.

AGENCIES WANTED. Young engineer, b.a.sc. in c.e., with business and sales experience, speaking fluent French, would consider representing a firm as agent for Montreal or the province of Quebec. Apply to Box No. 891-W.

ELECTRICAL ENGINEER, grad. Univ. of N.B. '31. Experienced in surveying and draughting, requires position. Available at once. Will go anywhere. Apply to Box No. 893-W.

CIVIL ENGINEER, b.a.sc., jr.e.i.c., age 29, single. Experience includes two years in pulp mill as draughtsman and designer on additions, maintenance and plant layout. Three and a half years in the Toronto Buildings Department checking steel, reinforced concrete, and architectural plans. Available at once. Location immaterial. At present in Toronto. Apply to Box No. 899-W.

DESIGNING ENGINEER, a.m.e.i.c. Permanent and executive position preferred but not essential. Fifteen years experience in designing power plants, engine and fan rooms, kitchens and laundries. Thoroughly familiar with plumbing and ventilating work, pneumatic tubes, and refrigeration, also heating, electrical work, and specifications. Apply to Box No. 913-W.

CIVIL ENGINEER, b.sc., o.p.e. Experience includes several years on municipal work-design and construction of sewers, steel and concrete bridges, watermains and pavements. Available at once. Apply to Box No. 950-W.

CIVIL ENGINEER, b.sc. (Univ. of Sask. '33), s.e.i.c., age 28, single. Experience in testing hydro-electric equipment, draughting, surveying, city street improvements, technical photography. Available at once. Location immaterial. Apply to Box No. 986-W.

ELECTRICAL ENGINEER, s.e.i.c., b.sc., (N.S. Tech. Coll., '33), desires work. Experience in transmission line construction. Location or class of work immaterial. Apply to Box No. 1010-W.

ENGINEER SUPERINTENDENT, age 44. Engineering and business training, executive ability, tactful, energetic. Had charge of several large projects. Intimate knowledge of costs and prices, reports and estimates. Available immediately. Any location. Apply to Box No. 1021-W.

## Situations Wanted

CIVIL ENGINEER, b.sc. (Queen's, '14), a.m.e.i.c., Dominion Land Surveyor, 5 months special course at the University of London, England, in municipal hygiene and reinforced concrete construction. Experience covers legal and topographic surveys, plane tabling and stadia surveying, railway and highway construction, drainage and excavation work. Available at once. Apply to Box No. 1035-W.

ELECTRICAL ENGINEER AND GEOPHYSICIST. Age 36. Married. Seven years experience in geophysical exploration using seismic, magnetic and electrical methods. Two years experience with the Western Electric Company of Chicago, working on equipment and magnetic materials research. Experienced in radio and telephone work, also specializing in precise electrical measurements, resistance determinations, ground potentials and similar problems of ground current distribution. Apply to Box No. 1063-W.

ELECTRICAL ENGINEER, b.a.sc. Univ. Toronto '28. Experience includes Can. Gen. Elec. Co. Test Course. Also more than two years in the engineering dept. of the same company. Available on short notice. Preferred location central or eastern Canada. Apply to Box No. 1075-W.

ELECTRICAL ENGINEER, b.sc. Married. Eight years electrical experience, including operation, maintenance and construction work, electrical design work on large power development, mechanical ability, experienced photographer, employed in electrical capacity at present. Available on reasonable notice. Apply to Box No. 1076-W.

GRADUATE IN MECHANICAL ENGINEERING, 1927, desires opportunity in Diesel engine field, preferably in design and development work. Skilled draughtsman and clever in design. Familiar with basic theories of the Diesel engine and in touch with recent developments and applications. Anxious to obtain a foothold with up-to-date company. No objection to shopwork or other duties as a start but would prefer shopwork and assembly if possible. Apply to Box No. 1081-W.

CIVIL ENGINEER, b.sc., Sask. '30. s.e.i.c. Age 24 years. Experience in municipal engineering, including sewer and water construction, sidewalk construction, paving, storm sewer design, draughting, precise levelling, and reinforced concrete bridge construction. Unmarried. Available at once. Will go anywhere. Apply to Box No. 1115-W.

ELECTRICAL ENGINEER, b.sc.e.e. (Univ. of N.B. '31). C.G.E. Test Course included industrial control, induction motors and transformers; the transformer test included desk work for two months on computing losses, efficiencies, etc. Available at once. Apply to Box No. 1119-W.

GEODETIC AND TOPOGRAPHICAL ENGINEER, d.l.s., m.e.i.c. Experience in all kinds of geodetic and topographical surveys, especially photo-topography, well versed in all kinds of air photo surveys; Canadian and U.S. patent method of determining position and elevations of points from air photographs. Available at once anywhere in Canada or the United States. Apply to Box. No. 1127-W.

PETROLEUM CHEMIST, b.sc. in Chem. Eng. Age 25. Single. One and a half years experience as assistant chemist. Capable of taking charge in small refinery. Wishes position anywhere in Canada. Apply to Box No. 1130-W.

ELECTRICAL ENGINEER. b.sc., Queen's '33. Single, age 23. Anxious to gain experience. Present experience installing small private hydro-electric plant. Location immaterial. Available at once. Apply to Box No. 1137-W.

CIVIL ENGINEER, a.m.e.i.c., with over twenty years experience in field and office on construction, maintenance, surveying, location, etc., desires position preferably of a permanent nature. At present near Montreal, but willing to locate anywhere. Apply to Box No. 1168-W.

CIVIL ENGINEER, b.a.sc., s.e.i.c., age 26, single. Experience includes one year in bridge construction, plain and reinforced concrete, pneumatic caissons and surveying. Available at once. Any location. Apply to Box No. 1204-W.

PHYSICIST ENGINEER, B.Sc.Mech. (Queen's 1913), M.Sc., Ph.D.Physics (McGill 1929, '30). Experience in municipal engineering, producer gas installation and operation, university plant maintenance. Experienced teacher of college physics. Industrial and pure physical research experience. Age 42. Married. Apply to Box No. 1207-W.

MECHANICAL ENGINEER, b.sc. (Queen's Univ. '28), age 36, married, desires position of trust and responsibility. Experience includes fitting and assembly of machine tools, production, draughting, and maintenance. Five years teaching draughting and mathematics. Available on reasonable notice. Location immaterial. Apply to Box No. 1210-W.

COMBUSTION ENGINEER, a.m.e.i.c., with extensive experience in all phases of combustion engineering, including plant layout, piping, etc. Lately connected with prominent firm of automatic oil burner manufacturers. Apply to Box No. 1224-W.

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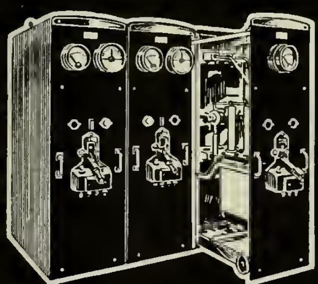

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# Purchasers' Classified Directory

*A Selected List of Equipment, Apparatus and Supplies*

**For Alphabetical List of Advertisers see page 18.**

A

**Acids:**
Canadian Industries Limited.
**Aerial Survey:**
Canadian Airways Ltd.
**Ammeters and Voltmeters:**
Bepco Canada Ltd.
Crompton Parkinson (Canada) Ltd
**Angles, Steel:**
Bethlehem Steel Export Corp.
**Ash Handling Equipment:**
Babcock-Wilcox & Goldie Mc-Culloch Ltd.
Combustion Engineering Corp. Ltd.
**Asphalt:**
Barrett Co. Ltd.
**Axles, Steel, Forged:**
Dominion Foundries & Steel Ltd
Dominion Steel & Coal Corpn. Ltd.

B

**Ball Mills:**
Dominion Engineering Works Limited.
Wm. Kennedy & Sons Ltd.
Foster Wheeler Ltd.
Wm. Hamilton Div. Canadian Vickers Ltd.
**Balls, Steel and Bronze:**
Can. S.K.F. Co. Ltd.
Wm Kennedy & Sons Ltd.
**Barking Drums:**
Canadian Ingersoll-Rand Company, Limited.
**Bars, Steel and Iron:**
Bethlehem Steel Export Corp.
Dominion Foundries & Steel Ltd.
Dominion Steel & Coal Corpn. Ltd.
**Bearings, Ball and Roller:**
Can. S.K.F. Co. Ltd.
**Billets, Blooms, Slabs:**
Bethlehem Steel Export Corp.
Dominion Foundries & Steel Ltd.
**Bins:**
Canada Cement Co. Ltd.
**Blasting Materials:**
Canadian Industries Limited.
**Blowers, Centrifugal:**
Can. Ingersoll-Rand Co. Ltd.
B. F. Sturtevant Co. of Can. Ltd.
**Blue Print Machinery:**
Montreal Blue Print Co.
**Boilers:**
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Canadian Vickers Ltd.
Combustion Engineering Corp. Ltd.
Foster Wheeler Limited.
E. Leonard & Sons Ltd.
Vulcan Iron Wks. Ltd.
**Boilers Electric:**
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Dominion Engineering Works Limited.
Northern Electric Co. Ltd.
**Boilers, Portable:**
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Northern Electric Co. Ltd.
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Can. General Elec. Co. Ltd.
**Brakes, Magnetic Clutch:**
Northern Electric Co. Ltd.
**Bridge-Meggers:**
Northern Electric Co. Ltd.
**Bridges:**
Canada Cement Co. Ltd.
Canadian Vickers Ltd.
Dominion Bridge Co. Ltd
**Bucket Elevators:**
Jeffrey Mfg. Co. Ltd.
**Buildings, Steel:**
Dominion Bridge Co. Ltd.

C

**Cables, Copper and Galvanized:**
Northern Electric Co. Ltd.
**Cables, Electric, Bare and Insulated:**
Can. Westinghouse Co. Ltd.
Can. General Electric Co. Ltd.
Northern Electric Co. Ltd.
**Caissons, Barges:**
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**Cameras:**
Associated Screen News Ltd.
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Can. Westinghouse Co. Ltd.
Lancashire Dynamo & Crypto Co. of Can. Ltd.
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The Superheater Co. Ltd.
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Foster Wheeler Ltd.
Wm. Kennedy & Sons Ltd.
E. Leonard & Sons Ltd.
The Superheater Co. Ltd.
Vulcan Iron Wks. Ltd.
**Castings, Alloy Steel:**
Dominion Foundries & Steel Ltd
**Castings, Steel:**
Dominion Foundries & Steel Ltd.
Wm. Kennedy & Sons Ltd.
Vulcan Iron Wks. Ltd.
**Catenary Materials:**
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**Cement Manufacturers:**
Canada Cement Co. Ltd.
**Chains, Silent and Roller:**
Hamilton Gear & Machine Co.
Jeffrey Mfg. Co. Ltd
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**Chemicals:**
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**Chemists:**
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Roast Laboratories Reg'd.
**Chippers, Pneumatic:**
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**Choke Coils:**
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**Circuit Breakers:**
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Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.
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Crompton Parkinson (Canada) Ltd.
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Bailey Meter Co. Ltd.
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Babcock-Wilcox & Goldie-Mc-Culloch Ltd.
Canadian Ingersoll-Rand Company, Limited.
**Concrete:**
Canada Cement Co. Ltd.
**Condensers, Steam:**
Babcock-Wilcox & Goldie-Mc-Culloch Ltd.
Canadian Ingersoll-Rand Company, Limited
Foster Wheeler Limited.
**Condensers, Synchronous and Static:**
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Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Crompton Parkinson (Canada) Ltd.
Harland Eng. Co. of Can. Ltd.
Lancashire Dynamo & Crypto Co. of Can. Ltd.
Northern Electric Co. Ltd.
Bruce Peebles (Canada) Ltd.
**Conditioning Systems, Air:**
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**Conduit:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co Ltd.
**Conduit, Underground Fibre, and Underfloor Duct:**
Northern Electric Co. Ltd.
**Controllers, Electric:**
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Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.
**Couplings:**
Dart Union Co. Ltd.
Dresser Mfg Co. Ltd.
**Couplings, Flexible:**
Dominion Engineering Works Limited
Dresser Mfg. Co. Ltd.
**Couplings, Flexible:**
Wm. Hamilton Div. Canadian Vickers Ltd.
Hamilton Gear & Machine Co.
Wm. Kennedy & Sons Ltd.
**Cranes, Hand and Power:**
Dominion Bridge Co.
**Cranes, Locomotive:**
Dominion Hoist & Shovel Co. Ltd.
**Cranes, Shovel, Gasoline Crawler, Pillar:**
Canadian Vickers Ltd.
Dominion Hoist & Shovel Co. Ltd.
**Crowbars:**
B. J. Coghlin Co. Ltd.
**Crushers, Coal and Stone:**
Canadian Ingersoll-Rand Company, Limited.
Jeffrey Mfg. Co. Ltd.
Wm. Kennedy & Sons Ltd.

D

**Dimmers:**
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**Disposal Plants, Sewage:**
W. J. Westaway Co. Ltd.
**Ditchers:**
Dominion Hoist & Shovel Co. Ltd.
**Drills, Pneumatic:**
Canadian Ingersoll-Rand Company, Limited.
**Dynamite:**
Canadian Industries Limited.

E

**Economizers, Fuel:**
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Combustion Engineering Corp. Ltd.
Foster Wheeler Limited.
B. F. Sturtevant Co of Can. Ltd.
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**Electric Railway Car Couplers:**
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Harland Eng. Co. of Can. Ltd.
Waterous Limited
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Canadian Ingersoll-Rand Company, Limited.
Waterous Limited
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Waterous Limited
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Foster Wheeler Limited.
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Foster Wheeler Limited.
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F

**Feed Water Heaters, Locomotive:**
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**Floodlights:**
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Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd
**Floor Stands:**
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**Floors:**
Canada Cement Co. Ltd.
**Forcite:**
Canadian Industries Limited
**Forgings:**
Bethlehem Steel Export Corp.
Dominion Steel & Coal Corpn. Ltd.
**Foundations:**
Canada Cement Co. Ltd.

G

**Gaskets, Asbestos, Fibrous, Metallic, Rubber:**
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**Gasoline Recovery Systems:**
Foster Wheeler Limited.
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Canadian Vickers Ltd.
Dominion Bridge Co. Ltd.
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**Gears:**
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Dominion Engineering Works Limited.
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Wm. Kennedy & Sons Ltd.
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Crompton Parkinson (Canada) Ltd.
Harland Eng. Co. of Can. Ltd.
Lancashire Dynamo & Crypto Co. of Can. Ltd.
Northern Electric Co. Ltd.
Bruce Peebles (Canada) Ltd.
**Governors, Pump:**
Bailey Meter Co. Ltd.
**Governors, Turbine:**
Dominion Engineering Works Limited.
**Gratings, M. & M. Safety:**
Dominion Bridge Co. Ltd.

H

**Hangers, Ball and Roller Bearing:**
Can. S.K.F. Co. Ltd.
**Headlights, Electric Railway:**
Can. General Elec. Co. Ltd.
Can. Ohio Brass Co. Ltd.
Can. Westinghouse Co. Ltd.
**Heat Exchange Equipment:**
Foster Wheeler Limited.
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C. A. Dunham Co. Ltd.
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Canadian Ingersoll-Rand Company, Limited.
Dominion Hoist & Shovel Co. Ltd.
Wm. Hamilton Div. Canadian Vickers Ltd.
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W. J. Westaway Co. Ltd.

I

**Indicator Posts:**
Jenkins Bros. Ltd.
**Industrial Electric Control:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.
**Injectors, Locomotive, Exhaust Steam:**
The Superheater Co Ltd.
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Milton Hersey Co. Ltd.
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Bepco Canada Ltd.
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Crompton Parkinson (Canada) Ltd
Ferranti Electric Ltd.
Moloney Electric Co. of Canada, Ltd.
Northern Electric Co. Ltd.
**Insulating Materials:**
Canadian Industries Limited.
**Insulators, Porcelain:**
Can. Ohio Brass Co. Ltd.
Northern Electric Co. Ltd.
**Intercoolers:**
Foster Wheeler Limited.

J

**Journal Bearings and Boxes, Railway:**
Can. S.K.F. Co. Ltd.

L

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Canadian Industries Limited.
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Associated Screen News Ltd.
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Canadian Industries Limited.


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MONTREAL
Established 1869
Agents: Harvard Turnbull & Co., Toronto
Filer Smith Machinery Co., Ltd., Winnipeg Gordon & Belyea, Ltd., Vancouver

# Purchasers' Classified Directory

**Library Films:**
Associated Screen News Ltd.
**Lighting Equipment, Industrial and Street:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.
**Lightning Arresters:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Ferranti Electric Ltd.
Northern Electric Co. Ltd.
**Line Materials:**
Can. Ohio Brass Co. Ltd.
Northern Electric Co. Ltd.
**Locomotives, Electric:**
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.

**M**

**Machinery, Hydraulic:**
Dominion Engineering Works Limited.
**Machinery, Metal and Wood-Working:**
Dominion Engineering Works Limited.
**Magnetic Separators:**
Northern Electric Co. Ltd.
**Material Handling Equipment:**
Jeffrey Mfg. Co. Ltd.
**Metallurgists:**
Roast Laboratories Reg'd.
**Meters, Boiler, and Coal:**
Bailey Meter Co. Ltd.
**Meters, Electric:**
Bristol Co of Can. Ltd.
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Ferranti Electric Ltd.
Northern Electric Co. Ltd.
**Meters, Flow:**
Bailey Meter Co. Ltd.
Neptune-National Meters Ltd.
**Meters, Liquid (Hot or Cold):**
Bailey Meter Co. Ltd
Neptune-National Meters Ltd.
**Mine Cars:**
Canadian Vickers Ltd.
**Mining Machinery:**
Canadian Ingersoll-Rand Company, Limited.
Canadian Vickers Ltd.
Dominion Engineering Works Limited.
**Motion Pictures:**
Associated Screen News Ltd.
**Motors, Electric:**
Bepco Canada Ltd.
The Can. Fairbanks-Morse Co. Ltd.
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Crompton Parkinson (Canada) Ltd.
Harland Eng. Co. of Can. Ltd.
Lancashire Dynamo & Crypto Co. of Can. Ltd.
Northern Electric Co. Ltd.
Bruce Peebles (Canada) Ltd.
**Moulded Goods, Rubber and Asbestos:**
The Garlock Packing Co. of Can. Ltd.

**O**

**Oil Burning Equipment:**
Bethlehem Steel Export Corp.
**Oil Refining Equipment:**
Foster Wheeler Limited.
**Ornamental Iron:**
Vulcan Iron Wks. Ltd.

**P**

**Packings, Asbestos, Cotton and Flax, Metal, Rubber:**
The Garlock Packing Co. of Can. Ltd.
**Paints, all purposes:**
Canadian Industries Limited.
**Paving Materials:**
Barrett Co. Ltd.
**Penstocks:**
Canadian Vickers Ltd.
**Phase Rotation Indicators:**
Ferranti Electric Ltd.
**Photographs, Commercial and Portrait:**
Associated Screen News Ltd.
**Piling, Steel Sheet:**
Bethlehem Steel Export Corp.
**Pillow Blocks, Plain, Ball and Roller Bearing:**
Can. S.K.F. Co. Ltd.
**Pinions:**
Hamilton Gear & Machine Co.
**Pipe, Wood Stave:**
Canadian Wood Pipe & Tanks Ltd.
**Pipe Coils:**
The Superheater Co. Ltd.
**Pipe Couplings and Nipples:**
Dart Union Co. Ltd.
**Plates, Steel:**
Bethlehem Steel Export Corp
Dominion Foundries & Steel Ltd
**Pneumatic Tools:**
Canadian Ingersoll-Rand Company Ltd.
**Pole Line Hardware:**
Can. Ohio Brass Co. Ltd.
Northern Electric Co. Ltd.
**Polishes:**
Canadian Industries Limited.
**Powder, Black and Sporting:**
Canadian Industries Limited.
**Power Switchboards:**
Bepco Canada Ltd.
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Crompton Parkinson (Canada) Ltd.
Harland Eng. Co. of Can. Ltd.
Northern Electric Co. Ltd.
**Preheaters, Air:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Combustion Engineering Corp.
Foster Wheeler Limited.
**Projectors:**
Associated Screen News Ltd.
**Pulleys:**
Plessisville Foundry.
**Pulleys, Ball Bearings, Loose:**
Can S.K.F. Co Ltd.
**Pulp and Paper Mill Machinery:**
Can. General Elec. Co. Ltd.
Canadian Ingersoll-Rand Company, Limited
Can. Westinghouse Co. Ltd
Dominion Engineering Works Limited.
Wm. Hamilton Div. Canadian Vickers Ltd
Harland Eng. Co. of Can. Ltd.
**Pulverized Fuel Systems:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Bethlehem Steel Export Corpn.
Combustion Engineering Corp. Ltd.
Foster Wheeler Limited.
Wm. Kennedy & Sons Ltd.
**Pump Valves, Rubber:**
The Garlock Packing Co. of Can. Ltd.
**Pumps:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Canadian Ingersoll-Rand Company, Limited.
Foster Wheeler Limited.
Wm Hamilton Div. Canadian Vickers Ltd
Harland Eng. Co. of Can Ltd.
Waterous Limited
**Purifiers, Water:**
W. J. Westaway Co. Ltd.

**R**

**Radiator Air Vents and Traps:**
Jenkins Bros. Ltd.
**Radiator Valves:**
Can. Ohio Brass Co. Ltd.
Jenkins Bros. Ltd.
**Radio Receiving Sets:**
Can. General Elec. Co Ltd
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.
**Radio Transformers:**
Ferranti Electric Ltd.
**Rail Bonds:**
Can. Ohio Brass Co. Ltd
U.S. Steel Products Co.
**Rail Braces and Joints:**
B. J. Coghlin Co.
**Railway Equipment:**
Can. General Elec. Co. Ltd.
Canadian Ingersoll-Rand Company, Limited.
Can. Ohio Brass Co. Ltd.
**Receivers, Air:**
Canadian Ingersoll-Rand Com- Limited.
E. Leonard & Sons Ltd.
**Recorders**
Bailey Meter Co. Ltd.
Bristol Co of Can. Ltd.
**Refrigerating Machinery:**
Canadian Ingersoll-Rand Company, Limited.
**Regulators, Feed Water:**
Bailey Meter Co. Ltd.
**Reservoirs:**
Canada Cement Co. Ltd.

## Purchasers' Classified Directory

**Riveted Pipe:**
Dominion Bridge Co. Ltd.
**Roads:**
Canada Cement Co. Ltd.
**Road Machinery:**
Plessisville Foundry.
**Rods:**
Bethlehem Steel Export Corp.
**Rolls, Paper Machine:**
Dominion Engineering Works Limited.
**Roofing, Prepared:**
The Barrett Co. Ltd.
**Roofs, Built-up:**
The Barrett Co. Ltd.
**Rope, Wire:**
Dom. Wire Rope Co. Ltd.

S

**Screening Equipment:**
Canadian Ingersoll-Rand Company, Limited.
Foster Wheeler Ltd.
**Separators, Electric:**
Northern Electric Co. Ltd.
**Sewers:**
Canada Cement Co. Ltd.
**Shingles, Prepared Asphalt:**
The Barrett Co. Ltd.
**Shovels — Powered Electric or Gasoline:**
Canadian Vickers Ltd.
**Smokestacks:**
Canada Cement Co. Ltd.
Canadian Vickers Ltd.
Foster Wheeler Ltd.
E. Leonard & Sons Ltd.
**Softeners, Water:**
W. J. Westaway Co. Ltd.
**Sporting Powder:**
Canadian Industries Limited.
**Springs — Automobile, Railway, Wire:**
B. J. Coghlin Co. Ltd.
**Stains:**
Canadian Industries Limited.
**Steam Plant Equipment:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Combustion Engineering Corp. Ltd.
Foster Wheeler Limited.
Harland Eng. Co. of Can. Ltd.
**Steel Plate Construction:**
Canadian Vickers Ltd.
Dominion Bridge Co. Ltd.
Foster Wheeler Ltd.
E. Leonard & Sons Ltd.
**Stokers:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Combustion Engineering Corp. Ltd.
**Structural Iron and Steel:**
Canadian Vickers Ltd.
Dominion Bridge Co. Ltd
Vulcan Iron Works Ltd.
**Superheaters:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Foster Wheeler Limited.
The Superheater Co. Ltd.
**Surge Absorbers:**
Ferranti Electric Ltd.
**Switchboards, Power Lighting:**
Bepco Canada Ltd.
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Crompton Parkinson (Canada) Ltd.
Harland Eng. Co. of Can. Ltd.
Northern Electric Co. Ltd.

T

**Tanks:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Braithwaite & Co. Engineers Ltd.
Canada Cement Co. Ltd.
Canadian Vickers Ldt.
Dominion Bridge Co. Ltd.
Foster Wheeler Ltd.
E. Leonard & Sons Ltd.
Vulcan Iron Wks. Ltd.
**Tanks, Wood:**
Canadian Wood Pipe & Tanks Ltd.
**Tees:**
Dart Union Co. Ltd.
**Telegraph Line Material:**
Northern Electric Co. Ltd.
**Testing Sets:**
Moloney Electric Co. of Can., Ltd.
**Thermometers, Recording:**
Bailey Meter Co. Ltd.
Bristol Co. of Can. Ltd.
**Tiles:**
Canada Cement Co. Ltd.
**Tinplate:**
Bethlehem Steel Export Corp.
**Towers, Cooling, Fractionating:**
Foster Wheeler Limited.
**Track Tools:**
B. J. Coghlin Co. Ltd.
**Transformers, Instrument, Testing, Distribution:**
Bepco Canada Ltd.
Ferranti Electric Ltd.
Moloney Electric Co. of Can., Ltd.
**Transformers, Lighting and Power:**
Bepco Canada Ltd.
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Crompton Parkinson (Canada) Ltd.
Ferranti Electric Ltd.
Moloney Electric Co. of Can., Ltd.
Northern Electric Co. Ltd.
Bruce Peebles (Canada) Ltd.
**Transmission Poles and Towers:**
Dominion Bridge Co. Ltd.
**Trolley Materials:**
Can. Ohio Brass Co. Ltd.
**Tubes, Boiler, Lapwelded Steel, and Iron:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Canadian Vickers Ltd.
E. Leonard & Sons Ltd.
**Turbines, Hydraulic:**
Dominion Engineering Works Limited.
Wm. Hamilton Div. Canadian Vickers Ltd.
Wm. Kennedy & Sons Ltd.
**Turbines, Steam:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Harland Eng. Co. of Can. Ltd.
**Turbo Generators:**
Bepco Canada Ltd.
Can. General Elec. Co. Ltd.
Can. Westinghouse Co. Ltd.
Lancashire Dynamo & Crypto Co. of Can. Ltd.
**Turntables:**
Dominion Bridge Co. Ltd.

U

**Unions:**
Dart Union Co. Ltd.

V

**Valve Controls:**
Northern Electric Co. Ltd.
**Valve Discs, Rubber:**
The Garlock Packing Co. of Can Ltd.
Jenkins Bros. Ltd.
**Valves:**
Can. Ohio Brass Co. Ltd.
Dominion Engineering Works Limited.
Jenkins Bros. Ltd.
**Valves, Relief:**
Neptune-National Meters Ltd.
**Varnishes:**
Canadian Industries Limited.
**Ventube:**
Canadian Industries Limited.

W

**Washers, Air:**
Canadian Ingersoll-Rand Company Limited.
**Water Cooled Furnaces:**
Babcock-Wilcox & Goldie-McCulloch Ltd.
Combustion Engineering Corp. Ltd.
Foster Wheeler Limited.
**Waterproofing:**
The Barrett Co. Ltd.
**Welding Machines, Electric and Accessories:**
Can. General Elec. Co. Ltd.
Can. Ohio Brass Co. Ltd.
Can. Westinghouse Co. Ltd.
Northern Electric Co. Ltd.
**Wheels, Fly and Gear:**
Hamilton Gear & Machine Co.
**Winches, Stop-log and Headgate**
Canadian Vickers Ltd.
**Wire:**
Bethlehem Steel Export Corp.
**Wire, Electric, Bare and Insulated:**
Can. General Elec. Co. Ltd.
Northern Electric Co. Ltd.
**Wire Rope:**
Dom. Wire Rope Co. Ltd
**Wire Springs:**
B. J. Coghlin Co. Ltd.
**Worm Gears:**
Hamilton Gear & Machine Co.

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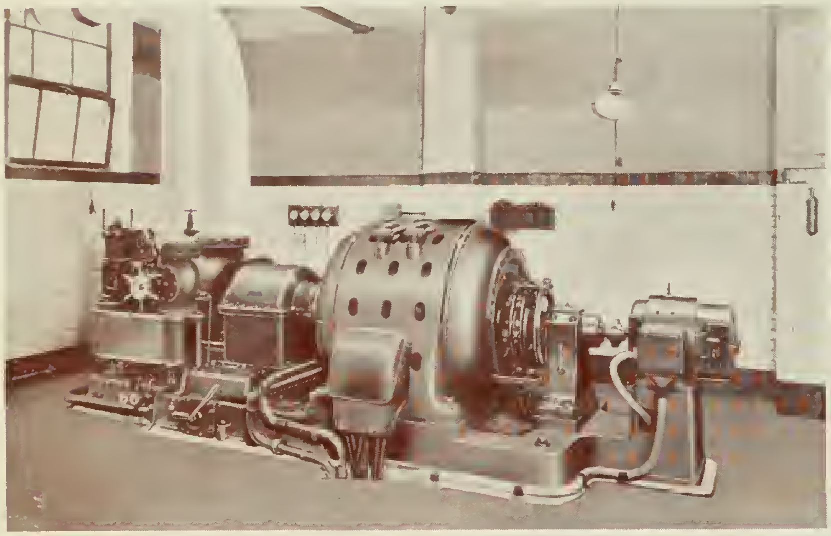
# ANNOUNCEMENT

Messrs. W. H. Allen Son & Co., Limited, Bedford, England, announce the appointment of Babcock-Wilcox & Goldie-McCulloch Ltd. as sole Canadian agents for Allen Diesel Oil Engines and Allen Steam Turbines. In Allen equipment is embodied the highest quality of the world famous British engineering design and workmanship, and the new connection here announced is the Canadian purchaser's assurance of prompt, efficient and intelligent service.



*400 K.W. Back Pressure Allen Turbine connected through reducing Gear to Generator.*

## TURBINES

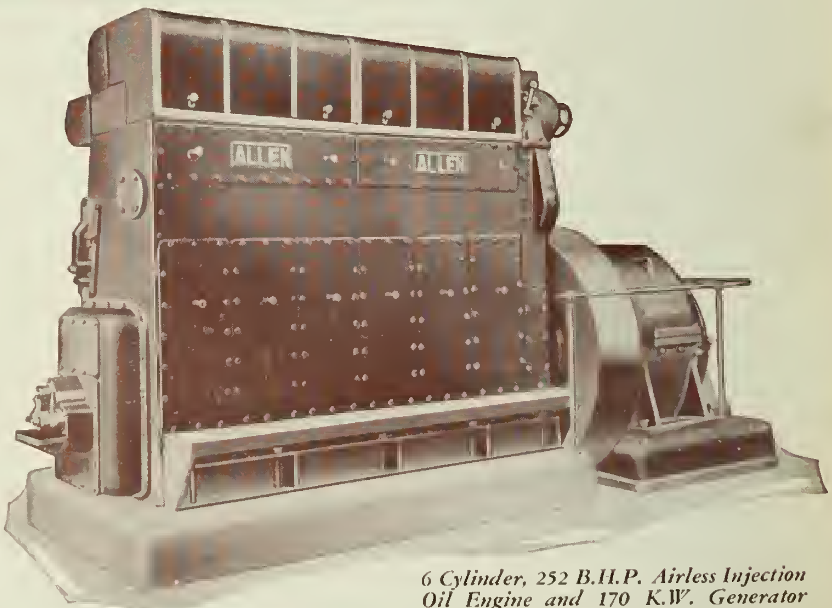
The economy of producing Power as a By-Product with an Allen Steam Turbine should be investigated where the need for Electric Power exists side by side with a process or heating Steam Load.

Allen Turbines have an established reputation for economy and reliability in operation.

## OIL ENGINES

For Power Generation, Driving Centrifugal Pumps and Air Compressors, as well as for Railway and Marine Propulsion.

Characterized by Easy Starting... Smooth and Silent Running... Absence of Vibration... Long Working Life... Economical running and upkeep costs with absolute dependability.




*6 Cylinder, 252 B.H.P. Airless Injection Oil Engine and 170 K.W. Generator for land installation.*

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