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Canadian Air Transportation

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Paper presented before a meeting of the Montreal Branch of The Engineering Institute of Canada on November 4th, 1937.

SUMMARY.—After a brief history of the development of air transport in Canada, the author discusses the special geographical, climatic, and traffic conditions which apply, and the features of aircraft design which they call for, to ensure satisfactory performance and easy maintenance under northern conditions.

Since the earliest days of which there is any record, transportation has played a leading part in the development of empires and civilization. Genghis Khan, one of the greatest conquerors and Empire builders of all time, was able to overrun the greater part of Europe, overcoming numerically stronger and better equipped armies due to the mobility of his striking force, composed principally of cavalry mounted on Mongol ponies. This enabled the Tartar hordes to move incredible distances overnight to attack their enemies from an entirely unexpected quarter.

Centuries later Spain owed her greatness largely to her navy and merchant marine, which not only brought to her the wealth of the then known world, but enabled her to conquer and colonize distant lands. It was not until the defeat of the Spanish Armada, which was symbolic of Spain's greatness on the ocean and consequently in trade, that her wealth and power started to wane, and that of Britain to rise. From that day Britain's merchant marine steadily increased until it became supreme on the trade routes of the world, and with the growth of foreign trade carried on the ocean, the wealth and power of the British Empire has grown until it is the envy and admiration of all.

Similarly the internal development of nations can be traced to the expansion of transportation. It is not necessary to look further than Canada to see the growth of wealth and population which took place with the building of the Canadian Pacific Railway across the Prairies to Vancouver. Without a railroad across the Western Provinces this great territory could not have been developed except by railroads being extended north from the United States, in which case our neighbours to the south, and not Canada, would have benefited.

Until the present time the history of the world has been an incessant conflict amongst the nations for supremacy on the surface trade routes, but December 17th, 1903, the day on which Orville Wright made the first successful flight in a power driven aircraft, saw the birth of another race among nations for the trade routes of the air. The intensity of this race can be judged by the following subsidies paid by the various Governments to their nationals to encourage the development of commercial aviation:

Accurate figures for European air transport subsidies are difficult to obtain, but in a report issued by the League of Nations Air Transport Co-operation Committee in 1935, it shows that the total cost of air transport to the European tax payer for the period of 1930 to 1932 inclusive was two thousand million francs or approximately ninety million dollars at that time. It further shows that every ton kilometre by air cost the tax payer 44 francs 70 centimes or approximately two dollars per ton kilometre at that time.

In a book entitled "By Air" written by Sir Harry Brittain and published in 1935, he points out that the votes for civil aviation of the leading nations for 1931 were as follows:

U.S.A.	£2,480,814	exclusive of air mail payments.
U.S.A.	5,548,705	inclusive of air mail payments.
Germany	2,119,475	
France	2,037,883	
Italy	798,183	
Great Britain.	678,400	

The U.S. Department of Commerce Air Commerce Bulletin for May 15th, 1937, shows that on domestic and foreign routes, exclusive of Hawaiian operations, 18,324,012 lb. of mail were carried for which the operators received $19,724,488.53 or better than one dollar per pound.

The capital invested in the major airlines in the U.S.A. is in the neighbourhood of $125,000,000. The subscribed capital of Imperial Airways, excluding 25,000 deferred ordinary shares of £1 par value, all held by the British Air Ministry, and excluding an issue recently offered of one million ordinary shares of £1 par at 30s. each, is £1,624,080.

The significance of these figures lies in the fact that capital required for air transportation on a large scale is low when compared to large ground and water transportation systems, and a nation does not have to be immensely wealthy to take part in this race for world supremacy in the air, if it has sufficient vision and courage to play its part. Canada not only has great wealth in its natural resources waiting to be developed, but is geographically favoured by being in the middle of the shortest air routes connecting the centres of trade and commerce of Europe, America and Asia.

At the close of the war in 1918 many Canadian pilots who had received their training during the war were anxious to continue flying in commercial life, but the public were not ready for this new form of transportation, and consequently the money to develop it was not available. Apart from stunt flying and joyriding, the first serious attempt to use aircraft commercially was on forest surveys, forest fire patrol and photography. The first serious attempts, however, to provide commercial air transportation was not until 1924, when the Laurentide Air Service Limited established a route between Haileybury and Rouyn. This undertaking did not prosper and it was not until December 1926, when Mr. James A. Richardson formed Western Canada Airways, that air transportation in the North, as it is known today, came into being. Since 1926 many air transportation companies have been formed, and the following impressive figures show the volume of traffic transported by air in 1936, just ten years later:

Miles Flown	Hours Flown	Pay Pass.	Freight or Express	Mail
7,100,401	76,443	99,451	22,947,105 lb.	1,161,069 lb.

In this type of air transportation Canada leads the world, and the volume of freight handled exceeds the airborne freight and express, not only in the United States, but in all other countries except possibly Russia, for which country no figures are available. In reaching this imposing record new problems had to be overcome, most of which being of a pioneering nature added to the difficulties.

Up until 1918, aircraft designers had been concentrating on military aircraft, but from 1919 more attention was given to producing aircraft for the transportation of passengers and express between the centres of population both in Europe and America. These machines, however, had all been designed for local requirements, with little, if any, thought to their use as seaplanes. In Canada in 1926 when air transportation really started there was practically no manufacturing of aircraft, with the result the foreign market had to be analyzed for the most suitable machine.

Northern Canada is, fortunately, provided with an abundance of lakes and rivers which make satisfactory airports, both summer and winter, but this in itself provided the problem of choosing a machine which would operate as a seaplane in summer and a skiplane in winter.

The most suitable machine available in 1926 for Canadian use was the Fokker Standard Universal, made in New Jersey, the chief characteristics of which were as follows:

Tare Weight—lb. Landplane	Tare Weight—lb. Seaplane	Gross Weight
2,100	2,521	4,000

Disposable Load—lb. Landplane	Disposable Load—lb. Seaplane	Pass.	Crew	Cruising Speed—m.p.h.
1,900	1,479	4	1	80

This machine was a great improvement on any machines previously used, and fulfilled the requirements of being rugged; could be used as a seaplane or landplane; comfortable for passengers, and had a good cargo space owing to the size of its cabin.

Along about this time American aviation received a great stimulus through the public interest created by Lindbergh's Atlantic flight; the demand for commercial aircraft was considerably increased, and there began to appear on the market several medium sized, general purpose aircraft, such as the Bellancas and Fairchilds. As the demand for aircraft in Canada increased, subsidiaries of American firms were formed in this country for the manufacture or assembly and sale of American aircraft to Canadian operators. The De Havilland Aircraft Company of England also formed a subsidiary company in Toronto to cater to Canadian operators, as also did the Junkers Aircraft Company of Germany.

Fig. 1—Indian canoe train leaving Chibougowan Post for Oskelaneo to pick up freight.

By 1929 air transportation in the North had outgrown the usefulness of the Fokker Standard Universal, which was being replaced by more, efficient machines such as Fokker Super-Universals, Fairchild FC2W2's, Junkers W-33's and 34's, and Bellancas. In passing it is interesting to note that the prototype of the Junkers W-34 was designed and built in Germany in 1917, was one of the first successful all metal machines, and is today considered by many as the most efficient general purpose machine in operation in Canada. Being of all metal construction it is more costly than a machine of an equivalent size of composite construction using metal, wood and fabric, and is one reason why it has not been manufactured in this country. Canadian Airways' experience, however, shows that the extra cost is warranted by the extreme ruggedness of this machine and the lower maintenance costs.

The years 1928 and 1929 saw the promotion of many small air transportation companies which went bankrupt during the depression, and although this period was difficult for the aircraft operator, it had an even worse effect on the aircraft manufacturer, particularly in Canada. Operating companies going out of business all over the continent placed on the market innumerable second hand aircraft at sacrifice prices, making it impossible for the Canadian aircraft manufacturer to sell new equipment, or develop new types of aircraft especially designed for Canadian needs.

Coincident with the market break in 1929, a very definite phase in the development of northern air transportation ended. It should be remembered that in 1926, although there were available pilots and air engineers the equal of any in the world, there were no executives, traffic agents or cost accountants experienced in aviation to look after the business side of air transportation as distinct from the practical operation of the equipment. The operations were of necessity spread over a vast territory with practically no communication once the aircraft left its base on the railroad, and as the machine was away from its base sometimes for days or weeks at a time, the pilot, in addition to operating his machine, had to be the business representative, salesman and traffic agent for the company. To a lesser extent he still has to be today, although the situation is materially improved through the development of short wave radio and two-way communication between aircraft and the ground.

From the foregoing it can be readily seen that operations were not carried on as efficiently or economically as could be desired, but, fortunately, rates were at a high level and companies who operated on sound business lines were able to build up sufficient reserves to see them through the lean years ahead.

The years 1930 to 1932 inclusive was a period of retrenchment and consolidation. It was soon evident that the traffic could not stand the rates that had been charged during the boom period, and would have to be drastically reduced. It was also realized that before the rates could be reduced to a level which would draw the traffic, costs would have to be reduced by increased hours flown per month per machine and more efficient equipment. It also became very evident that whereas the number of passengers travelling in the North varied greatly with prosperity, there would always be a large quantity of freight moving to mines and trading posts, and although passenger traffic is the more lucrative, northern air transportation, like the railroads, would have to depend on freight for its steady volume of traffic.

A survey of the world markets in 1931 indicated that the most efficient machines available were the Junkers W-34, having a cruising speed of 90 m.p.h. and mean disposable loads on skiis and pontoons of 2,794 lb. and for heavy freighting the single engined Junkers JU-52 with a cruising speed of 90 m.p.h. and mean disposable load on skiis and pontoons of 7,286 lb. The arrival of the Junkers JU-52 in Canada saw the commencement of large tonnage shipments of freight by air. Since 1931 the freight moved by air has increased tenfold, and 1937 should see a good increase over 1936.

With the re-valuation of gold, prospecting and development of prospects received a tremendous impetus; the demand for air transportation increased very rapidly, and soon the capacity of all available aircraft was taxed to the limit. Until this time, passengers realizing northern air transportation was still in the pioneering and formative stage, had been content to travel along with the miscellaneous cargoes of mail and freight, sitting on packsacks and cased goods. During this period however air transportation in the United States had developed rapidly, schedules had been speeded up, and great attention was being given to passenger comfort, and it was not long before the effect of this development was felt in Canada. Mining engineers, salesmen and executives began to demand comfortable seats and better aircraft. The problem was temporarily solved by placing in operation small aircraft such as the Wacos and Stinsons, four-passenger machines cruising at approximately 110 m.p.h.

With this increased demand for aircraft the Canadian manufacturers at last gave thought to the design of machines to meet local conditions, and in 1934 the Canadian Fairchild Company developed the Fairchild Super 71. The chief characteristics of this machine, which is a high wing monoplane, was the all metal fuselage and the large door at the rear of the cabin for accommodating bulky pieces of freight. This machine, once the development troubles were overcome, has given excellent service and the manufacturer showed considerable courage and deserves credit for producing this machine at a time when the immediate future of air transportation was still uncertain. The Super 71 was followed by the Fairchild 82 in which the fuselage instead of being all metal is the standard steel tube fabric-covered type. This machine was the first to appear in this country with special "bush" type seats for the passengers arranged in the form of a bench running lengthwise on each side of the cabin. This arrangement allows greater seating capacity and when the machine is used for freighting, the seats fold down against the wall of the fuselage. Both the Super 71 and the Fairchild 82 are developments of the Fairchild 71C and use the same mainplanes.

The first modern machine to be designed entirely in Canada for Canadian conditions was the Noorduyn "Norseman" and its success is largely due to the manufacturer having consulted the operators and given a close study to operating conditions in the North before producing the machine. There has been in the past too great a tendency for the manufacturer to tell the operator what he requires, instead of asking what is required and then doing his best to produce it. The Norseman is a high wing monoplane having a tubular steel fuselage and empennage with wooden wings, all components being fabric-covered. The chief characteristics of the Norseman are its rugged construction, and improved cruising speed over equivalent machines in use at this time. By actual test on operations on a long haul route over a period of 244 hours flying, the cruising speed was 128 miles per hour on floats.

Table I is a tabulation of machines used by Canadian Airways on northern transportation from 1926 to date. The makers of the aircraft may take exception to the cruising speeds as being lower than that indicated when performance tests were made to obtain the type certificate. The operator, however, is more concerned with the actual speed made good on operations, rather than theoretical speeds, or speeds obtained under optimum conditions when type tests are carried out. The tabulated speeds are those actually obtained over a long period of operations and obtained by dividing the total miles covered by the flying time. This method of arriving at cruising speeds may be unjust to aircraft powered with supercharged engines whose optimum cruising altitude is over 5,000 ft., but except on long hauls, operations are rarely carried out at this height. On the other hand, on the majority of northern operations where it is unsafe to indulge in instrument or blind flying through lack of aids to navigation, it is often impossible to reach optimum cruising altitude due to clouds or poor visibility from other causes. The operator, however, is only interested in the performance he actually obtains as it is on this he has to base his costs.

A glance at this tabulation shows that the effective cruising speed in ten years has only increased on the latest Canadian machine in operation 40 m.p.h., and since 1928 only 25 m.p.h., and on the majority of machines in use since 1928 only 17 m.p.h. The increase in disposable loads, except for the Junkers JU-52, since 1928 has been negligible. The increased speed has been obtained principally by increased horsepower and not by improved aerodynamical

Table 1

Aircraft		Engine		Weight Empty			Weight Loaded		Weight Disposable		Passengers	Crew	Average Cruising Speed	Date
Make	Type	Make	Type	H.P.	L.P.	S.P.	L.P.	S.P.	L.P.	S.P.				
Fokker	Std. Universal	Wright	J-5	200	2,300	2,500	4,000	4,000	1,700	1,500	4	1	80.88	Dec. 25 1926
Fairchild	FC2W2	P & W.	Wasp	410	2,990	3,125	5,500	5,500	2,510	2,375	6	1	92.45	June 1928
Fokker	Super Univ.	"	"	410	3,250	3,650	5,500	5,500	2,250	1,850	6	1	95.87	July 1928
Junkers	W. 34	"	Hornet	525	3,550	3,650	5,960	5,510	2,410	1,860	7	1	98	May 1929
Bellanca	CH 300	Wright	J-6	300	2,475	2,810	4,075	4,610	1,600	1,800	5	1	99.6	Nov. 1929
Bellanca	Pacemaker	"	J-6	300	2,365	2,900	4,300	4,835	1,935	1,935	5	1	99.6	Nov. 1929
Junkers	JU-52	BMW	VII au	610	8,360	9,480	15,875	16,535	7,515	7,055	(up to wt. cap.)	2	76.84	Oct. 1931
Junkers	W. 33	Junkers	L. 5	310	3,760	4,020	6,600	6,600	2,840	2,580	8	1	91.78	Feb. 1932
De Havilland	Fox Moth	Gipsy	Major	120	1,250	1,270	2,100	2,100	850	830	3	1	78	Mar. 1933
De Havilland	Dragon 84	" (2)	"	2 x 120	2,610	2,775	4,500	4,500	1,890	1,725	8	1	96	May 1933
Fairchild	71	P. & W.	Wasp	410	3,230	3,490	5,500	5,500	2,270	2,010	6	1	92.45 (c'vtd.)	Feb. 1935
De Havilland	Dragon Rapide 89	Gipsy 6	Major	2 x 185	3,550	..	5,500	..	1,950	..	8	1	123 (wheel oper.)	Sept. 1935
Fairchild	Super 71	P. & W.	T1D1(Wasp)	525	4,320	4,530	7,000	7,000	2,680	2,470	8	1	94	Dec. 1935
Fairchild	82	"	SC1 "	450	3,649	3,705	6,325	6,325	2,685	2,620	9	1	100	Feb. 1936
Fairchild	71C	"	Wasp	410	3,310	3,660	6,000	5,900	2,690	2,240	6	1	92.45 (c'vtd.)	June 1936
Stinson	Reliant	Lycoming	R680-B5	245	2,590	2,800	3,750	4,000	1,160	1,200	4	1	98	July 1936
Fairchild	82	P. & W.	S3H1(Wasp)	550	3,840	4,055	6,325	6,325	2,485	2.270	9	1	101	Sept. 1936
Junkers W. 34	W. 34	"	SC1 "	450	3,700	3,850	6,600	6,600	2,900	2,750	8	1	96 (converted)	Dec. 1936
Junkers	JU-52	Rolls-Royce	Buzzard	920	9,725	10,100	16,755	16,540	7,030	6,440	(up to wt. cap.)	2	89	Mar. 1937
Junkers	W. 34	P. & W.	S3H1(Wasp)	550	3,678	4,032	6,600	6,600	2,922	2,568	7		106 (converted)	May 1937
Noorduyn	Norseman	"	S3H1 "	550	3,930	4,185	6,450	6,450	2,520	2,265	9	1	121	May 1937
Noorduyn	Norseman	"	SC1 "	450	3,785	4,050	6,450	6,450	2,665	2,400	9	1	114	Dec. 1937

efficiency of the machine. In comparison with the increase in performance and efficiency of commercial aircraft in foreign countries, this is most disappointing, but the reasons are obvious.

The United States and all of the major European nations realized many years ago the importance of aircraft, not only for national defence but also for trade and commerce, and have heavily subsidized not only the

Fig. 2—Fairchild Super 71 Skiplane at the Hudson Bay Post, Lake Manowan, P.Q.

operator but the manufacturer by competitions for high performance military aircraft, the winner being given substantial orders. The knowledge gained thereby has been applied to commercial aircraft suitable for the country in question and services required. In some cases subsidized operators have been able to build up sufficient reserves to place orders with manufacturers to design machines for their requirements. Imperial Airways and Pan American Airways are notable examples.

The production of a new type machine is not only slow but extremely costly and only justified where there is a demand for a considerable number of that particular type.

In Canada, where the demand is comparatively small and where several types are required, the situation is aggravated, and if the Canadian operator is to obtain efficient machines for northern transportation at a reasonable cost, some form of assistance is necessary. It is suggested that this might take the form of an annual subsidy of a moderate but adequate sum of money to be used for the design of aircraft suitable for northern operations.

The operation of northern air transportation can be compared to branch lines on railroads where it is customary to handle mixed loads of mail, freight, express and passengers, stopping at every intermediate point to discharge and embark traffic. Speed is, therefore, of secondary consideration to load carrying capacity and economical operation. Speed, nevertheless, remains a very desirable feature where it is obtained by improved aerodynamic qualities in the machine for a given power and payload. The faster machine is cheaper per mile and can accomplish more work in a given time. Speed gained by increased engine power alone is not economical.

In the design of a general purpose aircraft for "bush" lines, the following points require consideration:

The machine should be a monoplane designed primarily as a seaplane. Opinions differ as to whether it should be a high or low wing type; both have their advantages. For passenger carrying, photography, sketching and reconnaissance, the high wing monoplane has the obvious advantage of better visibility for the passengers, camera operator or observers. It also has the advantage of greater clearance for the wing when approaching high docks. When approaching floating or low docks the high wing is a disadvantage in that it is usually too high to be caught by the mooring party, should it be necessary to give assistance in high winds. The high wing also permits easier loading in that the trailing edge of the plane in no way obstructs the loading door.

The advantages of the high monoplane are the drawbacks of the low wing type. The mainplanes block the downward vision from the cabin, and unless the machine is of some size and has a considerable dihedral angle there is danger of fouling high docks or mooring posts on the docks. The trailing edge of the wing usually comes close enough to the back loading door into the cabin, to interfere with the loading of pieces of freight which are difficult to handle. The low wing type is easier to handle in high winds on the ground; the mainplanes are less liable to serious damage in event of an under-carriage failure, and some authorities claim are aerodynamically more efficient.

The cabin should be roomy so that the full payload can be carried when the freight to be transported is bulky. In present day machines there is seldom sufficient space to carry a maximum load by weight of bulky but light articles such as parcel post or furs. It should also have sufficient length to carry the ordinary run of drill rods, lumber et cetera. As this machine is to be used for mixed loads of passengers and freight the cabin should be divided by a removable partition; the forward part to accommodate four passengers in comfortable chairs; the rear part for baggage, mail, et cetera. This partition, however, must be easily removable, so that the full cabin space can be utilized for long pieces of freight when required. The floor must be reinforced to withstand the concentrated weight of heavy machinery and the walls protected from damage. There should be doors on each side of the cabin, fore and aft, to facilitate loading and unloading on either side of the machine. One of the doors at the rear into the freight compartment should be 4 by 5 ft. or as large as the construction of the machine will allow, to facilitate loading of bulky pieces of freight. A roof hatch should be incorporated in any aircraft to be used for freighting, as it permits the use of a derrick for loading and unloading difficult pieces. This hatch should be as large as possible, and as it is not continuously required it would be possible to design it as a stressed part of the airframe. The dimensions of the cabin should be approximately 15 ft. long, 6 ft. high and 4 ft. 6 in. wide. In addition there should be a separate compartment of at least 36 cu. ft. for the storage of emergency supplies, such as rations, sleeping bags, heaters, oil pails, etc. This compartment must have an entrance from the outside of the machine so that admission through the cabin is not necessary.

The cabin should be well ventilated to permit of its being kept cool in summer and conversely well insulated and heated to keep it warm in winter. Both the ventilating and heating systems should be capable of control by the passengers.

The pilot's cockpit should be designed with the maximum of comfort for the crew and have complete dual control incorporated. As the machine being considered is for general purposes and may, therefore, be used on photography where accuracy of flight lines are essential, particular attention should be paid to forward visibility and a window should be incorporated in the floor between the pilot's legs, to obtain a clear view of the ground directly beneath the machine. It is considered essential that the side windows, on both sides, be made to open for ventilation and to assist visibility in the event of the windows becoming frosted or oiled up. Some adequate system of defrosting should be provided but as defrosters are not infallible, windows to open must be provided as an additional safeguard. Adequate heating must be provided for winter flying.

In the past instrument flying has not been used to any extent on northern transportation, but undoubtedly it will be in the future, possibly sooner than is indicated today; therefore, more attention must be given to the layout of the instrument panel than has been in the past. The instrument panel can be likened to the nervous system in the human body and must function right, otherwise the consequences may be disastrous. Opinions differ as to the best grouping of instruments, consequently there is no standard lay-out. This is a feature to which designers might pay more attention, as it would materially assist pilots in taking over new types of aircraft, if they did not have to get accustomed to a new distribution of instruments. It is axiomatic, however, that the navigating instruments should be grouped so that they are readily seen by the pilot without his eyes having to wander all over the panel. Some prefer these instruments to be directly in front of the pilot on the left hand side of the cockpit, but for dual control machines where a co-pilot is carried, a better arrangement is in the centre of the panel on a level with the eye. In this position both pilots can readily see them. The tachometer should also be easily read from either seat; the position of the remainder of the engine instruments being of secondary consideration.

Generally speaking there is room for great improvement in the installation of instruments, particularly the compass, which in some cases appears to have been placed in the cockpit anywhere as an afterthought. Next to the airspeed indicator, bank and turn indicator and rate of climb indicator, there is no more important navigating instrument than the compass, for without it on many occasions the pilot is as helpless as a blind man. It is of prime importance that the aircraft manufacturer pay more attention to the location of compasses, so that the interference from electric wiring, generators, et cetera is not so great that corrections cannot be made.

With the exception of the all metal Junkers aircraft, the mainplanes of most aircraft in northern service have either box or solid wooden spars, and although very satisfactory, they have one serious drawback. Regardless of how efficient a pilot may be, at times he is forced to land on snow or ice conditions which cause an undercarriage failure. On these occasions, particularly in low temperatures, it is very common for the resultant shock on the wing tip to break the main spar. At any time the splicing or replacing of a main spar is a costly major repair, and when this has to be done in the open or under improvised shelter many miles from the railroad the difficulties and costs mount very considerably. Cases are known where the obstacles have been so great that it was cheaper to abandon the machine. Junkers aircraft have been subject to as many undercarriage failures as any other type of aircraft in the North, but no serious structural damage has ever been done to the wings due to their having metal tubular spars, which will bend without fracturing, and regain their normal position once the weight is taken off. In the course of time the operator would be saved thousands of dollars, if this safety factor were to be incorporated in fabric covered mainplanes, by using metal spars. The initial cost of a metal spar would be higher than a wooden spar for the same purpose; this extra cost, however, should be more than taken care of by decreased maintenance.

The tail plane should be of cantilever design, there being considerable risk in damaging bracing wires or struts on the externally braced type. Trimming tabs should be incorporated in preference to an adjustable tail, care being taken that the controls are not subject to freezing from spray.

The land undercarriage should be especially designed for winter conditions in Northern Canada. In the past most machines used in the North have been designed for operations as land machines flying from prepared aerodromes on wheels, and whereas for this purpose they may be quite suitable, generally speaking for northern operations on skiis, they have been lacking in shock absorbing qualities and consequently strength. Every winter there are undercarriage failures, through no fault of the pilot having to land on surfaces too rough for the undercarriage to withstand. It is costly enough to have to repair an undercarriage many miles from steel where all parts have to be specially taken in by air, and when one considers that a failure of this type usually causes serious damage to the frame of the machine, such as broken tubes or spars, the situation is aggravated. In a few cases undercarriage failures far from steel have done sufficient damage to cause the complete loss of the machine due to insurmountable difficulties in repairing the machine under existing conditions. It can be seen therefore that too much care cannot be given to the design of the undercarriage. It has been shown by experience that the most satisfactory shock absorbing device is an oleo strut which should have at least a ten inch travel.

In the design of oleo legs for use with skiis it should be borne in mind that these must withstand the downward shock load of the full weight of the ski on a bounce. Due to normal lag, when a machine leaves the ground suddenly by bouncing off drifted snow, the oleo leg does not fully extend until the ski is clear of the snow. The resulting impact load, when the oleo leg reaches its limit of extension, is very heavy and on occasion has been known to break a 1,200 lb. check cable.

Float undercarriages have fortunately given little trouble from breakages. They have, however, too little leeway for adjusting the rigging of the floats to take care of the idiosyncrasies of individual machines. Cases occur from time to time where a machine one year may perform satisfactorily on a given set of floats, and the following year on the same set of floats have a very poor performance. When this situation arises it is extremely difficult to correct through there being insufficient adjustments possible on the struts or fittings to alter the rigging on the floats. In some cases a different pair of floats will solve the difficulty, but it should not be necessary to do this, if when designing the floats and undercarriage attention were paid to this feature.

Fig. 3—Winter operating base at Oskelaneo, P.Q. Fairchild 71C and Junkers W34, also loading crane, winter engine covers, radio masts, etc.

In designing the undercarriage care must be taken to see that the tread of the floats is wide enough to permit the use of a 6 in. lens when the machine is used for photography. In the past this has not been the case, with the result that certain machines cannot be used for photography with cameras fitted with a wide angle lens.

The floats should be of all metal construction, internal wooden formers having been found unsatisfactory except when comparatively new. In time these wooden formers rot from moisture and the maintenance costs become excessive. Design should be such that running repairs to any part of the skin can be made by working through the regular inspection holes. These inspection holes must therefore be so spaced that any part of the float can be reached by the length of an average man's arm.

Adequate reserve buoyancy at the stern is desirable. It appears to aid stepping of the float, is important when loading the machine, and in the event of heavy snow accumulating on the rear of the fuselage and tail plane during the night may be instrumental in preventing the machine from sinking at the mooring.

The float rudders to be effective must be below the level of the float bottom. They must also be easily retracted from the pilot's cockpit, and so designed that jamming of the float rudders does not prevent the free movement of the air rudder. This is usually taken care of by spring loading the float rudder cables.

When one considers that during approximately five months of the northern operating season all operations are conducted on skiis, their importance can readily be appreciated. To date manufacturers and aeronautical engineers have not given sufficient thought to ski design, and the ski as used universally in the North is the result of trial and error coupled with the experience of the operating companies. The results have been surprisingly good, but aerodynamically great improvements can be made.

With one exception skiis as used by Canadian operators are constructed with wooden bases. The greater the ratio of length to breadth the lower is the running coefficient of resistance and sporting skiis have a ratio as high as 30 to 1. This ratio is reduced on aircraft for ease in turning and the ratio used is mostly between 4½ and 5 to 1, and loaded from 160 to 175 lb. per sq. ft. The conventional type of ski is laminated ash, copper riveted, having three or more brass covered runners on the bottom to protect the wood from damage on rough ice, stones and concrete aprons in front of hangars.

A large part of the total resistance of a moving ski is due to rubbing friction, therefore the choice of material for the runners is of prime importance. Dural, aluminum, stainless steel, brass and wooden runners have all been tried; none of them, however, are satisfactory under all conditions. The most satisfactory to date has been brass. One of the weaknesses of metal shod runners is the ease with which the metal becomes damaged running over broken ice, thinly covered rocks, et cetera, necessitating too frequent replacements of the covering, and often the replacement of the wooden runner beneath the metal covering. Scratches and gouges on the metal coverings also, greatly increase the resistance.

One ski manufacturer in Alberta endeavoured to solve this problem by using uncovered iron bark or iron wood runners, which worked most satisfactorily in the North West Territories. Not only was there less running friction, but the iron bark runners after two seasons hard usage showed no signs of wear. A set of these skiis was tried out at Sioux Lookout, Ontario, but due to the different quality of the snow, once the ski came to rest for only a comparatively few minutes, the effort required to again get the aircraft moving was so great that this type of runner was discarded. The difference in performance was due to the snow in the North West Territories being drier than in Ontario. Generally speaking, the drier the snow the less the rubbing friction of the ski, although in extreme cold when the snow is very crystalline this rubbing friction increases considerably. Due to the great variation of the snow in different localities it is doubtful whether a satisfactory runner to suit all conditions will ever be obtained.

One ski manufacturer in Vancouver has had considerable success in making sporting skiis of laminated bakelite and wood with bakelite bottoms. Reports indicate that in the soft, wet snow in both British Columbia and Quebec these skiis are a great improvement over the standard wooden skiis. Not only are they stronger, but have less tendency to stick than the waxed skiis, and have the added advantage that they do not have to be repeatedly treated with wax or any other preparation. They have not as yet been tried on aircraft or in extreme cold as encountered in the Far North. It is hoped to test a set of these skiis on aircraft this winter.

The greatest resistance is encountered with heavy wet snow, it being impossible at times even with a lightly loaded machine to get up sufficient speed to take-off. These conditions are of course a great hindrance to ordinary toboggans and sleighs as used with dogs and there are various methods of overcoming it. In Northern British Columbia some of the oldtimers used to take with them a mixture of tar and pitch, with which they used to treat the toboggans. The Eskimos use frozen mud runners which they ice periodically by spraying on water and obtaining a polished finish by stroking it with a piece of polar bear hide or any nonfrosting fur. The system of waxing sporting skiis is well known and effective, but none of these methods are practical with aircraft on northern operations, so it is suggested that research into the possibility of impregnating wooden runners with wax or some other preparation to prevent skiis sticking on snow is justified.

Trimming gear has to be used to keep the ski in proper attitude to the line of flight and for landing. The conventional type consists of flexible cable attached to the front and rear of the ski. In the forward cable is incorporated one or more strands of shock absorbing cord to hold the front of the ski, slightly above the horizontal, the rear cable being used as a check to prevent the nose of the ski being pulled too high by the shock cord. Although this trimming device serves its purpose it is crude and aerodynamically inefficient, creating so much resistance that the average machine is faster on floats than skiis. It has the added disadvantage of having to be detached every night to prevent the shock cord losing its elasticity.

Squadron Leader A. Ferrier, A.M.E.I.C., of the Department of Transport, has designed an internal trimming device for holding streamline skiis in the correct position relative to the line of flight under all conditions. This device works on a cam and roller principle operated automatically in such a manner that when the aircraft is in flight the skiis are positively locked in their proper position, but when the aircraft is on the ground and flexibility of ski position is required the cam and roller action has a slight movement allowing the ski to change its angle approximately 15 deg. on either side of the vertical. Such a device appears to be easy to manufacture, is light in weight, should be trouble-free, and due to its location have no drag which would retard the speed of the aircraft when fitted with skiis.

During the past few years the National Research Council in co-operation with the aircraft manufacturers and The Royal Canadian Air Force have been developing a self aligning streamline ski, based on the principle that a streamline form aerodynamically sound should maintain its correct attitude in relation to the line of flight. Good progress has been made and self aligning streamline skiis have been flown satisfactorily under aerodrome conditions, but it is felt in some quarters that this type of ski should be rigorously tested under northern conditions, to thoroughly try out the construction under commercial conditions. The ski bottoms are made of wood with plywood covering, and experience to date has shown that plywood covering on

Fig. 4—Air mail being loaded into Fokker Super Universal.

Fig. 5—Ore cars being loaded into a Junkers JU52.

skiis is too subject to damage, causing the interior to fill with snow and slush, making the skiis abnormally heavy. The flat wooden ski as used today is quite flexible and tends to conform to uneven snow conditions and has a certain amount of give when travelling over drifted snow. The streamline ski being rigid would not do this and it is felt by some that on account of this when made of wood rigid skiis would not stand up to the strenuous service demanded in the North.

Probably the most efficient ski that has yet been used commercially in Canada is the all metal streamlined ski with internal trimming device, manufactured by the Lockheed Aircraft Corporation, Burbank, California. This ski was designed for use on the Lockheed Electra 10A in Alaska. It is an outstanding example of what can be done when funds are available, and trained engineers collaborate with an operator. The skiis are aerodynamically so efficient that even on a high speed aircraft, with folding undercarriage, the machine with a fixed undercarriage was only reduced in cruising speed approximately five miles per hour. When installing the skiis the folding undercarriage is removed and the skiis attached to the machine by means of a specially designed and streamlined undercarriage having an oleo shock leg with 10 in. travel obviating the necessity of a shock absorbing pedestal. The outstanding feature of these skiis is that they are loaded approximately 450 lb. per sq. ft., or more than double the normal loading in use in Canada. These skiis were tried out between Winnipeg and Red Lake alongside standard skiis in general use, and in spite of the heavy loading, they performed more satisfactorily in very heavy slush than the lighter loaded standard skiis. This type of ski is giving equal satisfaction in Alaska under very different snow conditions, and leads one to believe that the standard loading of skiis in Canada could be materially raised, thereby reducing the weight of ski and correspondingly increasing the payload. The Lockheed skiis are very expensive in comparison to wooden streamlined skiis, but if produced in quantity, as would be required in Canada, the price should be materially reduced.

The dimensions of these skiis are:

Main Skiis:

Overall length. . . . . 15 ft. 10 in.
Greatest width . . . . . 1 ft. 7¼ in.
Bearing surface at rest 5 ft. 5⅜ in. x 1 ft. 7¼ in.

Tail Ski:

Overall length . . . . . . 4 ft. 4⅜ in.
Greatest width. . . . . . 9 in.
Bearing surface at rest 3 ft. 0 in.

On the conventional ski many types of pedestal are in use. Solid wood, built-up wood, built-up sheet steel, built-up aluminum alloy sheet, welded tubing and various types of shock absorbing pedestals such as welded tubing using rubber shock cord, aluminum alloy cast pedestal with oleo cylinder and piston of a similar type to those used as shock absorbing devices for undercarriages. One would have thought that by now, in a country where aircraft skiis are more extensively used than in any other country, with the possible exception of Russia, that our manufacturers and designers could have produced a satisfactory and more or less standard type of ski pedestal. It is another indication of what little thought has been given to the design of aircraft components for the Canadian operator. Most pedestals in use have their good points. Generally speaking the solid or non-shock absorbing pedestal has proved the most satisfactory, and of these except for their weight the wooden pedestal is better, being more easily streamlined, stronger, and cheaper. There should be, however, a great future for a streamlined, reinforced sheet steel or sheet aluminum alloy pedestal which will stand up to the severe strains to which it is subjected. The non-shock absorbing steel tube pedestal is satisfactory except for the difficulty in streamlining, and without streamlining the drag is not only serious, but snow and slush tends to lodge and build up at the base of the tubes.

The steel tube shock absorbing pedestal is of such a height that breakage of tubing occurs too frequently, and due to its flexibility when turning in soft snow the inside ski has a tendency to cut in, sometimes to an alarming extent. Failures are also quite frequent in the larger sizes of cast aluminum pedestals.

If the Canadian aircraft manufacturer would take the trouble to provide the operator with long travel oleo shock absorbing struts on the undercarriage, there would be no need for the added expense and troubles coincident with shock absorbing pedestals. A minimum travel of 10 in. is required, the extra cost of which in comparison to a 6 in. travel leg or a shock absorbing pedestal is slight. Some manufacturers advance the argument that a 10 in. travel would cause the machine to roll too much when on wheels; there is no reason, however, why the air pressure in the oleo could not be decreased to take care of this. Not long ago Canadian Airways took delivery of some English twin-engined De Havilland machines in which the undercarriage did not have sufficient shock absorbing qualities for use on skiis. The Canadian agent on request immediately obtained new shock absorbing struts with sufficient travel, which have been so effective that no repairs were required on the machines at the end of the season, whereas machines working alongside equipped with standard undercarriages required considerable repairs. If it can be done for one machine there is no reason why it cannot be done for another.

The location of the pedestal on the ski is of considerable importance. If the pedestal is located too far forward the ski has a tendency to push snow ahead of it on occasion, seriously increasing the resistance to the ski and consequently its efficiency for take-off. Generally speaking the farther back from the centre of the ski the pedestal is placed the less tendency is there to pack snow ahead of the ski. If, however, the pedestal is moved too far back the pitching moment of the ski presents a problem and a compromise has to be made. For average snow conditions a satisfactory location for the pedestal is over the centre of the ski, for this not only reduces the pitching moment to a minimum, but does not tend to unduly push snow ahead of the ski. For conditions of wet, heavy snow as encountered in some localities a satisfactory position has been found to be 55 per cent of the length of the ski measured from the front at the point where the ski begins to bear on the snow.

The National Research Council during the winter of 1935-36 carried out tests to investigate the snow characteristics of aircraft skiis, the results being published in a most interesting Interim Report by Mr. G. J. Klein, Division of Mechanical Engineering. The tests were carried on last winter but were handicapped by lack of snow. The Research Council is to be commended on their efforts, and it is hoped the tests will be completed and result in the production of more efficient skiis for northern operations.

For Canadian conditions the manufacturer does not appear to have given sufficient thought to engine cowlings. Modern low drag cowlings for radial motors are seldom designed with the requirements of seaplane and winter operation in mind. They permit engines to overheat dangerously during prolonged slow running on water and provide inadequate control of airflow for very cold weather. This problem is becoming increasingly serious for summer operations on floats with air-cooled motors which are being designed for high speed aircraft in which it is easier to obtain an adequate airflow, than it is with a slower machine. The ideal cowling should have sufficient control to not only cool the motor in summer, but also be sufficiently airtight in winter to render it unnecessary to cover the engine with a tarpaulin when stopped for a short while in order to prevent it from cooling too rapidly. This is probably one of the most difficult problems facing the designer of aircraft for Canadian use, but it should be possible to make improvements over existing cowlings if more thought and research were given the problem.

Apart from there being insufficient cooling control on most cowlings, the maintenance on them is excessive through cracks and breakages due to too light gauge material being used. Aircraft designers seem to feel that weight must be saved at all costs in all components not subjected to structural stress or strain. In principle this is undoubtedly correct and the operator will probably always expect more payload than the designer can give him, but there is no economy if the revenue derived from a few pounds extra payload is more than used up in added maintenance, and lost time taken for the repairs.

Bullets, grommets or other fastening devices usually give trouble due to their flimsiness, and to overcome this the latest types of cowling fasteners as used by American manufacturers should be used. These fasteners must positively lock the cowlings to the engine bearers or airframe and at the same time should be easily removable on winter operations with gloved hands. On some of the later types of aircraft cowling fasteners have so far given satisfactory service and can be easily removed with a screw driver. There are a good many cases, however, where the pilot may want to remove cowlings and where the tool kit cannot be easily reached. This is particularly important in case of fire. For this reason a fastener easily operated without the use of tools is advisable.

It is not proposed to deal at any length with various types of engines; there are, however, a few remarks which are applicable generally to engines for northern air transportation in Canada. The aircraft designer is demanding and consequently the engine designer is producing engines suited to high speed aircraft normally operating at considerable heights, and in the near future long range air transportation will be carried on at heights of 25,000 ft. and even higher as technical advancements are made. Engines for this type of work are supercharged and have high compression ratios. On northern air transportation where flights are comparatively short and operating altitudes low, these engines are not suitable. It would be equivalent to using a thoroughbred horse for farm work.

Engine manufacturers, unfortunately, do not seem to appreciate this, for they continue to extol the merits of their engines having 6.5 to 1 or even higher compression ratios, pointing out that these engines operate successfully on 80 octane fuel as generally used in Canada. These engines would and do operate satisfactorily on this fuel on wheels, where acceleration is quick and take-off time short. They will not, however, stand up when used on slow aircraft on skiis or floats where acceleration is much slower and take-off time very much longer, with consequently less efficient cooling of the motor. The use of high compression engines on bush operations has invariably been followed by excessive cylinder, piston and spark plug troubles. Theoretically, possibly, these troubles should not develop, the fact remains that they do, and experience has shown it is inadvisable to use air cooled motors with a compression ratio of higher than 6 to 1. This seems to be an ideal ratio for bush operations and the newest types of motors are now giving 600 hours between overhauls—a remarkable performance when one considers the rough usage they get and that only ten years ago radial air cooled motors required overhaul after 225 hours.

A moderately supercharged engine is desirable for it gives added horsepower for take-off, can be used to advantage at altitude on longer flights, and gives no trouble if carefully handled and the recommended manifold pressure not exceeded. Where more power, however, can be taken out of the motor than it can continuously stand, pilots are prone to take advantage of this fact, particularly under poor conditions for take-off, with resultant damage to the motor.

What promises to be a most useful development in engines is the radial air cooled sleeve valve motor developed by the Bristol Aeroplane Company in England. These use a single sleeve type valve and obviate the necessity of frequent servicing which is both expensive and inconvenient in bush operations. One of the greatest troubles with high performance engines has been caused by valve trouble through the use of heavily doped fuels and higher speeds of rotation. The sleeve valve offers a solution.

Fig. 6—Emergency case brought out in a Fairchild 71C.

It is unfortunate from the standpoint of northern operations that the development of medium sized liquid cooled motors has been neglected, and it is doubtful if there is available today a satisfactory water cooled motor of 450 to 550 horsepower. There are on the market very excellent high powered watercooled motors, which however, are too large for the average machine used in Northern

Canada. It is significant that the Russians on their Polar exploration flights, and through Siberia are using liquid cooled motors. The old disadvantage of leaks in the cooling systems of liquid cooled motors is a thing of the past. Canadian Airways have operated Junkers and Rolls-Royce liquid cooled motors and have found them much easier to handle on bush operations both in summer and winter. Their reliability is as good as the best air cooled motors and their maintenance costs are lower. The extra weight per horsepower is more than counteracted by simplicity of cowling and temperature control over a very wide range.

Diesel motors have given very interesting results, particularly in Germany. At present their chief value lies in long range operation where the extra weight of the motor is offset by the lower fuel weight. There is also the obvious advantage of lessened fire hazard, particularly in the event of a serious crash. Some authorities, however, feel that with the advent of high performance gasoline motors and fuel of very high octane rating, the advantage of the Diesel motor on long flights is considerably lessened.

Insufficient attention has been given in Canadian aircraft to care and speed in changing engines. At present it is a laborious process, taking the best part of a day and under difficult conditions in the North even longer. When this is compared to the ease and speed with which motors are changed on transports used in the States, it is not very flattering. Engine mounts should not be welded to the fuselage, but be quickly detachable by the removal of four bolts or taper pins, so that the engine and mount can be removed and a new mount and engine installed with a minimum loss of time. To facilitate this it should be possible to bring all engine connections such as oil, gas and water lines, electrical connections and controls to the fire wall and simply hooked up to the opposite numbers on the airframe.

Engine designers should do everything possible to make the oil screens more accessible. Today in most installations one of the most troublesome items of maintenance for the mechanics is to remove the oil screens for cleaning and inspection. This is particularly true on winter operations where oil screens often have to be removed in the open with bare hands in temperatures many degrees below zero. Under these conditions maintenance crews have a tendency to pass up examination of oil screens, increasing the danger of sudden bearing failures, which could have been caught in time to prevent any serious damage, had the oil screens been easily removable and examined regularly.

Probably the greatest inconvenience in northern air transportation in winter is the necessity of having to drain the oil each night and warm it and heat the motor in the morning before starting. Where electric power is available it is comparatively easy to keep the motors warm with ordinary strap heaters, but it is still common practice to drain the oil. Immersion heaters for oil are satisfactory in machines which have suitable tanks; the Lockheed Electra is an example.

Various experiments have been tried to obviate the necessity of heating the motors by using very light grade oils, but generally speaking these have not proved satisfactory in Canada. The Mechanical Engineering Staff of the United States Army Air Corps have for some time been investigating this problem and have devised a very ingenious method for starting motors without the application of heat, and have experienced no difficulties in starting cold motors in temperatures as low as −20 deg. F.

In sub-zero temperatures the viscosity of normal oils is so great that it is often impossible to even turn the engine over using man power on the tip of the propeller, which affords considerable leaverage. The system employed to overcome this by the U.S. Army method is to supply oil to the engine diluted with gasoline to the proper lubricating viscosity for sub-zero temperatures before the engine is stopped. When oil is diluted in this manner and poured through the engine before stopping, no heat is required for re-starting the motor even after long periods in sub-zero temperatures. A detailed description of this system and the necessary apparatus and accessories is

Fig. 7—Fairchild 71C with two canoes loaded ready for delivery.

given in a paper prepared by Weldon Worth, Assistant Mechanical Engineer, United States Army Corps, and published in the S.A.E. Journal for July 1937. It is hoped that this method can be used for Canadian operations.

Northern Canada is bountifully supplied with lakes and rivers which make natural landing grounds both summer and winter. For most localities a single engined machine is preferable. It is, generally speaking, more economical to operate and has the advantage of only one engine to maintain and service. This is a distinct advantage in winter when the time required to heat the motor and oil before starting is considerable, and naturally adds to the expense of operations. This advantage will, of course, disappear when a satisfactory method is devised of starting engines when cold. There are, however, a few routes which to comply with Air Board Regulations necessitate the use of twin-engined aircraft. There is also the psychological effect of added safety on passenger services. On account of this, and as the demand for twin-engined aircraft will increase, any machine for general purpose work in Northern Canada should be so designed that it will take either one engine in the nose or two smaller engines in the mainplanes.

As to the performance characteristics of a general purpose machine, if a questionnaire were issued to the various operators there would probably be a fair unanimity of opinion as to load characteristics but a wide divergence on speed. If speed can be obtained without unduly adding to the initial cost of the machine and is attained by aerodynamical efficiency rather than increased engine power, the importance of speed cannot be overstressed, for the operating cost per mile is in direct proportion to the miles covered in any given time. This does not only refer to so many miles per hour, but to so much work accomplished per day, for the operators' overhead costs are fixed regardless of the number of hours flown. It, therefore, follows that the more trips per day flown the more economical the operation, and the number of trips completed particularly on a freight operation is partly dependent on the ease of loading, unloading and running maintenance required on the machine. This in turn is dependent on the thought and care put into the design of the aircraft and is nearly as important as speed. As an example the Junkers JU-52 operated by Canadian Airways and carrying two and a half tons payload can be and is loaded in fifteen minutes, and unloaded in less, due to the large loading door and platform. The average machine with a payload of 1,500 to 2,000 lb. except when hauling easily handled freight such as small package goods, takes as long and sometimes longer to load and unload.

In northern transportation due to the competing forms of transportation being so slow in comparison, speed is not as important as on interurban runs competing with automobile and railroad transportation, and for this reason more attention should be paid to ton-mile or passenger-mile costs. Speed in miles per hour is not an economy when

Fig. 8—Fairchild 71C and two Junkers W34 at Goldpines loading fuel oil.

dependent on engine power, and due to Canada's proximity to the United States, where the operators are forced by competition to call for speed and more speed, there is danger of attaching too much significance to this item in aircraft performance.

Canadian operators would do well to study the development of Imperial Airways who have built up an enviable reputation for economy and reliability and did not unduly stress the requirement of speed until the first two requisites of successful air transportation were attained.

The operations of Imperial Airways are far more analogous to operations in Northern Canada than are the interurban operations in the States. It is true that Imperial Airways' operations are of a different character, requiring very different types of machines; it was however on their Empire routes essentially a pioneering effort, stretched over vast distances where unknown obstacles had to be faced and overcome, as in Northern Canada. Under these pioneering conditions, it was economy and reliability of aircraft that was required rather than speed. Having attained this objective Imperial Airways then demanded speed, and have now in operation aircraft, as witness the Empire boats, second to none.

It is suggested that for general air transportation in Northern Canada an economical cruising speed for the immediate future would be 125 to 130 m.p.h. at 65 per cent power at sea level. This speed should be attainable at reasonable cost. If, however, a cruising speed of 140 m.p.h. can be economically obtained without unduly raising the initial cost of the machine or by using excessive engine power and without sacrificing payload capacity, so much the better.

The payload requirements of a machine are dependent on volume of traffic and intensity of schedule, which varies considerably in different localities, and owing to the traffic being largely dependent on mining development, there is a considerable fluctuation in the same locality from year to year. A machine should be of a size that it can be operated as near to capacity load as possible. Competition in the past few years has created an unhealthy situation by increasing the number of schedules and number of machines in various districts far in excess of the traffic requirements. This has educated the public to look upon northern air transportation in much the same light as a taxi service in cities. A customer expects service when he wants it, and is not prepared to wait for an established schedule as he is with railroad or steamship travel, consequently as far as passengers are concerned, if he wishes to retain the business the operator must be prepared to give service at short notice even if a payload is not available.

Freight and express, except perishables, can be held within reason until payloads are available, which is fortunate as it assists in making up payloads when the passenger traffic is light, and warrants the use of a larger machine than is at first apparent. On certain favoured routes where passenger traffic is heavy there is undoubtedly room for a smaller machine to specialize on taxi service and small charter trips, but for most districts the most economical machine should be capable of handling fair sized loads of passengers, freight and mail. For these conditions a machine should have a disposable load on floats of 3,000 lb. This would enable the aircraft to comfortably handle in two compartments four passengers and baggage with 1,000 lb. of express, freight and mail, and on short routes under favourable conditions slightly more.

As already noted the ground conditions in winter are extremely rough, consequently a slow take-off and landing speed is of the greatest importance in winter time to prevent damage to skiis or undercarriage. During summer slow take-off speed is as important on floats to prevent overheating of the motor through an excessively long run on the water to attain flying speed. The machine should be able to take-off fully laden on floats in a flat calm in 25 seconds.

In northern transportation where one cannot safeguard airports from the close proximity of obstacles by zoning restrictions, and where the lakes are often comparatively small with high timber and hills around the shores, a quick rate of climb is very desirable. This should be at least 1,000 ft. in the first minute, and as the machine may be required on photographic operations it should have a service ceiling of at least 17,000 ft.

From the foregoing, the following required specifications are indicated for a general purpose aircraft for northern transportation:

Type: Monoplane convertible land and seaplane.
Power: Single-engined, moderately supercharged air or liquid cooled motor of 500 to 550 h.p. Compression ratio not to exceed 6 to 1.
Twin-engined, each engine sufficient power to take-off and climb to 4,000 ft. on one engine.
Crew: Two.
Disposable Load: 3,000 lb. as seaplane.
Passenger Accommodation: (a) As passenger aircraft—10.
(b) As passenger and freight—4.
Cabin Dimensions: Length 15 ft.
Height 6 ft.
Width 4 ft. 6 in.
Range: Six hours.
Cruising Speed: Sea Level—125-130 m.p.h., 65 per cent power.
Landing Speed: Not to exceed 60 m.p.h. fully loaded.
Initial Rate of Climb: 1,000 ft. per min.
Service Ceiling: 17,000 ft.

As already stated a large volume of traffic has been made available since 1932 by drastic lowering of rates to the customer. A point has been reached, however, where regardless of volume, rates cannot be further reduced with existing equipment. The quantity of airborne freight in the North although considerable, is small in comparison to the volume moved by ground transport. Given more efficient machines there is no reason why aircraft should not entirely supplant ground transportation in the North, except on favoured routes where steamboats can ply or where there are roads the year round. It is as much to the interest of the manufacturer to provide efficient equipment as it is to the operator to increase his business by providing cheaper air transportation, and it is to be hoped that every effort will be exerted to produce more economical machines which will make available to the operator greatly increased volume of traffic, on which both manufacturer and operator are dependent for their welfare.

Some New Developments in Refrigeration and Cold Storage

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Paper presented before the Ottawa Branch of The Engineering Institute of Canada, on February 11th, 1937.

SUMMARY.—Discusses the advantages of "quick freezing," the equipment needed, and the recent developments in gas storage and the control of humidity in storage rooms.

The application of artificial refrigeration to the transport and storage of perishable foodstuffs is of comparatively recent origin. The value of low temperature for preserving perishables has been known since antiquity from the simple fact that they could be kept longer in the winter than in the summer. Certain of the principles of artificial refrigeration, such as evaporative cooling, were probably known to the ancients but there is no evidence to indicate that these were applied to the preservation of foodstuffs.

In the modern sense, the first half of the 19th century saw refrigeration in its embryonic state. During that period the predecessor of our modern ice machine came into being, artificial ice was made in significant quantities for the first time, and artificial cooling had been crudely applied to the preservation of foodstuffs, as judged by modern practice. Many of these early applications of refrigeration were concerned with the transport of perishables, since the meat producing countries such as North and South America, and Australia, were anxious to export their products to Great Britain, where the growing scarcity of meat had become a serious problem. Most of the early attempts were unsuccessful owing to deterioration of the product as a result of inadequate cooling equipment and the comparatively long time necessary for transportation. One of the first reasonably successful shipments of meat was made on the S.S. *Frigorifique* from Buenos Aires to Rouen in 1877. This shipment was organized by Tellier who invented an ammonia-absorption machine in 1859 and a compression machine in 1867.

These events mark the portal to the large structure which now represents the modern science and application of refrigeration. In this paper it is proposed to pass through the completed part of this structure to the region that is still under construction, to examine a few of the additions that are sufficiently advanced to determine their form and significance. Before doing so, however, it is important to distinguish between transport and storage problems. In general, physical conditions that are satisfactory for storage are also suitable for transport, provided such facilities are available on the carrier. The distinction really arises from the kind of product. Briefly, problems of preservation arise with products that are produced seasonally such as fruits. On the other hand, commodities such as beef and bacon are ordinarily available throughout the entire year in a producing country but transport problems arise in connection with their export to foreign markets. Importing countries are primarily interested in transportation, and producing countries in preservation, and since the storage period is generally increased by lowering the temperatures, one finds that lower storage temperatures are commonly used in producing (e.g. America and Russia) than in consuming countries (e.g. Great Britain).

Temperature

Since temperature is one of the most important factors determining the safe storage life, its influence will be discussed first. The temperature range commonly employed for transport and storage varies from 55 to −20 deg. F. depending on the product and the period of transport or storage necessary for successful marketing. This temperature range may be subdivided into three distinct parts. The first may be termed chilled storage for natural products and includes the temperature range from 55 deg. F. to their freezing point, usually about 30 deg. F. Chilled storage is employed wherever the safe storage life of the commodity at these temperatures exceeds the period of preservation required, or where the product, e.g. shell eggs, beef carcasses and large fruits, cannot be frozen without suffering a loss of quality. In this temperature range the safe storage period is usually determined by certain biological changes such as the growth of micro-organisms and physiological changes in the product.

The temperature range from somewhat above 30 to 15 deg. F. is used chiefly for the storage of products to which salt has been added, or water extracted, during processing, e.g. bacon, pickled herring, and fatty substances such as butter. Such products have lower freezing points than natural products, and if necessary can be held at temperatures somewhat below 30 deg. F. without freezing.

For storage in the frozen condition the temperature ranges employed extend from 15 deg. F. to the lowest economically attainable; −20 deg. F. is about the lowest temperature in commercial use for storage purposes at the present time. The exact temperature recommended depends on the product and the period of preservation required. Temperatures above 15 deg. F. are not recommended, since the product is only partly frozen at temperatures above 25 deg. F., while microbiological activity continues slowly at temperatures down to at least 20 deg. F. Furthermore, all the disadvantages of freezing are involved without prolonging the safe storage period nearly as much as at still lower temperatures.

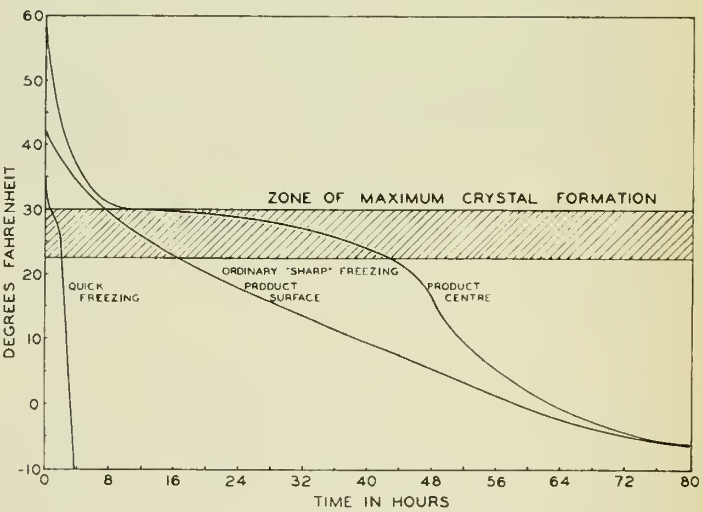
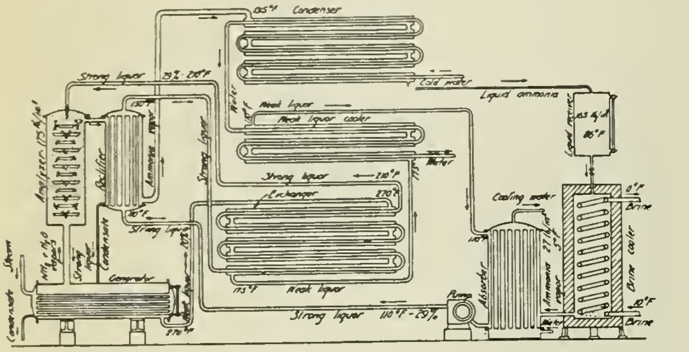


Fig. 1—Freezing rates by "quick" and "ordinary" methods.

Quick Freezing

The need for extending the storage life of commodities held in chilled storage has recently resulted in several new developments. It has been found that certain commodities such as small fruits and vegetables, and cuts of beef, can be frozen without a loss in quality if they are frozen quickly. Quick-freezing implies passing through the zone of maximum crystallization in from thirty minutes to one hour, in contrast to ordinary freezing which requires from ten to seventy-two hours. Figure 1 shows a comparison of quick and ordinary freezing rates. Ordinary freezing is accomplished by placing the commodity in a room at freezing temperatures, the temperature being the same, or slightly lower than the subsequent storage temperature.



(*Courtesy of American Society of Refrigeration Engineers*)

Fig. 2—Single stage absorption machine.

Quick-freezing is accomplished by bringing small packages or pieces of the commodity into contact with plates or immersing them in brine at temperatures of −40 deg. F. or lower, and many modifications of these two general methods are in use.

The advantage of quick-freezing over ordinary freezing is due to the production by the former method of much smaller ice crystals, more uniformly distributed within and between the cells of the product. This results in less destruction of the tissues, with little loss of flavour or weight by drip when the product is subsequently thawed. It is essential that quick-frozen materials should be subsequently stored at relatively low (freezer) temperatures, (e.g. below 0 deg. F.) to prevent growth of the ice crystals during storage, otherwise the real advantage of quick-freezing might be lost. This illustrates one of the reasons for using low storage temperatures, that is, below 0 deg. F., for frozen products.

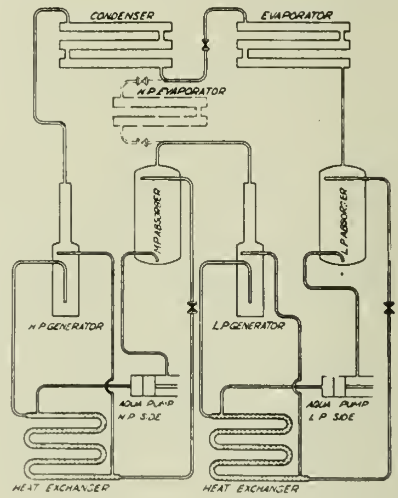
It is evident from these considerations that the food industry requires very low temperatures for freezing, and moderately low temperatures for subsequent preservation. At the present time the conditions are frequently attained with equipment designed to operate at higher temperatures. In some instances multi-stage compressors are employed, and in others rotary booster compressors have been installed ahead of the old single-stage machines. These devices are far from being the last word in low temperature refrigeration.

The Maintenance of Low Temperatures

It is interesting to digress at this point and see how the refrigeration engineer has contributed toward the economical production of these low temperatures. Judging from the papers presented in June 1936 at the 7th International Congress on Refrigeration, it appears that the engineers from nearly all countries are agreed that although low temperatures can be attained by compression methods, the absorption machine is a more practical solution. This conclusion is based on the fact that the relative capacity of an absorption machine does not fall off as rapidly at low temperatures, e.g. low suction pressures, as that of a compression machine. The ordinary compression cycle, in which ammonia and carbon dioxide are the most commonly used refrigerants for low temperature work, needs no description. The absorption cycle differs from this in that the low pressure is produced by the absorption of ammonia in water, while the high pressure is produced by heating the aqueous ammonia. Figure 2 shows a diagram of the absorption machine of about 1932. The first point to note is that it is a single stage machine, and although heat is used on one side to produce cold on the other, the heat exchangers provided are only capable of transferring sensible heat. In other words the heat of condensation and absorption are lost to the cooling water. Furthermore the percentage of water vapour in the gas leaving the rectifier and the percentage of ammonia in the weak liquor used for absorption are such that −35 deg. F. is about the lowest temperature attainable at ordinary steam pressures and condenser water temperatures.

Since 1933 considerable work has been done to increase the efficiency of the absorption machine under ordinary conditions and to modify it for the production of low temperatures of the order −60 to −100 deg. F. The efficiency has been increased by about 100 per cent by making use of part of the heat of condensation and absorption in accordance with the thermodynamic principles laid down by Altenkirch in 1913. A similar increase in efficiency was obtained by adding zinc chloride to the aqueous phase. In order to attain lower temperatures the water has been replaced with lithium nitrate which forms liquid compounds with ammonia; with this system it has been possible to attain temperatures of −85 deg. F. using the usual steam pressures and condenser water temperatures.

Another method of attaining low temperatures has been the design of a two-stage aqua-ammonia absorption machine as shown in Fig. 3. The design of a two-machine that would operate successfully by this method was an engineering achievement. In a two-stage compression machine if one stage exceeds the capacity of the other the interstage pressure rises or falls until a balance is obtained. The same is true in a two-stage absorption machine as far as the ammonia vapour is concerned, but it is not true for the aqueous vapour. If the vapours passing from one stage to another are not rectified sufficiently, a transfer of water between the two stages results, and as these must operate as closed circuits to attain low temperatures, the machines must be carefully designed to avoid this difficulty.



(*Courtesy of Refrigerating Engineering*)

Fig. 3—Two-stage absorption machine.

Machines of this type can attain temperatures of the order of −100 deg. F.

It might be interesting to touch on a new industrial application of low temperature refrigeration which is related to the food industry. As you are aware, dry ice, or solid carbon dioxide, is now used to a considerable extent for the preservation of foodstuffs during transport by truck or in small containers over short distances. Its use for food transport purposes would be increased considerably if its cost could be lowered. For instance, the cooling of railway refrigerator cars with dry ice would be possible if the cost of this material could be reduced to about one cent per pound. At the present time the cost is generally about twice this figure and is due principally to the cost of purifying the gas obtained from coke, or fermentation processes and to the cost of compression. The application of the absorption refrigerator at temperatures below about −70 deg. F. would make it possible to effect the transformation of liquid carbon dioxide to solid carbon dioxide at moderate pressures, thus reducing the cost of compression. This procedure would doubtless also reduce the purification costs. Low temperature absorption plants have already been installed in some of the chemical industries for similar purposes.

Gas Storage

Although proper methods of freezing will extend the safe storage period of certain products that would otherwise have to be kept in the chilled state, this method is not applicable to some commodities as they are handled and marketed today, such as apples, whole carcasses of beef, etc. Present methods of extending the safe storage period of such commodities involve some supplementary method of preservation in addition to reduced temperatures. Fruit and vegetable products are alive, and even at chilled temperatures, respire and produce carbon dioxide. If the storage period of apples, for instance, is to be extended the rate at which these life processes proceed must be reduced further than is possible by reducing the temperature to the freezing point. Investigations made by the Food Investigations Board of Great Britain over the last ten years have shown that this can be done by allowing the carbon dioxide produced to accumulate in the store. The ordinary refrigerated store must therefore be converted into a gas-tight space. Carbon dioxide concentrations in excess of about 10 per cent are, however, detrimental to the product and the carbon dioxide must be kept at about this level by either manually or automatically controlled ventilation. In certain cases the storage life can be extended still further by reducing the oxygen concentration, as well as increasing the percentage of carbon dioxide Since the product absorbs oxygen in the respiration process as well as producing carbon dioxide, it can again be made to produce the necessary conditions. When both oxygen and carbon dioxide are to be controlled the excess carbon dioxide is removed by absorption in a lime suspension, instead of by controlled ventilation which would admit oxygen. As oxygen is absorbed by the product for the production of carbon dioxide the oxygen content gradually falls until a concentration of about 5 per cent is reached, and it can be maintained at this value by controlled ventilation.

An atmosphere containing 10 per cent carbon dioxide will double the storage life of chilled beef. This product, however, is dead and does not produce carbon dioxide except when attacked by living micro-organisms which is the reaction that must be suppressed. Under these conditions the carbon dioxide must be added from tanks, and such a practice is only feasible commercially if the storage space is gas-tight; thus very little gas is required for replacement, after the original charge has been added. This has been accomplished even on ships, and within the last three years the shipment of chilled beef from Australia to England, an eight-week transport period, has become a commercial enterprise as the result of gas-storage.

Control of Conditions

Another factor that must be considered if the maximum storage life of a given product is to be obtained, is the relative humidity. Nearly all products tend to dry out at relative humidities below about 95 per cent. In chilled storage the direct loss of weight may be several percent

Fig. 4—Poultry stored for 6 months at 7.5 deg. F. and 100 per cent relative humidity.

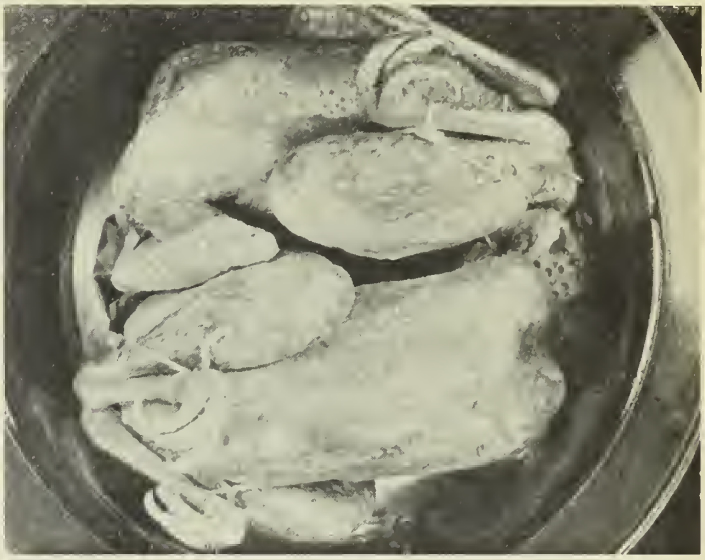


Fig. 5—Poultry stored for 6 months at 7.5 deg. F. and 50 per cent relative humidity.

and result in serious losses. In most instances, however, the greatest loss is caused by the depreciation in quality caused by shrinkage. Even in freezer rooms, at temperatures of 0 deg. F. the surface desiccation may result in a serious loss in saleability. This is illustrated in Figs. 4 and 5, which show the appearance of frozen poultry stored at 7.5 deg. F. for six months over snow, or a relative humidity of 100 per cent, and over a solution that maintains a relative humidity of about 50 per cent. The chickens stored at the high relative humidity are in excellent condition, but those stored at the lower humidity show the uneven surface drying, known as freezer-burns, store-burn or pock marking. At the present time losses from this cause are reduced by wrapping the product in special moisture proof papers, but the final solution of the problem probably lies in the development of a practical method of humidifying freezers. Investigations along this line are now under way at the National Research Laboratories.

In chilled storage rooms the control of relative humidity is intimately related with the control of temperature. Even in some of the better commercial chilled storage rooms, the temperature may differ by as much as 2 deg. F. in different parts of the room even after the product has cooled down. When the stored product produces heat within itself by respiration, even greater spatial variations are observed. Under these conditions it is impossible to maintain relative humidities higher than that about 85 per cent in the warmer regions without risk of condensation in the colder parts. Forced air circulation is commonly employed to reduce these spatial differences in temperature and in modern commercial installations no cooling grids are placed in the room, the air being cooled in an external cooling battery and forced into the room. Although forced air circulation is a step in the right direction it has not yet solved the problem entirely. In the first place it is extremely difficult to make the air traverse the stacked product uniformly at all points. In most of the present day stores the bulk of the air passes over the product and along corridors and does not pass through the product at all. Secondly, since this air must remove both the heat generated by the product and that entering through the walls, it must be warmer in the region of the exit duct than in the region of the supply duct. In some cases the temperature difference between these two regions, at air flows which are commercially feasible, is of the order of the space variations observed with the internal cooling grids. In order to solve this difficulty it is obvious that the air must traverse the minimum length of product, which is usually the vertical dimension, and if possible the two sources of heat, the product and the leakage through the walls, should be dealt with separately.

These considerations have led to the "jacket" system of air distribution, a system developed and tested in the artificial ship's hold at the Ditton Laboratory, one of the investigational units of the Food Investigation Board of Great Britain. In this system the cold air is delivered into the space above the stack of product by a duct which circles the room near the ceiling. This air then passes down through the product which is packed in tightly without spacing strips or dunnage. The air is drawn off through a slatted floor, up between duct-work forming a false wall or jacket, and is collected in a return duct which circles the space just beneath the delivery duct. It was found that a better air distribution was obtained when the product was stored without dunnage than with dunnage. This system provides the other conditions necessary for minimum temperature differences in the refrigerated space. The air traverses the minimum or vertical dimension and in passing through the product suffers a temperature change which corresponds only to the heat generated in the stack, the heat passing through the walls being removed subsequently in the jacket. Using this system it has been possible to reduce the spatial variations in temperature to a fraction of a degree in a space having the approximate dimensions of a ship's hold. Whether or not it can be modified for use in warehouse rooms remains the subject of future investigations.

Agriculture and Engineering

E. S. Hopkins, Ph.D.,
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Paper presented before a meeting of the Ottawa Branch of The Engineering Institute of Canada on March 11th, 1937.

SUMMARY.—Notes on some economic factors affecting present day farming, stressing the need for greater technical ability to take advantage of improved farm machinery and the information furnished by scientific agricultural research.

Among the fourteen or more different classes of engineers, there is included an agricultural engineer. At present the agricultural engineer in Canada occupies a very lowly rank almost like some rare species of plant. However, it is to be hoped that the position and importance of agricultural engineers may improve and that the other classes of engineers may also find it interesting and profitable to enter certain fields of agricultural work related to their special branches of engineering.

There are several branches of agriculture in which some phase of engineering has a direct relationship. It is only necessary to mention the following farm work to show this important relationship.

Relationship between Agriculture and Engineering

In the humid regions of Eastern Canada and British Columbia, drainage is an essential feature of farm improvement. The civil engineer is sometimes called upon to construct large outlet surface ditches in order to provide additional drainage for farm land. In many cases, such work should be greatly increased and certainly the additional drainage of private farm land either by surface drainage or by underdrainage is very desirable. In the dry regions of Western Canada and the inter-mountain valleys of British Columbia, irrigation is an important phase of agricultural work. It is very probable that in future years it will become much more important. Even today, hundreds of small private individual irrigation projects are being developed under the Prairie Farm Rehabilitation Act programme in Western Canada. Farm buildings offer a promising field for improvement and undoubtedly would undergo a very great change if more money were available on the farm.

Labour saving devices are nowhere more necessary than on the farm, to eliminate as much as possible the drudgery of farm work. Farm machinery production has for many years been a prominent phase of industrial work. Tractors have entered the field of agriculture in considerable numbers and promise to expand with improvement in design and ability to do more and cheaper work. Rural electrification makes possible many comforts and conveniences in agricultural work and in farm homes where electric power is available at reasonable rates.

Soil drifting, water erosion and flood control are all phases of agricultural work which have a direct bearing on certain fields of engineering and which have utilized the services of engineers, especially in the United States. In future years they promise even wider scope.

Early Agriculture

In primitive times agricultural work was largely done by slaves. As the work was entirely of a manual character, no special intelligence was required and the slaves were directed by the landed proprietors.

This condition existed in the Southern United States up to the time of the liberation of the slaves in 1864. A similar condition existed in Russia where the serfs, who were really slaves, were liberated in 1861. In many other countries slaves were forced to undertake all the arduous farm work.

Even today, in many countries, the class of labour undertaking farm work can scarcely be compared, from an educational and financial point of view, with people in urban centres. Only where agriculture has evolved to a position in which the operator can enjoy a reasonable standard of living, is this condition overcome.

A very surprising and disappointing aspect of continental European agriculture is to observe the large number of women forced to undertake the heaviest kinds of farm labour. Every effort should be made to prevent the adoption of this practice in Canada.

Farming as a Way of Living

During depressions, agriculture is confronted with the plans of zealous enthusiasts who suggest moving the inexperienced, unemployed from the city to abandoned farm property or to virgin land. It would seem from the suggestions of these enthusiasts that the unemployed would merely have to move to the farm, plant some vegetables and farm crops and live comfortably ever after. In boom times, industry draws labour from the farm but in depressions the farm is expected to re-absorb the unemployed. No thought seems to be given to the necessity of securing sufficient revenue to meet expenses which are absolutely necessary in this modern age. It is not sufficient to provide food and housing on a farm; it is necessary to conduct a business which will provide additional revenue for fuel, taxes, clothes, education and many other items.

Furthermore, no thought seems to be given to the effect of such extra production on decreasing the prices of products and making conditions which are already burdensome even more severe for the other farmers on the land. There is also the question of securing suitable virgin land which may be used for profitable farming. To engage in farming on a scale that offers any hope of a reasonable standard of living for the farm family, after the free land or homestead stage of agriculture, requires a considerable amount of capital.

Farming as a way of living is a very poor conception of agriculture. It is based on a primitive self-sufficient type of farming which derives no advantages from modern agriculture and engineering.

Urban and Rural Populations

A marked change is taking place in many countries throughout the world in the relative percentage of rural and urban populations. In primitive times it was necessary for a large percentage of the people to live on the farm. In no other way was it possible to produce sufficient food.

Fig. 1—The first successfully operated combine in Canada was used on the Dominion Experimental Station. Swift Current, Saskatchewan, in 1922.

Fortunately times have changed and where modern agriculture and engineering exist, it is possible to greatly reduce the number of people on the farm and at the same time produce sufficient food for the urban population.

The following table shows the number and per cent of the urban populations in Canada, England and Wales, and the United States.

Rural and Urban Population in Canada

	1901		1931	
	Number	Per cent	Number	Per cent
Rural	3,318,887	62.3	4,804,728	46.3
Urban	2,005,080	37.7	5,572,056	53.7

Rural and Urban Population in England and Wales

	1891		1931	
	Number	Per cent	Number	Per cent
Rural	7,257,240	25	8,000,459	20
Urban	21,745,280	75	31,951,541	80

Rural and Urban Population in the United States

	1880		1930	
	Number	Per cent	Number	Per cent
Rural	35,383,345	70.5	53,820,223	43.8
Urban	14,772,438	29.5	68,954,823	56.2

It will be seen from the above data that the percent of the people in Canada, England and Wales, and in the United States living in rural communities, has appreciably decreased. This is true particularly in Canada and the United States, although it occurs also in England and Wales.

It should be remembered in any consideration of these percentages of urban and rural population, that the rural population includes quite an appreciable number of people living in small villages. In the United States the rural population includes towns up to 2,500 people. In Canada the urban population includes all incorporated cities, towns and villages; the population required for incorporation varies in different provinces and in Ontario must exceed 750 inhabitants. While 46.3 per cent of the population in Canada is classified as rural, only 29 per cent of those gainfully employed are employed in agriculture.

It has been estimated that the percent of the population actually living on farms in the United States in 1800 was 97 per cent of the entire population. In 1850, it was 90 per cent, while in 1930, only 23 per cent were actually on farms. Some predictions have indicated that 15 per cent of the people actually living on farms would be sufficient to produce an adequate supply of food.

Investment on the Farms

There is a very wide variation in the value of farm property in different parts of the country. In some communities the total value of all farm property is extremely low, indicating that it is essentially a type of agriculture which might be classed under the heading of "a way of living." In other places, the value is much greater, indicating that considerable investment is involved and that the farm business is essentially a commercial enterprise.

It will be seen from the following table that the total value per farm varies from $2,216 in the State of Mississippi, to $17,654 in Illinois. It is obvious that as these are State averages, there are many farms with considerably smaller investments and others with investments much greater. As the investment becomes greater, the need of engineering and scientific agriculture becomes more urgent. The farm becomes a commercial enterprise in which business methods must be followed if interest is to be returned on the capital invested and a fair return made for the labour.

The table below shows this situation.

Average Value of Farm Property

Region	Value
Canada, 1931	$ 7,273
New Brunswick	3,043
Ontario	7,283
Saskatchewan	9,326
United States, 1930	9,103
Mississippi	2,216
New York	10,712
Illinois	17,654

Investment in Farm Machinery

The total investment in farm machinery in Canada, according to the 1931 census, was $650,664,000. This investment was 12.4 per cent of the value of all farm property. The average inventory value of farm machinery on Canadian farms is $894 per farm, which means that approximately double this sum was actually spent in the purchase price of the machinery.

Increase in Farm Tractors

According to the 1931 census, the number of tractors in Canada amounted to 105,360. Of this number 81,659 were reported from the three Prairie Provinces. As there are 728,623 farms in Canada, it would mean that throughout the entire country, there was about one tractor to every seven farms, while in the three Prairie Provinces, there would be one tractor to approximately every three farms.

In the United States, it is estimated that in 1936 there were 1,500,000 tractors on farms. As there are 6,288,648 farms in the United States, according to the 1930 census, it means that there is now approximately one tractor on every fourth farm. There has been a substantial increase in the number of tractors in use in Canada, United States, Russia, Great Britain and other countries.

On the other hand, the number of horses and mules has decreased. In Canada the maximum number of horses and mules occurred in 1922, with a total of 3,648,871. This number dropped in 1935 to 2,931,357. In the United States, the maximum number of horses and mules occurred in 1920 with 25,323,000. In 1934 there were only 16,873,000. It is difficult to realize the significance of these figures but in the United States the decrease in the number of horses would be equivalent to a single line of horses, each occupying 15 feet, around the entire world at the equator. In Canada it would be equivalent to a similar single row 2,152 miles in length. This large decrease in horse population has made a large acreage of farm land available for other crops.

Inventions in Farm Machinery

In the early days, ploughing was done with a metal faced wooden plough. A crude wooden contraption served as a harrow. The seed was sown by hand.

Harvesting was done with the scythe and later with the cradle. The grain was removed by threshing with a flail.

It is interesting to observe that many important agricultural inventions have been developed within the last 150 years. In 1797 James Newbold invented the cast-iron plough. Unfortunately, the farmers were opposed to this plough thinking that it would poison the soil. In 1831 the mower was invented by Manny. In the same year McCormick invented the reaper. In 1837 Deere developed the steel plough while in 1842 J. I. Case introduced the thresher. In 1870 the twine binder replaced the wire binder. In 1870 the portable steam engine was developed for belt work and in 1892 the first successful tractor was introduced. It is only within the last few years that Diesel engines and pneumatic tires have become available for farm tractors.

It is difficult to realize the improvements which have taken place in agricultural equipment. A mere recital of the dates of inventions is not sufficient to visualize the marked improvement which has occurred.

On the Central Experimental Farm at Ottawa a new agricultural museum is being established. Some equipment has already been secured and it is interesting to compare some of the earlier types of machinery with present day models. As the early models were obtained in Canada and were used by early settlers, it shows how great has been the advance even within the short history of Canada. An old wooden plough equipped with an iron point to protect the implement from excessive wear has been obtained; also, an old wooden binder which offers a marked contrast to the present steel frame power binder in use today. Scythes, sickles and cradles are also available as relics of the past.

A striking demonstration of the marked contrast between old farm equipment as compared with present models was demonstrated in the 1931 meeting of the American Society of Agricultural Engineers at Ames, Iowa. The delegates to this meeting witnessed a demonstration in which a large field of wheat was being harvested on the one hand by two men, one operating a tractor and the other a combine. In contrast to this modern method of harvesting, there was located in another portion of the same field the old primitive method but arranged with a sufficient number of men to harvest an area equal to that handled per day with the tractor and combine. In order to accomplish this task, twelve men were working side by side cutting the wheat with cradles. Following the cradlers were twelve men who raked and bound the wheat into sheaves. After the binders, came 48 men with flails on their shoulders who would be required to thresh the grain which the cradlers were cutting. It was necessary, therefore, to have 72 men with the old method of cradling and threshing the grain with the flail to equal the work of the two men operating the tractor and combine.

Agriculture is a Complicated Business

With the change in farming methods from the early primitive machinery to the modern labour saving machinery, more technical ability is necessary for the farmer. Furthermore, with improvements in varieties of various crops, impairments in soil fertility, use of commercial fertilizers, attacks of insects and fungus diseases, considerable scientific knowledge is necessary if farming is to be properly and economically conducted. It is not only necessary that the farmer should have considerable physical ability but he must have a technical knowledge of farm machinery and considerable scientific information on the proper methods of growing crops and handling livestock.

In industrial occupations, the workman or professional man is frequently confined to one very limited field. He does not need to know and is not expected to know other lines. The carpenter, bricklayer, motorman, dentist or doctor knows and practises only his special trade or profession. With the farmer, however, this condition is very different. It would be ruinous for the farmer to know only one particular line.

Radio broadcasts have recently been improved by a very interesting type of programme. The celebrated Professor Quiz has introduced a programme which is both amusing and instructive. The questions which he asks are comprehensive, covering a wide range of subjects and if answered correctly reveal a good general education. If questions of an agricultural nature were to be asked, the number of successful contestants would be very few. On one occasion a candidate was asked if he knew what a "whiffletree" was but the candidate had never heard of this kind of tree.

In order to indicate some few subjects in which the farmer must have information, the following questions might be presented:

1. Why is it that loose smut of wheat and barley must be treated differently from loose smut of oats or covered smut of wheat, oats and barley? What treatments would be suggested for these diseases?

Fig. 2—The combined corn harvester and silage cutter has been used successfully for many years on the Central Experimental Farm, Ottawa.

2. Certain dust treatments or sprays are effective in treating seed grain for certain smuts but are not effective against rust. What is the reason for this?
3. Western wheat stem sawfly attacks wheat in strips in the newly developed strip farming plan to combat soil drifting, more than it does wheat seeded in a solid block. Why is this the case and how might it be prevented?
4. Large areas in Eastern Canada suffer from what is known as "brown heart" of turnips. It has been learned recently that ten pounds per acre of a certain commercial fertilizer will correct this trouble. What is this material?
5. What is the difference between a 2-12-6 fertilizer and a 4-8-8 fertilizer?
6. What is meant by a "nutritive ratio of 5 to 1" in feeding stock?
7. At what stage in maturity should alfalfa be cut for hay and for silage?
8. What is the lowest permissible gradient for tile underdrainage? What home-made device might enable this grade to be maintained?
9. Give the names of three rust resistant varieties of wheat.
10. How is the labour income of the farm calculated?

An attempt to answer these questions will indicate the difficult problems with which the farmer is presented. This list does not commence to include a great number of other problems equally difficult to answer.

The Effect of Modern Machinery and Improved Organization on the Cost of Production

The introduction of improved machinery has made possible a very considerable reduction in the cost of producing various crops. In some studies conducted by the Dominion Experimental Farms and reported in bulletin No. 159, "Cost of Producing Farm Crops in the Prairie Provinces," it was found that the cost of producing wheat on summer-fallow from 1923 to 1930 on the Dominion Experimental Farms in the Prairie Provinces was 64 cents per bushel. The yield of wheat in this particular case was 27.4 bushels per acre. The cost of producing wheat after wheat was 75 cents per bushel with a yield of 19.8 bushels per acre.

In some calculations which were made on the cost of producing wheat on different sized farms, a very marked difference was found between small and large farms. With a one-quarter section farm, the cost of producing wheat was estimated at $1.02 per bushel. With a one-half section farm, the cost was estimated at 79.5 cents per bushel. On a one section farm, the cost was further reduced, varying with different methods of handling the farm. If the work were handled entirely with horses, the cost was estimated at 77.4 cents per bushel, while if it were handled entirely with tractor and combine, the cost was 63.6 cents per bushel. Further reductions in cost took place with larger farms until with a two or three section farm, the cost was reduced to from 55 to 51 cents per bushel. It is not possible for all farmers to acquire two or three sections of land, but even on smaller farms, mechanical equipment may be utilized to good advantage.

It is interesting to visit large mechanized farms. While it is true that some of these have not succeeded financially, it is also true that others have been quite successful. The farm of Mr. Florence at Humbolt, Minnesota, offers a striking example of a mechanized industrial farm. On this farm, twelve men seeded 14,000 acres of grain. The work was handled with five Diesel tractors working in day and night shifts. Purchases were made economically on a large scale and the business was arranged so as to get the greatest economy of labour without any sacrifice in quality.

While some people disapprove of large mechanical farming enterprises, claiming that in some vague manner they may impair the social conditions in the country, it would seem that such enterprises permit of a better utilization of machinery, engineering and scientific agricultural knowledge. The well-meaning but uninformed commentator who views agriculture from the window of a pullman car and who might be called a "trained" observer, is scarcely in a position to offer any really helpful suggestions. It is certain that persons engaged in engineering or scientific agriculture can assist much more effectively in developing improved types of agriculture.

The Future

While at first glance it might seem that farming is not a very competitive business, inasmuch as the production of neighbouring farmers has little immediate effect on a farmer's revenue, nevertheless, considered in its broad national and international character, farming is very competitive. Only the most efficient farmer can hope to produce sufficiently economically to enable a reasonable revenue to be derived from the farm. Unless such a revenue is obtained, the standard of living on the farm will fall much too low for Canadian aspirations. With a gradual increase in world population and with little additional virgin land available, it would seem that agriculture should offer in the future a very promising field.

In the Province of Ontario itself, there are fewer farms today than there were fifty years ago, although the urban population has greatly increased. When this limitation of land will begin to make itself felt no one can predict, but that it must ultimately arrive no one can question. Certainly, modern scientific agriculture and engineering should and will play a very important part in increasing the financial returns from the farm and in improving the position of the farmer.

The Geology of Northern Ontario

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Paper presented before the Toronto Branch of The Institute, on October 15th, 1936.

SUMMARY.—A brief account of the pre-Cambrian formations which cover most of Northern Ontario, followed by notes on the later rocks of Southern Ontario whose history ended with the Ice-age of the Pleistocene.

Geology is the study of the structure of the earth's crust and the substances which compose it and is, therefore, concerned chiefly with rocks. The formation of rocks is going on to-day as it has been even since the first crust was formed. Rocks are classified on the basis of their origin as sedimentary, igneous, and metamorphic. Sedimentary rocks are largely the products of weathering and erosion and are usually thought of as having settled from running or standing water in beds. Igneous rocks are formed by the cooling of molten magmas and may be either volcanic or plutonic in origin. Metamorphic rocks are highly altered igneous or sedimentary rocks. Rocks are also classified for certain purposes on the basis of their age relationships, that is the period in the earth's history at which they were formed. Estimates of the age of the earth, or rather of the length of time from the formation of the first crust up to the present, vary from a few million years up to 2,000 million years. The most recent scientific investigations, based largely on measurements of the rate of disintegration of radioactive minerals, favour the larger figures.

The accompanying table (Fig. 1) shows the main divisions of geological time with an estimate of the probable lengths of time represented by each. Owing to the wide variation in the estimate of the age of the oldest rocks of the earth these figures must be taken with a grain of salt, but at any rate the proportions of the various divisions are approximately correct. There is one major line of separation or break between those rocks known as pre-Cambrian and those known as Paleozoic or later. The boundary between these two types may be seen just beyond Orillia. The pre-Cambrian rocks may be illustrated by the bed rock as seen in Muskoka while the later divisions are represented by the comparatively flat lying rocks such as occur in Southern Ontario.

The earliest work on the classification of the Paleozoic rocks was done in England, and hence the names used. The earliest attempt to subdivide the pre-Cambrian was done in Canada by Sir William Logan who was the first director of the Geological Survey of Canada. This work was commenced by him in 1843 on the north shore of the St. Lawrence and continued later on the north shore of Lake Huron. Much further work has been carried on since then in Ontario by such well known geologists as A. P. Coleman, A. C. Lawson, the late W. G. Miller, the late W. H. Collins, and others.

Since the geology of Northern Ontario is under discussion we are concerned mainly with that division known as the pre-Cambrian.

Pre-Cambrian

With regard to the geological time table given above it should be understood that the scheme of classification used here for the pre-Cambrian will not apply for the pre-Cambrian rocks of the world or of Canada, or even of all of Northern Ontario. Geological processes since the beginning of the formation of the earth's crust have gone on much as they are going on to-day: that is to say, certain areas were covered by the sea and sedimentary rocks were being deposited, while in other areas volcanic eruptions were taking place or land surfaces were being eroded away. The general order of events was much the same, however, and the classification used here is about as general as can be applied for this part of the pre-Cambrian (see Fig. 2).

Features of the pre-Cambrian

The area underlain by pre-Cambrian rocks in Ontario viewed from the ground appears very rugged and picturesque. Yet viewed from an aeroplane a few hundred feet in the air the skyline appears to be very even and much like a level plain with its surface dotted by innumerable lakes and streams. The elevation of Lake Superior which may be taken as base level is 600 feet above sea level. The highest known point of Northern Ontario, Tip Top mountain on the north shore of Lake Superior, is 2,122 feet. As a matter of fact there are comparatively few elevations in Northern Ontario higher than 1,400 feet above sea level. During pre-Cambrian times there were several periods of mountain building when great ranges of mountains were undoubtedly built, but throughout many millions of years the rocks were undergoing the slow processes of weathering and erosion as a result of which these mountains were worn away leaving only their roots, with elevations of only a few hundred feet.

Keewatin

Going back to the classification of rocks on the basis of age we start with the lowest division in the pre-Cambrian, the Keewatin series. Very little is known about the nature of the earth's crust prior to Keewatin time.

	Cenozoic Era	Quaternary	Pleistocene	One million years
		Tertiary		550 million years
	Mesozoic Era	Cretaceous		
		Jurassic		
		Triassic		
	Palaeozoic Era	Permian		
		Carboniferous		
		Devonian		
		Silurian		
		Ordovician		
		Cambrian		
Pre-Cambrian	Proterozoic Era	Late Proterozoic	Keweenawan	1450 million years
			Animikie	
			Huronian	
		Early Proterozoic	Algoman	
			Timiskamian	
	Archaeozoic Era		Laurentian	
			Keewatin	

Fig. 1—Geological Time Table.

The Keewatin period was a time of great volcanic activity, probably on a scale greater than has happened at any time since then. Keewatin rocks consisted of lavas of basic to acid composition in the form of flows and tuffs or explosive volcanic rocks. Many of these volcanic rocks were erupted under water and between periods of eruptions sediments were being deposited. These areas of Keewatin rocks are represented on our geological maps by areas in green colour and a glance at one of these maps will show how widely scattered they are. From an economic standpoint the chief ores that were deposited in Keewatin times were the richer sections of iron formation which were formed as a result of chemical precipitation. Under this head comes the Helen mine of the Michipicoten area as well as the Lake Superior iron ores.

Laurentian

Following the deposition of the Keewatin rocks comes a period of granite intrusions. Mountain building processes took place and the rocks of the Keewatin period underwent folding. The geological work so far has not separated these Laurentian granites from the later granites. The main evidence for granites of Laurentian age consists of the presence within the next great series of rocks of vast numbers of boulders of granite. These Laurentian rocks probably gave rise to ore deposits but if so they have been largely eroded away and we do not know definitely of any remaining deposits of Laurentian age.

Timiskaming Series

Following this came widespread encroachments of the sea and the deposition of extensive areas of sediments consisting of conglomerate with granite boulders, quartzite, slates, etc. Sediments of Timiskaming age are particularly noteworthy in our better known camps, such as Porcupine, Kirkland Lake and Sudbury, but similar types are found in many other areas of Northern Ontario. Iron ores similar to those of the Keewatin series were deposited in Timiskaming time.

Algoman

Then comes another great period of mountain building attended by intrusions of granite and other igneous rocks. As a result of this folding one finds that all the older rocks which were originally deposited in fairly flat beds are now standing on edge or dipping at very steep angles.

The Algoman period was a very important one from the standpoint of ore deposits in Northern Ontario and Quebec, for with it one associates most of our major gold deposits and other deposits of copper, lead, zinc, etc.

Huronian

Following this came another period of deposition of sedimentary rocks known as the Huronian, including the Cobalt series of Cobalt, and the Bruce series of the north shore of Lake Huron, and two somewhat later sedimentary series known as the Animikie of Sudbury and the Port Arthur region. It will be noted that these areas of sediments while large are more localized. Much of the crustal rocks had become more stabilized and many areas were not further covered by the sea. The rocks of this series differ from the older rocks in the fact that they are not so highly tilted except locally but lie fairly flat. Again iron ore deposits are the only deposits of economic value.

Keweenawan

Further intrusions of basic to acid igneous rock took place along with local mountain building processes. With the diabase of this period is associated the rich deposits of silver of the Cobalt area along with cobalt, nickel and arsenic.

The great norite-micropegmatic sheet of Sudbury with which are associated the great nickel-copper ores of that area belong here, as do also probably some of our minor deposits of gold.

This is the end of the pre-Cambrian rocks which probably underlie all the later rocks of the world and are exposed in the areas mentioned. From the standpoint of ore deposits the pre-Cambrian rocks are extremely important as a source of ore deposits of certain types. They are the oldest rocks of the earth's crust and consequently have been subjected to the most stresses and strains and have the most favourable structures for the deposit of ores. On the other hand, of course, they have been subjected to erosion over a much greater length of time than the later rocks and hence in many cases only the roots of ore bodies that formerly existed are left.

Fig. 2—Geological Sketch Map of Ontario.

Paleozoic and Later Rocks

Above the pre-Cambrian rocks are deposited the paleozoic rocks consisting in Ontario of flat lying sandstones, limestones, and shale, such as all are familiar with in southern Ontario. These rocks occur only in a strip along Hudson and James bay and in a small area near Haileybury. The country along the Hudson's bay is quite flat and poorly drained with only small vegetation, except along the river valleys. They contain some deposits of clay, lignite, and gypsum, but as yet have not been productive.

Pleistocene

The last great event or events which affected the surface of Canada was the coming of the great glaciers during Pleistocene times. A few hundred thousand years ago for some reason the climate of the northern hemisphere became colder and ice and snow began to accumulate at certain points. The accumulation continued for hundreds of years until the ice had a thickness of many thousands of feet. Under the influence of its own weight the glacier flowed outward from its centres. The work of the glaciers was two-fold. In its outward movement it removed much surface material. As it moved over the country it served to reduce the irregularities of the unevenly eroded surface. Rocks were stripped of soil and fresh unoxidized surfaces were exposed. In the lee of steep hills pockets of weathered material were left, but most of the material picked up was scattered far and wide. That is the reason why in Ontario there are no placer deposits. This country with its numerous lode deposits of gold and other mineral should probably otherwise have been an ideal placer country.

During the retreat of the ice sheet on the other hand till, sand, and gravel were deposited wherever the ice front remained stagnant for any length of time and esker ridges were found at the margins. The out-flowing water from the melting ice supplied efficient transportation for some of the finer material and spread it out into sand plains. Hollows were filled and river valleys drained so that former drainage systems were entirely disorganized. The myriads of lakes that dot the surface of Northern Ontario were due more than anything else to the effects of the glaciers.

Several very large lakes were formed by the damming action of the glaciers including Lakes Agassiz, Algonquin, Ojibwa, and Iroquois. The remains of the old beach levels of the lakes may be seen at various points in the north country. In the case of Lake Ojibwa fine clay from the glacial till was spread out on its floor as a result of which there are the flat clay belts of the section along the transcontinental railway.

The advances and retreats of the glaciers were the last great geological events affecting the surface of Northern Ontario. The length of time since the retreat of the last great ice sheet to the present is roughly estimated at 20,000 years, a very short time, geologically speaking. During this time only the slow processes of erosion have acted to affect the land surface. During the last fifty years these changes due to erosion have been supplemented by the coming of settlers. A few sections have been turned to agricultural uses, much of the valuable timber has been removed, while water levels of some of the lakes and rivers have been altered for water power purposes. A striking feature of the topography of Northern Ontario when viewed from an aeroplane is the number of mine shafts and dumps scattered over the country. Present developments in the mining industry indicate that these will become a still more striking feature of our northern Ontario topography.

DISCUSSION ON THE PAPERS[1] OF THE

Symposium on the Burning of Canadian Coals

Investigation of Canadian Coals Including Their Testing, Classification and Utilization[2]

A. C. Fieldner[3]

Messrs. Haanel and Gilmore are to be congratulated on the preparation of a most interesting and informative review of the highly important fuel investigations that have been conducted by the Mines Department of Canada during the past several years.

These investigations are of great value to producers and users of coal. The determination of the chemical and physical properties of coal is of fundamental importance in the improvement of coal preparation and coal utilization. The large-scale tests reported in this paper have given data for comparing the suitability of various domestic and foreign coals for use as fuel, for the production of coke and gas, and eventually for the manufacture of synthetic gasoline.

In the United States Bureau of Mines, a somewhat similar programme has been followed with respect to our own coals. The members of our staff have kept in close touch with the staff of the Bureau of Mines of Canada and have benefited greatly by this interchange of ideas. The respective Bureaus have worked together in developing methods for testing coal and both institutions have used these same methods of tests. The results, therefore, are directly comparable and useful to each other.

Members of the staff of the Mines Department in Canada have participated in the work of our committees, and the fundamental research on which some of the methods are based was done in the laboratories at Ottawa. Through this co-operation our continent has avoided the confusion that prevails on the European Continent due to having different methods of testing, different nomenclature, and different classification.

The paper calls attention to the importance of a correct understanding of the definition of the "as-received" basis of coal analysis. Ordinarily this term means what it says, and in the United States one thinks of the "as-received" analysis as a close measure of the condition of the coal at the mine, since the largest fraction of American coals now being mined is low in moisture content and is received in the laboratory substantially as mined. However, in the case of low-rank bituminous coal, sub-bituminous coal, and lignite the "as-received" condition may be considerably lower in moisture than the coal as mined, unless special precautions against moisture loss are observed in taking and in transmitting the sample to the laboratory. This point should be emphasized in reporting "as-received" analyses that may have lost some original mine moisture.

In regard to the discussion of "dust index" or "dustiness," it is believed that "dust index" should be qualified to include the method of determination. The "dust index" resulting from the tumbler test might be called the "tumbler dust index" to differentiate it from the settling-plate method now being considered by the American Society for Testing Materials.

The term "size stability" has definite merit from the point of view of the coal producer and it will be a more welcome term than "friability."

Table IV, which contains a comparison of the classification of Canadian coals according to rank by the A.S.T.M. method and according to the "specific volatile index," calls attention to a real problem of nomenclature in using these two classifications. Confusion is likely to result from the use of the same names for different kinds of coal in the two scales of classification. The commercial user of coal will be mystified by having the same coal called "sub-bituminous" in the S.V.I. classification and "high-volatile A or B" in the A.S.T.M. classification. It is to be hoped that some revision of nomenclature can be made.

The results of the large-scale storage tests conducted on Nova Scotia coal are of great practical value. The development of methods for storage of coal without danger of spontaneous heating is of significance in smoothing out the effect of seasonal variations in the demand for coal. Moreover, storage would safeguard consumers against interruptions in supply. Much more research is needed on the problem of coal storage.

It is gratifying to note that domestic fuel tests have been made wherein variable rates of combustion are incorporated with standby firing for the night. This method of test reproduces practical conditions and should furnish a better appreciation of the most suitable methods for utilizing domestic fuel.

The latter part of this paper, which deals with coal carbonization and hydrogenation investigations, is of interest to industry in the United States as well as in Canada. Several years ago, coal-carbonization tests were made on the same lot of Canadian and American coals by the Mines Department of Canada and the Bureau of Mines of the

[1] Papers published in the Engineering Journal, July 1937.

[2] By Messrs. B. Haanel, M.E.I.C., and R. E. Gilmore, M.E.I.C., Division of Fuels, Bureau of Mines, Ottawa.

[3] Chief, Technologic Branch, U.S. Bureau of Mines, Washington. Published by permission of Director, U.S. Bureau of Mines.

United States. The Canadian tests were made on a commercial coke oven and also on a semicommercial-size byproduct oven installed at the Mines Department laboratories. The Bureau of Mines tests were made in a special coal-carbonization unit, designed in co-operation with the American Gas Association and known as the BM-AGA apparatus. Valuable data on the correlation of these methods of test were obtained.

The results reported by the authors of this paper on the hydrogenation of coal are of special interest to the United States Bureau of Mines. Recently we completed a similar coal-hydrogenation plant and are beginning a study of the suitability of our coals for the production of synthetic oil. Preliminary tests on a Pittsburgh coal from the Bureau of Mines Experimental Mine show results comparable to those reported in the paper on Yorkshire coal: 79.6 per cent oil; 14.1 per cent gas; and 3.8 per cent of aqueous liquor; and the consumption of hydrogen was 8.2 per cent.

This paper records in few words a tremendous range of experimental work on coal. While much has been done, much more remains to be done. Enormous progress will be made in the next half century in the production of energy. Conservation of fuel resources will become increasingly important, and public sentiment will insist on economical mining and the most efficient possible utilization of the country's fuel reserves.

A. W. Gauger[4]

The review of the work of the Canadian Bureau of Mines, Division of Fuels, on coals of Canada, as presented by Messrs. Haanel and Gilmore, is an indication of the excellent programme of investigation being conducted by this Division. To comment on the many phases of coal technology outlined in this paper is hardly within the scope of a brief discussion. The writer will therefore confine himself to a few brief statemens in connection with the section on fusion point of ash.

While this determination gives a rough indication of the tendency of a fuel to form clinkers when burned, there is no simple relationship between the two. The experience of some engineers has been such as to indicate the need for high ash fusion coals in underfeed stokers operating at high ratings; the experience of other engineers dealing with different power plants, different personnel, and different coals, has indicated that low fusion coals (below 2,200 deg. F.) can be burned at ratings of over 50 lb. per sq. ft. of air-admitting surface per hour. Clinker is the resultant of many contributory causes of which the coal ash is only one. Among these causes may be listed: properties of coal; types of fuel burning equipment; firing practice; and human factors.

One may not say that ash fusion temperature specifications may be lowered in accordance with lowering of ash content below that considered normal or average in all cases. There are examples in practice in which a lower ash softening temperature coal may be burned at a higher rating if the ash content is increased. Such factors as the coking properties and air distribution are of great significance in this connection.

T. W. Harris[5]

This paper has been read with interest and the only comment is with regard to the "Use Classification" on page 512. The printing of a series of articles is being undertaken to further supplement and broaden the information as reported by Sub-committee VI on the Correlation of Scientific and Use Classification. This work is being done under the guidance of the Coal Committee of the National Association of Purchasing Agents of which the writer is chairman.

Acceptances have been received from a number of leading authorities on coal in the United States for the writing of these papers which are covering both the factors in the selection of coal and the various uses. A number of articles have already been written and are being published by the National Association of Purchasing Agents.

The work has been conducted under the auspices of the Coal Classification Committee and therefore necessarily must be confined as far as possible to a statement of facts rather than expression of opinions. The articles as printed will expand the usability of the "coal selection charts" prepared by the committee as the articles contemplate presenting not only the opinions of the contributors but also bringing in the economic factors as well.

* * *

Characteristics and Quality of Nova Scotia Coals[6]

Mark W. Booth, M.E.I.C.[7]

Dr. Sexton is to be congratulated in presenting a paper which bears no apologies, or any reservations, in describing the characteristics and quality of Nova Scotian coals.

He has shown by the chemical analysis that the coal is of a high grade, and in the particular field covered by his own experiments, that the fuel compares very favourably with the imported product.

As a large proportion of the solid fuels used in the Provinces of Quebec and Ontario, in which provinces Nova Scotian coal has to find its greatest market, is in the domestic heating field, and the author's paper shows that the fuel generally is of a high grade, and under proper conditions of burning, superior results can be obtained from it.

This refers particularly to the coke obtained from Nova Scotia (e.g. the gas coke and Dosco coke); and it is pleasing to note the reference to the character of the refuse obtained, which "is in the form of solid heavy clinker easily disposed of by the householder."

Published literature and generally former papers given before The Institute, have referred to the clinker obtained from Nova Scotia fuels as being of an objectionable nature because it had fused.

To one accustomed to both kinds, it can be said that this form of clinker is much to be preferred to that obtained from the non-fusing kind, for instance the American anthracites, which Dr. Sexton well describes as giving a large volume of dusty ash which is disagreeable to handle and contains a good deal of unburned carbon.

It can be truthfully said that the fused clinker is many times more desirable than this latter dusty kind.

Referring to the boiler trials described in the paper and giving results obtained from the standard Horizontal Tubular Boiler. There are a good many H.R.T. boilers in Central Canada, and the point made by the author that settings for this type of boiler can be too high is a good one.

Designers appear to forget the long flame travel available in the setting of an H.R.T. boiler before the chilling effect of the boiler tubes is reached, and have endeavoured to imitate the design required for a water tube boiler by giving a large volume of combustion space directly under the front of the boiler.

This is entirely against the principle of the H.R.T. boiler, and a lot of disappointment has been met with by this practice.

[4] Director, Mineral Industries Research, Pennsylvania State College.

[5] Chairman, Fuel Committee, National Association of Purchasing Agents.

[6] By F. H. Sexton, LL.D., President, Nova Scotia Technical College, Halifax, N.S.

[7] Steam Engineer, Dominion Steel and Coal Corporation, Sydney N.S.

The weathering tests described are important considering the amount of storing that Nova Scotian coals are liable to, due to geographical and winter transportation limitations, and these show that Nova Scotian coals do not deteriorate in storage as regards composition and evaporative value for steam raising purposes.

This paper has of course not dealt with the characteristics and quality of Nova Scotian coals from the general steam raising and other standpoints, but if the original high quality is there to begin with, and the coal can be delivered to the consumer's plant as such, general engineering progress in the art of the combustion of these coals will take care of the rest.

G. H. Jenkins[8]

The general quality of Nova Scotia coal is well known, and it is conceded that some of it is of high quality, both for steam and other purposes. However, it is not the intention to discuss the quality of Nova Scotia coal, but rather to make a few comments on its preparation, transportation, and banking, as they affect the Canadian National Railways in the hope that they may be of interest to other buyers of coal, and perhaps to the coal producers as well.

The Canadian National Railways have been, for many years, large buyers of this coal. The delivery is by rail and water. The latter is more important. The quantity is larger, and, besides there are handling and banking factors to be considered, which do not mean so much in the more direct rail-borne delivery.

The banking of coal in the high temperatures during the summer makes it necessary to take great precautions to avoid heating and firing. There is always a risk in this respect, but experience indicates that, with the exercise of proper care, it is not unsurmountable. If coals selected for banking are those that are known to be less susceptible to spontaneous combustion than others, the danger is greatly reduced.

In a broad way, and in the absence of any special conditions, it has not been found that there is much, if any, loss in heat value in the banking of Nova Scotia coal, even when piled for several years. On the surface of piles, there is a certain amount of weathering and dullness of appearance, but it is superficial. Actually, one feels that coal in banks, at times, goes through a certain mellowing or seasoning process, so that as far as chemical characteristics are concerned, it is just as acceptable as fresh mined coal. In fact, coal from stock piles is often preferred by locomotive foremen to fresh mined coal.

The size degradation of coal handled in and out of ships or stock piles, is a factor of importance, and one that can never be fully overcome. It is necessary that great care be taken to see that nothing is done during these operations that might increase unduly this degradation.

The mixture of snow and ice, taken with fine coal from piles during the winter months, is a serious problem. Even with the utmost care in the loading, it is always there. The finer the coal, the more serious the results, because fine coal, stuck together with ice, will cause trouble in stoker-fired engines.

The proper cleaning of coal at the mines and keeping it free from extraneous matter in transit, is a factor that cannot be over-emphasized.

These observations are based on the Nova Scotia coal ordinarily purchased by the Canadian National Railways, for water delivery.

* * *

An Economic Use for New Brunswick Coal[9]

J. D. Garey, A.M.E.I.C.[10]

The following tabulation* is somewhat similar to Table II appearing in Dr. Stephens' paper but is extended to a final cost per ton of coal in the plant of the N.B. Power Company at Saint John and an ultimate cost per million B.t.u. as fired. The samples for this tabulation were taken by the writer in November 1935 and all were from cars loading at the mine shafts. These samples were enclosed and sealed in glass containers, and an analysis of each sample was made as soon as possible after the sample was taken.

In Table III in Dr. Stephens' paper:

Operator	Tons	Average per cent combustible	Average per cent combustible for all operators	Deduction for quality under contract	Average cost per ton combustible including freight
A.	6,568	80.87	82.8	8.6c. per ton	$4.03
B.	3,050	84.4			or
C.	3,426	81.5			74,000
D.	522	85.5			B.t.u.
E.	1,217	83.1			for
F.	1,048	82.2			1 cent

An analysis of the above table gives the following results:

Average combustible received per ton of coal......	82.2% or 1,644 lb.
Average B.t.u. per lb. combustible................	15,000 B.t.u.
B.t.u. per ton of coal as received................	24,660,000 B.t.u.
Average price per ton of coal as received.........	$3.22
Cost per ton of combustible (corrected)...........	$4.03
Cost per million B.t.u. $\frac{4.03}{30,000,000}$	13.43c.

[8] General Fuel Agent, Canadian National Railways, Montreal.

[9] By John Stephens, D.Sc., M.E.I.C., Professor of Mechanical Engineering, University of New Brunswick, Fredericton, N.B.

[10] Chief Engineer, N.B. Power Co., Saint John, N.B.

*Typical Proximate Analysis and Costs

Origin	Per Cent					B.t.u. per lb.		Cost per ton—$				$
	Water	Volatile	Carbon	Ash	Sulphur	B.t.u. as received	B.t.u. dry	Cost at Mine	Freight Saint John	Cartage	Total Cost	Cost per Million B.t.u.
A	3.13	30.59	52.87	16.54	7,39	12,345	12,745	2.50	0.95	0.35	3.80	0.1539
B	4.93	29.53	50.99	19.48	8.22	11,545	12,145	2.70	0.95	0.35	4.00	0.1732
C	10.39	29.80	58.65	11.55	3.38	11,920	13,305	2.70	0.95	0.35	4.00	0.1677
D	3.91	30.61	52.12	17.27	7.69	12,000	12,500	2.70	0.95	0.35	4.00	0.1666
E	4.41	31.27	45.99	22.74	6.71	11,090	11,595	2.50	0.95	0.35	3.80	0.1713
F	5.17	27.70	47.11	25.19	6.01	10,765	11,350	2.70	0.95	0.35	4.00	0.1860
G	3.91	27.60	45.86	26.54	6.45	10,710	11,145	2.25	0.95	0.35	3.55	0.1657
Average	5.12	29.58	50.51	19.90	6.55	11,482	12,112	2.58	0.95	0.35	3.88	0.1692

In Dr. Stephens' Table IV:

Tons	Average per cent combustible for all operators	Deduction for quality under contract	Average cost per ton combustible including freight
24,310	79.4 Max. 92.4 per cent (51 tons) Min. 76.4 per cent (8,550 tons)	20.05c. per ton	$3.64 or 82,000 B.t.u. for 1 cent

An analysis of the above Table IV gives results as follows:

Average combustible received per ton of coal	79.4% or 1,588 lb.
Average B.t.u. per lb. of combustible	15,000 B.t.u.
B.t.u. per ton of coal as received	23,820,000 B.t.u.
Cost per ton of coal as received	$2.89
Cost per ton of combustible (corrected)	$3.64
Cost per million B.t.u. $\frac{3.64}{30,000,000}$	12.13c.

The results of the tabulation and the results of the analysis of Dr. Stephen's Tables III and IV, although obtained by entirely different methods, when compiled have very similar results.

R. E. MacAfee, M.E.I.C.[11]

Coal from the central New Brunswick field has always been considered difficult from a combustion point of view when burned in quantity in refractory furnaces. The most difficult feature of this coal is its high ash content and low ash fusion temperature. Dr. Stephens reports that the ash fusion temperature goes down as low as 1,700 deg. F. This is a very low ash fusion temperature and necessitates a furnace design that will permit the gases of combustion to be cooled to practically this temperature in order to eliminate the ash sticking on the first rows of boiler tubes and in addition, the ash that is deposited in the bottom of the furnace must be cooled to the point where it becomes dry and friable before it reaches the ash hopper so that it can be removed in the dry state by ordinary ash removal methods without trouble. On the other hand, in order to secure good combustion efficiencies, it is necessary to keep the furnaee temperature as high as possible. These two conditions seem to have been well taken care of in the furnace design illustrated. Dr. Stephens does not mention specifically ash adherence to boiler tubes, but it is assumed that this does not occur at ratings up to 325 per cent.

The writer's experience generally bears out that reported in this paper. To burn this coal successfully, it is necessary to have a fully water cooled furnace, liberal furnace volume and effective cooling in the bottom of the furnace to give good ash removal conditions. The design at this plant has a staggered water screen made up of tubes on 14 in. centres. The writer prefers either a hopper bottom made up of tubes on 6 in. centres with smooth cast iron blocks clamped to the tubes on the furnace side with a heat conducting bond between the tubes and blocks, the back of the tubes being covered with plastic insulation, block insulation and a steel casing, or a flat floor made up in the same manner. This construction gives a very cold surface which immediately chills the ash that falls on it.

The superheater performance given in the paper is extremely interesting. The writer's experienee when burning this coal is that the actual superheater performance agrees substantially with that estimated.

Preheated air temperature is influenced by two main factors: (1) general overall efficiency of the unit and (2) drying wet coal in the pulverizer. It may be judged from the paper that the second condition predominated in the 1935 addition to this plant. Pulverizer capacity, preheated air temperature and moisture are closely related in any pulverized coal plant. High moisture content in the coal can best be taken care of with a lower air temperature in a pulverizer that forces all the primary air entirely through the coal bed, thus giving a much more intimate coal and air mixture in the pulverizer resulting in much better drying.

The fineness of pulverization reported in the paper is excellent. Probably Dr. Stephens could give fineness figures after longer periods of operation. It would also be interesting to know the life of the hammers and the maintenance on the pulverizers per ton of coal pulverized.

This paper has served a useful purpose and the data presented will greatly assist those attempting to burn this coal.

J. Roberts[12]

The statement which Dr. Stephens made in his paper that "the fineness of pulverization was not of great concern" is of considerable interest. This might be true with certain types of coal, but in the experience of the writer when using slack coal from the Maritime provinces in pulverized fuel plant, an endeavour is made to pulverize to 82 per cent through a 200 mesh.

Also of interest are his remarks that the mills of the New Brunswick Electric Power Company were able to handle coal up to 9.6 per cent moisture. The writer's experience has been that it is practically impossible to handle coal in impact mills over 5 per cent moisture. On the Canadian National system, the mechanical department are not only responsible for handling coal in locomotives, but also have a very large number of stationary power plants, scattered over the entire system—some of these plants are old and more or less obsolete and others are modern plants. The power plant at the Point St. Charles locomotive shops is entirely modern, handling pulverized coal (Maritime Provinces slack coal) and one unique feature is that it is constructed to operate from 50 over 300 per cent of rating. This was made possible by a combination of water walls and air-cooled walls. The entire plant is an interesting installation, operating during the winter months at 300 lb. pressure at over 300 per cent of boiler rating.

The Author (Prof. John Stephens, M.E.I.C.)

Mr. Garey's statistics of the costs of Minto coal seem to be in substantial agreement with those of the New Brunswick Eleetrie Power Commission.

Variations, due to different prices and freight rates, are to be expected.

The energy contents given by Mr. Garey are rather higher than would have been expected from the experience at Grand Lake. B.t.u. contents to five significant figures are of interest as showing the possibility of this degree of precision. Reasonable doubt of the value of the third figure is often felt.

In answer to Mr. R. E. MacAfee, Grand Lake ash does not adhere to boiler tubes or water walls at 325 per cent rating and since writing the paper, ratings up to 400 per cent have been experienced with a like result. Slagging is not found on any tubes and the fly ash keeps the surfaces clean and bright.

No need has been found for supplementary cooling effect in addition to that provided by the water screen tubes at 14 in. centres. The sugestion of a water cooled hopper should help those who must use smaller furnace volumes.

The superheater condition has been since improved by the removal of a few baffle tiles, but the inherent

[11] Manager, Eastern Branch, Babcock-Wilcox and Goldie-McCulloch Ltd, Montreal.

[12] Chief of Motive Power and Car Equipment, Canadian National Railways, Montreal.

difficulty remains with the combination of a large water cooled furnace, a steep temperature gradient through the first bank of tubes and a convection superheater.

Mr. MacAfee's remarks on pulverizer performance are of great interest to those in charge of the Grand Lake plant. The information he asks for is not at present available, in view of the great secular variation in the coal. It may be taken, however, that the pulverizer maintenance costs are comparatively high. This is compensated for by the fact that even 10 per cent moisture coal will not plug the impact mills.

The fineness of pulverization described in the paper has been maintained.

In reply to Mr. J. Roberts, it should be stated that it was not intended in the paper to give the impression that fineness of pulverization was not of "great concern."

If good results are being obtained on a weight of combustible per kw.h. basis, however, fineness is of secondary importance. Mills should not be criticized adversely if they pass some ungrindable pyrites in comparatively large form.

At Grand Lake, the mills must and do grind coal of over 5 per cent moisture. The experience there with slack of 9.6 per cent moisture was accurately described in the paper.

It is noted that Mr. Roberts uses the term "Maritime Provinces slack coal." This does not appear to be justified as a generic name for a product of such wide variation in quality.

* * *

Some Observations on the Use of Bituminous Coal as Locomotive Fuel[13]

G. H. Jenkins[14]

The use of bituminous coal as a locomotive fuel as discussed in Mr. Roberts' paper leaves no doubt of the importance of this subject to the fuel department of a railway that provides the coal that is burned in the locomotives; and probably a few remarks concerning the purchase of coal are in order. More than half of the coal used by the Canadian National in Canada today is from Canadian mines. This is nearly twenty per cent of all the coal produced in Canada. Nova Scotia contributes the largest tonnage; Alberta a close second, New Brunswick third, and British Columbia last. We also buy some Saskatchewan coal, but not for locomotive fuel purposes.

In arranging for this coal supply many things must be considered, including some relating to policy. Any information that assists in making a wise selection of coal is utilized and the main concern is what the coal will do when used under actual service conditions. Considerable reliance is placed on the work of inspectors who are constantly in touch with sources of coal supply, our chemist is also a great help. Further valuable assistance is obtained from the Dominion Department of Mines, and other outside agencies.

It is known that the chemical, physical, and burning characteristics of coals are not all alike. On account of conditions it is not possible to obtain 100 per cent delivery of so-called No. 1 coals. This involves acceptance of certain quantities of coal of usable quality but less suitable for our purposes, and it is the endeavour to utilize the best coals for important or fast services, and the others to best advantage in other services. Efforts in this respect have not been unsuccessful.

Experience has shown no standard specification of coal can be applied everywhere. A general stipulation for hard structure, high fusing point, or high volatile, is not desirable, when some of the coals available will not measure up to the stipulations named due to their inherent nature. The one general condition is that coal shall be cleaned of extraneous impurities and loaded on to railway cars in the best possible condition and size as called for by the purchase agreement.

An endeavour is made to maintain as strict a coal inspection as any other railway on the North American continent, and quite apart from the fact that this is in the interest of the railway, such a policy is actually rendering an important service to the coal producers even if they do not all appreciate our attitude at the time.

It is conceded that while the coal producers have the sole responsibility for cleaning the coal there is also a responsibility resting with the railways. That is, if there is any deterioration in the quality or size condition of the coal through carelessness in handling where the railways are responsible, then it is in their power to correct this and they must do so.

The mechanical department frequently check up on coal performance, and in addition make frequent formal running tests in order to keep coal quality ratings up to date. This is done from time to time, due to changing conditions in the coal product, or the introduction of new sources of supply. In addition to testing one coal against another, there is the important question of testing the same coal in various sizes, such as mine-run or lump, egg, nut, etc. There is a large field for tests of this kind, which are proposed with the idea of developing the advantages of a particular size or sizes of coal including the size degradation caused by the movements of coal through locomotive stokers from tender to distributor plate.

Locomotive coal operating conditions in a country like Canada are more exacting in the winter than in the summer months, and if possible, a superior coal should be furnished in the winter.

A large proportion of the coal used is loaded in open cars, which means that for three to five months in the year it is subject to some quality deterioration due to ice, snow, etc. Coal is also moved in box cars, which means that it is protected and thus kept free from ice and snow, but against this there is the greater size degradation due to additional handling, as compared with coal furnished in open top cars.

Winter conditions prevent the water transportation of a large tonnage of locomotive coal and make it necessary to use coal from stock piles where it has been placed during the navigation season. In the handling of this coal and with the snow conditions as they are in Canada, it is, at times, difficult to keep the coal entirely free from snow and ice. These conditions reduce the useful heat delivery of the coal to some extent.

There is also the question of some loss in heat value in the banking operations. This is with reference to the heating and firing hazard, which is always present more or less, although by the exercise of great care, the Canadian National have been fortunate in being free from any serious occurrences. However, the final delivered condition of the coal is likely to be unfavourably affected at times, by heating and firing, while in stock piles.

The presence of tramp iron, etc., in coal has always been serious, but it is more so today, with the large number of stoker-fired engines. Pieces of scrap metal, etc., getting in the stoker mechanism are serious. One method of eliminating this material at the mine is by the installation of magnets at the ends of picking tables, and these are installed at quite a number of mines.

The mechanical cleaning of the coal is an important factor today, and quite a large percentage of the coal received is mechanically cleaned by one method or another.

[13] By John Roberts, Chief of Motive Power, Canadian National Railways, Montreal.

[14] General Fuel Agent, Canadian National Railways, Montreal.

F. Williams, A.M.E.I.C.[15]

Through close contact with the fuel problems of the Canadian National Railways for a good many years the writer is able to appreciate the amount of co-operative effort exerted by the mechanical and fuel departments, and the value of this co-operation. Some problems have been eliminated, some have been mitigated to a very appreciable extent, but unfortunately a great many of them still persist and will probably continue for many years to come. The only way to treat such problems is to look them squarely in the face and surmount them by the most practical means which can be devised.

To cite a typical example—Mr. Roberts mentioned the tendency of some fuels to plaster the back tube sheet with slag. This condition persisted on one division to such an extent that the back tube sheets had to have the slag removed at the end of every round trip and this operation entailed the removal of a section of the brick arch to obtain access to the tube sheet. The difficulty was eventually surmounted by omitting the deflector plate in the stoker, removing the second flight from the front end of the stoker conveyor screw and installing soot blowers at the back tube sheet. The engines on this division now run for the full thirty-day washout period with increased efficiency and availability; there has also been a great reduction in the consumption of arch brick.

The difficulties encountered are far too diversified to permit of anything like a comprehensive survey and as soon as one is solved another seems to take its place. However, life without its perplexities would soon become tame and it is only the constant battle with adverse circumstances which enables the railway management to separate the wheat from the chaff when selecting men for supervisory positions.

* * *

The Burning of Low Rank Alberta Coal[16]

A. G. Christie[17]

Professor Robb has ably presented the present state of the art of steam station development in western Canada. The details of equipment are fully considered. However, it is inadvisable to draw too definite conclusions on the basis of these data, as the art itself is changing rapidly and experience with western coals is steadily increasing. The possibilities of new methods and new equipment are well illustrated in Mr. Bull's accompanying paper.

Professor Robb mentions briefly the interconnection of water and steam power in his opening paragraphs. There is much misunderstanding on this important subject. The rivers of western Canada have their full flows during the summer months when electrical loads are lowest. The normal run-off is small in winter when the electrical loads are maximum. Hydro plants, to operate the year round, must store water in lakes during the summer to care for the winter deficiency in run-off. In some cases this storage can be effected at a reasonable cost, particularly when these storage lakes can be located in the mountains. An alternate method is to care for periods of low flow by the operation of auxiliary steam plants. This plan has particular merit when these plants can be located at load centres near the ends of the longer transmission lines, since outages would be less serious.

Engineers no longer consider hydro and steam power as competitors but rather as complementary sources of power. Each should be developed as component parts of a system to the extent that such additions would result in lower total system costs for a given output.

Alberta has many coal fields which can supply low cost fuel to steam plants. The situation in that province warrants an unbiased study of the correlation of these two sources of power so as to effect lower rates to customers. Too often when this subject is raised, local prejudices or political considerations dominate the discussion and a true understanding of the situation is not presented to the public.

Referring to the paper itself, the annual load factors as shown by the curves are low, indicating a small industrial power load in these western cities. The performances of the stations expressed in B.t.u. per kw.h. show excellent progress in station betterment. Auxiliary power requirements seem high, although this may be due to the relatively small size of the equipment and the continued use of many old steam-driven auxiliaries. The ratio of fixed charges to total cost shows a wide variation. Plant 1 in Fig. 8 has an unusually low ratio. Can Professor Robb explain why this plant is so much below the usual average ratio?

The heat values per pound and the cost per ton vary widely between different western coal fields. It would, therefore, seem better for Professor Robb to express fuel costs in terms of cents per million B.t.u. rather than in dollars per ton. In the case of the Saskatchewan cities freight forms probably the larger portion of the total coal costs.

Western Canada will experience rapid growth in the next twenty-five years. New plants must be built and new equipment added to present plants and this paper will serve as a base of reference to which the design and performance of the newer plants may be compared.

H. G. Thompson, A.M.E.I.C.[18]

In the section of Professor Robb's paper devoted to boiler feedwater some very interesting points were presented. One of these was the extent to which it has been found possible to reduce feedwater make-up. With this amounting to 4 per cent, or less, of the total boiler feed the problem of providing suitable make-up becomes a relatively simple one, whether evaporators, external softening or internal chemical treatment are used.

There appears to be a definite tendency on the part of larger industrial organizations to go to the higher pressures, and the amount of make-up being much greater in most cases than for the straight generating plants, the matter of proper boiler water conditioning will become increasingly important. Also, the problem is not entirely one of eliminating scale at the evaporating surfaces. With higher percentages of make-up there are more possibilities for scale in the feedlines, pumps, regulators, heaters, economizers, etc. and this part of the equipment must be kept clean as well as the boiler.

Reference was made in the paper to the descaling feature incorporated in modern evaporators and in this connection it is our understanding that the practice of using chemical treatment in evaporators is becoming more and more common because it permits of uninterrupted operation and better heat transfer.

In the matter of preventing corrosion by the use of sodium sulphite, mention might be made that considerable success has attended the use of certain organic materials for this purpose. These have the advantage of serving at the same time to prevent the deposition of feedline scale as well as helping to condition phosphate sludges and other benefits.

The Author (Prof. C. A. Robb, M.E.I.C.)

The author appreciates the scope of the discussion which has been presented.

[15] Mechanical Engineer, Canadian National Railways, Montreal.

[16] By C. A. Robb, M.E.I.C., Professor of Mechanical Engineering, University of Alberta, Edmonton, Alta.

[17] Professor of Mechanical Engineering, The Johns Hopkins University, Baltimore, Md.

[18] Aluminate Chemicals Ltd., Toronto, Ont.

Professor Christie has contributed an appreciation of the possibilities of steam power stations in western Canada which may well serve to stimulate those charged with their design and operation to make the fullest possible use of the experiences and developments in the larger stations on this continent.

The statement that "engineers no longer consider hydro and steam power as competitors but rather as complementary sources of power" cannot be stressed too strongly when the real objective is a reliable supply of power at minimum cost.

In regard to the wide variation in the ratio of fixed charges noted by Professor Christie, and the unusually low ratio shown in Fig. 8, the explanation tendered the author in regard to Plant No. 1 is that "a block of debentures were written off during the year 1936." It would appear that the usual provision has not been made in the case of this plant.

Mr. Thompson's understanding that the practice of providing chemical treatment for the raw water make-up served to the evaporators is becoming more common, is correct. Suitable control is required, even in these circumstances, to inhibit carry-over from the evaporator.

In regard to the higher percentage of make-up required in certain industrial plants, two have reported a make-up of about 33 per cent. In such cases chemical treatment of the feedwater requires special consideration.

* * *

The Saskatchewan Lignite Industry[19]

B. W. Parker[20]

Mr. Sutherland is an outstanding authority on the production and burning of lignite coal, and is largely responsible for the development in Winnipeg of the use of lignite coal for commercial purposes, by his advice to consumers' requirements.

The United States had been the chief source of coal for commercial purposes in Winnipeg until the year 1932, when the increased tariffs and conditions of production under the N.R.A. raised the price to a prohibitive figure and consumers had to find a new source of supply. No time was lost by those interested in the lignite industry to take advantage of the situation to introduce this fuel for commercial use, and with the assistance of the freight subvention allowed by the Federal Government, consumers soon discovered that lignite could be burned in a satisfactory manner and was as cheap, and in some cases cheaper, than the high grade American coal formerly used.

As pointed out in the paper, this industry, like the construction industry in Canada, suffers severely from seasonal conditions. This is not a fuel that can be mined and stored above ground like high grade bituminous coal, but must be produced as required. However, Mr. Sutherland's preference for a system of mining having a minimum of seasonal fluctuation in employment appears to be sound in principle.

When government enters the field of industry control consumers nearly always suffer, and in consequence the action of the Saskatchewan Government was viewed with alarm by large coal consumers. However the increase to date in the price of lignite has not been serious. Many large consumers have gone to considerable expense however in equipping their boilers for burning lignite, and the risk in doing so is becoming apparent owing to the action of the Saskatchewan Government and the recent reduction in freight subvention which at any time might be withdrawn altogether.

It is to be hoped that the Saskatchewan lignite operators will realize this situation and endeavour to take the necessary steps to establish and maintain a firm price so as not to discourage further use of lignite in Manitoba.

R. A. Strong, A.M.E.I.C.[21]

Mr. Sutherland in his paper gives a clear outline of the situation faced by the Saskatchewan lignite operators in producing a coal which has so many distinct disadvantages.

For several years the writer was associated with the author while working on an attempt to eliminate the unfortunate seasonal operations in the lignite mines of both North Dakota and Southern Saskatchewan. It was considered at that time that the upgrading of this fuel by carbonization and briquetting would allow for its increased sale in both the domestic and power fuel markets as well as an aid in its storage, thus making it possible to produce the fuel during the entire year at a steady rate rather than seasonally as has been indicated in the paper.

It is well known that the attempts to overcome this disadvantage by the means mentioned has not materialized and in view of developments in other fields it is unlikely that it will do so except in certain cases where conditions are definitely favourable.

The increase in tonnage from the Saskatchewan field during the past few years is one of the bright spots in the coal industry of Canada and this increase is in no small measure due to the efforts of Mr. Sutherland's company and his own personal contribution to the increased knowledge and use of a fuel which, as previously stated, has decided disadvantages in comparison to the fuels with which it competes. As an example of this it might be stated that from 1917 to 1921 the production of lignite from the Saskatchewan field was approximately 350,000 tons per annum. This was increased, due to scientific sales efforts and concentration on the methods outlined by the author for use of this fuel, to practically 1,000,000 tons in 1935 which represents an increase of 158 per cent over 1929, a peak year for the Canadian coal industry. This might be contrasted with a 24 per cent decrease in Alberta, a 17 per cent decrease in Nova Scotia, a 57 per cent increase in New Brunswick and a 47 per cent decrease in British Columbia during the same period.

With respect to the suggestions made regarding the elimination of uneconomic properties for the benefit of the miners employed in the industry, as well as the operators, this is a subject which must of necessity be handled by the authorities in control of the coal resources which, in this case, is the province of Saskatchewan. It is very difficult to arrive at a correct conclusion in regard to this proposal inasmuch as it would require somewhat dictatorial powers on the part of some authority to make a decision as to which properties should be operated. While such a situation has distinct merits and has been attempted through legislation in other countries it also has the disadvantage of being subject to very severe criticism on the part of those who have invested money in what might be termed uneconomic properties.

It would appear to me that the Saskatchewan field will, unfortunately, be compelled to develop along the same lines as other fields and that such suggestions as the author make, will take place only through the elimination of these properties on the basis of economics rather than legislation.

* * *

Experience in Burning Western Canadian Coals[22]

A. G. Christie[23]

This paper plainly demonstrates that Mr. Bull has availed himself of modern developments in power plants as rapidly as these have been evolved. His early uses of

[19] By R. L. Sutherland, Combustion Engineer, Truax-Traer Coal Company Limited, Winnipeg, Man.

[20] Vice-President, Northern Public Service Corporation, Winnipeg.

[21] Engineer, Department of Mines, Ottawa.

[22] By E. W. Bull, Supt. Light and Power Department, Regina, Sask.

[23] Professor of Mechanical Engineering, Johns Hopkins University.

underfeed stokers, preheated air, pulverized coal, radiant superheaters, extraction heating of feed water and water cooled furnaces are evidences of his recognition of progress in the art and of his courage in applying these new developments to the combustion of the little-known coals of western Canada. The additional knowledge presented in this paper on the characteristics of these abundant and potentially valuable fuels will be of great worth to others contemplating their use in boiler furnaces.

One is at once impressed by the frankness of the author in presenting the shortcomings of plant and fuels during the various stages of development and the remedies which he found effective. Doubtless some will wish to know why he chose certain types of pulverizing equipment in preference to other standard types. It would also be of interest to have Mr. Bull state his opinions on the suitability of the several mills for the preparation of the coals that he has tested.

Many western plants employ chain grate stokers to burn low volatile and non-coking coals. Some of the coals burned by the author had sufficiently high ash contents to appear suitable for chain grate stokers. What were the reasons for not trying the widely-used chain grate stoker on his western coals?

Mr. Bull mentions coal dust fires with lignite. Has he experienced fires with any of the other coals and if so from what causes? Have any coal dust puffs or explosions occurred and from what causes? If such occurred what remedies have been applied to avoid their future occurrences?

A statement of particular interest relates to the experience with lignite char and other pretreated material. It is apparent from this paper that the treated material has limitations as a transportable fuel that may offset its other advantages.

Apparently mill drying, using preheated air, was employed to remove moisture from the raw coal. If this is the case, what temperature of air is supplied to the mills? Recent practice seems to indicate that higher air temperatures are permissible than in earlier installations. Possibly higher drying air temperatures might aid in the better grindability and pulverization of the Saskatchewan lignite. Mr. Bull might also state how much drying was found necessary.

An objection to the use of pulverized coal has been the fly-ash discharge from the chimney. Has this given any difficulty at Regina and, if so, what means have been employed to decrease its amount? Are any future changes under consideration to deal with fly ash?

When the new plant at Edmonton was under consideration, the use of pulverized coal was discussed. The Edmonton coals appear to have higher grindability factors. Probably the factor that induced the late William Cunningham to decide on chain grate stokers in place of powdered coal was the possible nuisance from fly ash that would be discharged by the Edmonton plant. This station is located quite centrally in the city in the deep valley beside the Saskatchewan river. Stacks sufficiently high to carry this dust above the city's homes were out of the question.

The tests of March 1937 in Table III of the author's paper show efficiencies with several classes of coal that are practically equal to the best results obtained in other much larger central stations. A statement from Mr. Bull of his average production cost per kilowatt-hour for the past year would be of much interest, particularly if broken down into its elements of fuel, labour, repairs and maintenance and supplies.

The last line states that the plant cost $90.00 per kilowatt of capacity. This is a low figure for a plant of this size located at such a distance from the source of equipment. This price indicates an unusual combination of good engineering and careful purchases of equipment.

The writer hopes that this paper will lead to a wide discussion by western members of their own experiences in fuel burning so that certain conclusions may be formed regarding the best methods of burning the coals of western Canada.

Mr. Bull is to be congratulated on his excellent contribution to our knowledge of these fuels.

C. A. Robb, m.e.i.c.[24]

Mr. Bull is to be congratulated upon his paper which is timely and presents the results of an obviously extended investigation. The paper will have special interest for all those concerned with the quality of engineering represented in thermal power stations in the area served by the fuels of Alberta and Saskatchewan.

In reviewing the test data, certain questions arise, and the author might care to add details which would permit comprehensive study of the material. The addition, for example, of the CO and O content of the flue gas, and the analysis of the fuel, would make it possible to set up a boiler heat balance.

What gain in per cent was obtained from the novel application of the water-cooled ash pits of 1921?

The boiler trials of 1922 (Table I) can hardly be considered to give a fair comparison of what might be done with these coals on modern equipment. The limitations of the stoker in handling so great a variety of fuels is evident in the wide variation of the efficiencies, which range from 62.2 per cent for Saskatchewan lignite to 81.8 per cent for bituminous coal, and in the low CO_2 content of the flue gases from the Alberta lignites.

The Saskatchewan lignite test of 1933 shows an efficiency of 81.36 per cent. It would be interesting to know how this would compare with the average efficiency for the year.

The author's conclusion that "the fuel should be ground to extreme fineness" is not clear. Does he mean extreme fineness in passing all screens, or simply a high percentage passing the 40 mesh?

Would he give a brief summary showing the effect, in recent years, of the improved efficiency of the steam generating plant on the annual station performance?

No reference is made to scrubbing of the flue gases, or to the quantity of ash recovered, although the plant is shown in Zone Map No. 1 as Res. Dist. A and within city limits.

L. A. Thornton, m.e.i.c.[25]

Mr. Bull's contribution to steam power plant practice in the West has been outstanding, and the results he has attained are matters of respect on the one hand and envy on the other hand from those of us who are also engaged in the same problem. Mr. Bull is in a peculiar way thoroughly conversant with every detail of the subject with which he deals, and is in a position to substantiate by actual performance any of the experiences which he has related.

The coal from the Crow's Nest district is not dissimilar in general properties from the steam coals you are familiar with in the East, but the lignite fuels from the Drumheller and Saskatchewan fields present problems which are not as well understood, either by the operators in the East, or, indeed, by the designers, and the experiences of men like the author have been of great assistance in bringing about efficient methods of handling of this coal.

[24] Professor of Mechanical Engineering, University of Alberta, Edmonton.

[25] Commissioner, Saskatchewan Power Commission, Regina.

THE AUTHOR (E. W. Bull)

Replying to points raised in discussion by Mr. A. G. Christie. Due to the toughness of certain coals, especially lignite, it was considered that the type of pulverizer where the material to be pulverized is definitely acted upon by a rolling action between guided metal rings and rollers or balls, was a better principle than a hazardous condition of contact in impact mills at high speed.

The definite rolling action brought about a greater action of coal particles on other coal particles in their passage between rollers, or balls, and grinding rings.

The only dust fires encountered were with lignite in the burner plenum chamber, due to sifting, and this was only because lignite dust, when dry and undisturbed, ignites at a low temperature. The remedy was, as stated, to avoid an accumulation by keeping this dust moving towards the furnace and venting the pipes to the furnace.

No bituminous coal dust fires have been encountered with preheated air as high as 450 deg. F.

The air temperature to the mills has been up to 450 deg. F. and the coal and air temperature to the burners has been as high as 210 deg. F. with bituminous coal with only surface moisture, and 110 deg. F. when burning Saskatchewan lignite with 33 per cent inherent moisture.

It appears that the inherent moisture in the particles of Saskatchewan lignite, originally 33 per cent in the coal feed, is reduced to about 17 per cent, which gives a satisfactory condition for lighting up on entering furnace.

In an endeavour to further improve conditions for burning lignite, No. 10 boiler which started operation in September 1937, was designed to give 500 deg. F. preheated air, of course with the necessary tempering air connections for carrier air to the pulverizer in use, when burning bituminous coals.

Due to the plant location and the direction of the prevailing winds, there has been no difficulty with fly-ash of later years, or since a determined effort was made to grind the coal to a fineness of 85 per cent through 200 mesh screens.

Previous to this, coarse particles in the immediate vicinity of the plant had been a source of some trouble.

Replying to points raised in discussion by Mr. C. A. Robb. Heat balance computations have been made on certain tests run on lignite, but it was not considered advisable to add further to an already long paper on experience by including these lengthy records.

In recent years the plant has not operated continuously on high or low pressure, consequently, any statements of yearly efficiency should also carry explanatory notes. High pressure operation of boilers with bituminous coals show monthly averages of above 85 per cent efficiency.

The term grinding to extreme fineness means that over 85 per cent will pass a 200 mesh screen and the author's experience is that when this condition is met, only a very small percentage will not pass a 40 mesh screen.

Under the conditions as set out in reply to Mr. Christie's discussion, no necessity has arisen for scrubbing of flue gases.

* * *

British Columbia Coals in Metallurgy[26]

BERNARD DUNELL[27]

The Consolidated Mining and Smelting Company of Canada are unusually well placed for obtaining a wide range of information on the burning of coal, in that they not only burn an immense quantity in their varied metallurgical processes, but also burn a large amount on chain grate stokers as well as in pulverized form for steam raising purposes.

Mr. McNaughton makes mention of a coal containing 22.9 per cent moisture as having been burned in pulverized form at the Fuel Research Laboratories, Ottawa. It would be interesting to know how much the water content of this coal was reduced in pulverizing, or what the moisture content was at the point of entering the coal burner. It would also be interesting to know whether Mr. McNaughton has made any determinations as to the highest percentage of moisture allowable for burning coal satisfactorily in pulverized form, particularly with regard to the small burners which he describes as burning only one ton of coal per day. Presumably the percentage of volatiles in the coal would have a bearing on this.

As mentioned by Mr. McNaughton, the ash fusion temperature of a coal is often of vital importance, and it is frequently a surprise to find that coal companies are not always in a position to give this information readily. In the design of a boiler and boiler setting and the selection of the stoker, where even moderately high boiler ratings are contemplated, it is essential to know the fusion temperature of the ash if furnace troubles are to be avoided. Provided this information is available, it is not of so much consequence if the fusion temperature is low, as proper provision can be made by giving adequate grate area, if the coal is to be burned by means of stokers, and by designing the boiler with a suitable "fraction cold." If the coal is to be burned in pulverized form, sufficient furnace volume and proper "fraction cold" must be provided so that the particles of ash, which are molten during combustion of the coal surrounding them, have become solidified before they reach the boiler tubes or furnace floor, otherwise "birdsnesting" of the ash on the tubes will occur, or it will solidify in a mass on the furnace floor.

During the past thirteen or fourteen years the writer has been privileged in being able to discuss with the Consolidated Mining and Smelting Company their combustion problems, and would like to take this opportunity of acknowledging the valuable assistance and whole-hearted co-operation that he has universally received.

* * *

The Burning of Canadian Coals[28]

F. A. COMBE, M.E.I.C.[29]

The papers presented in this symposium form a valuable series and particularly so to the combustion engineer, and to those engaged in the actual design and operation of steam plants. In addition to reports of laboratory work on the classification and analysis of fuels, information is given regarding results obtained and difficulties experienced with the burning of various coals, both from the Western and Eastern Districts by different methods and on different types of equipment in a number of steam plants operating under actual commercial conditions.

Tests made on hand fired small steam boilers in government and university testing plants, of which reports are given, may serve a useful purpose in determining certain basic characteristics of the coals burned but can hardly be used for definite comparisions of values for practical purposes.

Today, mechanical methods of firing are quite generally adopted, even in the small plants, and equipment and special furnace settings have been designed to suit particular coals. For example, good results can be obtained with underfeed stokers in correctly designed furnaces burning Nova Scotia coals, but such stokers have apparently not proved to be altogether satisfactory for Alberta coals.

Obviously the resources at the disposal of the Department of Mines or the universities cannot provide for

[26] By R. R. McNaughton, Smelter Metallurgist, Consolidated Mining and Smelting Company of Canada Limited, Trail, B.C.

[27] C. C. Moore and Company, Engineers, Vancouver, B.C.

[28] General Discussion on the Symposium on the Burning of Canadian Coals.

[29] Consulting Combustion and Steam Engineer, Montreal.

installation in utility, industrial or other active plants. In this connection it would be well worth while for the government, through some committee or agency, to form contacts for co-operation with a selected number of active steam plants to investigate, analyze and assemble data which is available or possible to obtain for a comprehensive and continuing study of the subjects on which the papers presented have given a general review.

This does not apply, of course, to the tests with domestic heaters, which tests apparently must be carried out under artificial conditions. It is interesting to note the comparison of figures from tests on domestic heaters made by the Department of Mines in the 1925 and 1935 series; also the corresponding tests with different grades of Nova Scotia coals carried out at the Nova Scotia Technical College. Some years ago the Fuel Committee of the Montreal Branch of The Engineering Institute carried on an investigation on the burning of fuels available in the Montreal district and made records of actual consumptions in a number of houses over an entire heating season using different fuels under conditions which were considered to be average for the ordinary householder. These figures agreed in general as to comparative values with the Ottawa tests made at that time.

It would be of interest, and of value in developing improved designs of house heaters, if the heat balance of the tests made were published showing where losses occurred and giving flue gas temperatures, together with details of heaters used and observations as to smoke, soot, etc., particularly for Nova Scotia coals.

Mr. Munroe's paper deals very clearly with the production of coke in Canada for domestic use. It is gratifying to note the success of experiments by which certain Nova Scotia coals may be prepared to form a satisfactory fuel for domestic coke manufacture.

In the writer's opinion there are economic possibilities for a wider use of gas and domestic coke than at present.

Mr. Munroe points out the effect on Canadian producers of the importation of low priced coke from Europe. This is obviously a matter for government attention and control since with business and human nature as it is, it is useless to expect any one to pay even ten cents more per ton for equal quality on the theory of general benefit by keeping money in the country.

The papers by Messrs. Haanel and Gilmore and by Professor Stansfield contain much original and valuable matter on the classification and testing of coals and the extremely interesting and important suggested formulae for combustion results and the use of gross vs. nett efficiency, supplementing the extensive work which they have carried out in the past.

A phase of the subject which could profitably be studied further is the character of the low fusible ashes, which is referred to briefly in the paper by Messrs. Haanel and Gilmore. In general, analyses of coals give merely the percentage of ash and the fusion point, but do not include analysis of the ash or slag as to iron content and other constituents. Particularly with coals from Nova Scotia and New Brunswick, the difficulties of burning result largely from the iron content slag and its formation in either an oxidizing or a reducing atmosphere. With the coke, iron and fluxing materials under forced draft we have all the elements of a first class blast furnace. Ash from certain western coals, which have an equal or lower fusion point, do not behave in the same manner nor present difficulties of the same kind, due to their different composition and character. As illustrative of one minor difference in effect, Professor Robb and Mr. Bull refer to the successful use of carborundum or carbofrax bricks in side walls of stoker furnaces burning Alberta coals. This material in solid brick form is rapidly attacked by the molten ash from Nova Scotia or New Brunswick coals, although the action can be reduced to a considerable extent by effective air cooling with special thin wall blocks.

From practical experience gained in the past, much improvement has been made during recent years in furnace design and equipment to meet the difficulties formerly encountered, but further investigatory work and published information as to ash constituents, characteristics and action under conditions obtaining in boiler furnaces would be of value.

Mr. McNaughton points out a feature which is not often considered, that is, the choice of coal to give a particular colour of ash as sometimes called for in a metallurgical furnace.

Dr. Stephens remarks upon the significance of boiler efficiency. Although possibly not altogether relevant to the subject under discussion, the writer would like to add his plea for the discontinuance of the use of the term "percent rating" when speaking of the output of a boiler unit, based on the old standard of ten square feet of heating surface per boiler horsepower. With modern steam generators comprising water wall furnaces, segregation of evaporating and water heating surfaces, etc., ratings on such a basis are absurd and mean nothing. The writer has preached this for many years and hopes that a more rational basis of performance soon will be recognized and generally used.

G. H. Jenkins[30]

The fuel department of the Canadian National Railways are large users of Western Canadian coals, and Alberta furnishes the largest portion. More than half of all of the coal purchased from Canadian mines in the west is used as locomotive fuel and firing practices are based on using the coal that is available in the vicinity of the Canadian National lines. This coal is not all alike, either in respect to rank, physical, or chemical characteristics, and an attempt is made to distribute the coals to areas where they will be used to best economic advantage. Some of it is not of the hardest structure, and, in some cases, the final size condition is not improved by further size degradation, caused in box car handling.

Against the foregoing size deficiency, however, some of the chemical constituents of Alberta bituminous coals, like the high fixed carbon content, low sulphur and moisture, and high ash fusing point, are desirable, and help balance the various factors entering into the use of Alberta coal for locomotive fuel purposes.

In order to reduce the number of cars in company coal service during grain carrying months, when cars are wanted for the commercial business, it has been the practice to move coal to selected points in the off-season, and dump it on the ground, which means another handling and size degradation.

The loss of heat value through storing selected Alberta bituminous coals in banks has not been found to be great. Heating and firing is a risk but it is not insurmountable.

[30] General Fuel Agent, Canadian National Railways, Montreal.

THE ENGINEERING JOURNAL

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

VOLUME XXI JANUARY, 1938 No. 1

A New Year's Message

The President and Council take pleasure in conveying to all members of The Institute cordial greetings and hearty good wishes for 1938.

To these should be added a word of appreciation of the constructive interest in the affairs of The Institute shown by the membership during the past year. Thanks to their active co-operation the Semicentennial celebrations were successful beyond our expectations, improvement in general conditions has been reflected in the substantial progress of The Institute itself, and it seems likely that in the coming year definite steps will be taken towards the establishment of closer relations between The Institute and the Associations of Professional Engineers.

With these and other encouraging features in mind an optimistic view of The Institute's prospects for 1938 seems amply justified.

Negotiations with Provincial Associations

During the year just closed there has been considerable activity of the Council on the lines of laying foundations for co-operation with a number of the Provincial Professional Associations, a matter in which President Desbarats has played a very prominent part through the medium of personal conferences in various parts of the country.

In the Province of Nova Scotia the greatest advance has been made, and through conversations between the representatives of the Council of The Institute, of the Institute's Branches and the officers of the Association of Professional Engineers, the tentative basis of an agreement has been reached, which it is hoped will lead in due course to a close co-operation in that Province. Naturally certain formalities are still required for the final consummation, such as the approval of the necessary enabling by-laws of the Institute and the Association.

Conferences have also been held in New Brunswick to a similar end, which while not as far advanced as in the case of Nova Scotia, nevertheless lead Council to hope that a satisfactory arrangement will be reached in the near future.

At the time of going to press, discussions are also under way with the Association of Professional Engineers of Manitoba. It will be remembered that a fairly definite scheme was under discussion in that Province a year or so ago and no doubt this proposal will form the basis of future conferences.

Our Branches and the Young Engineer

It is encouraging to note the success of the measures which have been taken in several of The Institute Branches with the object of developing the interest of our Junior and Student members in the work of The Institute and in engineering problems and topics other than those at which they happen to be working individually.

With such an end in view, the 'Junior Section' of the Montreal Branch was formed some five years ago and has been functioning actively since that time. It has shown a steady increase in numbers and in the popularity of its meetings, of which twelve were held in 1936 with an average attendance of forty-nine. The papers, usually in English (but occasionally in French), are well presented and give rise to active discussion in which everyone is encouraged to take part. That this section is filling one of the young engineers' real needs, is indicated by its growth from an original membership of seventeen to over ninety at the present time. It is managed entirely by its own elected representatives, and provides two papers annually for presentation at a meeting of the Montreal Branch.

Another example of a successful organization of similar character exists in Peterborough, where the younger members have formed a 'Junior and Students' Discussion Club' under the auspices of the Branch. The Club's deliberations are largely informal. At some of the meetings written papers are presented by members and then discussed. For other meetings, two speakers are appointed well in advance of the date selected. They choose their own subjects, of which the remaining members are promptly notified; in this way everyone comes prepared to contribute to the discussion. The average attendance at such meetings has been thirty. The subjects—largely electrical—have included such topics as commutation, fluorescent lighting, high voltage direct current transmission, and lightning protection.

Branch organizations of this kind, formed at centres where there are enough Students and Juniors to club together, can render a very real service to The Institute and to our younger 'engineers-in-training.' They do this, first, by bringing to The Institute the right type of young and active member, who will later be available to take part in the regular activities of the Branch and of The Institute, and, secondly, by giving these young men opportunities to secure training in public speaking and the conduct of meetings, to increase their store of professional knowledge, and to meet each other and the senior members of the profession under congenial and informal conditions.

The Fifty-Second Annual General and General Professional Meeting

The Annual General Meeting for 1938 will be convened at Headquarters, 2050 Mansfield Street, Montreal, on Thursday, January 20th, 1938, at eight o'clock p.m.

After the transaction of formal business the meeting will be adjourned to reconvene at the Hotel London, London, Ont., at 2.30 p.m. on Monday, January 31st, 1938, continuing with the Professional Sessions on the following days.

Programme of Meeting in London

(Subject to minor changes)

Headquarters: The Hotel London

MONDAY, JANUARY 31st

10.00 a.m. REGISTRATION.

12.30 p.m. INTRODUCTORY LUNCHEON (Ball Room).

Members $1.00.

Chairman: A. O. WOLFF, M.E.I.C., Chairman of the London Branch.

Welcome by His Worship the Mayor of London.

Address by PROFESSOR J. A. SPENCELEY, University of Western Ontario. Subject: "Robinson Crusoe."

2.30 p.m. ANNUAL GENERAL MEETING OF THE INSTITUTE (Ball Room).

Reception and discussion of reports of Council, Committees and Branches.

Discussions on proposals for the amendment of the By-laws.

5.00 p.m. Scrutineers' Report and Election of Officers.

Address of the Retiring President.

Induction of new President.

8.30 p.m. ANNUAL GENERAL MEETING (continued if necessary).

TUESDAY, FEBRUARY 1st

9.30 a.m. PROFESSIONAL SESSION (Ball Room).

Chairman: J. A. VANCE, A.M.E.I.C.

The following papers will be presented and discussed:—

(1) **Engineering the Highways for Safety,** by A. A. Smith, M.E.I.C., Chief Engineer, and C. A. Robbins, District Engineer, Toronto, Department of Public Highways, Ontario, Toronto, Ont.

2.15 p.m. (2) **Engineering Efficiency into the Highways,** by Miller McClintock, Ph.D., Director, Harvard University Bureau for Street Traffic Research, Cambridge, Mass.

7.00 p.m. ANNUAL DINNER OF THE INSTITUTE (Ball Room).

THE PRESIDENT in the chair.

THE HON. MITCHELL F. HEPBURN, Prime Minister of Ontario, will address the members and ladies present.

The prizes and medals of The Institute will be presented.

The Dinner will be followed by an *entertainment* organized by the London Branch of The Institute.

Tickets for Dinner and Entertainment $2.50 per person.

WEDNESDAY, FEBRUARY 2nd

9.30 a.m. PROFESSIONAL SESSION (Ball Room).

Chairman: R. L. DOBBIN, M.E.I.C.

The following papers will be presented and discussed:—

(1) **Precipitation in Southwestern Ontario,** by John Patterson, Controller, Meteorological Service of Canada, Toronto, Ont.

(2) **Surface Run-off in the Thames and Grand River Basins in Ontario,** by Norman Marr, M.E.I.C., Chief Hydraulic Engineer, Dominion Water and Power Bureau, Ottawa, Ont.

(3) **Agricultural Drainage in Southwestern Ontario and its Effects on Stream Discharge,** by G. A. McCubbin, M.E.I.C., Surveyor and Civil Engineer, Chatham, Ont.

(4) **Flood Control and Water Conservation in Southwestern Ontario,** by F. P. Adams, A.M.E.I.C., City Engineer, Brantford, Ont.

12.30 p.m. OFFICIAL LUNCHEON (Ball Room).

Members $1.00.

THE ONTARIO VICE-PRESIDENT in the chair.

Address by MAJOR F. L. C. BOND, M.E.I.C., General Manager, Central Region, C.N.R., Toronto, Ont.

2.15 p.m. PROFESSIONAL SESSIONS (held simultaneously in the Ball Room and City Hall Auditorium).

(*A*) In the *Ball Room,* the discussion on **Flood Control** will be continued.

(*B*) In the *City Hall Auditorium: Chairman:* COL. IBBOTSON LEONARD, M.E.I.C., the following papers will be presented and discussed:—

(1) **Canadian Steam-Electric Power Plants,** by C. A. Robb, M.E.I.C., Professor of Mechanical Engineering, University of Alberta, Edmonton, Alta.

(2) **Design and Construction of the 18-foot Steel Pipe Line at Outardes Falls, Que.,** by A. W. F. McQueen, A.M.E.I.C., Hydraulic Engineer, H. G. Acres and Company, Ltd., Niagara Falls, Ont. and E. C. Molke, A.M.E.I.C., formerly Designing Engineer, H. G. Acres and Company Ltd., Niagara Falls, Ont.

Natural Science Building, College of Arts, University of Western Ontario.

Municipal Offices, London, Ontario.

LADIES' PROGRAMME

A special programme of entertainment for the ladies is being arranged by the Ladies' Committee.

Visiting ladies and ladies of the London Branch will be guests of the Branch at the following—Tea at Byron Sanatorium on Monday afternoon, following by a Theatre Party in the evening; also a Luncheon and Bridge on Tuesday at the London Hunt and Country Club.

Visiting ladies will also be guests of the Branch at the Luncheons on Monday and on Wednesday at the Hotel London.

INDUSTRIAL PLANTS AND PUBLIC INSTITUTIONS

The Committee will be happy to make arrangements for members who would like to visit any of the industrial plants or public service institutions in or near London; members will please notify the Registration desk as to their wishes regarding this.

Among such establishments may be mentioned the following:—

- The University of Western Ontario
- The Byron Sanatorium
- The City Waterworks and Sewage Disposal Plant
- The Industrial Plants of
  - E. Leonard and Sons Limited
  - Empire Brass Mfg. Co. Limited
  - General Steel Wares Limited
  - George White & Sons Co. Limited
  - John Labatt Limited
  - Kellogg Company of Canada Limited
  - London Concrete Machinery Co. Limited
  - London Structural Steel Co. Limited
  - McCormick's Limited
  - Murray Shoe Company Limited
  - Roberts-Wilcox Canadian Co. Limited
  - Service Lamp Co. Limited
  - Sparton of Canada Limited.

Dual Highway—Toronto to Hamilton.

Dual Highway—Toronto to Hamilton.

ANNOUNCEMENTS

Hotel Arrangements

In order to be certain of accommodation members are *urged to make definite arrangements for rooms at least a week in advance.* Reservations are to be made directly with the Hotel—acknowledgment will be made direct to member.

The Hotel London quotes the following rates:—

Single room with running water and toilet—
$2.50 per day.
Single room with bath—
$3.00 and $3.50 per day.
Double room with bath—
$4.00, $4.50 and $5.00 per day.

The Hotel London is the headquarters for the meeting—all attending are requested to register at the meeting headquarters immediately upon arrival.

Railway Rates

Both railways offer the following return rates for groups of ten or more:—

(*a*) Organized parties having a minimum of ten up to fourteen persons: Single fare and a half.

(*b*) Organized parties of fifteen to twenty-four persons: Single fare and a quarter.

(*c*) Organized parties of twenty-five or more: Single fare and one-tenth.

All these fares require the party to travel together on the same train and date on the going trip, with individual return on any train within the time limit of sixteen days. They apply either to coach rates or ordinary first-class rates. Members intending to proceed to London by train are requested to *notify their Branch Secretaries* without delay, so that parties may be made up locally.

Local Committee on Arrangements

Chairman.................... E. V. Buchanan, M.E.I.C.
Vice-Chairman................ J. A. Vance, A.M.E.I.C.
Secretary.................... D. S. Scrymgeour, A.M.E.I.C.

Members...	S. W. Archibald, M.E.I.C.	H. L. Hayman, A.M.E.I.C.
	F. C. Ball, A.M.E I.C.	W. C. Miller, M.E.I.C
	F. A. Bell, A.M.E I.C.	V. A. McKillop, A.M.E.I.C.
	H. F. Bennett, M.E.I.C.	H. A. McKay, A.M.E.I.C.
	D. M. Bright, A.M.E.I.C.	J. R. Rostron, A.M.E.I.C.
	J. Ferguson, A.M.E.I.C.	W. R. Smith, A.M.E.I.C.
	G. J. Forristal, S.E.I.C.	W. H. Wood
	R. W. Garrett, A.M.E.I.C.	A. O. Wolff, M.E.I.C.

Ladies Committee

Chairman.................... Mrs. E. V. Buchanan

New Dominion Public Building, London, Ont.

The Work of the Hydro-Electric Power Commission of Ontario

An Address Delivered by T. H. Hogg, D.Eng., M.E.I.C.

At a dinner on December 8th, 1937, on the occasion of his appointment as Chairman of the Commission.

Mr. Chairman, Mr. Prime Minister, honoured guests, and members of the Engineering Fraternity of Canada: Tonight I address myself to the engineering fraternity of Canada, partly because the nine societies which have sponsored this gathering in my honour are thoroughly representative of the engineering fraternity of Canada, partly because individual references to each society might call for distinctions of some delicacy, and partly because, on this unique occasion, my heart goes out to the profession at large.

In an interview given last month, I made a statement to the effect that I was not interested particularly in my job as Chairman, but was intensely interested in what could be done with it. This was one way of intimating that there is attached to this post a responsibility so great, involving a burden so considerable as to more than offset any personal satisfaction or feeling of pride arising out of the distinction which it carries, leaving only one thing to rejoice over; fortunately that one thing is a very big thing in which I said I was intensely interested, "what can be done with the job?" I am inspired by the opportunity to do something much greater than I have ever done before for one of the greatest institutions in my native Province, in whose service I am proud to say I have spent the best part of my life; for that opportunity I wish to express my most sincere thanks to the Prime Minister of Ontario and his colleagues. To you who have so spontaneously expressed your approval of my appointment, I feel the deepest personal gratitude. At the same time I feel that the choice of an engineer as Chairman of the Commission is a tribute to the engineering profession to which I belong, rather than a mark of personal distinction.

How can any man fail to do his very best when he is supported by the knowledge that so many friends pin upon him their hopes for the accomplishment of fine things, confident that he will not be found wanting.

Opportunities have opened up to me through my activities as an engineer, and my reputation as an engineer is dear to my heart. The activities which are described as "executive," and which will henceforward claim an even greater portion of my time than formerly, are of a more recent order.

Years of experience in the engineering field inevitably establish as a matter of course, cautious approach, careful inquiry and measured appraisal, the attitude of mind which can rest only on a firm foundation of fact, and which frowns on irresponsible exaggeration and subterfuge; I think you will agree that this common heritage of the mature engineer is an asset in any responsible post.

However, for responsible executive positions, something more is required; there must be the capacity to effectively synchronize, each in its proper perspective, a variety of administrative functions and to so direct the co-ordinated organism that its purpose may be fully, effectively and economically achieved. I can only hope that the qualities and capacities demanded for the performance of the executive duties which now devolve upon me may prove to be present in sufficient measure to enable me to discharge the trust which has been placed in my hands in a manner which will reflect credit upon the Commission, so that it will continue to be a source of pride to its employees and the public at large.

The story of the origin and phenomenal development of that great institution founded by Sir Adam Beck which we in Ontario call "Hydro," must be familiar to most people in this Province and to many elsewhere, for it has been told over and over again. Yet I sometimes wonder how many grasp the significance of the story or have more than a meagre appreciation of the nature and function of this enterprise which is so vital to the well being of Ontario homes and industry; indeed, many of those who have been immersed in "Hydro" activities for upward of twenty-five years or more must pause and take stock to realize what it is today, so great has been its growth and extension, yet so unobtrusive.

Prior to the depression, the whole enterprise was characterized by an uninterrupted record of expansion, until it seemed as though there could be no end to it, not even a pause. This period was not without difficulties. Difficulties in obtaining power to meet the rapidly increasing demands. Difficulties due to selfish interests, and many other difficulties too numerous to mention.

This enterprise, with its $314,000,000 in physical assets, exclusive of any assets of the municipal electric utilities, its interest bill of $13,000,000 per year, its annual wage outlay between $8,000,000 and $9,000,000, its forty-one generating stations aggregating 1,425,000 horsepower in capacity, its peak-load demand, which last year was about 1,600,000 horsepower and this year will be materially greater, and its 18,000 circuit miles of transmission lines of all voltages, including rural, has tremendous potentialities for good. With proper handling, it is a servant of incalculable value, but lacking intelligent direction it may be transformed into an exacting taskmaster, perhaps even a gigantic octopus. If the interests of this institution should ever become secondary to other interests in the minds of the men who are at its head, then, surely, the transition from servant to octopus is inevitable.

Active in Three Fields

The object and justification for the existence of the Hydro-Electric Power Commission of Ontario is the distribution of power throughout the Province in the best interests of all the people. Naturally, the people's interests demand that power be supplied at the lowest possible cost consistent with security of service and proper guarantees of future supplies. The Commission has no assets in its own rights; it is simply a trustee administering the affairs entrusted to it. In the discharge of its responsibilities, the Commission is active in three principal fields:

1. The municipal field.
2. The fields of rural supply.
3. The Northern Ontario field.

Bear with me while I enlarge somewhat on this, even though much of the ground is familiar.

In the municipal field, the Commission is principally concerned with the wholesale delivery of power to cities, towns and villages, which, in turn, distribute it to individual customers, subject to certain Commission supervision. The municipalities associate themselves into co-operative groups, usually referred to as systems, which collectively are responsible for all provisions made on their behalf in the form of power developments, transmission facilities, power purchases or services.

Each system is a separate and distinct entity, and the municipalities of which it is composed are entitled to all benefits derivable therefrom and obligated for all its losses, quite independently of the success or failure of any other "system" or group of municipalities.

It is, of course, a cardinal principle that each municipality must pay its proper share of the cost of power and each municipality is obligated under the Power Commission Act and its contracts to ensure the Commission against default.

In the second field; namely, the field of rural supply, the Commission is both wholesaler and retailer. The settled parts of the Province are divided into rural districts. Each rural district derives its power supply from one of the municipal systems and pays for it on a cost basis as though it were a municipality of the group, and each is financially independent of all the others. Neglecting the fact that the Province bonuses rural areas to the extent of supplying half the capital cost of rural primary lines, rural power is sold to rural customers on a strictly cost basis at rates depending upon the district cost of power and the added cost of distribution; the act provides for the collection of over-due accounts by tax levies.

It will be noted that in both the municipal and rural fields, the Province assumes no risk unless through the insolvency of its municipalities, for the latter are obligated under the terms of their contracts and the Power Commission Act for all expenditures made on their behalf by their trustee, the Commission.

In these two fields of endeavour, viz., municipal and rural, the Commission's physical properties have rapidly spread all over Southern Ontario, where there are now scores of generating stations, hundreds of transformer stations, and a veritable network of transmission and distribution lines.

In Northern Ontario, the third field, the situation is quite different from either of the other two, and should be particularly interesting to mining men. In the main, even the settled part of the country is sparsely settled and a great deal of it is in the natural state. The distances are great and the principal demand for power comes from mines or industries associated with the mining industry. No group of municipalities exists in this territory which could possibly finance developments of the magnitude needed to supply the mines and allied industries. Consequently, the title to the power developments and transmission systems rests in the Province and the risk of loss, in case of customer default or from any other cause, rests upon the Province and not upon any group of municipalities as in Southern Ontario. The Commission operates the Northern Ontario properties, which consist of the Nipissing, Sudbury, Abitibi, Patricia, and St. Joseph districts, as trustee for the Government.

Throughout these districts there is great activity. Generating stations, transformer stations and transmission lines are making their appearance at an astonishing rate. The large Abitibi Canyon plant is rapidly being loaded with primary power, generating stations have been established and extended on the Albany and English rivers at Rat Rapids and Ear Falls, respectively, and the recently acquired Crystal Falls plant on the Sturgeon river has been connected to the Wahnapitae system to provide for the growing load.

Starting insignificantly in the 1890's, the metal mining industry of Ontario has now become one of the major industries of the Province, second only to agriculture. Its output in 1936 was valued at $165,000,000, and the estimate of the Ontario Department of Mines for 1937 approaches $205,000,000. During 1936 it employed 23,000 men and paid an annual wage bill of $35,300,000.

Moreover, despite the ups and downs of the stock market, present indications point to a large and prolonged increase in mining activity. Forecasts of the Ontario Department of Mines indicate that there will be a 15 per cent increase in mineral production in 1937 over 1936. Diamond-drilling, which is always considered an excellent yardstick in appraising the general trend in mining development, showed a 100 per cent increase in core footage in 1936 over 1935. Diamond-drilling companies alone spent last year $1,500,000 in wages and employed 1,473 men.

Mines must have power, and many mines must have cheap power otherwise they cannot operate. In many cases the Commission is in a position to supply the power at rates which permit the opening and operation of the mines, but the question of financial guarantees sometimes presents an obstacle. Will the mine prove itself, or will it be a failure? Caution urges against the investment of capital in transmission lines to supply a mine which may only operate a few years, and all manner of reasons are brought forward as to why the Commission, as trustee of the Government, should take no risk, but should invariably require the mines to deposit security which would guarantee the Commission against any possible loss.

Is this a short-sighted viewpoint? It is apparent that large capital expenditures should not be made on behalf of uncertain mining prospects; but may there not be circumstances under which the Province, through the agency of this Commission, might well co-operate with established mines in the construction of transmission lines which enable them to be supplied with electric power? Participation to this extent might be justified, and might actually be made attractive by charging such rates for power as, in the aggregate, would show a profit notwithstanding an appropriate allowance for short life and consequent losses. This is the practice of privately owned power companies, and the arguments in favour of its adoption by the Province are worthy of very careful consideration. For example, suppose a mine should close down after a few years of operation, leaving the Commission with a capital investment in a transmission line which has not been fully retired; is it not possible that the indirect benefit to the Province of that few years of mine operation might more than offset the loss of the unretired capital so that the Province would actually gain by a transaction which superficially might appear to be to its disadvantage?

A precedent already exists in rural operation for Provincial aid where the indirect return justifies it. In that case, the Government furnishes capital to the extent of one-half the cost of the primary lines without any expectation of its return, whereas in the mining field it would look for compensation for all losses from revenue received from the successful mines. As already stated, this is the policy of large private power companies operating in mining areas. These companies recognize that they, too, must have a stake in the mines if the mining country is to be developed, and they are content to take more or less selected risks.

In any large organization, the question of financial reserves is one of great importance and considerable complexity. From its inception, the Commission has set up three principal reserves:

1. A sinking fund, which is accumulated to retire all capital indebtedness.

2. A depreciation and obsolescence reserve, which accumulates at a rate sufficient to make available for replacement or reconstruction, at the end of their useful life, the full capital cost of all buildings and apparatus.

3. A contingency reserve, which is drawn upon to defray the cost of all manner of individually unpredictable events; for example, damage caused by lightning, winds and floods. This contingency reserve furnishes the broad stabilizing influence of insurance.

As the state of these reserve accounts is an indication of the soundness of the general financial position of Hydro, it has been the subject of considerable public discussion of late years. I do not intend to analyze these reserves or the security which they provide, but I am very pleased to say that they are in excellent condition and that Hydro's position is very strong indeed. The safeguarding of these funds and the continuance of a sound policy with respect to reserves is quite evidently one of the most important duties of the Commission, and I assure you that I shall let nothing interfere with their maintenance in the soundest possible condition, while at the same time making such proper use of them as they were and are intended to fulfil.

After the intense anxiety of depression and early recovery years, it is pleasant, and I think I may say, without being misconstrued, that it is gratifying, to contemplate the healthy, vigorous and substantial load growth which all systems of the Commission are showing. Leaving out of consideration all deliveries of secondary power, namely, surplus power which the Commission supplies at will or when available, the Niagara System has been running 10.5 per cent higher than last year, Eastern Ontario 11 per cent, Thunder Bay 18 per cent, and Georgian Bay, where the Ragged Rapids plant of 10,000 horsepower is under construction, none too soon to provide for next year's growth, 8 per cent above last year. In the Northern districts, Abitibi is up 41 per cent, Sudbury 8 per cent, Nipissing 10 per cent, Patricia 18 per cent and St. Joseph 77 per cent. Last December the annual growth in primary load of all systems was 9.6 per cent, and there is every indication that that figure will be exceeded this year.

Notwithstanding the importance of this question of load growth, a detailed analysis of the figures is altogether too intricate for presentation here; publication of further information relative to loads will be reserved for future statements.

Prior to the fall of 1925, there had been a great deal of discussion as to advisability of making extensive steam power developments, which was terminated by a pronouncement of the Commission in favour of hydraulic power. I wish to point out that there are still extensive undeveloped hydraulic power resources in Southern Ontario on interprovincial or international streams, where the development of power cannot be undertaken without interprovincial or international agreements. As agreements of this kind often take considerable time to consummate, the prospect of obtaining power from these sources, in the immediate future, is uncertain.

However, every possible effort should be made to develop and utilize these resources before resorting to steam, although, for certain special purposes, steam power may have its place in the composite framework of the Commission's resources and in the not too distant future.

As an engineer, I am acutely conscious of the fallibility of even the best apparatus, of the reality of the service threat to existing plants through the enormous forces of floods, winds and ice, and of the degree of probability that substantial losses in supply may occur for considerable periods of time and for a variety of reasons. This is not a question of timidity; it is simply a realization of the nature and ominous consequences of the possible occurrence of certain events, commonly classed as contingencies, which might disastrously affect the service being rendered by the Commission.

Shortage Would Be Grave

Can the industries of this Province complacently face the possibility of a shortage in power? You, as engineers, recognize the enormity of the consequences of a serious shortage for weeks or months; but do the people at large, who would be called upon to face that loss, realize what it would mean? I think not.

Considering the hazards and the weight of responsibility which rests on this Commission, and bearing in mind the lengths to which other large public utilities go to provide against contingencies, I ask you whether it is surprising that I stress the necessity of making provision for the two undernoted requirements:

1. Provision of a continuously available power reserve, in excess of primary requirements, to meet contingencies which may arise without warning.
2. Positive provision for future load growth so as to guarantee adequate supplies from economical sources.

This question of future supplies is one on which I wish to make my meaning very clear, so, at the risk of labouring the point, I shall cite an example:

Suppose a survey of resources indicates that from the long-range point of view it is economical and desirable to undertake a certain large hydraulic development, and suppose that three years must be allowed from the time this project is authorized until power can be obtained from it. It is obvious that such a development must be authorized at least three years in advance of the anticipated date on which power from it will be needed and that the estimated growth requirements of the intervening years must either be in hand or available on demand or otherwise obtainable and assured.

It is only the part of common prudence to avoid onerous commitments so long as the future is not being jeopardized by doing so, but it is also the part of wisdom to complete preliminary arrangements and always have work so well in hand as to be able to meet, by acceleration of existing programmes or otherwise, whatever growth in demand is reasonably probable. Failure to do this may have much more serious consequences than an error in the reverse direction, especially as the cost of reserve power is comparatively little owing to the ready market for it on an at-will basis.

There is a question that has recently excited a great deal of public interest and, in some quarters, considerable apprehension, about which a few words may be appropriate here; I refer to the nature of the relationship between employer and employee, often referred to as the relationship between capital and labour. The struggles which have taken place in the past between employees indicate very clearly that it is not wise to have employees who are dissatisfied, much less resentful and bitter. Such a state of affairs is demoralizing and adversely affects the efficiency of the service being performed. When no better alternative is in evidence a worker will usually accept with comparative cheerfulness a very low wage provided he is convinced the business in which he is employed cannot properly pay more; whereas he would keenly resent being held down to a low rate if he were convinced that a higher rate were in all fairness amply justified.

The full significance of this will be apparent when it is remembered that no system of supervision or coercion will wring from an unwilling disgruntled worker his best efforts, for his best is invariably the spontaneous product of his interest, his enthusiastic voluntary effort and his will to do, as well as his skill and intelligence. Compared with this "best" the grudging minimum of the dissatisfied worker is but a poor apology, expensive at almost any price.

I believe this to be a fundamental psychological fact and the prime reason why progressive management today recognizes the need for scrupulous fairness in dealing with employees and lays such stress upon the establishment of effective channels through which views and ideas may be interchanged, facts displayed, explanations made, agreements reached and mutual understanding attained, to say nothing of much incidental technical benefit. Without such a channel suspicion is apt to grow into misunderstanding, misunderstanding into resentment and resentment into cessation of work.

Workers usually respond to progressive managerial methods of this kind and quickly recognize the mutuality of their interest with that of management. Their attitude of mind toward management changes from one of suspicion and latent antagonism, with all its attendant dangers of possible injury to the business in which they are engaged, to one of sympathy and understanding, which, in turn, stimulates in them the otherwise dormant desire to increase their efforts in the interests of that business in the confident hope and expectation that their efforts will be fairly rewarded by management; in other words, the spirit of understanding and fairness displayed by management begets a like spirit among the workers.

In the Commission's case this contact channel has been established for the benefit of all employees, through a plan of representation, by which employees are provided with duly accredited representatives who act on district and general committees, and meet with management representatives. While the plan is young as yet, much has already been accomplished in the way of establishing improved standards of wages and working conditions, and it is my firm conviction that, properly administered in a spirit of frankness, fairness, mutual appreciation of difficulties and sympathetic readiness to make concessions, it will be of the greatest value, both to the staff and to the Commission.

I am sure you will agree that it is only proper, both from the point of view of economy and social justice, that a large publicly owned utility such as ours should give constructive leadership in the matter of fair treatment of its employees, especially when it is realized that, taken by and large, the individuals who comprise the Commission's staff are well trained and well qualified for their work. If the foregoing is accepted it must also be conceded that special care must be exercised in the selection of employees for the service according to qualifications, that systematic training methods are necessary, and that those who fail to measure up to the progress requirements must be weeded out at the earliest possible stage, in their own interest as well as that of Hydro.

In short, the performance of the Commission's staff is a matter of great importance, and nothing should be left undone to establish and maintain it upon the highest possible level.

The splendid reputation now enjoyed by all ranks of the Commission's staff has been earned by loyal and efficient service and is well deserved. I have for them only words of the highest praise and I am confident that the Commission can count on them all to maintain if not improve their present record in this respect.

Under the British system it is considered that every citizen of voting age has an inalienable right to have a voice in government and in public affairs relating thereto. The method of expression may vary widely but the right remains.

Without public confidence the administration of a publicly owned institution must become more or less weak and lacking in constructive contribution. Therefore, the Commission must maintain and, if possible, increase public confidence in its administration; failure to do so would be fatal. But how can public confidence be acquired and retained without keeping the public fully and effectively informed about all important Hydro matters and encouraging constructive criticism of Hydro affairs?

Let me voice a word of caution about public criticism. Criticism may be just or unjust, intelligent or ignorant, well-meaning or selfish, straightforward or misleading, constructive or destructive, but, if it is not actually vicious it all has its place; in the main, public criticism, like vigorous opposition in government, is healthy, particularly if it is honest. It promotes caution, a tendency to weigh and consider. It reveals new viewpoints and new vistas which might otherwise escape attention. In the case of this Commission even the somewhat irritating and troublesome investigations of the past have brought in their train indirect benefits.

Nevertheless, there is a time and a place for everything, and even though I am not altogether a newcomer to this work, a short period of adjustment will necessarily be required to enable me to properly and intelligently appraise my responsibilities; when the adjustment period is over I shall welcome constructive criticism.

My remarks tonight would not be complete if I did not refer to my fellow-Commissioners. From the very first, both Mr. Houck and Mr. Smith have given every indication of their firm intention to discharge their duties in formulating and directing Hydro policies in a way which will do credit to themselves, to the Commission, and to the municipalities.

I approach my new responsibilities as Chairman of the Hydro-Electric Power Commission with humbleness of mind. My duties as Chief Engineer will not take me away from familiar ground, but those of Chairman involve a greatly extended field of activities, and call for the exercise of very different qualities.

Before closing, there is one last word I would leave with you; it is not new, yet it can scarcely be driven home too often.

If we do not want excellence in the conduct of Hydro affairs to lapse and become one of the many sporadic things which momentarily appear upon the stage of life only to disappear and be forgotten, we must constantly be alive to the dangers which from time to time beset Hydro, and we must test all proposals with respect to it in the light of their effect upon the future.

If this viewpoint is to be carried forward as time goes on, the Commission must constantly seek to improve the already high standard of Hydro service, to maintain it at a level which will be unexcelled elsewhere and to expand the great advantages which Hydro affords the people of Ontario.

If we think of ourselves as trustees, who, though not exactly answerable to future generations for our acts, are, nevertheless, morally responsible for handing down this great public heritage unimpaired, we shall probably not go far astray.

Past-Presidents' Prize 1937-1938

The subject prescribed by Council for this competition for the prize year July 1st, 1937 to June 30th, 1938, is **"Stream Control in Relation to Droughts and Floods."**

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 not 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 Council at the beginning of the prize year, which shall be July 1st 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, 1938,** by the General Secretary of The Institute, either direct from the author or through a local Branch.

OBITUARIES

Morris Stansfield Blaiklock, M.E.I.C.

Members of The Institute will learn with regret of the death of Morris Stansfield Blaiklock, M.E.I.C., on November 25th at his home in Montreal. He was 78 years of age at the time of his death, having then born in Quebec City on July 19th, 1859.

Mr. Blaiklock was educated in Montreal and in 1885 was indentured to W. T. Thomas, an architect, entering the engineering department of the Grand Trunk Railway in 1880. From 1890 to 1892 he acted as assistant engineer on the construction of the St. Clair tunnel, when he returned to Montreal as an inspector of operations for the railway. In 1897 he was appointed resident engineer of the eastern district and superintendent in 1902. He became engineer, maintenance of way, Grand Trunk Railway System, in 1907, holding this position until 1912 when he was appointed assistant chief engineer, operating department, of the Canadian National Railways. In 1930 he received the appointment as assistant chief engineer of the system, retiring in 1931 after more than 50 years of service.

Mr. Blaiklock was particularly active in connection with the co-operative management plan with maintenance of way employees on the Canadian National System and continued as chairman of the general co-operative committee of maintenance of way employees after his retirement.

He joined the Canadian Society of Civil Engineers in June 1909 and became a Life Member in October 1932.

Allison Robert Chambers, M.E.I.C.

It is with great regret that we announce the sudden death of Allison Robert Chambers, M.E.I.C., of New Glasgow, Nova Scotia, in Montreal on December 4th, at the age of 58 years. Mr. Chambers was born at Halifax, January 14th, 1879, receiving his technical education at McGill University from which he graduated with the degree of B.Sc. in 1904. From that date until 1908 he acted as mining engineer and resident manager for the Nova Scotia Steel Company at Wabana, Newfoundland. In 1909 he was appointed mining engineer and in 1911 assistant manager of the ore mines and quarries department of the same company at New Glasgow, Nova Scotia. He was later designated manager and served in that capacity until 1917 when he founded and became president of the Malagash Salt Company.

Mr. Chambers from that time devoted himself not only to the operation of the salt mine of this company at Malagash but also to expanding the use of the product.

He was one of the pioneers in investigating and advocating the use of common salt to stabilize the surface of highways and to him is due much credit for the progress already made in this practice in Canada and elsewhere.

Mr. Chambers became a Member of The Institute in January 1919.

Horace Bruce Kippen, A.M.E.I.C.

We regret to announce the death of Horace Bruce Kippen, A.M.E.I.C., who died on December 10th, 1937, at his home in Toronto. Mr. Kippen was born in Kent, England, on September 3rd, 1862. He came to Canada at an early age and his first engineering experience was with the Atlantic and North Western Railway, in Maine in 1887. In 1889 he was engaged on the Qu'Appelle, Long Lake and Saskatchewan Railway, then later on the Saskatoon and Battleford Railway, surveying a projected line from Saskatoon to Battleford, and with the Calgary and Edmonton Railway.

He was appointed assistant engineer with the Quebec Central Railway in 1894. Sir William Van Horne later employed him on the construction of a railway in Cuba. Between 1904 and 1910 he had charge of the building of the Canadian Pacific Railway lines and bridges on the Toronto Sudbury route.

Mr. Kippen later joined the Canadian National Railway and became assistant engineer on maintenance, retiring in 1932.

He joined the Canadian Society of Civil Engineers as a Student in November 1890, transferring to the class of Associate Member in 1894.

John Grant MacGregor, M.E.I.C.

The death of John Grant MacGregor, M.E.I.C., a Life Member of The Institute, occurred in Vancouver, B.C. on October 19th, 1937. Mr. MacGregor was born at Morryburgh, Scotland, on May 10th, 1862, and was educated at Gartshorrie Academy and School of Mines. From 1880 to 1885 he was an engineering pupil of James Fraser of Inverness, Scotland, and from 1886 to 1890 acted as assistant engineer on the Caledonia Railway. He came to Canada in 1890, receiving an appointment as assistant engineer of the Canadian Pacific Railway at Montreal on the survey and construction of branch lines. In 1899 he became principal assistant engineer with the Great Northern Railway, Quebec, and from 1900 to 1903 was principal assistant and bridge engineer with the Cincinnati, Hamilton and Dayton Railway. From that date until 1909 he held appointments with the Louisville and Nashville and with the Guelph and Goderich Railways, where with the latter he also acted as assistant to the late Mr. P. A. Peterson. In 1909 Mr. MacGregor was appointed chief engineer of the Alberta Central Railway.

He enlisted and went overseas with the Royal Canadian Engineers in 1916 and when demobilized held the rank of captain. On his return to Canada Mr. MacGregor had charge of highway work at Jasper Park, Alberta, and from 1925 to 1932 acted as resident engineer at Killarney, Manitoba.

For three or four years prior to his death Mr. MacGregor was virtually an invalid.

He joined the Canadian Society of Civil Engineers in April 1894 and transferred to the grade of Member in 1912.

Cyrus James Russell, A.M.E.I.C.

It is with deep regret that we record the passing of C. James Russell, A.M.E.I.C., in Sault Ste. Marie, Ont., on December 5th, 1937, after an illness of two and a half years. Mr. Russell was born in Renfrew, Ontario, in January 1885. He spent his early years in Renfrew and obtained his early education there. Following his graduation from the Renfrew Collegiate Institute. Mr. Russell taught school for three years. He then attended the School of Practical Science in Toronto for two years. A short period in electrical construction work in Northern Ontario, followed after which Mr. Russell joined the staff of the Tagona Water and Light Co. Limited, Sault Ste. Marie, Ont., in 1911, as line foreman. In 1914 he became associated with the City of Sault Ste. Marie, Ont. Water and Light Commission as line superintendent. This position he held until 1918 when he joined the staff of the Great Lakes Power Co., Limited, as line superintendent, which position he held until his death. Mr. Russell joined The Institute as an Associate Member in September 1925.

PERSONALS

H. D. Brydone-Jack, A.M.E.I.C., has been made assistant manager, department of personnel, Canadian Pacific Railway, Montreal. He graduated from McGill University with the degree of B.Sc. in 1911 and has since been employed with the Canadian Pacific Railway in various capacities, principally in Western Canada, until he came to Montreal in 1934.

Lt.-Col. G. R. Turner, M.C., D.C.M., R.C.E., A.M.E.I.C., has been detailed to attend a course at the Imperial Defence College, London, England. Lt.-Col. Turner graduated from the Staff College at Quetta, India, and on his return to Canada in 1927 was appointed assistant director of engineer services, Department of National Defence, Ottawa. For the last three years he has been on the general staff, Department of National Defence, Ottawa.

John G. Spotton, A.M.E.I.C., has resigned from the sales staff of Messrs Delany and Pettit to enter the business of manufacturers' representative in the field of electrical and mechanical engineering equipment. Mr. Spotton graduated in engineering, from the University of Toronto in 1922 and was connected with radio and electrical work in Guelph as the Spotton Engineering Company up to 1931, then with the above firm until his recent change. He is making his headquarters in Toronto and will represent a number of companies manufacturing engineering equipment.

Otto Holden, A.M.E.I.C., has been appointed chief hydraulic engineer of the Ontario Hydro-Electric Power Commission. He graduated from the University of Toronto in civil engineering with the degree of B.A.Sc. in 1913 and after a short period with the Public Utilities Commission, London, Ont., he joined the engineering staff of the Ontario Hydro-Electric Power Commission. In 1918 he was placed in charge of the design of hydraulic plants and since then has been engaged on developments at Cameron Falls, Ranney Falls, Queenston, Chats Falls and others. Mr. Holden has been assistant hydraulic engineer since 1923.

Promotions in the Royal Canadian Air Force

The following flying officers were recently promoted flight lieutenants: D. S. Blaine, S.E.I.C., R. C. Mair, S.E.I.C., and W. A. Orr, S.E.I.C. D. S. Blaine is a graduate of the Royal Military College and Queen's University in 1934. R. C. Mair received his engineering training at the University of Alberta from which he graduated in 1934. W. A. Orr also studied at the University of Alberta, graduating with the degree of B.Sc. in electrical engineering in 1932. All three have been with the Royal Canadian Air Force since prior to graduation.

Promotions in the Saguenay Power Company

F. L. Lawton, M.E.I.C., has recently been promoted chief engineer of the Saguenay Power Company. Prior to this he was electrical engineer with this company and with the Duke-Price Power Company, with whom he has been connected since 1927. Mr. Lawton graduated from the University of Toronto with the degree of B.A.Sc. in electrical engineering.

J. R. Hango, A.M.E.I.C., has become power engineer for the Saguenay Power Company. He is a graduate of the University of Alberta in 1927 in electrical engineering and after taking a course with the Canadian Westinghouse Company in Hamilton, Ontario, he joined the Duke-Price Power Company.

Charles Miller, A.M.E.I.C., has been promoted to the position of hydraulic engineer with the Saguenay Power Company Limited. Mr. Miller has been with the Duke-Price Power Company and the Saguenay Power Company since 1930. He is a graduate of Queen's University in civil engineering in 1930.

Amendments Proposed to the By-laws of The Institute

The following proposals to amend existing By-laws and to introduce a new By-law are hereby presented for the information of corporate members prior to the Annual General Meeting.

The proposals comprise (A) the addition of a new Section 76, and (B) amendments to Sections 44 and 51.

As printed below, matter not contained in existing By-laws is shown in **bold face** type.

(A) Proposed New Section

This would read as follows:

Section 76. **The council may co-operate with any association or corporation of professional engineers constituted by an Act of any Province of the Dominion of Canada (hereinafter referred to as "the Association") in furtherance of the mutual interests of the members of the Institute and of the Association. To this end, the council may, notwithstanding the foregoing By-laws, enter into an agreement with the Association regarding—**

(*a*) **The admission and classification as members of the Institute (in accordance with the foregoing By-laws insofar as the council in its discretion deems advisable) of applicants for membership in the Institute who are members of the Association;**

(*b*) **The amount, if any, and method of collection of entrance fees payable by applicants for membership in the Institute who are members of the Association;**

(*c*) **The amount and method of collection of annual fees payable by members of the Institute who are also members of the Association;**

(*d*) **Provision for the termination of the said agreement;**

(*e*) **Any other provisions necessary for the carrying out of the said agreement.**

To become effective, the said agreement, after publication in the Journal of the Institute, must be sanctioned by—

(1) **An affirmative vote of two-thirds of the letter ballots cast by the members of council; and**

(2) **An affirmative vote of a majority of all valid letter-ballots cast by the corporate members of the Institute resident within the Province of the Association.**

The above proposal for a new section is now presented by the council. It has also been accepted by the three accredited representatives of the thirty-one corporate members who put forward a series of proposals dated September 25th, 1937, in lieu of all but two of those original proposals. The council greatly appreciates the action of these representatives in making possible the submission to the membership of one brief general new by-law that will enable appropriate co-operation agreements to be worked out between The Institute and the provincial Associations of Professional Engineers.

(B) Sections 44 and 51

These sections in their amended form would read as follows:

Meetings of Council

Section 44.—The council shall meet at least once each month, from the beginning of October to the end of April, and at such other times as may be deemed necessary.

Eleven members shall constitute a quorum.

A meeting of council at which not less than five members are present, but not a quorum, shall constitute a "Committee of Council" to receive reports and make recommendations only, and all their resolutions must be approved by a majority of the council by letter-ballot or by a regular meeting of the council.

Management

Section 51.—Each branch shall be managed by an executive committee which shall include:—

(*a*) A chairman, secretary and treasurer, and not less than three other members, all to be known as elected members and to be balloted for by all members of the branch entitled to vote at branch elections. The secretary and treasurer may, as an alternative, be appointed by the executive committee, instead of being elected by the members of the branch.

(*b*) Those members of council resident within the jurisdiction of the branch, to be known as ex-officio members, **such ex-officio members not to exceed four in number and to be determined by the order of their official seniority,** and

(*c*) The immediate past-chairman and the immediate past-secretary of the branch, to be known as members emeriti, these latter to be members for only the year immediately following their term of office.

The above proposals for amendments to Sections 44 and 51 have been presented by thirty-one corporate members, whose representatives have requested the council to submit them to the members on a separate ballot from that for the new Section 76, and also in such form that a separate vote may be taken for each of the sections to be amended.

R. J. DURLEY,
Secretary.

Montreal,
December 27th, 1937.

ELECTIONS AND TRANSFERS

At the adjourned meeting of Council held on December 20th, 1937, the following elections and transfers were effected:

Members

BALLOU, Frederick H., Mech.Eng., (Stevens Inst. of Technology), chief engr., B.C. Sugar Refining Co. Ltd., Vancouver, and Canadian Sugar Factories Ltd., Raymond, Alta.

CAMERON, Alan Emerson, B.Sc., M.Sc., (McGill Univ.), D.Sc., (Mass. Inst. Tech.), Deputy Minister of Public Works and Mines, Province of Nova Scotia, Halifax, N.S.

JOHNSON, James Henry, M.E., (Syracuse Univ.), chief engr., The Borden Co. Limited of Canada, Tillsonburg, Ont.

PARTRIDGE, John Kenneth, (Univ. of Leeds), senior asst. engr., Dept. Public Works of Canada, Toronto, Ont.

Associate Members

BOISMENU, Romeo, (Ecole Polytechnique), supt., Town of Hawkesbury, Ont.

SMITH, John Leslie, B.Sc., (Univ. of Leeds), senior asst. engr., Aeronautical Engineering Division, Department of Transport, Ottawa, Ont.

STEVENTON, Harry Elgin, B.Sc., (Univ of Man.), service engrg. work, Otis-Fensom Elevator Co., Hamilton, Ont.

TEAGLE, Robert Wills, B.A.Sc., (Univ. of Toronto), asst. constrn. mgr., Seigniory Club, Montebello, Que.

VINET, Pierre Paul, B.A.Sc., C.E., (Ecole Polytechnique, Montreal), B.Sc. (Mech.), (Mass. Inst. Tech.), professor at the Ecole Polytechnique, Montreal, and consulting engineer.

WALKEY, Arthur Wallace, B.Sc., (Univ. of Man.), junior engr., Dept. Public Works of Canada, Winnipeg, Man.

WRIGHT, Errol Harcourt, B.Sc., (Queen's Univ.), asst. engr., Northwestern Utilities Limited, Edmonton, Alta.

Juniors

BRYCE, John Bemister, B.A.Sc., M.A.Sc., (Univ. of Toronto), junior engr., hydraulic dept., H E.P.C. of Ontario, Toronto, Ont.

CARTER, William Franklin Shaen, B.Eng., (McGill Univ.), Canadian Ingersoll Rand Co. Ltd., Montreal, Que.

DYKE, William Edgar, B.A.Sc., (Univ. of Toronto), estimator and designer, Dominion Bridge Co. Ltd., Lachine, Que.

HOLT, William George Herbert, B.A.Sc., (Univ. of Toronto), mechanical designer, Dominion Bridge Co. Ltd., Lachine, Que.

MORGAN, Ralph T., B.Eng., (McGill Univ.), mech. engr., Canadian International Paper Co. Ltd., Three Rivers, Que.

Affiliate

LOGGIE, Gerald Purves, Lt.-Col., R.C.O.C., Ordnance Representative, Dept. of National Defence, Lôndon, England.

Transferred from the class of Associate Member to that of Member

WIGGS, Gordon Lorne, B.Sc., (McGill Univ.), consulting engineer, 1702 University Tower, Montreal, Que.

Transferred from the class of Junior to that of Associate Member

AITKENS, John Currey, B.Sc., (Univ. of Man.), mine engr., Madsen Red Lake Gold Mines Ltd., Red Lake, Ont.

CLARK, James Ernest, B.Sc., (Queen's Univ.), field engr., transmission dept., Bell Telephone Company of Canada, Ottawa, Ont.

HOULDEN, James Walter, B.Sc., (Queen's Univ.), ballistic engr., Canadian Industries Ltd., Brownsburg, Que.

*KING, Eric Charles, relief first operator, Churchill River Power Company, Island Falls, Sask.

LUSBY, Gerald Winkworth, B.Sc., (N.S. Tech. Coll.), engr., Ford Motor Co. of Canada Ltd., Windsor, Ont.

MATHIESON, Thomas Stanley, B.Sc., (Queen's Univ.), designer, Falconbridge Nickel Mines Ltd., Falconbridge, Ont.

MORTON, Ralph MacKenzie, B.A.Sc., (Univ. of B.C.), asst. elect'l engr., Bepco Canada Ltd., Montreal, Que.

NORMAN, Douglas, B.Sc., (Univ. of Man.), distribution transformer engr., Canadian General Electric Co. Ltd., Toronto, Ont.

ROWE, Gordon William, B.Sc., (Univ. of Man.), field engr., C. D. Howe Co. Ltd., Port Arthur, Ont.

Transferred from the class of Student to that of Associate Member

ANTENBRING, Clarence V., B.Sc., (Univ. of Man.), designer, Cowin & Co. Ltd., Winnipeg, Man.

BAILEY, Loring Withall, B.Sc., (McGill Univ.), station supt., Gatineau Power Company, Grand Falls, N.B.

BARBOUR, Ronald Granville, B.Sc., M.Sc., (Univ. of N.B.), industrial engr., T. Pringle & Son, Ltd., Montreal, Que.

BARR, Frederick Gordon Fordyce, B.A.Sc., (Univ. of Toronto), asst. to equipment engr., gen. traffic dept. (western area), Bell Telephone Co. of Canada, Toronto, Ont.

BOUTILIER, Frederick Thomas, B.Sc., (N.S. Tech. Coll.), asst. to aluminum plant supt., Aluminum Co. of Canada, Ltd., Arvida, Que.

CARTER, John Russell, B.A.Sc., (Univ. of Toronto), designer, engrg. dept., Canadian Johns-Manville Co. Ltd., Asbestos, Que.

CLARKE, Owen Mawbey, B.Sc., (McGill Univ.), asst. mgr., Worthey Park Estate, Ewarton, Jamaica, B.W.I.

DALTON, Peter Dudley, B.Sc., (McGill Univ.), constrn. mgr., George A. Fuller Co. of Canada Ltd., Toronto, Ont.

DARLING, Thomas Creighton, B.Sc., (McGill Univ.), sales engr., Canadian General Electric Co. Ltd., Montreal, Que.

DEANS, Charles Warbrick, B.A.Sc., (Univ. of B.C.), M.Sc., (Iowa State Coll.), estimator, Western Bridge Co. Ltd., Vancouver, B.C.

GAGNON, Elmore Gerard, B.Sc., (McGill Univ.), equipment service supt., Northern Electric Co. Ltd., Montreal, Que.

HARTNEY, James Rowan, B.Sc., (McGill Univ.), inspr., Willis, Faber & Co. of Canada Ltd., Montreal, Que.

HAWLEY, Eric Farwell, B.Sc., (McGill Univ.), asst. foreman, test dept., English Electric Co. of Canada Ltd., St. Catharines, Ont.

HAYES, E.bert Harvey, B.Sc., (Univ. of N.B.) equipment engr., Northern Electric Co. Ltd., Montreal, Que.

HULME, Gordon D., B.Sc., (McGill Univ.), engr., dept. of development, Shawinigan Water & Power Co. Ltd., Montreal, Que.

INGHAM, Jason Harold, B.Eng., (McGill Univ.), mech. designer, Dominion Bridge Co. Ltd., Montreal, Que.

JONES, Allison Maurice Stevens, B.Sc. (Forestry), B.Sc. (Civil), (Univ. of N.B.), chief field engr., Anglo-Canadian Pulp & Paper Mills Ltd., Mauriceville, Que.

KIRK, William Douglas, B.Sc., (Queen's Univ.), M.Eng., (McGill Univ.), engr., E. G. M. Cape & Co. Ltd., Montreal, Que.

LEVIN, Max, B.Sc., (Univ. of Man.), Dept. of Highways Ontario, Bancroft, Ont.

LOCKE, Charles William Evans, B.A.Sc., (Univ. of B.C.), constrn. and mtce. engr., Pacific Mills Ltd., Ocean Falls, B.C.

MAHON, Albert Gordon, B.Sc., (N.S. Tech. Coll.), asst. engr., Nova Scotia Power Commission, Halifax, N.S.

MASON, Orley B., B.Eng., (McGill Univ.), development engr., Imperial Oil Limited, Sarnia, Ont.

MILLER, William F., B.Sc., (Queen's Univ.), inspr. of electricity and gas., Dept. of Trade and Commerce, Sudbury, Ont.

MORRISON, J. Alexander, B.A.Sc., (Univ. of Toronto), director, utilization laboratory, Consumers Gas Company, Toronto, Ont.

OUIMET, J. Alphonse, B.Eng., (McGill Univ.), operations engr., Canadian Broadcasting Corporation, Montreal, Que.

ROSS, George Victor, B.Sc., (N.S. Tech. Coll), asst. engr., Engineering Service Co. Ltd., Halifax, N.S.

SILVER, Ralph Charles, B.Sc., M.Sc., (McGill Univ.), protection engr., Gatineau Power Company, Ottawa, Ont.

STADLER, John Charles, B.Sc., (McGill Univ.), station mgr., CRCM-CBF, Canadian Broadcasting Corporation, Montreal, Que.

Transferred from the class of Student to that of Junior

BACKLER, Irving Saul, B.Eng., (McGill Univ.), consltg. engr., 1577 Van Horne Ave., Montreal, Que.

* Has passed Institute's examinations.

BILLETTE, Roger, B.Sc., (McGill Univ.), designer and tester, elect'l. repair dept., Shawinigan Water & Power Co., Three Rivers, Que.

BRADDELL, Eberhard Sylvester P., B.Sc., (Univ. of Man.), Northern Electric Co. Ltd., Winnipeg, Man.

BURRI, Henry William, B.Eng., (McGill Univ.), proposition engr., Mathews Conveyor Co. Ltd., Port Hope, Ont.

CAPELLE, William Abram, B.Sc., (Univ. of Man.), purchasing agent, engr.'s dept., T. Eaton Co. Ltd., Winnipeg, Man.

CARSON, Mervyn Shannon, B.Sc., (Univ. of Sask.), production engr., Link-Belt Ltd., Toronto, Ont.

CRAIG, Carleton, B.Eng., M.Eng., (McGill Univ.), lecturer, dept. of civil engrg. and applied mechanics, and dept. of maths., McGill University, Montreal, Que.

DENTON, Allan Leslie, B.Sc., (Univ. of N.B.), office engr., Lamaque Mining Co. Ltd., Bourlamaque, Que.

DUNLOP, J. Russell, B.Eng., (McGill Univ.), dftsman., Canadian International Company, Gatineau, Que.

DYER, John Henry, B.Sc., (N.S. Tech. Coll.), electr'l. switchgear dftsman., English Electric Company of Canada, St. Catharines, Ont.

ECKENFELDER, George Victor, B.Sc., (Univ. of Alta.), ap'tice. engr., Calgary Power Company, Seebe, Alta.

FLEURY, Maurice, B.A.Sc., C.E., (Ecole Polytechnique, Montreal), asst. engr., Sun Trust Ltd., Montreal, Que.

FRASER, Allan Donald William, B.Eng., (McGill Univ.), in operating dept., Beattie Gold Mines, Duparquet, Que.

FRISKEN, Orval James, B.Sc., (Queen's Univ.), asst. engr., The DeLaval Co. Ltd., Peterborough, Ont.

GOODMAN, Hyman Bernard, (McGill Univ.), 5653 Hutchison St., Montreal, Que.

GROLEAU, Arnold John, B.Sc., (McGill Univ.), traffic dept., Bell Telephone Company of Canada, Montreal, Que.

HAMILTON, Parker C., B.Sc. (Civil & Elec.), (N.S. Tech. Coll.), district engr., Gunite & Waterproofing Ltd., and Construction Equipment Co., Ltd., Halifax, N.S.

HOUGHTON, Thomas Walter, B.Eng., (McGill Univ.), dftsman., Canada Paper Company, Windsor Mills, Que.

INGLES, Charles Leycester, Lieut., R.C.E., (Grad., R.M.C.), B.Sc., (Queen's Univ.), c/o Canada House, Trafalgar Square, London, England.

JACKSON, Kenneth Arthur, B.Sc., M.Sc., (Univ. of Alta.), radio service and sales, Taylor & Pearson Ltd., Edmonton, Alta.

KAUTH, Carl Gladstone, B.Sc., (Queen's Univ.), operator, Dominion Oxygen Co. Ltd., Toronto, Ont.

KENT, William Leslie, B.Sc., (Univ. of Alta.), junior asst. engr., Stuart Cameron & Co. Ltd., Vancouver, B.C.

LAZORKA, Dick, B.Sc., (Univ. of Sask.), timekpr., Dept. of Mines and Resources, Prince Albert, Sask.

NIX, Charles Edward, B.Sc., (Univ. of Alta.), asst. to cost acct., Shawinigan Water & Power Company, Montreal, Que.

PARSONS, Ezra Churchill, B.Sc. (Civil & Elec.), N.S. Tech. Coll., supt. for Ralph & Arthur Parsons, contractors, Walton, N.S.

PERLSON, Ellsworth Hartland, L/Corp., R.C.M.P., (Grad., R.M.C.), B.Sc., (McGill Univ.), Edmonton, Alta.

POOLER, Gilbert Douglas, B.Sc., (Queen's Univ.), Woodroffe, Ont.

POPE, Joseph Morley, B.Sc., (McGill Univ.), asst. to elec. engr., Belgo Divn., Consolidated Paper Corpn. Ltd., Shawinigan Falls, Que.

REINHARDT, Gerard Victor, B.Sc., (N.S. Tech. Coll), mech. design dept., Dominion Bridge Co. Ltd., Montreal, Que.

SHANKS, Victor, B.A.Sc., (Univ. of Toronto), elect'l. lab. asst., Sangamo Electric Co., Toronto, Ont.

SOMERS, Claude Judson, B.Sc., (Univ. of N.B.), field engr., Howard Smith Paper Mills, Cornwall, Ont.

STANFIELD, John Yorston, (Grad., R.M.C.), B.Sc., (Civil & Mech.), (N.S. Tech. Coll.), Candn representative, Anti-Hydro Waterproofing Co., Newark, N.J.

WALKEM, Richard, (Grad., R.M.C.), Vancouver Iron Works, Vancouver, B.C.

Students Admitted

ATHEY, Frank A. P., (Univ. of Man.), 138 Roslyn Road, Winnipeg, Man.

DUSSAULT, Jean, (Ecole Polytechnique, Montreal), 74 Laurendeau Ave., Montreal East, Que.

GADS, Leonard Eustace, (Univ. of Alta.), Edmonton, Alta.

GOHIER, Roch Edward, (Grad., R.M.C.), (McGill Univ.), 1321 Sherbrooke St. W., Montreal, Que.

HALL, John Herbert, (McGill Univ.), 2559 De La Salle Ave., Maisonneuve, Montreal, Que.

HUGHES, William Fraser, dftsman., Consumers Glass Co. Ltd., Montreal, Que.

JONES, Stuart, (McGill Univ.), 47 Strathearn Ave., Montreal West, Que.

McAULAY, Graham Falconbridge, (Univ. of Alta.), 12907-103rd Ave., Edmonton, Alta.

PALMQUIST, David Ernest, B.Sc., (Univ. of Man.), 5846 Jeanne Mance St., Montreal, Que.

PROKOPY, Peter J., (Univ. of Alta.), St. Joseph's College, Edmonton, Alta.

ROSS, George, (Univ. of Alta.), 7200-104th St., Edmonton, Alta.

STEEVES, Kenneth Leslie, (Univ. of Alta.), P.O. Box 191, University of Alberta, Edmonton, Alta.

THIBAULT, Joseph George, B.Sc., (Univ. of Man.), 5846 Jeanne Mance St., Montreal, Que.

THOMLINSON, Leonard, (McGill Univ.), 2063 Stanley St., Montreal, Que.

THORSSEN, LeRoy Allan, (Univ. of Alta.), P.O. Box 85, University of Alberta, Edmonton, Alta.

WILSON, John Pye, (Queen's Univ.), senior dftsman., civil aviation divn., Dept. of Transport, Ottawa, Ont.

BOOK REVIEW

Geodetic Position Evaluation

By W. M. Tobey, revised and enlarged by J. E. R. Ross, Canada Department of Mines and Resources, Geodetic Service Publication No. 7, 1937. 63 pp. 6½ by 9¾ inches, paper, $1.50.

Reviewed by JAMES WEIR, A.M.E.I.C.*

This brochure gives concise explanation of the theory and examples of calculation of latitude and longitude through length and azimuth, and also the inverse problem of deriving the length and azimuth of the geodetic line between two fixed points on the spheroid. Clarke's 1866 spheroid is used, this being the adopted spheroid for the North American Datum. The tables are based on its dimensions.

The revision has clarified the explanation, and the tables now extend for the range 42 to 70 degrees latitude. Geographic positions here envisaged are not to be confused with observed latitude and longitude, subject to considerable errors. When the directions of a large triangulation network have been given their most probable values by a least squares adjustment, and the sides have been calculated, the next step is the evaluation of the geographic positions. The triangulation is projected on the adopted reference spheroid.

The method here followed is distinctly Canadian, but has recently been adopted by the Section of Geodesy, Military Section of China. It is believed to be accurate, even in high latitudes, for lines up to 100 miles in length, and could easily be extended to embrace longer lines through the addition of discarded terms of the series expansions. In modern practice such lengths are rare.

In addition to the enlarged tables essential to the method, many tables in common use in geodetic practice are included in the enlargement.

An appendix of the common spheroids, Clarke of 1866, Bessel of 1841, and Hayford of 1909, with their dimensions and constants is given, and a summary also of salient facts of Physical Geodesy appears.

An unusually complete and well-selected conspectus of the formulae for series and expansions, and of the trigonometric formulae, is given in this appendix. For a ready-reference of the mathematical side of geodesy conveniently assembled, these tables are a real contribution.

*Associate Professor of Geodesy, McGill University.

RECENT ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

American Geophysical Union, Section of Hydrology: Transactions, South Continental Divide Snow-Survey Conference, Regional Meeting June 1937, Denver, Colorado.

Reports, etc.

Alberta Research Council: Geological map of Alberta, 1937.

American Society for Testing Materials: Standards on Electrical Insulating Materials, Specifications Methods of Testing, November 1937.

American Standards Association: Safety Code for Elevators, Dumbwaiters and Escalators, 1937.

American Telephone and Telegraph Company: Engineering Report No. 39, Characteristics of Power System Faults to Ground, Feb. 1937.

Bell Telephone System, Technical Publications, Monographs: Organic Finishes—Effect of Film Thickness; Moisture in Textiles, Simplified Circuit for Frequency Substandards; Electrochemical Techniques in Corrosion Study; Some Contemporary Advances in Physics—XXXI Spinning Atoms and Spinning Electrons; Filters and Transformers Using Coaxial and Balanced Transmission Lines; A Ladder Network Theorem; A Multiple Unit Steerable Antenna for Short-Wave Reception; A Model of Ferromagnetic Action; Carrier Telephone Systems—Application to Railroad Circuits; Moisture Adsorption in Cotton and Other Fibrous Insulating Materials; A High-Precision Sound-Film Recording Machine; Purified Rubber for Electrical Insulation; Some Fundamental Experiments with Wave Guides; Light Signals on Moving Bodies as Measured by Rods and Clocks; The Dependence of Hearing Impairment on Sound Intensity.

Canada, Department of Mines and Resources: Tide Tables for the Atlantic Coast of Canada, 1938; Tide Tables for the Pacific Coast of Canada, 1938.

Canada, Department of Pensions and National Health: Sewage Treatment for Isolated Houses and Small Institutions; Wells; Home Treatment of Rural Water Supplies; The Rat Menace.
Canada, Department of Transport: Annual Report for the Fiscal Year April 1, 1936 to March 31, 1937.
Institute of the Aeronautical Sciences: Bibliography of Aeronautics, pt. 21—Blind Flight, Automatic Pilot, Ice Formation; pt. 22— Radio; pt. 28—Fuels; pt. 31—Metal Construction of Aircraft; pt. 37—Airports; pt. 40—Helium; pt. 44—Airways, pt. 46—Gliding and Soaring. (Works Progress Administration)
McGill University: Annual Report, 1936-37.
Ontario, County of Wentworth: Fifteenth Annual Report of the Road System, 1937.
Ontario, Department of Mines: Bulletin No. 115, Mineral Production of Ontario, First Nine Months, 1937.
Victorian Institute of Engineers: The Essential Principles of the Layout of Industrial Buildings and Equipment, Roy J. Bennie, Oct. 1937.
World Power Conference: Statistical Year-Book of the World Power Conference, No. 2, Data on resources and annual statistics for 1934 and 1935 including for the first time statistics relating to coke and manufactured gas. 1937.

Technical Books, etc.

Handbook of the German Machinery Industry, 1937. (*Association of the German Machinery Manufacturers.*)
Hydraulic Structures by A. Schoklitsch, translated by S. Schulits. 2 vols. (*American Society of Mechanical Engineers, N.Y. 1937.*)
Scientific and Technical Societies of the United States and Canada. 3rd ed. (*National Research Council, Washington, 1937.*)

BULLETINS

Conveyors.—The Mathews Conveyer Company, Ltd., Port Hope, Ontario, have prepared a 55-page bulletin containing illustrations of representative installations of conveying equipment developed by them during the past twenty-five years.

Automatic Controls.—The Alco Valve Company, Inc., St. Louis, Mo., have issued several bulletins dealing with automatic control devices for refrigeration and air conditioning and containing illustrations and price lists.

Cutters.—A 4-page leaflet has been received from the Brown & Sharpe Manufacturing Co., Providence, R.I., describing their special purpose cutters.

Lathes.—The South Bend Lathe Works, South Bend, Indiana, have issued a new catalogue for January 1938, demonstrating the new 1938 9-inch precision lathes, as well as precision lathes of all types.

Glass.—A 29-page booklet has been received from the Duplate Safety Glass Company of Canada, Oshawa, Ont. Good illustrations are accompanied by short descriptions and cover the various uses of glass in the home.

Navigational Instruments.—A 48-page catalogue has been received from Henry Hughes and Son, Limited, London, illustrating and describing their 1938 navigational instruments.

Welded Design.—A 34-page bulletin received from the Lincoln Electric Company, Cleveland, Ohio, was published with the aim of providing information relative to electric welding as applied to the design of machines and machinery structures.

Pressure Pipes.—Canadian Johns-Manville Company Limited, Toronto, Ont., have issued a 32-page bulletin describing the manufacture and use of their transite pressure (asbestoes-cement) pipe for water transportations.

Exhaust Fans.—The Northern Blower Company, Cleveland, Ohio, describe their new high speed "Norblo" exhaust fans in a 4-page bulletin.

Excavation and Grading.—The Cleveland Tractor Company, Cleveland, Ohio, have issued an 80-page booklet describing, with numerous illustrations, the most modern methods of moving earth.

Auto Patrols.—A 40-page booklet has been issued by the Caterpillar Tractor Company, Peoria, illustrating the various types and uses of auto patrols.

Diesel Tractors.—The Caterpillar Tractor Company, Peoria, Ohio, give particulars of their Diesel tractor in a 32-page booklet recently received.

Registration in the Faculties of Applied Science or Engineering in Canadian Universities, Session 1937-1938

By direction of Council enquiries have been addressed to the engineering schools in Canada asking for particulars of their undergraduate registration for the current year in the various branches of engineering.

The following table has been compiled from the information furnished in reply. In some respects it is necessarily incomplete; for example, some universities have courses in forestry, or forest engineering and have included them, while others have not done so.

University	Year	General Course	Agriculture	Architecture	Ceramic	Chemical Engrg. & Chemistry	Civil	Electrical	Forestry	Geology & Mineralogy	Mechanical	Metallurgy	Mining	Physics, Engrg.	Total
British Columbia	2nd	163													163
	3rd	97													97
	4th	2				17	6	19	5	6	5	5	15		80
	5th					12	6	14	4	5	4	5	10		60*
Total	.....	262				29	12	33	9	11	9	10	25		400
Alberta	1st	89													89
	2nd					9	8	15					33		65
	3rd					13	7	14					26		60
	4th					14	2	9					10	1	36*
Total	.....	89				36	17	38					69	1	250
Saskatchewan	1st	182													182
	2nd	90													90
	3rd		2		2	7	8			3	20			1	43
	4th		4		1	7	7			1	15				35*
Total	.....	272	6		3	14	15			4	35			1	350
Manitoba	1st	70													70
	2nd	32													32
	3rd						17	27							44
	4th						13	29							42*
Total	.....	102					30	56							188
Toronto	1st			4	1	68	29	34		7	52	17	49	15	276
	2nd			3	1	53	14	35		1	30	33	44	13	227
	3rd			2		56	20	23		2	20	14	30	6	173
	4th			6		40	4	23			25	12	32	6	148*
	5th			8											8*
Total	.....			23	2	217	67	115		10	127	76	155	40	832
Queens	1st	180													180
	2nd	191													191
	3rd					22	4	15		5	16	12	47	2	123
	4th					21	8	9		2	22	12	34	3	111*
Total	.....	371				43	12	24		7	38	24	81	5	605
Ecole Polytechnique, Montreal	1st	120													120
	2nd	55													55
	3rd	34													34
	4th	26													26
	5th	34													34*
Total	.....	269													269
McGill	1st	107		1											108
	2nd	79		4		22									105
	3rd			5		20	7	13			26	9	20		100
	4th			5		19	7	8			25	5	14		83*
	5th			5											5*
Total	.....	186		20		61	14	21			51	14	34		401
New Brunswick	1st	26													26
	2nd	19													19
	3rd						4	5							9
	4th						8	5							13*
Total	.....	45					12	10							67
Nova Scotia Technical College	1st														
	2nd														
	3rd	1					6	13			6		8		34
	4th						4	11			10		6		31*
Total	.....	1					10	24			16		14		65
Grand Total	.....	1597	6	43	5	400	189	321	9	32	276	124	378	47	3427

*Indicates those graduating in the Spring of 1938 = 606 Total.

BRANCH NEWS

Border Cities Branch

J. F. Bridge, A.M.E.I.C., Secretary-Treasurer.
F J. Ryder, Jr.E.I.C., Branch News Editor.

On Tuesday, November 16th, 1937, the members and ladies of the Border Cities Branch held a joint meeting and inspection tour with the Detroit Section of the American Society of Mechanical Engineers.

The Ford Company of Canada Limited invited the members and friends to visit their power house and new body plant.

Among the features of the tour were the 100 lb. bent-tube boilers for pulverized coal firing, and the pass-out turbines. The three boilers have a normal rating of 165,000 lb. of steam per hour and a peak rating of 200,000 lb. or better. One new 5,000 kw. turbine generator takes steam at 800 lb. 800 deg. F. and exhausts at 175 lb. 500 deg. F. into a 10,000 kw. low pressure turbine. Another new turbine has 20,000 kw. capacity and is a condensing double-bleeding unit.

The new body plant is the most up-to-date plant of its kind in Canada using the most modern types of material handling equipment, conveyors, etc.

After this very interesting trip, the parties returned to the Prince Edward hotel for dinner, which was attended by 192.

Remarks of welcome were made by our President, C. F. Davison, A.M.E.I.C., and were responded to by Mr. C. F. Freund, President of the Detroit Section of the American Society of Mechanical Engineers.

On behalf of the Ford Motor Company, Mr. J. E. Porter welcomed all present and gave a short synopsis of the workings and operation of the new plants.

The ladies present adjourned to another room where they made up fourteen tables of bridge.

The speaker for the evening, Mr. Henry Kreisinger, engineer, the Combustion Engineering Company, Inc., presented a paper on "Combustion of Pulverized Coal."

At the close of Mr. Kreisinger's excellent paper, it was found that there was a long list of names presented for discussion of the paper. However, owing to the lateness of the hour, it was only possible to hear one or two short synopses.

After the adjournment of the meeting, the ladies rejoined the men and refreshments were served. This international joint meeting was considered a most successful affair.

Edmonton Branch

M. L. Gale, A.M.E.I.C., Secretary-Treasurer.
F. A. Brownie, Jr.E.I.C., Branch News Editor.

Branch Chairman J. D. Baker, M.E.I.C., delivered the address of the evening at the Edmonton Branch's first dinner meeting of the season. The meeting was held at the Macdonald hotel on November 19th, 1937. The speaker's topic was "Some Phases of Telephone Engineering."

Mr. Baker has been for a number of years Deputy Minister of Telephones in Alberta, having joined the Calgary Telephone System as a young man thirty-four years ago. At that time the Calgary system boasted some 200 phones and an exchange over a bookstore. As part of the Alberta Government Telephone System, it now has one of the most modern plants on the continent.

The speaker dealt with the general features of the method of planning and developing a modern telephone system so that the system itself will keep pace with the changes in a rapidly developing community, in an orderly and economical fashion.

From the technical features of his paper the speaker went on to some more general aspects of the telephone business in Alberta. Slides were used to illustrate what care has been used and what success achieved in making exchange buildings conform with surrounding buildings when engineering factors demanded sites in fine residential districts and suburban business sections. Of great interest too were slides showing the havoc wrought on rural lines by severe storms of recent years, and emergency measures used to restore service.

The interest of the audience in the paper was attested to by the discussion which followed. Deputy Chairman W. E. Cornish, A.M.E.I.C., presided.

Hamilton Branch

A. R. Hannaford, A.M.E.I.C., Secretary-Treasurer.
W. W. Preston, S.E.I.C., Branch News Editor.

The Problems of Braking High Speed Trains

The largest audience of the year, numbering 250 persons, attended the joint meeting of the Hamilton Branch E.I.C., and the Hamilton Group A.I.E.E., when they met on November 9th, 1937, in the Westinghouse Auditorium. The speaker of the evening was Mr. W. E. Sprague, Secretary of the Canadian Westinghouse Company, Limited, and Manager of the Air Brake Department, Mr. Sprague spoke on the subject, "The Problem of Braking High Speed Trains," and illustrated his remarks with lantern views.

The speaker explained how the difficulties of braking fast trains have become greater with improvements in the rolling stock of railways. A decrease in the weight of equipment and an increase in speed have opposed ease of braking because adhesion between rail and wheel is less for reduced weight and journal speed is least when speed greatest. Furthermore, the braking equipment for any particular train has to be suitable for its predecessors.

Mr. Sprague outlined the history of the air brake and showed pictures of a progression of improvements from the simple, straight air brake of 1896 to the universal type used on present-day passenger trains. A recent advance has been the use of an electrically operated governor to prevent damage from sliding of wheels on the rails during braking. Standard practice now requires a brake shoe on each side of the wheel, for the two-fold purpose of obtaining additional friction and of neutralizing the stresses to which the car journal is otherwise subject.

The speaker also described the results of field tests in braking high speed trains. A passenger train with an initial speed of 40 miles per hour would be found to come to a drift stop, on the level, in a distance of 19,000 ft. A train travelling at 100 miles per hour had been stopped in 3,000 ft. but this had been known to weld the brake shoe to the wheel and set the right of way on fire.

The meeting was opened by D. W. Callander, A.M.E.I.C., Chairman of the Hamilton Group A.I.E.E., who handed the remainder of the meeting over to Col. E. G. McKay, A.M.E.I.C., Chairman of the Hamilton Branch E.I.C., Mr. Sprague was introduced by Mr. C. A. Price, Chief Engineer, Canadian Westinghouse, and H. B. Stuart, M.E.I.C., proposed a hearty vote of thanks to the speaker.

Representatives from the London Branch E.I.C. were present to invite the local members to attend the Fifty-second Annual General and General Professional Meeting, to be held in London, January 31st to February 2nd, 1938. Of these gentlemen, the following spoke briefly: E. V. Buchanan, M.E.I.C., Chairman of the Annual Meeting, H. A. Bennet, A.M.E.I.C., Chairman of Papers Committee, and J. A. Vance, A.M.E.I.C., London District Councillor.

Lethbridge Branch

E A. Lawrence, S.E.I.C., Secretary-Treasurer.
R. F. P. Bowman, A.M.E.I.C., Branch News Editor.

The Lethbridge Branch held a dinner meeting in the Marquis hotel on Saturday evening, November 20th, 1937. During and after the dinner, orchestral and vocal selections were rendered by George Brown's instrumental quartette and Mr. R. H. Standen.

The Bus vs. Street Railways

The speaker of the evening was Alderman J. A. Jardine, who spoke on "Bus versus Street Railways," a question of increasing concern in the city of Lethbridge. Mr. Jardine illustrated the great increase of bus service in urban transportation, both as an auxiliary to, or substitute for street car systems. The inducements for this change he cited as being: reduced operating costs and greater flexibility of service, together with the possibility of providing service in districts where light population density or short distances rendered the installation of street cars inadvisable. However, each city has its own particular set of conditions which make the problem complicated and render it difficult to set forth hard and fast rules as to the desirability of either type of service.

Dealing with the situation in Lethbridge, the speaker pointed out that the present street car system has an operating cost of 17.46 cents per car mile, whereas bus manufacturers claim that their products are capable of operating at 11 cents per car mile, including fixed charges and depreciation. He then gave particulars of the annual deficits which the present system is piling up, and described some of the heavy maintenance which will be necessary shortly, if the street cars are kept in operation.

He then pointed out that although it was desired to call for tenders for a bus franchise, it was found that the city charter did not permit the city to give such a franchise as long as the street railway was in operation and that attempts to have the Provincial Legislature amend the charter to overcome this obstacle had so far met with no success.

A very interesting discussion followed Mr. Jardine's address, many aspects of the history and operation of the street car system being brought out.

Mr. P. M. Sauder also gave an interesting report on the Semicentennial celebrations held in Montreal in June.

Ladies Night

The Lethbridge Branch, Engineering Institute of Canada, held a Ladies Night at the Marquis hotel, on Saturday, December 6th, 1937. During dinner, George Brown's instrumental quartette rendered a number of selections, followed by vocal solos by Mrs. A. Wright and Mr. R. H. Standen.

The speaker was W. L. McKenzie, A.M.E.I.C., whose subject was "10,000 Miles Along the Coast of Asia." He described part of a round the world tour he had taken last winter and in a humorous and delightful manner brought to his audience a picture of the coast of Asia from Japan to the Suez Canal. After the address the members and their wives enjoyed bridge on the mezzanine floor of the hotel.

London Branch

D. S. Scrymgeour, 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 the 15th November, 1937, in the Auditorium of the City Hall. The speaker of the evening was W. J. Bright of the Johns-Manville Company, and his subject "Heat and Its Control."

A. O. Wolff, M.E.I.C., chairman of the Branch, presided and introduced the speaker.

HEAT AND ITS CONTROL

Mr. Bright gave a short address regarding the making of the talking picture on the above subject, which had been produced by the Johns-Manville Company. It is the first sound movie ever to be made on this subject and depicts the story of heat from the time man worshipped the sun to present day methods of development and manufacture of heat conservation materials.

Special sets, accurate in detail, were used to show James Watt's invention of the steam engine, and other historical milestones in the story of man's attainment of mastery over heat.

Actual laboratory demonstrations, animated drawings and shadowgraphs were used to visualize the nature of heat and other technical phases of the story.

The picture likewise showed man's first efforts toward the scientific conservation of heat, the activity in a modern heat research laboratory, and how modern materials for conserving heat are developed, manufactured and utilized.

After the showing of the picture a number of various insulating materials were handed round for inspection and in which great interest was taken by the 70 members and guests who were present. Many questions were asked and fully answered by Mr. Bright.

A hearty vote of thanks was proposed by W. C. Miller, M.E.I.C., seconded by V. A. McKillop, A.M.E.I.C., and carried unanimously.

Montreal Branch

E. R. Smallhorn, M.E.I.C., Secretary-Treasurer.

JOINT MEETING WITH ILLUMINATING ENGINEERING SOCIETY

"A New Approach to the Industrial Lighting Problem, and Current Trends of School Lighting" was the subject of an address by H. B. Dates, head of the Electrical Engineering Department of the Cleveland Case School of Applied Science, which was given in the Institute headquarters on November 15th. This proved to be an exceptionally interesting address and was heard by a large number of members of both societies. The address was well illustrated.

Joint chairmen: Huet Massue, A.M.E.I.C., and D. M. Jones.

TRENDS IN ELECTRICAL COMMUNICATION

On November 18th J. L. Clarke, M.E.I.C., transmission and foreign wire relations engineer with the Bell Telephone Company of Canada, was the speaker. He discussed the aims of electrical communication, progress made in the past and the status at present. Particular attention was given to the telephone but other methods of electrical communication were discussed. The lecture was illustrated by slides and a number of demonstrations were given.

H. J. Vennes, A.M.E.I.C., acted as chairman.

JUNIOR SECTION

On November 24th, 1937, two interesting papers were presented before the section: "Some Aspects of an Electric Mine Hoist," by D. E. Evans, S.E.I.C., of the Dominion Engineering Works Limited, and "Mesures de Sécurité Influant la Construction d'une Route Rurale," by Lucien Perrault of Les Laboratories Industriels et Commerciaux.

J. S. Lochhead, S.E.I.C., acted as chairman.

SEWAGE TREATMENT

W. S. Lea, M.E.I.C., consulting engineer, Montreal, on November 25th gave a talk on various treatment processes for purification. Particular attention was given to new developments in equipment which have rendered treatment more economical and efficient and a number of the more modern treatment plants were described. The paper was illustrated by slides.

The chairman was A. Cousineau, A.M.E.I.C.

THE GEOLOGICAL SURVEY OF CANADA

The purpose and scope of the geological survey of Canada was the subject of a paper by Dr. F. J. Alcock, given on December 2nd. Dr. Alcock's investigations have extended from Nova Scotia to British Columbia and he has been in this field since 1911.

This address began with the work accomplished by Sir William Logan and included the work undertaken up to the present day, through the publication of geological reports and maps and by other services to aid in the development of Canada's mineral industry.

Prior to the meeting an informal dinner was held at the Windsor hotel.

C. R. Lindsey, A.M.E.I.C., was chairman.

JUNIOR SECTION

The closing meeting of the fall session was held on December 8th, taking the form of a "student night." Papers were presented by Graham Treggett, fourth year Civil Engineering student at McGill University, on the "Construction of Log Flumes," and by Lucien Buteau, S.E.I.C., a recent graduate of the Ecole Polytechnique, on "Etude comparative de deux sources d'approvisionnement en eau potable pour la ville de Sherbrooke."

Jean Flahault, S.E.I.C., was chairman.

MATERIAL HANDLING BY EQUIPMENT OF THE CONVEYOR TYPE

W. J. Ramsay, of the Mathews Conveyor Company, Elwood City, Penn., gave an address on December 9th. This covered a brief history of the development of conveyor equipment and the suitability of the various types for particular conditions. A number of interesting views were shown.

An informal dinner was held at the Windsor hotel prior to the meeting.

Chairman: Prof. C. M. McKergow, M.E.I.C.

TRENDS AND MODERN METHODS OF CITIES' ASSESSMENT AND TAXATION

The Assistant Director, Citizens' Research Institute of Canada and Bureau of Municipal Research of Toronto, Joseph E. Howes, presented a most interesting paper on the above subject on December 16th. This covered the trend of taxation in the principal Canadian cities since 1922 and the effect of this on tax collection. Canadian assessment methods were compared with the English system and possible improvements in Canadian assessment methods were also discussed. Considerable interest was taken in this meeting and discussion followed.

An informal dinner was held at the Windsor hotel before the meeting.

J. G. Chenevert, M.E.I.C., acted as chairman.

Ottawa Branch

R. K. Odell, A.M.E.I.C., Secretary-Treasurer.

BUREAU OF STATISTICS TABULATING MACHINES

The tabulating machines in operation at the Bureau of Statistics were the subject of an address at the noon luncheon at the Chateau Laurier on November 18th, given by A. Ernest Thornton, superintendent of Mechanical Tabulation at the Bureau. Mr. Thornton, in collaboration with Fernand Belisle of the same organization, had invented and built the mechanical tabulating machines in operation there.

In compiling census of agriculture information, for instance, individual data relating to each farm is first of all recorded by means of small round punch-holes on small cards, the location of each hole upon each separate card reoresenting a certain definite item of information. In summing up this information for all the farms of any municipality, the cards recording the data for the municipality in question are run through a mechanical tabulator which automatically records the counting of all items under similar headings after which a permanent record on a large sheet of paper of the various totals is obtained by photography. The process of summing up the information further for provinces or other large divisions follows in a similar manner.

The tabulating machines are electrically operated. The various mechanical arrangements whereby the operations are carried out were briefly touched upon by the speaker, since owing to their intricacy they could hardly be covered in detail in the short space of time at the speaker's disposal. In a general way, however, as each card is passed into the machine, pins drop through the various punch holes into cups of mercury below, thereby closing separate electrical circuits and actuating the counting device corresponding to each pin. The speed at which the counting takes place may be realized from the fact that for 1,240 farms the machine required less than 6 minutes of operation for the collection and totalizing of 520 facts for each.

Mr. Thornton stated that in the summation of the information there is no possibility of figures being left out as there are always certain ways in which the totals must balance. Cards which may inadvertently have information which is quite evidently incorrect recorded upon them—such as, for instance, a two-year old child being recorded as attending school—are automatically rejected by a "verifying machine" which calls attention to the material which requires checking over.

The machines at the Bureau are capable of handling 520 items of information at the same time. The nearest approach to these machines in any other country, stated the speaker, are those of the United States government at Washington which are able to handle 60 items at the one time.

The Canadian machines do not cause unemployment, Mr. Thornton pointed out. They are doing work which would be utterly impossible to perform by hand and at the same time have the results available "before they are old enough to be put into the Archives." The results are on record quickly for purposes of study at any time and for all this work a large staff is required.

Mr. Thornton extended an invitation to the members of Ottawa Branch to pay a visit to the Bureau of Statistics and see the tabulating machines in operation.

Saguenay Branch

C. Miller, A.M.E.I.C., Secretary-Treasurer.
J. W. Ward, A.M.E.I.C., Branch News Editor.

At a meeting of the Saguenay Branch on October 15th, 1937, Mr. McNeely DuBose, General Superintendent of the Saguenay Power Company, presented a paper entitled "The Cost of Power" to some thirty-five members and guests in the main office of the Aluminum Company of Canada.

Cost of Power

There are three fundamental factors which govern the cost of electricity. These are:

(1) The average value of the investment in generating station and distribution lines. This proportion of cost is more or less fixed.

(2) The cost of operation which includes labour and materials, fuel and taxes. This proportion of the cost varies with the cost and amount of fuel, and with the amount of taxes which the company must pay.

(3) Load factor—the most important of the three fundamentals. It is the ratio of the average power demand to the maximum power demand over a certain period of time.

As to the first fundamental, it is to be noted that the cost is that of the average of all plants and not the individual cost of each plant. The average value per horse power of Canadian generating plants taken from the 1935 Census of Industry published by the Dominion Bureau of Statistics is $205. The figure includes the cost of the generating station, the transmission and distribution systems, and all other property. The average cost of the generating stations above is $126 per horse power. On this figure of $126 per horse power we must set aside 5 per cent for interest on the investment and 2 per cent to retire the capital in 50 years and take care of major replacements during that time. On that basis, 7 per cent of $126 is $8.80 per horse power year on the installed plant capacity.

Coming now to the second fundamental. The average of the Ontario Hydro-Electric Commission system's costs for operation and maintenance amount to 2.2 per cent of the invested capital. For all of Canada, when taxes are taken into consideraion, the average cost of operation is 2.5 per cent of the total value of the plant. Applying this percentage to the average figure of $126 per horse power one finds that the cost of operation which includes maintenance and administration is $3.20 per horse power year. Adding this to the previous figure of $8.80 a total of $12.00 is obtained.

The third fundamental factor in establishing the cost of electricity now enters the picture. It is the rate of demand, more commonly called the load factor. The load factor, or the ratio of average demand to maximum demand, for all hydro-plants in the United States is a little below 50 per cent while the load factor for all hydro-plants in Canada is a little above 50 per cent. Consideration must then be given to the fact that the cost of $12 per horse power year worked out above is the cost which would be arrived at if all the power plants ran at full capacity twenty-four hours a day seven days a week. In order to ascertain the actual cost per horse power sold, it is necessary to divide the $12 price by the load factor. On this basis the average cost per year of hydro-electric power at the bus-bars of the generating station, using a 60 per cent load factor as being the average for Canada, would be $12 divided by 0.60 which is $20.

Saskatchewan Branch

J. J. White, M.E.I.C., Secretary-Treasurer.

The proposed October meeting of the Saskatchewan Branch was cancelled in order to co-operate with the Association of Professional Engineers, which organization held its semi-annual meeting for all engineers in Saskatchewan. A very good representation from the Saskatchewan Branch was present at the meeting, which was preceded by attendance at a Western Canada Rugby Conference game and later a dinner.

The November meeting was held on the 19th in the Science Lecture Room of Regina College. This was a joint meeting of The Engineering Institute of Canada, the Association of Professional Engineers and the American Institute of Electrical Engineers, and was the first of a series to be conducted during the winter months. The proposal is to have joint meetings throughout the winter season with the presiding officer of each organization alternating to have charge of the meeting. The meeting for November 19th saw The Engineering Institute of Canada in charge with Stewart Young, M.E.I.C., as chairman, and the guest speaker was Professor A. R. Greig, M.E.I.C., University of Saskatchewan, Saskatoon, Sask. His subject, which was thoroughly enjoyed by all the forty-five persons present, was "Coal and its Combustion." The Saskatoon Section of the Branch was represented at the meeting by Dean C. J. Mackenzie, M.E.I.C., and Professor I. M. Fraser, A.M.E.I.C., both of the University of Saskatchewan.

Sault Ste. Marie Branch

N. C. Cowie, Jr.E.I.C., Secretary-Treasurer.

The Sault Ste. Marie Branch of The Engineering Institute of Canada held a dinner meeting in the grill room, Windsor hotel, Sault Ste. Marie, on Friday, October 29th, 1937.

A short business meeting, at which the chairman, C. W. Holman, A.M.E.I.C, presided, was held immediately following the dinner.

The guest speaker of the evening was Dr. H. W. Johnston, M.D., Algoma Steel Corporation physician, who spoke on the subject "Health Service in Industry." Dr. Johnston traced the growth of health service in industry, the methods being used to select men for certain types of work and the measures taken to eliminate hazards to the workman. With regard to the hazards encountered, Dr. Johnston mentioned some of the most common and most dangerous that are met with and the ways taken to eliminate them or to guard against them.

The discussion that followed the address showed the keen interest the members had in the subject under discussion.

Centrifugal Pump Practice

A general meeting of the Sault Ste. Marie Branch of The Engineering Institute of Canada was held in the grill room, Windsor hotel, Sault Ste. Marie, on November 30th, 1937.

A dinner, served by the hotel staff, was enjoyed by the members and guests attending. A short business meeting followed the dinner. C. W. Holman, A.M.E.I.C., chairman of the Branch, presided at the meeting.

Following an introduction by the chairman, the speaker of the evening, Mr. G. H. Heyn, engineer, Northern Foundry & Machine Co., Limited, presented a very interesting paper entitled "Centrifugal Pump Practice." In his paper, which was well illustrated with pictures showing pump design and construction, and curves showing the characteristics of centrifugal pumps, Mr. Heyn discussed the characteristics of this type of pump, the specifications required to design and build the machine. He then illustrated how the designer and the manufacturer determines the type and style of centrifugal pump to fit a given set of specifications with the best efficiency. By means of the above mentioned illustrations and mathematical formulae he pointed out the relation between the various factors involved and the resultant operation of the machine.

At the conclusion of Mr. Heyn's paper the meeting was held open for an informal discussion of the subject.

Following the discussion, the members thanked Mr. Heyn for his well prepared, well presented and interesting paper on this subject.

Toronto Branch

A. U. Sanderson, A.M.E.I.C., Chairman.
A. E. Berry, M.E.I.C., Branch News Editor.

The second meeting of the Toronto Branch held in the Mining Building at the University of Toronto on November 4th, 1937, brought out a very excellent attendance. In addition to the members of The Institute, representatives were present from the American Society for Metals, American Society of Mechanical Engineers, and the American Institute of Electrical Engineers.

The Metallurgy of Metallic Arc Welding and Its Applications

The speaker, C. R. Whittemore, metallurgist, Dominion Bridge Co. Ltd., stressed the progress made in recent years in welding. Development work is intensive, and increased activity is recorded in every sphere of the industry, new applications of existing methods, as well as new processes being added to those already proved in practice. Many manufacturers have partially or wholly adopted welding.

In a very true sense the art of welding is largely metallurgical, particularly that of metallic arc welding which involves the proper choice of materials and their correct use. The problem, of course, is that of satisfactorily joining various pieces.

The main advantages of the process of welding applied to the fabrication of component parts are the economy, rigidity, simplicity, and beauty of the resulting product.

The most outstanding metallurgical contribution has been the replacement of the "bare" wire electrode with electrodes covered with mineral coatings, having slag forming characteristics. Metal deposited by this latter class of electrodes is characterized by high ductility, tensile strength, impact, fatigue and corrosive resistance as compared to low ductility, low impact, low fatigue and poor corrosive resistance for bare wire welds. The maximum values can only be obtained by observing the factors which affect the melting and solidification of the metal. These factors are the choice of the proper current, arc voltage, length of arc, and rate of travel, etc.

The microstructure of the joint varies with the method of welding and necessitates a complete understanding for the attainment of the best physical properties. The solidification of weld metal as deposited in a single layer results in the formation of a "columnar" structure, characteristic of cast metals. In multiple layer welding, each layer modifies the structure of the preceding one by annealing it.

To determine if the welded joint fulfils all requirements, various methods of testing have been adopted. These divide themselves into two main methods: (1) by physical testing of different types of welded specimens—destructive tests; (2) by examination of the finished weld—non-destructive tests.

The only positive method of ascertaining the degree of homogeneity of deposited weld metal and the completeness of fusion throughout the weld section is by means of radiographic inspection, using either x-rays or Gamma rays. X-ray inspection has proved the more satisfactory and in the welding industry it is chiefly confined to the examination of pressure vessels.

Of particular interest to Toronto engineers is, the fabrication by Dominion Bridge Company, Sorauren Ave., plant, by welding of the 48 in. diameter water supply pipe now being installed by the city. The pipe is made in twelve, eighteen and thirty foot lengths of $\frac{1}{2}$ and $\frac{9}{16}$ in. steel plate, rolled and automatically welded by the Unionmelt process, the latest contribution to the methods of producing a quality product. By this method, which is automatic, satisfactory welds can be made in plate up to one inch thick with only one pass. The welded steel shell is hydraulically tested, wire mesh reinforcing tacked inside the shell and the pipe centrifugally lined with $1\frac{1}{2}$ in. of concrete.

Vancouver Branch

T. V. Berry, A.M.E.I.C., Secretary-Treasurer.
J. B. Barclay, A.M.E.I.C., Branch News Editor.

Report of the annual meeting and dinner of the Vancouver Branch held in the Aztec room of the Georgia Hotel, on Tuesday November 16th, 1937.

Fifty-nine members and friends of the Branch sat down to dinner at 6:30 p.m. At the head table were seated Mr. H. N. Macpherson, chairman; J. N. Finlayson, M.E.I.C., Past-Presidents G. A. Walkem, M.E.I.C., and E. A. Cleveland, M.E.I.C.; Col. J. P. Mackenzie, M.E.I.C.; Major W. G. Swan, M.E.I.C.; James Robertson, M.E.I.C.; P. H. Buchan, M.E.I.C., Councillor, and E. A. Wheatley, M.E.I.C., Registrar, of the Association of Professional Engineers of B.C.

Following dinner the annual business of the Branch was transacted. Financial statements were read by the secretary-treasurer and showed the Branch to be in a healthy financial condition. The chairman, Mr. H. N. Macpherson, reported on the year's activities. The election of officers resulted in the election by acclamation of Col. J. P. Mackenzie, M.E.I.C., as chairman, and C. E. Webb, M.E.I.C., as vice-chairman, for the year 1938.

Trends in Engineering Education

The guest speaker of the evening was J. N. Finlayson, M.E.I.C., Dean of the Faculty of Applied Science of the University of British Columbia and head of the Department of Civil Engineering. Dean Finlayson addressed the meeting on "Trends in Engineering Education." The speaker traced the development in the education and training of the engineer from the early part of the eighteenth century down to the present time.

Illustrating by intimate details of the early life and training of such engineering geniuses as William Brindley, John Smeaton, John Rennie, Whitworth, Telford, George and Robert Stevenson, he demonstrated that their early training was the result of an apprenticeship system. The engineering attainments of these men were remarkable because their education was received entirely through their own ambition and perseverance and against overwhelming odds and difficulties.

As time went on, the apprenticeship system was found inadequate and in Great Britain engineering schools were developed to train the artisan, the technician and the designer. During the second half of the last century, due largely to the very severe competition of the technical schools and universities of the continent, the British Institutions were forced to pay greater attention to the scientific and theoretical training of the engineer.

In Canada the training of the artisan has been neglected and the speaker urged the support of all engineers for the renewal of the apprenticeship system and for the development of vocational and technical schools to educate and train the artisans of the future sufficient for the ever-growing needs of a complex society.

A vote of thanks to Dean Finlayson for his interesting and instructive address was moved by Major Walkem and heartily applauded.

Through the efforts of Major W. G. Swan, consulting engineer for the Provincial Government on the Pattulo Bridge, New Westminster, B.C., two reels of films were shown, describing the various phases of the construction of that bridge. Major Swan made running explanations during the exhibition of the films. A vote of thanks to Major Swan was proposed by Col. F. J. Simpson.

The Thames River in Flood

London, Ont.—April 1937

Fig. 1—West London Breakwater.*

Fig. 2—Coves Area, London, from the C.N.R. Embankment.*

Fig. 3—Wellington Street Bridge, London.*

At the Annual Meeting in London, Ontario, the professional session, held on Wednesday, February 2nd, will be devoted to a discussion on flood control, water conservation, agricultural drainage, precipitation, stream discharge and run-off in Southwestern Ontario. Papers on the above subjects will be presented by prominent Canadian engineers.

**Photographs by courtesy of Cairncross and Lawrence Company, London.*

Preliminary Notice

of Applications for Admission and for Transfer

December 27th, 1937

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, 1938

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

CHESTNUT—KENNETH RANDOLPH, of Saint John, N.B., Born at Fredericton, N.B., Oct. 8th, 1882; Educ., B.Eng., 1904, M.Sc., 1907, Univ. of N.B. R.P.E. of N.S.; 1904, instr'man. and dftsman., City of Fredericton; 1905, instr'man. and dftsman., City of Saint John; 1906, testing dept., General Electric Co., Lynn, Mass., and Windsor, Conn.; 1907, asst. prof. of civil engrg., Univ. of N.B. Topographer and dftsman on survey of Atlantic and Lake Superior Rly., Quebec; 1908-10, dftsman., instr'mn. and res. engr. on constrn., Nat. Transcontinental Rly.; 1910-14, Railways and Canals Dept. as inspecting engr. on G.T.P. Rly.; 1915-16, with Baird & Howie, contractors, on bridge foundation work in Maine and New Brunswick; 1917-18, asst. engr., C.N.R. Ocean Terminal, Halifax; 1919-20, asst. chief engr. i/c field work, on constrn. of Halifax Shipyards; 1920-21, with Bedford Constrn. Co., contractors, on highway constrn., and Nova Scotia Constrn. Co. on bridge foundations, and Canadian Bridge Co. on steel work in N.B.; 1922-23, land surveys in N.B., and acct. for R. Chestnut & Sons; 1924-25, field engr., Butler, Barnett & Taylor, West Palm Beach, Florida; 1925-26, office engr., Southeastern Engineering Corpn., Delray, Florida, on land subdivision, drainage and improvement work; 1927-28, chief inspr., Atmospheric Nitrogen Corpn. of Hopewell, Va., on constrn. of chemical works; 1929-32, district engr., Stone & Webster Engrg. Corpn., on constrn. of hydro-electric development in Missouri; 1932-33, asst. engr. on appraisal and valuation of public utilities for State of Missouri Public Service Commission; 1935, engr. for Town of Devon, i/c street paving; 1935 to date, asst. engr., National Harbours Board, Saint John, N.B.

References: F. C. Jewett, D. G. Ross, E. G. Cameron, V. S. Chesnut, A. Gray.

DILLON—MARMADUKE MURRAY, of 284 Dundas St., London, Ont., Born at Galt, Ont., May 18th, 1894; Educ., Private study in engrg. subjects. R.P.E. of Ontario, 1936; 1911-12, Hynes & Feldman, Architects, Toronto; 1912-13, estimator, Charters Lumber Co., Toronto; 1913-15, bldg. contractor, Simcoe, Ont.; 1915-19, overseas, C.E.F.; 1919-20, supt. and estimator, P. H. Secord Constrn. Co., Brantford, Ont.; 1920-22, supt. and dist. mgr., Wm. F. Sporling Co., Toronto; 1922-26, design-constrn. of clay plants, sales mgr., Denison Tile Co. Ltd., Windsor, Ont.; 1926-29, commenced business in London, Ontario, as estimator and detailer of reinforced steel; 1929 to date, design and detailing of reinforced concrete buildings, maintaining an office in private practice of structural engrg. under own name. Work includes struct'l. design of many large public buildings in London and Kitchener, Ont.

References: I. Leonard, H. A. McKay, E. V. Buchanan, J. A. Vance, S. W. Archibald, E. H. Darling, R. A. Crysler, A. B. Crealock, W. L. McFaul, J. B. Carswell, W. C. Miller, H. L. Hayman, W. M. Veitch, J. Ferguson, A. O. Wolff, H. F. Bennett.

GISLASON—STEFAN INGNOR, of 118 Rupert Road, Kenora, Ont., Born at Winnipeg, Man., Nov. 11th, 1908; Educ., B.Sc. (C.E.), Univ. of Man., 1931; 1931-34, dftsman., Kenora district office of Dept. of Northern Development of Ontario; 1934 to date, dftsman., Kenora district office of Dept. of Highways of Ontario.

References: E. A. Kelly, F. Petursson, G. H. Herriot, A. E. Macdonald, P. E. Doncaster.

KENT—CECIL CHARLES, of Winnipeg, Man., Born at Rhayder, Radnorshire, Wales, Feb. 24th, 1906; Educ., 1923-24, Univ. of London; 1924-28, ap'tice, locomotive bldg. and repair shops, Swindon, England; 1919-30, Northern Electric Co. Ltd., Montreal, telephone exchange layout, dfting.; 1930-31, C.P.R., Windsor Stn., Montreal, track and switch calculating and dfting.; 1933 to date, manager, Winnipeg office, Fetherstonhaugh & Company, Patent Solicitors.

References: R. S. Smart, T. Kipp, E. P. Fetherstonhaugh, T. C. Main, D. M. Stephens.

LASH—STANLEY DALE, of 4006 West 34th Ave., Vancouver, B.C., Born at Sheffield, England, March 31st, 1908; Educ., B.Sc. (Hons.), 1928, M.Sc., Univ. of London. Ph.D., Univ. of Birmingham, 1933; A.M.Inst.C.E., A.M.Inst.Struct'l Engrs., R.P.E. of B.C.; 1925 (3 mos.), asst. at the steam and Diesel power stn. of the First Garden City Co.; Letchworth, England; 1924 and 1925 (5 mos.), asst. with the Abertillery and District Water Board; 1927 (2 mos.), asst. at the Rye Harbour Improvement Works; 1929, dftsman., Northern Electric Co. Ltd., Montreal; 1929-30, struct'l. dftsman., Dominion Reinforcing Steel Co. Ltd., Montreal; 1930, struct'l. detailer, B.C. Electric Rly. Co. Ltd.; 1931, designer, Trussed Concrete Steel Co. Ltd., London; 1933-35, research asst. to Prof. Batho, M.Inst.C.E., for the Steel Structures Research Committee; 1935 to date, instructor in civil engrg., University of British Columbia, Vancouver, B.C.

References: J. N. Finlayson, H. J. MacLeod, E. E. Carpenter, P. H. Buchan, E. A. Wheatley.

MONTGOMERY—MORTIMER ANDREW, of 3637 Oxenden Ave., Montreal, Que., Born at Prince Albert, Sask., Sept. 1st, 1911; Educ., B.Sc. (Mech.), Univ. of Sask., 1934; 1935, sub-leader, Geological Survey; 1936-37, sales engr., Sarco Canada Ltd.; at present, engr., Canadian Blower and Forge Co. Ltd., Montreal, Que.

References: R. M. Hardy, B. A. Evans, E. L. Dilworth, C. J. Mackenzie, I. M. Fraser.

NUTTING—BRUCE POWELL, of 7322 Sherbrooke St. W., Montreal, Que., Born at Ottawa, Ont., Dec. 19th, 1901; Educ., 1919-22, McGill Univ., completed 1st year engrg.; 1922-23, asst. supt., Contact Bay Gold Mines, Dryden, Ont.; 1923-24, prospector and surveyor, Huronian Belt Co., Rouyn, Que.; 1925-29, asst. engr., and 1930 to date, district plant engr., Bell Telephone Company of Canada, Montreal, Que.

References: C. S. Dewar, G. E. Templeman, A. S. Wall, A. Scott, L. G. Buck.

SHIELDS—WILLIAM FISHER, of Nipigon, Ont., Born at Ballia, India, Jan. 28th, 1904; Educ., B.A.Sc., Univ. of Toronto, 1927; With the C.N.R. as follows: 1927-28, asst. bldg. inspr., 1928-29, bldg. inspr., 1929-31, instr'man.; 1932-36, not employed in engrg. work; 1937 (4 mos.), level engr., Ste Anne Paper Co., Ste Anne de Beaupre, Que.; August 1937 to date, field engr., Lake Sulphite Pulp Co., Nipigon, Ont.

References: A. T. Hurter, J. M. Gilchrist, H. L. Currie, S. B. Wass, C. B. Brown, J. Stadler, R. O. Sweezey.

SMITH—WILLARD A., of Rossburn, Man., Born at Binscarth, Man., Feb. 6th, 1913; Educ., B.Sc. (C.E.), Univ. of Man., 1936; Summers 1929-30, chainman; 1931-32, rodman, good roads, engrg. party, Prov. of Manitoba; 1936 to date, instr'man., Good Roads Board, Province of Manitoba.

References: J. N. Finlayson, A. E. Macdonald, G. H. Herriot, E. W. M. James, E. Gauer.

THOMSON—WILLIAM JAMES RENWICK, of 585 O'Connor St., Ottawa, Ont., Born at Pictou, N.S., Sept. 8th, 1894; Educ., B.Sc. in Civil Engrg., Tri-State College, Angola, Indiana, 1920. R.P.E. of Ont.; With the C.N.R. as follows: 1920-23, rodman, dftsman. and concrete inspr., at Capreol, Ont; 1923-30, instr'man. at Quebec, promoted to asst. engr. in 1930 and transferred to Cochrane, Ont.; 1930-33, asst. to divn. engr. at Cochrane, Ont.; With the Dept. of Highways of Ontario as follows: 1933-35, instr'man. on concrete pavements and location surveys, at Port Hope, Ont; 1935, transferred to Ottawa on same work; 1936-37, res. engr. at Becketts Landing Bridge; 1937, concrete pavements and general surveys; Sept. 1937 to date, asst. engr.

References: R. M. Smith, A. A. Smith, W. P. Wilgar, W. L. Saunders, S. J. H. Waller, A. K. Hay.

TUFF—JOHN HENRY, of London, England, Born at London, England, June 5th, 1897; Educ., L.C.C. School of Building, Brixton, London, 1910-13. Assoc. Member, Inst.Struct'lEngrs., 1930; 1913-14, junior designer, B.R.C. Engineering Co. Ltd., London; 1919-27, senior designer, with same company at Stafford; 1927-28, senior designer and engr., Messrs. Christiani Neilsen, London, England; 1928-29, deputy chief engr., Messrs. Johnson Engineering Co. Ltd., London; 1929-31, chief engr. of all constrnl. works, Metropolitan Tunnel and Public Works Co. Ltd., Pamplona, Colombia, S.A., work included, constrn. of main central highway of Colombia, involving the design and carrying out of reinforced bridges, high retaining walls, and other engrg. structures; 1931-37, asst. chief engr. for reinforced concrete designs, Great Western Rly. Co.; at present, asst. chief engr., reinforced concrete, S. H. White & Son, London, England.
References: H. B. Fergusson, C. G. DuCane, G. E. W. Cruttwell, A. C. Macdonald, A. Brooks.

WHITBY—EUGENE MORTIMER, of Hamilton, Ont., Born at Paris, Ont., Aug. 9th, 1879; Educ., 1895-99, articled with Messrs. Stewart & Son, Architects, Hamilton, Ont. R.P.E. of Ont.; 1899-1900, with various companies and the City of Niagara Falls, as dftsman. and instr'man.; 1901-03, dftsman. and instr'man., city engr.'s dept., Hamilton; 1903-04, dftsman., instr'man. and asst. engr. on plant constrn., International Harvester Co., Hamilton; 1904-10, 1st asst. i/c field party on elec. rly. and transmission line location and gen. surveys, Tyrrell & MacKay, Hamilton; 1910-14, 1st asst. to deputy city engr., City of Hamilton; 1914, appointed roadways engr. i/c surveys, pavement, sidewalk and all surface constrn., incl. estimating, supervn. of and respons. for pavement, street rly. paving plant constrn. and plant operation; 1930 to date, deputy city engr., City of Hamilton, Ont.
References: W. L. McFaul, H. A. Lumsden E. G. MacKay, J. W. Tyrrell, A. R. Hannaford, R. L. Latham, W. Hollingworth.

WILDE—WILLIAM CLAYTON, of Calgary, Alta., Born at Calgary, May 26th, 1913; Educ., B.Sc. (Elec.), Univ. of Alta., 1936; 1931-32, and summers 1933-34, ap'tice telephone switchman., Alberta Govt. Telephones; 1936 to date, student and telephone sales engr., Canadian Telephones and Supplies Ltd., Calgary, Alta.
References: J. D. Baker, W. E. Cornish, H. J. MacLeod, C. A. Robb, J. McMillan.

WRIGHT—LESLIE AUSTIN, of 2349 Grand Blvd., Montreal, Que., Born at Toronto, Ont., June 1st, 1888; Educ., B.A.Sc., Univ. of Toronto, 1910; 1907-11, vacation work in city engr.'s office, Toronto; 1911, res. engr., McGregor-McIntyre Ltd.; 1911-15, asst. engr. on grade separation, C.P.R.; 1915-16, asst. works mgr., P. Lyall & Sons.; 1916-20, engr., supt. of yards and plant, purchasing agent and supt., Foundation Co. of Canada Ltd.; 1920-32, store planning, designing, estimating, bldg. alterations, store fronts, etc., Kent-McClain Ltd., Toronto; at present temporarily engaged in financial counsel assignments.
References: J. M. R. Fairbairn, J. B. Challies, R. E. Chadwick, R. L. Dobbin, A. U. Sanderson, H. M. Scott.

FOR TRANSFER FROM THE CLASS OF ASSOCIATE MEMBER TO THAT OF MEMBER

JOST—LESLIE GORDON, of 8342 Kirkwood Drive, Los Angeles, California., Born at Guysboro, N.S., March 9th, 1887; Educ., B.Sc., McGill Univ., 1910; 1906-10 (summers), rly. location and struct'l. drawing; 1910-11, detailing, Canada Foundry Co., Toronto; 1911-12, checking and designing. Cleveland Bridge Co., Montreal; 1912-18, res. engr., Quebec Bridge, St. Lawrence Bridge Co. Ltd.; 1918-19, non-technical work, Great Lakes Engrg. Works, Detroit; 1919-28, Llewellyn Iron Works, Los Angeles; 1929 to date, with the Consolidated Steel Corpn. Ltd., Los Angeles. In charge of structural design all this time. In charge of detailing also for about a year. Chief engr. for one year until Oct. 15th, position abolished, depts. consolidated due to slackness, transferred from production to sales. At present, chief struct'l. engr. Regd. Civil and Struct'l. Engr., California. Member, Struct'l. Engrs. Assn. of So. California. Member, Am.Soc.C.E., 1937. (*St. 1909, A.M. 1913*)
References: W. P. Copp, R. B. Stewart, W. C. Thompson, F. P. Shearwood, P. L. Pratley, C. N. Monsarrat.

MASSUE—HUET, of 3815 St. Hubert St., Montreal, Que., Born at Montreal, May 24th, 1891; Educ., B.A.Sc., Ecole Polytechnique, Montreal, 1913; 1913-26, with the Quebec Streams Commission, i/c inventory of water powers and other investigations concerning the hydro-electric industry; 1926 to date, with the Shawinigan Water and Power Company, on further investigations of problems connected with the hydro-electric industry; since 1932 on statistical investigations and research work connected with rates and other commercial problems relating to the hydro-electric industry. (*St. 1912, A.M. 1918*)
References: J. C. Smith, A. Surveyer, O. O. Lefebvre, J. B. Challies, P. S. Gregory.

FOR TRANSFER FROM THE CLASS OF JUNIOR

BUTLER—ERNEST W. R., of Winnipeg, Man., Born at Ashton, Ont., March 16th, 1903; Educ., B.Sc. (Mech.), McGill Univ., 1924; 1924-29, sales service engr., and from 1929 to date, manager, Western Canada Branch, Bailey Meter Co. Ltd., Winnipeg, Man. I/c sales and service, including supervision, installn. and adjustment of steam boiler combustion control and metering equipment. (*St. 1924, Jr. 1930*)
References: E. V. Caton, T. C. Main, H. G. Thompson, N. M. Hall, F. S. B. Heward.

DONNELLY—WILLIAM DAVID, of 558 Partington Ave., Windsor, Ont., Born at Deseronto, Ont., Sept. 15th, 1904; Educ., B.Sc. (Mech.), Queen's Univ., 1925; 1925-26, stock layout man and stock gang foreman, Hudson Motor Car Co., Detroit, Mich.; 1926-30, dftsman. on stock handling equipment, conveyors, ventilating systems, plant layout, surveyor of yards and bldgs., for some company; 1930-32, dftsman. and estimator in schedule dept., Canadian Locomotive Co. Ltd., Kingston, Ont.; 1934-35, foreman in brake lining dept., Canadian Johns-Manville Co. Ltd., Asbestos, Que.; 1935 to date, mech. dftsman. on conveyors, heating and ventilating systems, piping layouts, Ford Motor Co. of Canada, Windsor, Ont. (*St. 1924, Jr. 1936*)
References: J. E. Porter, J. E. Daubney, V. W. MacIsaac, C. G. Walton, B. Candlish, C. F. Davison.

GRINDLEY—FRANK LLEWELLYN, of Medicine Hat, Alta., Born at Douglas, Isle of Man, England, March 21st, 1904; Educ., B.Sc. (Civil), Univ. of Alta., 1926; 1925, rodman, L. and N.W. Rly. (now C.P.R.); 1926-27, instr'man., C.N.R.; 1927, instr'man.. Aluminum Co. of Canada; 1928-30, res. engr., C.N.R.; 1931-33, misc. engrg.; 1934-35, foreman and asst. engr., Dept. of National Defence Relief Camps; 1935 to date, junior engr., Dept. of Agriculture, Dom. Govt., Regina, Sask. (*St. 1926, Jr. 1928*)
References: B. Russell, C. M. Moore, L. C. Charlesworth, R. S. L. Wilson, R. F. P. Bowman, A. C. Gardner.

PHIPPS—CHARLES FERDINAND, of Montreal, Que., Born at Winnipeg, Man., Aug. 31st, 1903; Educ., B.Sc. (Elec.), McGill Univ., 1924; 1922 (summer), gen. power house work, Jordon River power plant, Vancouver Island Power Co., B.C.; 1923 (summer), formwork constrn., La Gabelle power development, Shawinigan Engineering Co.; 1924-26, graduate ap'tice course, and from June 1926 to date, asst. engr. of transmission line design, Shawinigan Water and Power Company, Montreal, Que. (*Jr. 1931*)
References: J. A. McCrory, R. E. Heartz, F. S. Keith, J. Morse, C. R. Lindsey, C. V. Christie, E. Brown.

FOR TRANSFER FROM THE CLASS OF STUDENT

BAKER—JOHN ARTHUR, of London, Ont., Born at Hill End, Alta, April 15th. 1907; Educ., B.A.Sc., Univ. of B.C., 1930; 1930-33, commercial engrg., Northern Electric Co. Ltd., Montreal; 1933-36, radio sales and service; 1937 to date, sales engr., estimating and sales work, Taylor Electric Mfg. Co., London, Ont. (*St. 1930*)
References: D. S. Scrymgeour, A. B. Hunt, A. O. Wolff, D. M. Bright, J. F. Plow.

BARNSLEY—FRANK RICHARD, of Montreal, Que., Born at Victoria, B.C., Aug. 20th, 1901; Educ., B.A.Sc., Univ. of B.C., 1927. R.P.E. of Que.; 1918-19, ap'tice test dept., Can. Gen. Elec. Co Ltd., Peterborough, Ont.; 1919-27 (summers), operating small power and distrib. plant, Bowen Island, summer resort; With the Can. Gen. Elec. Co. Ltd., as follows: 1927-28, student test dept., Peterborough; 1928-30, industrial heating specialist, Toronto; 1930-33, industrial heating specialist, Montreal; 1933-35, distribution specialist, Montreal; 1935 to date, manager, air conditioning division, Montreal. (*St. 1924*)
References: W. T. Fanjoy, W. E. Ross, W. M. Cruthers, E. C. Kirkpatrick, R. H. Findlay, K. O. Whyte.

BENJAFIELD—PHILIP GRANT, of 146 Larch St., Sudbury ,Ont., Born at London, Ont., July 15th, 1907; Educ., B.Sc., Queen's Univ., 1932; 1929 (summer), rodman, Mich. Central Rly.; 1930 (summer), dftsman., Ont. Dept. of Highways; 1931 (summer), transitman, Lake Shore traverse on Lake St. Clair; 1934 to date, instr'man., field engrg. dept., International Nickel Company, Copper Cliff Ont. (bldg. constrn. in company towns and plants). (*St. 1928*)
References: C. O. Maddock, F. A. Orange, J. F. Robertson, W. C. Miller, W. P. Wilgar.

BENNETT—ROBERT DOUGLAS, of Montreal, Que., Born at Montreal, Dec. 5th, 1909; Educ., B.Eng., 1932, M.Sc., 1933, Ph.D., 1935, McGill Univ.; 1930 (summer), lacquer dept., Sherwin Williams Co. of Canada Ltd.; 1931 (summer), technical service, organic dept., Milton Hersey Co. Ltd.; 1933-34, graduate asst., 1934-35, head demonstrator, Dept. of Chemical Engrg., McGill University; 1935-36, chief chemist, Canadian Industrial Alcohol Co. Ltd.; 1937 to date, head of organic dept., J. T. Donald and Co. Ltd. (consultation, research and contract work). (*St. 1930*)
References: J. B. Phillips, J. R. Donald, J. F. Plow, C. M. McKergow, R. DeL. French.

BIESENTHAL—CLARENCE G., of Kapuskasing, Ont., Born at Pembroke, Ont., June 5th, 1909; Educ., B.Sc., Queen's Univ., 1936; 1935 (summer), dfting, and May 1936 to date, dfting., machine design, mechanical problems in paper mill, Spruce Falls Power and Paper Co. Ltd., Kapuskasing, Ont. (*St. 1935*)
References: C. W. Boast, R. S. Walker, D. N. McCormack, G. R. Connor, L. M. Arkley, L. T. Rutledge.

BLACHFORD—HENRY EDMUND, of 133 Hillcrest Ave., Montreal West, Que., Born at Montreal, Feb. 22nd, 1908; Educ., B.Sc., McGill Univ., 1931; 1929-31, design of induction motors, Montreal Armature Works Ltd., Montreal; 1932-33, supervn. of elect'l. installn., Can. National Steamships, Halifax, N.S.; 1935-37, estimating cost of telephone and special products equipment, Northern Electric Co. Ltd., Montreal, Que. (*St. 1930*)
References: H. J. Vennes, E. S. Kelsey, C. A. Peachey, T. Eardley-Wilmot, B. H. Steeves, G. B. Mitchell.

COLLISON—LLOYD SETH, of 140 Prospect St. N., Hamilton, Ont., Born at Leamington, Ont., July 12th, 1902; Educ., B.A.Sc., Univ. of Toronto, 1924; 1923, land surveying, Windsor, Ont.; With the City of Hamilton as follows: 1924-27, instr'man., 1927-29, asst. on waterworks constrn., 1929, asst. on sewer constrn., 1929-31, asst. on sewer design, 1931-33, asst. on roadway constrn; 1933 to date, on filtration plant operation, Hamilton, Ont. (*St. 1921*)
References: W. L. McFaul, J. Stodart, W. H. Collins, H. S. Philips, A. R. Hannaford.

CRAIG—WILLIAM ROYCE, of Picture Butte, Alta., Born at Chicago, Ill., July 4th, 1909; Educ., B.Sc. (E.E.), Univ. of Alta., 1933; Summers—1930-31, rodman and asst., 1932-34, instr'man and dftsman., Lethbridge Northern Irrigation District; 1934 (Fall), gravel checker, 1935 (Spring), instr'man., Alberta Road Dept.; 1935-36, surveyor and dftsman., Dominion Construction Co.; 1936-37, electrn., and at present, asst. master mechanic and office engr., Canadian Sugar Factories, Picture Butte, Alta. (*St. 1933*)
References: F. H. Ballou, P. M. Sauder, C. S. Clendening A. Thomson, N. H. Bradley, W. L. McKenzie, R. Livingstone, J. Haimes.

FERGUSON—ALLAN ANDREW, of Town of Mount Royal, Que., Born at Pictou, N.S., July 21st, 1907; Educ., B.Sc., McGill Univ., 1931; 1926-29 (summers), ap'ticeship, machine shop, marine hull and engine repairs and inspn., Pictou Foundry & Machine Co. Ltd.; Summer 1931, asst. to chief erector. Babcock-Wilcox and Goldie-McCulloch Ltd., high pressure boiler installn.; 1931-34, inspn. engr., sprinklered risk dept., Canadian Underwriters Assn., Montreal; 1934 to date, fire protection engrg. and insurance, industrial and municipal, Reed, Shaw & McNaught Ltd., Montreal, Que. (*St. 1929*)
References: E. R. Smallhorn, W. P. Copp, A. J. Foy, C. M. McKergow, H. W. Lea.

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References: C. H. Mitchell, R. W. Angus, E. A. Allcut, C. E. Fraser, D. C. M. Hume, H. R. Carefoot, H. B. Godwin.

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References: H. J. MacLeod, R. S. L. Wilson, R. J. Gibb, H. B. LeBourveau, H. J. McLean, G. H. Thompson.

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References: J. N. Finlayson, E. P. Fetherstonhaugh, A. E. Macdonald, G. H. Herriot, A. L. Cavanagh.

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References: W. G. Swan, W. H. Powell, J. S. Hewson, J. B. Challies, R. DeL. French, B. R. Perry, E. A. Wheatley.

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References: J. Garrett, E. Nelson, R. S. L. Wilson, F. K. Beach, H. R. Webb.

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The Precipitation of the Grand and Thames River Basins

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The subject proposed for discussion by The Engineering Institute is limited to the relation between precipitation in Southern Ontario and floods in the region drained by the Grand and Thames rivers. While complete data regarding floods are not available, Mr. Maclennan of the Hydro-Electric Power Commission of Ontario has kindly supplied stream flow measurements since 1914 in the Grand river area. These are published in a report issued by the Province of Ontario in 1932 on "Grand River Drainage." There are there some references to spring floods of great magnitude in earlier years. Some recent events of like nature have also been known through notices in the daily press.

For the present discussion years of evidently unusual floods were singled out to be examined as to the sequence of meteorological events during the previous winter and the contemporaneous spring. The apparent departure of these events from the average or normal course of weather sequences will be indicated for consideration.

The accompanying maps and diagrams deal first with average conditions. Figure 1 shows the average annual precipitation over Southern Ontario. This has been prepared from all observations taken since 1845. The earliest date is confined to Toronto, but some points contributed figures for the period between 1870 and 1880. Most of the data do not date back of 1885 and not all the early observations have been continuous. In the region of the most elevated sources of the Grand river the data are particularly deficient, that is, in the district including Dundalk and the townships of East and West Luther. In spite of the irregularities and deficiencies of the data, it is believed that the map gives a very fair presentation of the average annual precipitation.

The monthly amounts of precipitation when averaged over a long period for Southern Ontario show that there is little difference in the amounts to be expected from month to month. That is, there is no wet winter and dry summer as on the Pacific coast nor a dry winter and wet summer as on the prairies. For this reason the map of average annual precipitation serves well to show the local variations of susceptibility to precipitation.

The average amount for southern Ontario is about 32 or 33 inches. Most of the course of the Grand river is through a territory receiving nearly this amount. At the apex of watersheds of the rivers in Southwestern Ontario there is a small area in Dufferin county and the northern portion of Wellington county which receives about 38 in. as nearly as can be judged from the broken and scanty observations in that region. Run-off from this region at the apex of the watersheds should appear first at Belwood, below the Luther, Amaranth and Garafraxa swamps. It is, therefore, interesting to note that the published figures of run-off in the report already mentioned between 1914 and 1923 indicate that the flood run-off at Belwood when expressed as inches on the drainage area above that point, show generally a maximum or are exceeded only by the flood run-off at Galt.

In the case of the Thames, it appears that the precipitation averages about 3 in. more than over the drainage of the Grand, from the headwaters in the lower half of Perth county to the upper part of Elgin county. From an altitude of about 700 ft. above sea to the river mouth,

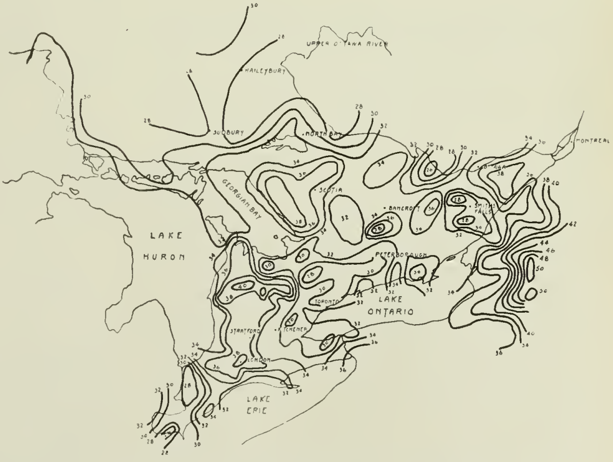

Fig. 1—Average Annual Precipitation over Southern Ontario.

that is, from near Wardsville to Lake St. Clair at 576 ft. above sea, the precipitation falls off sharply. At Chatham it averages about 30 in. or about 3 in. less than the average of the greater part of the Grand valley, while near the mouth of the Thames it is about 28 or 29 in. The few figures of run-off which it has been possible to check (from the stream-flow reports of the Dominion Water Power and Hydrometric Bureau, principally for the north branch of the Thames at Fanshawe, the south branch at Ealing and the mainstream at Byron, as well as the flow of the Grand at Galt) appear to agree rather well with the precipitation maps.

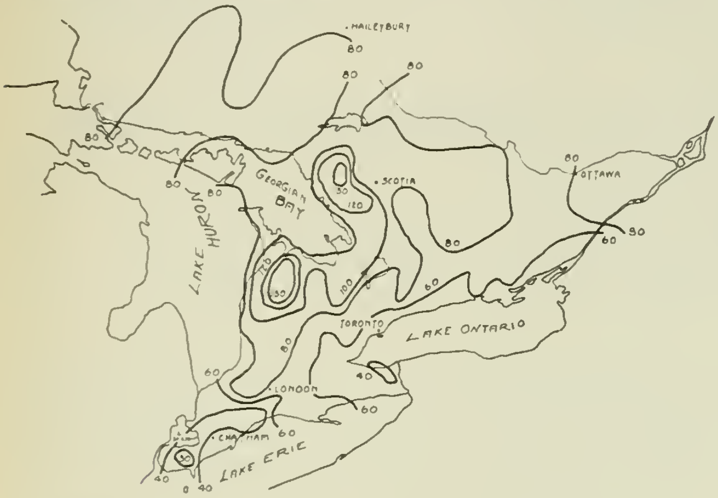

Fig. 2—Average Annual Snowfall Southern Ontario.

So far no distinction has been made between the rainfall and the water-content of snowfall. The map of average total snowfall shows about 60 in. annually from Guelph and Kitchener along the Grand to Port Maitland. To the west along the divide between the Thames and Grand drainages in Perth and Oxford counties the annual average rises to 80 in. Below London on the Thames the amount falls away from 60 in. to 40 or less at the mouth, but the north branch drains a territory with 80 to 90 in. of snow.

On the other hand, to the east of the Grand river snowfall is less but cannot be given with certainty. There have been in the past very few observations in Lincoln and Wentworth counties except along the Lake Ontario shore. It may be 50 in. or less.

North of Grand Valley village at the upper sources of the Grand river a small area averages probably 80 to 100 in.

Summarizing, it appears that the Thames above London so far as the north branch is concerned drains from a territory with precipitation of about 36 or 37 in. annually of which 23 per cent is snow, while the Grand drains from about 33 in. of which perhaps 18 per cent is snow. The south branch of the Thames approximates quite closely to the precipitation of the Grand below Brantford.

The meteorological observers do not systematically and regularly measure the depth of accumulated snow and the thickness of ice on the ground under the snow. Provision has been made for this on the forms supplied to them, but most of the observers make all observations voluntarily and little remuneration is allowed in any case. It has, therefore, been impossible to insist on these extra measurements with the result that estimates of the stored precipitation at various times in the winter do not stand on a very satisfactory basis. No attempt has been made to prepare maps of average storage.

The average temperature of the winter months, particularly of the mean daily minimum temperature, undoubtedly gives some idea of probable storage. Figure 3 indicates that the temperature is depressed along the ridges between Lakes Ontario and Erie on the one hand and Lake Huron on the other. This is, of course, to be expected, since the broken surface of the interior highlands radiates away to the sky on a clear night in dry polar air (particularly when snow-covered) at a faster rate than the lake surfaces. Towards such sinks as the marshes of the Grand, the increased density of the cooling air immediately above the ground will set the cold air draining down where it will continue to cool until fog has formed over the marshes. It is, therefore, not at all likely that the meteorological stations have been at points where the lowest temperatures have occurred. The map, however, may be taken to indicate the average minimum temperature of all the territory except natural sinks. It would appear from the temperature and snowfall maps so far considered that the greatest storage of winter precipitation should be in the region from Dundalk at the head of the Grand to the junction of the Conestogo and the Grand and thence southwestward along the creeks of the north branch of the Thames to the vicinity of St. Mary's and London. It will be seen that this region has a central area about the highest elevations where the mean daily minimum in February is as low as 5 deg. F., while the greater part experiences 10 deg. F. or less.

From the situation so far depicted it may be assumed that (*a*) fairly heavy snows accumulate on the higher levels near the sources of these two river systems, (*b*) in the spring the lower reaches clear first because of the higher temperature, (*c*) that the stored snow in the interior later dissolves and comes down to the lower valley. It should be fairly easy on these grounds to show statistically that a serious flood could result only after a winter of great snowfall, and that very seldom could this happen on the Grand river and should be of very rare occurrence on the Thames. The frequency of serious floods on the Grand river is greater than this simple view of the data supposes. The sequence of events in several years of exceptionally large floods on the Grand river were, therefore, examined in detail from November of the preceding year to the time of the flood peak in March or April. From this detailed examination it appears that the absolute magnitude of the snowfall is not so important as the actual sequence of events involving rainfall, snowfall, and thawing.

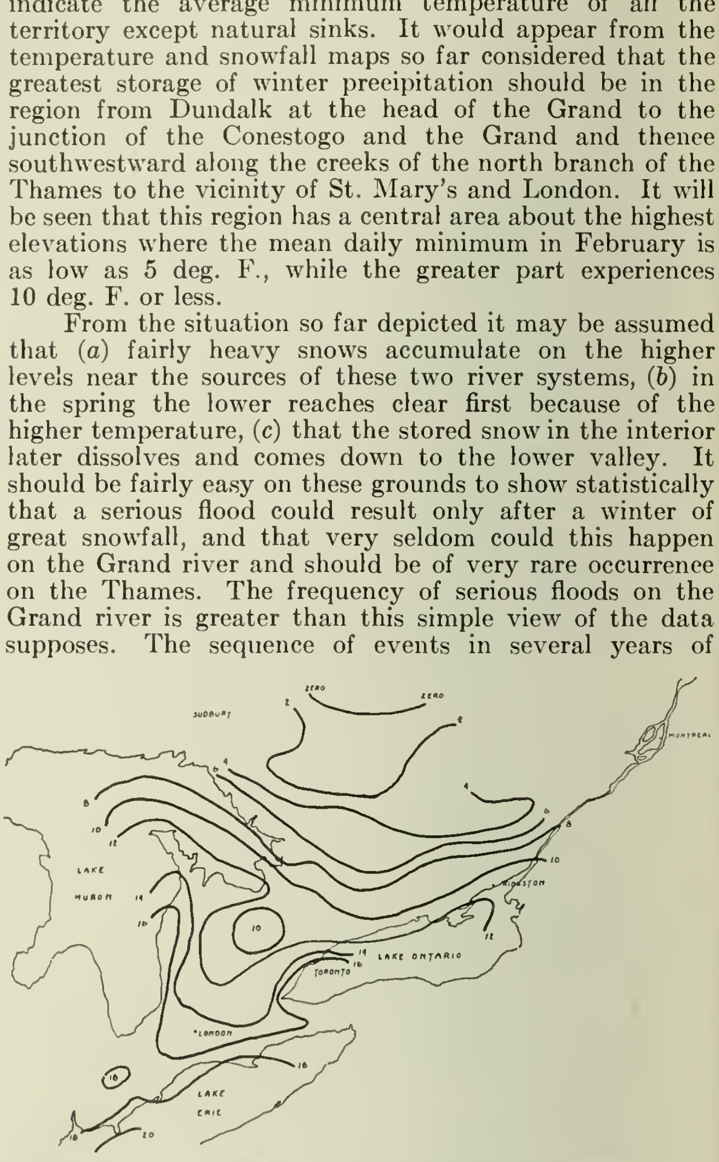

Fig. 3—Normal Mean Daily Minimum Temperature Dec. 1 to March 1.

It will not be possible to show here the details for each of these bad years. But in summarizing it may be

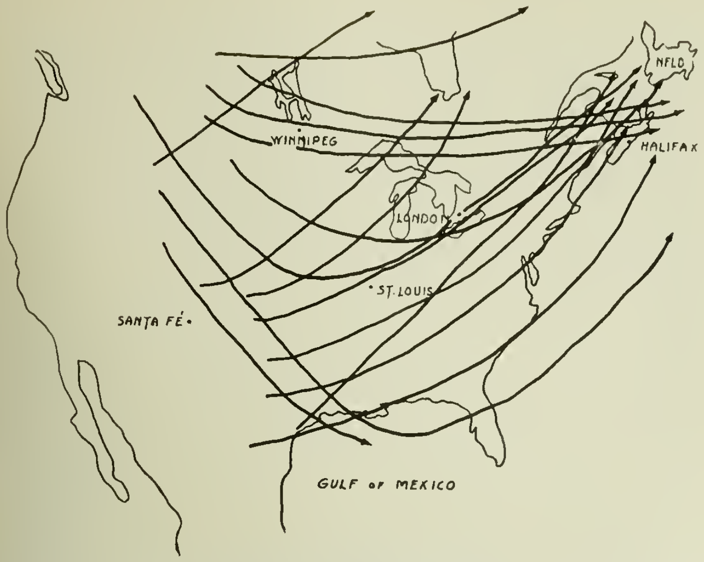

Fig. 4—Average Tracks of Pressure Minima Nov. 1 to Feb. 1 Preceding Bad Floods.

said that there was evident a general similarity in the type of weather experienced. Stated broadly, the course of events began with numerous movements of low pressure waves from the far southwestern portion of the continent to the Great Lakes or the St. Lawrence region in the early winter. There was then a period of sharp cold in February which was followed by a return to low pressure movements from the southwest bringing heavy or wet snowfalls or alternate snow and rain at the close of the winter. The continuance of the frequently recurring movement of comparatively mild and moist airmasses converging on eastern Canada brought heavy early rains. These heavy rains started the wet snow moving off the highlands while the lower valley was already too wet to absorb these rains.

The run-off in the lower valley of heavy spring rains on wet soil should naturally be heavy and tend to rapidly fill the lower courses of the river. In addition, evidence is found which suggests a coating of ice or frozen wet snow laid down on the upper portions of the watershed during the cold spell in February which followed the period of wet snow (or mixed snows and rains) of the preceding fall. Upon this nearly impervious surface the wet snows of late winter when attacked by heavy rains probably move downhill with great rapidity and with no opportunity for absorption of the freed water by any surfaces except possibly the marshes.

On the other hand, there were winters with fairly heavy snowfall throughout which appear not to have been distinguished by unusual floods in spring, even when March was above normal in temperature. Winters of frequently alternating thaws and freezes also seem devoid of serious consequences unless unusually heavy late snow is closely followed by at least moderately heavy rains.

Of the ideally worst conditions in spring (that of sudden release of stored moisture from the upper reaches under heavy rains when no part of the watershed or of the lower valley can absorb the rains, with run-off approaching totality), there are doubtless degrees of varying severity. There has been insufficient time to spare for meticulous examination of the observations in all years. A composite picture, constructed from the general features of a few bad flood-years, will serve to illustrate the meteorology of the floods of spring. In the preparation of these composite maps, it has been necessary to assume some familiarity with the general conception of precipitation as closely related to the movement of low pressure areas. In high pressure areas there is generally a mass of air which is nearly homogeneous over a wide extent at any given level above the ground. The air may be warm or cold, moist or dry, but little or no change is occurring between levels so that fair or fine, stable weather is experienced.

Along the boundary between such masses conditions are generally unsettled, with the moister, warmer and, therefore, lighter air ascending above the margin of the denser mass. Dynamic cooling of the load of water-vapour carried aloft by ascending currents is the preliminary to the fall of rain or snow. These unsettled conditions are generally at a maximum in the low pressure wave which runs along the boundary between distinct masses. The general paths of these low pressure systems during winters followed by bad floods are indicated on Fig. 4.

The most northerly paths are between masses of intensely cold and dry air moving along the surface of the continent from polar or arctic regions and air originally polar which has been somewhat modified in mid-continent. Such low pressure systems bring only light or very moderate snowfalls in winter and light rains only to the most southerly regions of Ontario. A winter with a great preponderance of such movements would be very cold over most of Ontario with precipitation much below normal.

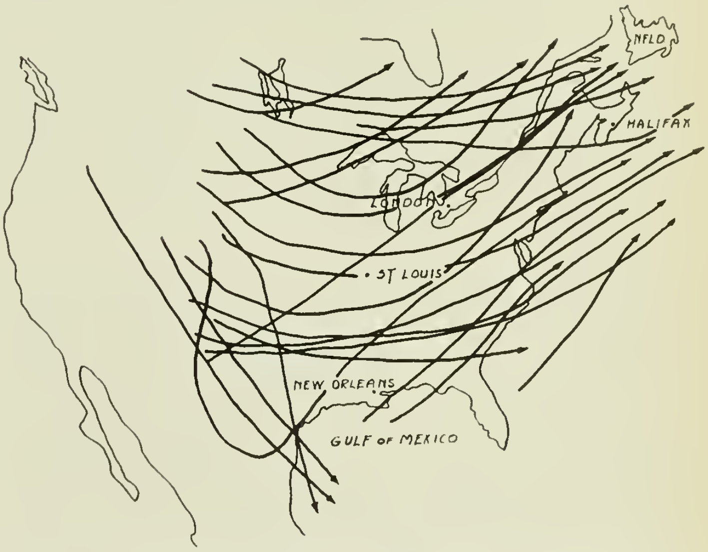

Fig. 5—Average Tracks of Pressure Minima During Midwinter Freeze-period of Bad Flood Years.

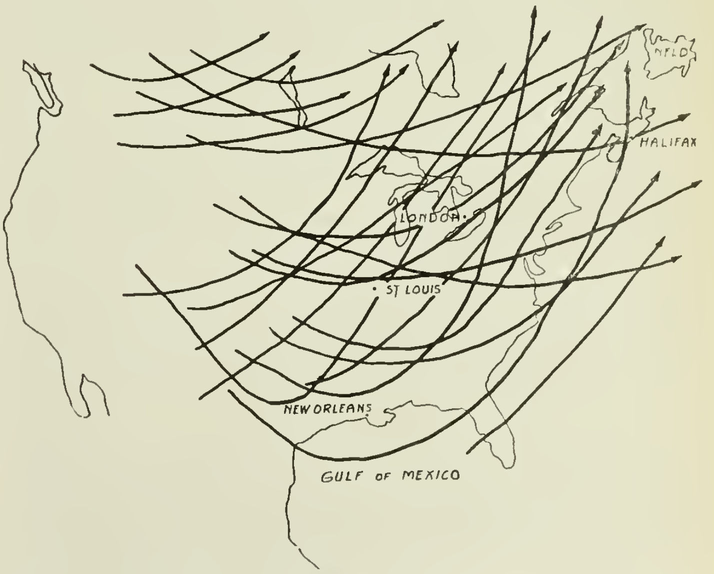

Fig. 6—Average Tracks of Pressure Minima in March and April of Bad Flood Years.

More southerly courses indicate low pressure waves moving along divisions between Pacific airmasses, considerably modified in character on the southwestern portion of the continent and masses of new polar or arctic air. Precipitation is heavier, much of it is snow in Southern Ontario and the cold weather following the cessation of the precipitation favours storage of the snow. The temperature fluctuations accompanying passage of the division between such masses are larger than in the first case mentioned. A preponderance of such movements, therefore, indicates a winter not only averaging nearly normal in all respects but seldom departing far from normal conditions.

The paths of low pressure movements which are seen beginning in the far southwest, or in the region of the Gulf of Mexico or in the Caribbean Sea, are worthy of special note. On the eastern side of the path the airmass has moved from over the warm waters of the south and will carry a load of water-vapour in the lowest layers. On the western side there is a denser and relatively much colder and drier airmass of either polar Pacific or polar basin air. In either case the precipitation will be of the heaviest character experienced in winter in Southern Ontario, but in the case of superposition of Atlantic air directly above air newly arrived from the polar basin, supercooled rain or ice particles will be added to the wet snow.

It will be seen from the composite maps (Figs. 5 and 6) that there is an unusually large number of movements involving southern airmasses in the early winter and again at the close of winter and the beginning of spring. These maps have shown the relation of flood periods in southern Ontario to the type of atmospheric circulation in the northern hemisphere which leads up to the floods. Figures 7 and 8, which show the temperature sequences in Southwestern Ontario in such winters, show the successive monthly variations from normal temperature at stations from north to south, Georgetown, Guelph, Kitchener, Stratford, Paris, Brantford. The winters of 1916, 1917, 1918, 1920, 1921, and 1929, chosen because of the magnitudes of the floods in the Grand river system, may be seen to follow much the same temperature pattern. That of 1929 is rather pronounced; early winter well above normal, midwinter below normal, and a very warm spring. The course of this winter is shown in detail at Brantford in Fig. 9. This diagram shows at the top the actual and normal rate of totalization of the falling precipitation from November 1st, 1928. As the collected amount increases, the scale swings downward to the right. At the bottom the individual falls of rain and snow are shown, rain by clear rectangles, snow by shaded rectangles. It will be noted that there were some very large falls of rain and comparatively little snow. What snow fell in November and December was well mingled with rain, while in January extraordinary rains alternated with snowfalls.

The daily march of temperature is shown along the middle of the diagram with a dotted line depicting the normal course of temperature. It is interesting to note the waves of warmth coming at very irregular intervals of about a fortnight and accompanied in each case by rain with a little snow as the following cold margin of the wave sweeps over the highlands. These following cold waves were severe after the middle of January was reached, with the temperature averaging below zero on February 27th. The heavy rains and the saturated top-soil must

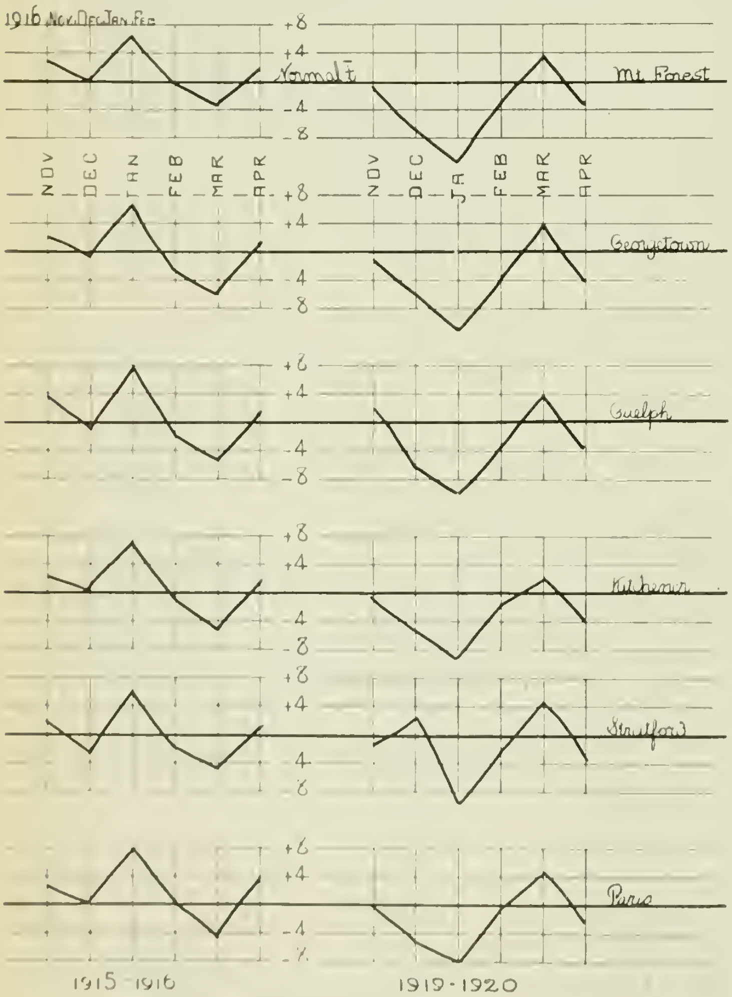

Fig. 7—Difference from Normal Temperature.

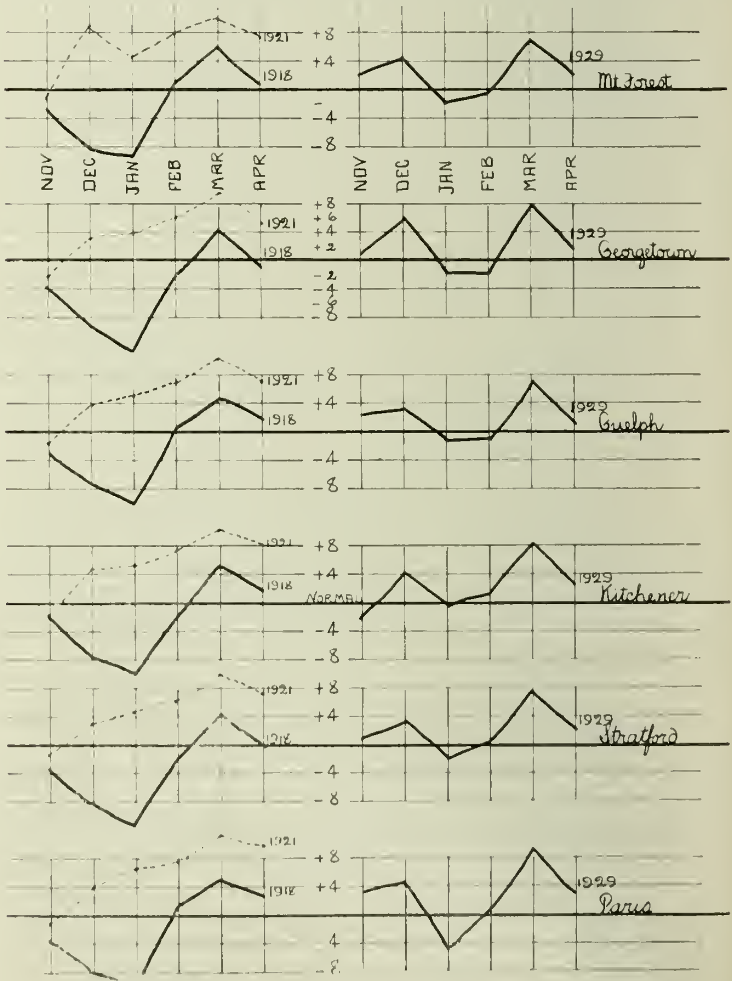

Fig. 8—Difference from Normal Temperature.

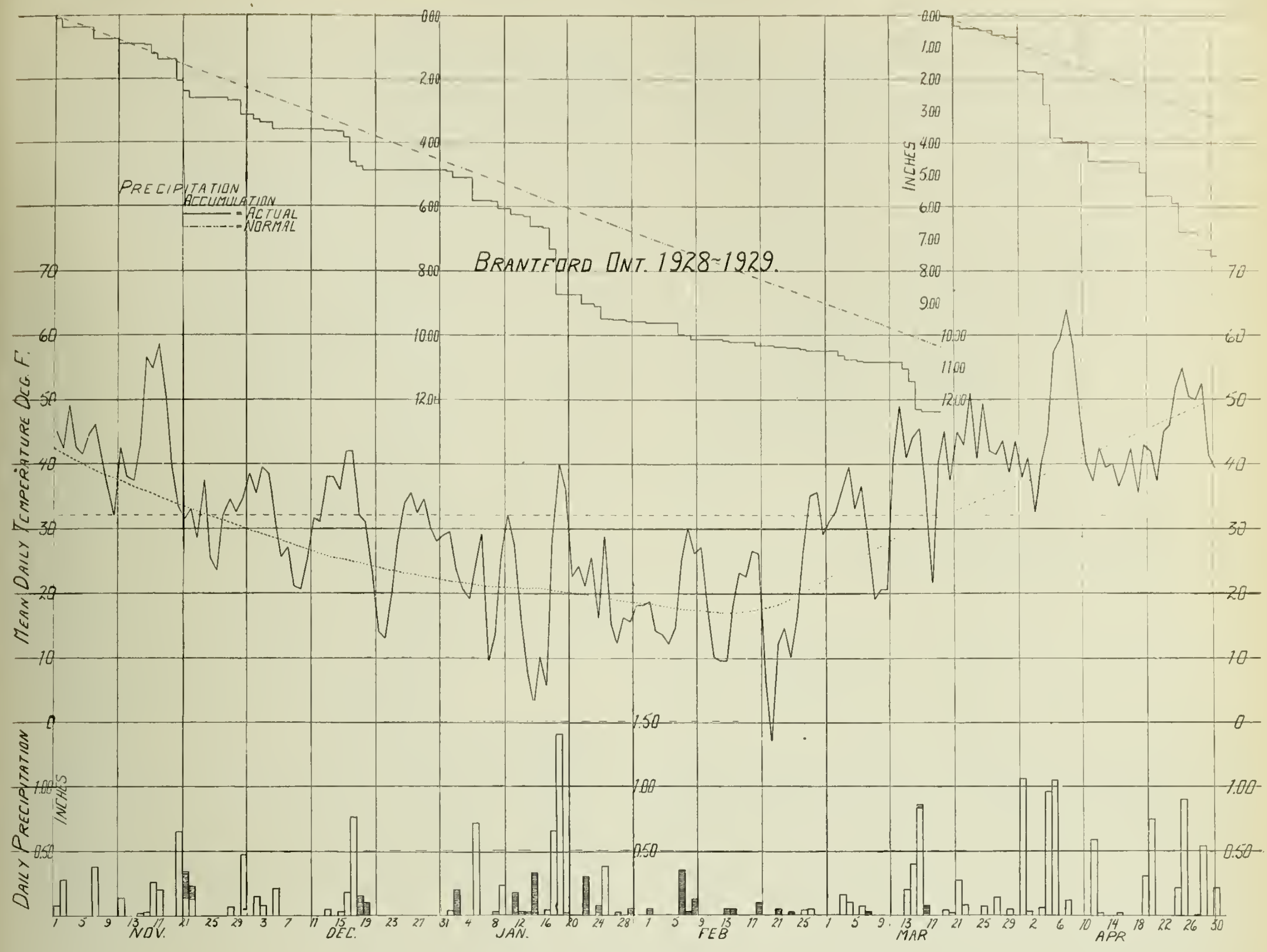

Fig. 9—Precipitation, Brantford, Ont., Winter 1928-29.

by these periods of sharp cold in January and February have created a glazed or icy foundation for the moderate but frequent snowfalls of late January and most of February.

From the figure it will be seen that by February 20th the total precipitation already fallen (top graph) was far above the normal amount. How much had already run off is not known. But records indicate that upstream there were similar conditions, except a larger proportion of wet snow. After that date the slope of the actual accumulation curve is less steep than the normal till March 2nd when the early rains began with swiftly rising temperature. The heavy rains of the 13th to 17th then set in.

In the top right-hand corner of the diagram there begins a new accumulation slope on March 15th. The extraordinary departure of this rainfall from the normal and the unusual warmth coincides with the worst period of spates and freshets. The highest peak was apparently that of the 11th to the 19th of March at Galt. It is perhaps correct to suppose that the rains of the 13th to 17th together with the stored amounts loosened by the warm waves of February 25th to March 3rd ran off completely from the icy substructure of the rains frozen prior to January 24th.

The heavy and frequent rains of March and April were probably more than sufficient to tax the capacity of the lower portions of the channel without the load of water shed from the saturated upper portions of the basin.

The history of the winter of 1936-1937 is interesting on account of the severe flood on the south branch of the Thames. It is desirable to review the course of events preceding this flood. The flood of 1937 in the Thames valley will be the only other specific instance which can be dealt with in detail. The only major item of the events preceding this flood which differs noticeably from the sequence associated with many similar occurrences in Southern Ontario was the lag on account of rather steady cold weather during March and the first three weeks of April. November in the Thames region was 4 or 5 deg. below normal with normal precipitation or more.

December was mild, 4 deg. above normal, with rains above normal. January was extraordinarily mild, 8 deg. or more above normal in the upper portion of the basin, with precipitation of 6 to 8 in., mostly rain, over most of the area draining to Lakes Erie and St. Clair. February was also very mild, about 6 deg. above normal, with heavy rains about the 1st, 8th and 14th. There were sharply cold periods of short duration followed or preceded by light snow. March was backward and so was April till about the 20th. On April 21st, after a sharp rise in temperature from about 35 deg. F. to 65 or 70 deg. F., more than an inch of rain fell in about 26 hours. This was followed by northwest and then by northeast winds with near frost for several mornings. On the 24th temperature again rose sharply to about 60 deg. F. or higher and very heavy rain fell.

From November 1st to April 1st about 17 in. had fallen on the Thames basin above London. Most of this had been rain during an abnormally mild December, January, and February. During the long freeze-period of March and part of April it would seem that the soil, saturated to an abnormal depth, had a large content of

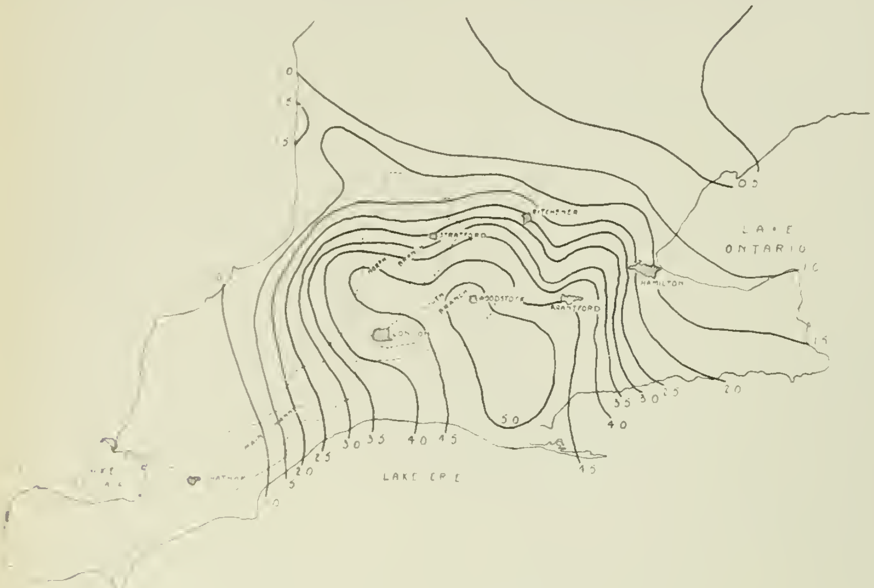

Fig. 10—Rainfall in inches Apr. 24-26th, 1937.

frozen water in the top-layer. After the inch of rain on the 21st, thaw-water added to the rain must have left the soil saturated to the point where the heavy downpour of the 25th and 26th was practically total run-off. Assuming that an inch of rain on the 21st falling on already saturated soil would have totally run off, then a sustained flow of 3,145 cu. ft. per sec. for five days would have been needed to carry all this water past the gauging station near Fanshawe on the north branch of the Thames, and about 2,700 cu. ft. per sec. past the gauge at Ealing on the south branch sustained for the same five days. On the night of the 24th began a rain which exceeded 5 in. over a portion of the south branch and more than 4 in. over the southern half of the north branch. The map in Fig. 10 indicates the distribution of this rain of about 48 hours. On top of the conditions created by the rain of the 21st following upon the abnormal rainfall of the winter, this last rain may without doubt be considered total run-off. To carry this additional rainfall away in five days would have required a sustained flow of 10,950 sec.-ft. at Fanshawe and 13,050 sec.-ft. at Ealing. Since the five-day period postulated for the run-off of the rain of the 21st was not complete when the great rains of the 25th and 26th were falling, our supposition is equivalent to a flow of over 14,000 sec.-ft. at Fanshawe and 15,750 sec.-ft. at Ealing on the 26th. The previous maxima recorded for one day were on March 25th, 1928, at Fanshawe of 12,510 sec.-ft. and on March 23rd, 1926, at Ealing of 9,230 sec.-ft.

A five-day run-off period has been taken for water totally shed from the surface of the basin without any knowledge of the actual gauge-readings of this period. For the most tortuous paths by tributary creeks to the mainstream at Ealing this assumes a mean speed of less than one mile per hour; and for the most direct route from, say, Innerkip to Ealing, about a quarter of a mile per hour. Hydraulic engineers will be familiar with stream-flow in this territory and will be able to amend these suppositions from actual measurements. All that the above considerations indicate is that very heavy rainfall upon already saturated top-soil must result in flood-stages.

1916 shows three peaks of warmth separated by two cold periods. 1917 shows an average early winter, diving steeply in February, then rising rapidly in March and falling again in April. 1918 shows a cool fall going down to a very severe January, then climbing to a warm March. 1920 is of the same character, except the early winter was normal or above normal. 1921 is in a class by itself. As far as departure from normal was concerned, the winter increased in mildness throughout to peak in spring. By comparison there is the winter of 1923. From a warm fall the weather went below normal to a moderate extent and stayed there till April. There was apparently one flood period during the first ten days of April which was about two thirds of the average of the preceding ten years at Belwood, 30 per cent below average at Conestogo, more than 50 per cent below normal on the Conestogo river, and more than 50 per cent below the seventeen-year average at Galt. For most of this year the precipitation was below normal.

The years 1914 and 1915, also devoid of interest, had late floods which were about the smallest on record. Elora had 52 in. of snow the winter of 1913 and 1914 and 4.94 in. of rain from November to March, but the greater part of the rain fell in November. February was very cold and

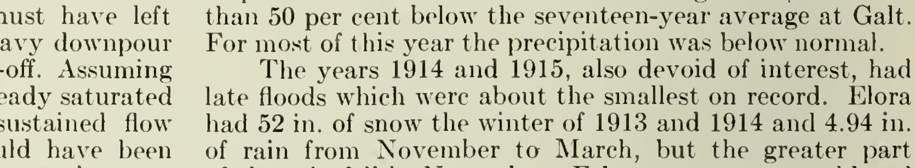

Fig. 11—Precipitation Nov. to Apr. 1936-37.

March about normal. In the winter of 1914-1915, 70 in. of snow fell at Elora and 4 in. of rain. December was cold, February warm, while January and March were about average. April was rather dry with several very cold days.

Summarizing again from the meteorological point of view, it may be said that the occurrence of damaging floods from spring rains appears to be largely dependent not only upon the magnitude of the rainfall but also upon the proportion of the run-off. The run-off ratio is in turn dependent upon the absorptive efficiency of the surface. This efficiency can be reduced to the vanishing point by (*a*) a glazed surface, (*b*) a surface already saturated. Both of these conditions are evidently dependent upon the preceding weather sequences in Southwestern Ontario. These sequences are incidents in large-scale change in the atmospheric circulation of the northern hemisphere.

There are two subsidiary points which have been brought out by the analysis of the figures which are worth mentioning. The first is that although the temperature begins to fall sharply on the highlands of the interior at an earlier date in the autumn than on the lowlands and the lower reaches of the valleys, yet in spring the rise of temperature on the highlands is faster than along the lower reaches of the rivers. The map (Fig. 12) shows the difference in degrees between the drop from autumn to midwinter and the rise from midwinter to spring. The quicker recovery of the highlands is noticeable in respect to both daily maximum and daily minimum temperatures. This will suggest that the disintegration of the top layers of snow during periods of fair weather may be proceeding at a much faster rate than is generally realized. Conversely during such fair weather the lower reaches of the valleys may not be clearing out as fast as is ordinarily taken for granted. A warm spring rain may then act as the trigger to release potentialities whose magnitude is out of proportion to the magnitude of the rainfall.

It will be seen from Fig. 12 that there is an area with a net gain of 10 deg. F. in the average daily maximum between the drop from November 15th to February 15th and the rise from February 15th to April 15th. A slightly greater proportion of this area covers the sources of the north Thames than the sources of the Grand. There is also a greater lagging of the temperature towards the mouth of the Grand than towards the mouth of the Thames.

The net gain of the average daily minimum is much less than that of the maximum but the areal differentiation is similar. It follows that sunny quiet days after the middle of February when the temperature on the highlands rises steeply after 10 a.m. probably have a greater effect on disintegrating the top layers of snow there than down

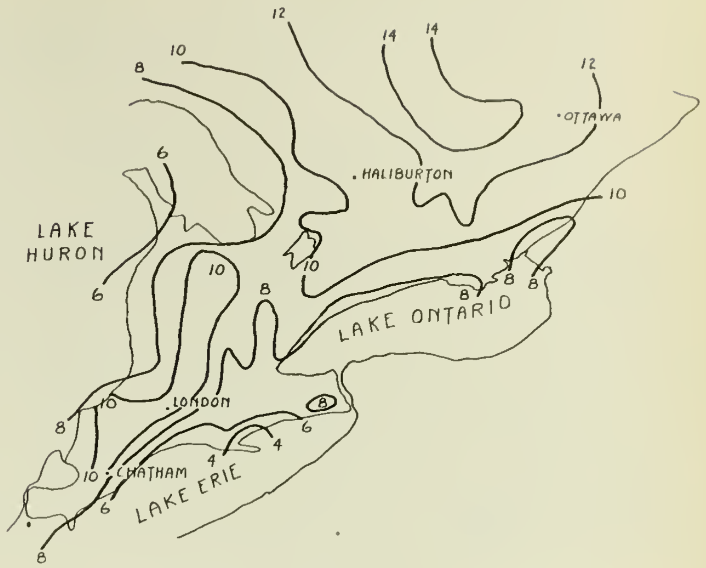

Fig. 12—Net gain Maximum Temperature (Rise in Daily Max. Feb 15th to Apr. 15th Less Fall of Same Nov. 15th to Feb 15th).

valley towards the lake. This point was not stressed when dealing with large floods, since it becomes a minor factor in contrast with the unusual warm waves preceding great floods. In more normal years its relative importance is increased.

The second subsidiary point worthy of mention arises from parallel comparisons of precipitation records in Southwestern Ontario with those of a century at Toronto. There are periods of very heavy precipitation in the Toronto record which have not recurred in the last half-century. These periods are, moreover, seen in the long record at Boston while fragmentary records from the vicinity of the Conestogo river also check very well. Considering the size of the airmasses involved in very wet periods, it is justifiable to suppose that there were much wetter periods in Southwestern Ontario than are shown in the records since 1885. No valid reason can be adduced against their recurrence at some future time.

Surface Run-Off in the Thames and Grand River Basins in Ontario

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Paper presented at the Annual Meeting of The Institute in London, Ont., February 2nd, 1938.

SUMMARY.—The author presents for reference the available records of run-off in the basins of two rivers in Southwestern Ontario, which are liable to extreme variations of flow, and have total drainage areas of 2,250 and 2,610 sq. mi. respectively.

The extremes of high and low flow experienced in the streams of the southwestern peninsula of Ontario in recent years have directed attention to the possibility of alleviating these conditions, particularly in the basins of the Thames and Grand rivers which occupy a large part of this peninsula. In any study of proposed remedial measures a knowledge of the surface run-off is essential. Therefore, it is the purpose in this paper to present for convenient reference a compilation of all run-off records secured in the Thames and Grand river basins.

Thames and Grand River Basins

Thames River Basin

The Thames river with a total drainage basin of approximately 2,250 sq. mi. has its source in the vicinity of Stratford in the county of Perth. Three main branches constitute the upper part of the river. The middle branch joins the south branch a short distance from Ingersoll and the north and south branches unite at the city of London to form the main stream. The river follows generally a southwesterly course and about seventeen miles below the city of Chatham empties into Lake St. Clair. The basin has a total length of about 120 miles and the river a total descent from source to mouth of 625 ft., of which about 200 ft. occurs in the main stream from London to the mouth. The basin has been largely cleared of forest for many years and contains throughout its area some of the most fertile agricultural lands in the province. It is quite thickly populated and the cities of Stratford, Woodstock, London and Chatham and towns of Ingersoll, St. Mary's and Ridgetown are located in the area.

Grand River Basin

The Grand river with a total drainage basin of approximately 2,610 sq. mi. has its source in the northwest part of the county of Dufferin and flows in a general southerly direction to the city of Brantford where it turns to the southeast and enters Lake Erie at Port Maitland. The principal tributaries are the Conestogo, Speed and Nith rivers. The basin has an over-all length of about 110 miles and the river from source to mouth a total descent of about 1,100 ft. Following the course of the river from Belwood bridge, about 142 miles from the mouth, there is a descent of about 469 ft. in the 52 miles from Belwood to the confluence of the Speed river and the Grand near Galt, and about 308 ft. in the remaining distance of 90 miles to the mouth. The Grand basin too has been largely cleared of forest for many years and the lands given over to agriculture. It is one of the most thickly populated areas of Ontario containing such industrial cities as Guelph, Kitchener, Galt, and Brantford, and the towns of Elora, Fergus, Preston, Hespeler, Waterloo, Paris, Caledonia, and Dunnville.

Run-Off Records

The Hydro-Electric Power Commission of Ontario began the systematic collection of run-off records of the Grand river in 1913 and of the Thames river in 1914 and continued until October 1st, 1919, when responsibility for this and other hydrometric work in Ontario was assumed by the Dominion Water Power Branch of the Department of the Interior in accordance with the terms of a co-operative agreement between the Commission and that Department. The work has been continued under this co-operative arrangement, the Dominion Government organization now being known as the Dominion Water and Power Bureau of the Surveys and Engineering Branch, Department of Mines and Resources.

In the Thames river basin daily records of gauge height and discharge commenced on March 13th, 1914, at Kilworth bridge about two miles downstream from the village of Byron. The station was maintained at Kilworth bridge until September 30th, 1922, when it was replaced by a new station about two miles upstream at Byron. Records were secured at Byron until March 1932 when the station was discontinued. The drainage area tributary to the river at Kilworth bridge is estimated at 1,270 sq. mi. and that at Byron at 1,230 sq. mi. In Table I the maximum, minimum, and mean monthly flows and the mean yearly

Table I—Thames River (Main Stream) at Kilworth May 1914-September 1922 and at Byron October 1922-September 1931.
Maximum, minimum and mean monthly discharge and mean yearly discharge in second-feet.
Drainage areas—At Kilworth, 1,270 square miles; at Byron, 1,230 square miles.

Year	October			November			December			January			February			March		
	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
1913-14																		
1914-15	470	320	419	2020	260	590	1830	275	755	2680	280	1490	9870	505	3340	3780	1030	1690
1915-16	2060	470	965	4630	336	1340	3000	460	1200	18450	1180	7340	10650	402	1280	16320	460	2660
1916-17	440	75	197	600	55	186	1380	125	690	1530		453	455		60	20030	545	5240
1917-18	1620	55	500	1230	255	505	1280	265	675	1260	385	830	4060	20	2040	17550	2020	6440
1918-19	560	55	255	790	395	540	9550	435	1940	5690	412	1270	1970	435	835	16860	1020	3770
1919-20	660	154	250	4130	330	580	3380	235	545	233	210	218	225	219	224	18340	225	4680
1920-21	530	154	243	2540	332	870	4350	705	1800	6420	383	1490	1280	279	510	16740	436	3820
1921-22	1540	185	468	3670	235	925	20520	560	2320	6240	235	915	15080	235	2340	6040	775	2170
1922-23	388	109	257	342	201	249	416	135	232	1870	265	500	354	168	232	9380	306	4340
1923-24	340	230	262	840	245	435	9560	1370	2890	5910	585	1870	1640	433	725	12620	346	3870
1924-25	342	139	198	167	109	141			266	177	103	129	15220	101	2480	16460	715	3670
1925-26	258	103	162	4490	204	1220	4060		680			550			520	23190	645	5020
1926-27	5450	525	1680	14150	1550	4170			835			499			1430	11220	950	4040
1927-28	[illegible]	170	311	6350	185	845			2150			1590			1220	13620		3060
1928-29			760	7440	735	2250			2230			2000			494	26520		6530
1929-30			147			273			177			3530			5360			2370
1930-31	560	60	144			123			202			120			183	14320		2090
Mean			427			660			1150			1460			1370			3850

Year	April			May			June			July			August			September			Year Mean
	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	
1913-14				6200	730	1720	1180	730	715	630	275	482	1420	275	432	2500	365	610	
1914-15	4170	520	1380	880	220	486	685	260	368	2060	260	585	4280	550	1490	3620	305	875	1120
1915-16	9300	1390	3440	11700	970	3330	7160	510	2000	440	75	276	240	85	129	240	75	116	2010
1916-17	10170	700	2740	10370	145	2140	7640	515	2130	8000	185	2670	515	55	290	265	22	143	1420
1917-18	4690	600	1320	1580	395	670	835	145	356	305	22	131	145		45	835	12	402	1158
1918-19	8180	745	2350	11040	745	2810	745	185	422	225	12	91	225	12	69	475	12	106	1210
1919-20	5680	985	1770	1440	195	488	235	154	174	1570	154	351	590	88	200	235	104	147	805
1920-21	14730	705	2660	2800	415	740	640	185	330	9000	100	875	235	140	181	320	140	194	1150
1921-22	16520	730	4310	775	262	505	6850	210	965	485	215	323	457	104	227	740	84	318	1310
1922-23	11980	690	2930	15050	324	1960	2870	189	630	756	150	213	300	162	200	1410	218	419	1020
1923-24	6840	710	2830	7210	575	2080	750	240	404	760	206	315	1430	194	442	358	194	249	1360
1924-25	1220	258	600																
1925-26	16670	1620	5060	2120	314	720	1530	157	348	167	96	115	3360	100	635	5540	200	1240	1360
1926-27	1970	458	840	4460	300	1420	1090	185	409	13360	142	1430	760	154	241	258	130	183	1430
1927-28	5630	615	2110	880	208	431			1010			615			445			177	1170
1928-29	18120	1100	3960	6490	690	1980	690	139	254			175			118			106	1750
1929-30	8520	515	2150	1020	204	487	2070	119	452	236	63	131			92			114	1250
1930-31	7240	383	2340	1900	204	660	399		198			605			344			206	605
Mean			2520			1330			655			550			328			330	1260

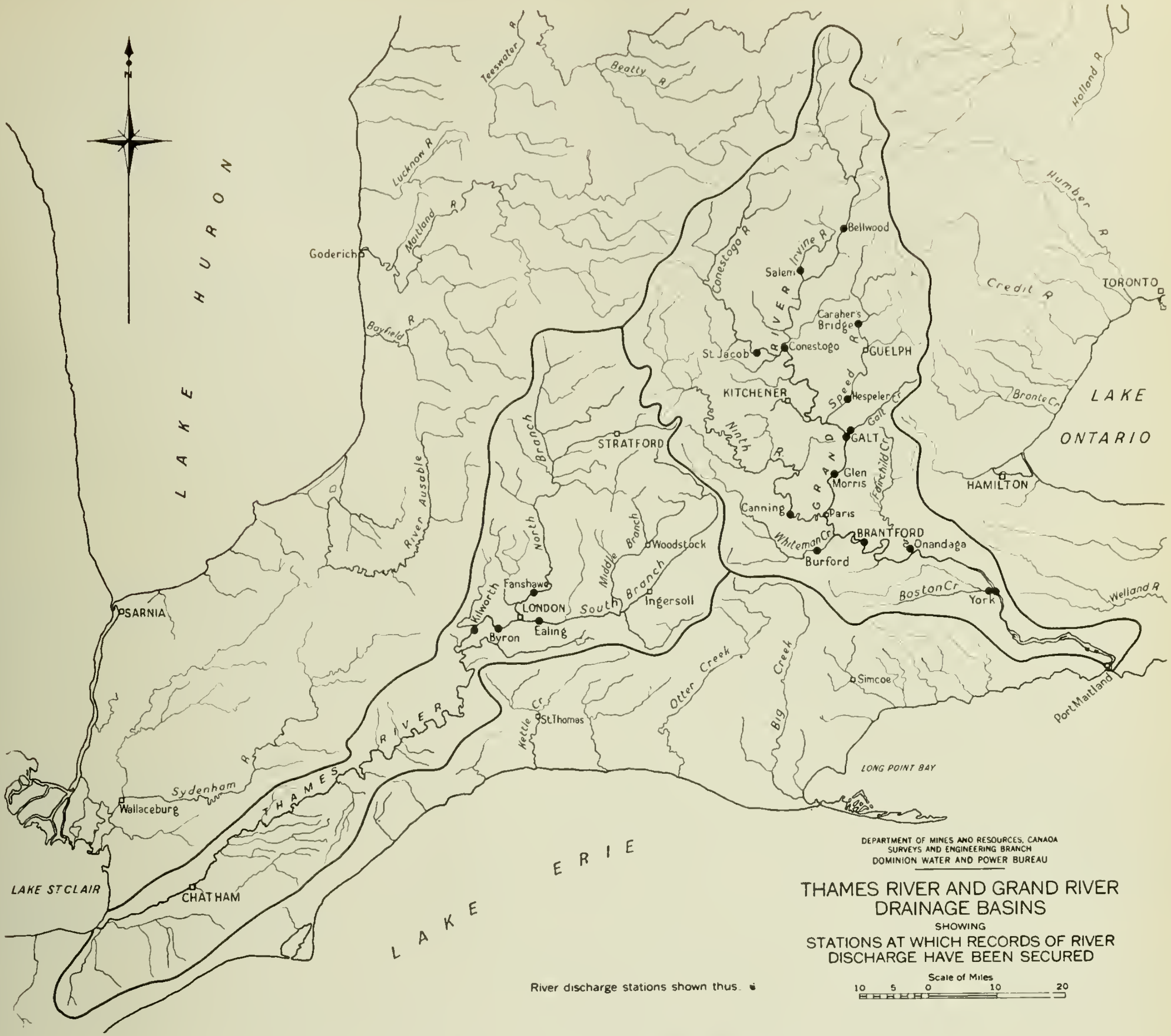

Fig. 1—Thames River and Grand River Drainage Basins.

flows are tabulated for the period of record at Kilworth bridge and Byron.

On the south branch of the Thames, daily records of gauge height and discharge were commenced on May 11th, 1915, at the Vauxhall traffic bridge about three miles above the junction of the south branch with the main stream. These daily records have been continued to the present time. The drainage area tributary to the south branch at Vauxhall bridge is estimated to be 515 sq. mi. Table II lists the maximum, minimum, and mean monthly flows and the mean yearly flows for the period of record.

On the north branch of the Thames daily records of gauge height and discharge were commenced on May 12th, 1915, at the highway bridge near Fanshawe Post Office about six miles above the junction of the north branch with the main stream. With the exception of a break which occurred for the year October 1934 to September 1935, these daily records have been continued to the present time. The drainage area tributary to the north branch at Fanshawe is estimated to be 585 sq. mi. Table III lists the maximum, minimum, and mean monthly flows and the mean yearly flows for the period of record.

In the Grand river basin stations were established in June and July 1913 at six locations on the Grand river and at nine locations on its tributaries. Descriptions of these stations and tabulations of the records secured are given hereunder.

The uppermost station on the Grand river was established at the bridge in the village of Belwood. Daily records of gauge height and discharge commenced on August 1st, 1913, and were continued to September 30th, 1923. The drainage area tributary to the river at Belwood is estimated to be 280 sq. mi. Table IV lists the mean monthly flows and the mean yearly flows at this station for the period of record.

The second station on the Grand was established at the bridge one-quarter mile below the village of Conestogo. Daily records of gauge height and discharge commenced on July 16th, 1913, and were continued to September 30th, 1923. The drainage area tributary to the river at Conestogo is estimated to be 550 sq. mi. Table V lists the mean monthly flows and the mean yearly flows at this station for the period of record.

The third station on the Grand was established at the Concession Street bridge in the city of Galt. Daily records of gauge height and discharge commenced on July 21st, 1913, and have been continued to the present time. The drainage area tributary to the river at Galt is estimated to be 1,360 sq. mi. As this is the key station in the Grand river watershed and has the longest term of record, the maximum, minimum, and mean monthly flows and the mean yearly flows are listed in Table VI for the period of record.

The fourth station on the Grand was established at the bridge in the village of Glenmorris. Daily records of gauge height and discharge commenced on July 22nd, 1913, and were continued to September 30th, 1920. The drainage area tributary to the river at Glenmorris is estimated to be 1,390 sq. mi. Table VII lists the mean monthly and the mean yearly flows at this station for the period of record.

At the fifth station on the Grand located at the Toronto, Hamilton and Buffalo Railway bridge in the city of Brantford, daily records of gauge height and discharge commenced on July 8th, 1913. These records were continued to September 30th, 1922. The drainage area tributary to the river at Brantford is estimated to be 2,000 sq. mi. Table VIII lists the mean monthly and mean yearly flows at this station for the period of record.

Table IV—Grand River at Belwood.
Mean monthly and mean yearly discharge in second-feet.
Drainage area—280 squares miles.

Year:	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Mean
1912-13											5	5	
1913-14	9	54	39	37	52	584	472	96	7	4	5	6	114
1914-15	10	77	130	79	179	937	650	76	21	35	279	391	239
1915-16	225	241	159	1,137	273	520	1,735	288	174	11	4	3	398
1916-17	9	18	100	19	15	1,319	895	193	116	557	18	4	274
1917-18	24	25	13	2	152	1,828	506	100	32	5	4	72	232
1918-19	134	235	607	311	92	954	701	573	63	10	9	9	311
1919-20	17	132	93	16	11	1,320	590	93	185	144	30	10	220
1920-21	36	243	570	359	107	1,430	550	95	57	107	7	6	300
1921-22	54	71	288	109	172	1,170	1,670	70	18	11	5	8	303
1922-23	7	7	7	13	12	483	1,750	690	90	13	14	8	257
Mean	53	110	201	208	106	1,050	950	227	76	90	35	47	264

Table V—Grand River near Conestogo.
Mean monthly and yearly discharge in second-feet.
Drainage area—550 square miles.

Year:	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Mean
1912-13											28	21	
1913-14	46	236	152	187	226	1,025	747	192	45	27	38	59	248
1914-15	49	153	217	98	426	1,443	1,163	167	102	99	765	846	461
1915-16	494	538	312	1,735	411	970	2,694	730	811	76	25	24	735
1916-17	47	53	96	82	40	1,839	1,325	398	260	1,250	93	43	463
1917-18	93	90	168	30	168	2,199	789	158	73	25	28	150	328
1918-19	300	318	854	743	141	2,103	1,121	983	142	25	29	30	571
1919-20	69	248	207	65	52	2,180	1,050	156	210	227	72	44	383
1920-21	95	434	845	645	231	2,280	1,040	368	185	243	77	53	545
1921-22	192	270	625	183	510	1,920	2,250	152	125	83	51	64	535
1922-23	56	64	122	80	52	1,250	2,400	1,130	197	60	32	58	460
Mean	144	240	354	383	226	1,720	1,460	443	215	212	113	127	470

Table II—Thames River (South Branch) near Ealing.
Maximum, minimum and mean monthly discharge and mean yearly discharge in second-feet.
Drainage area—515 square miles.

YEAR	OCTOBER			NOVEMBER			DECEMBER			JANUARY			FEBRUARY			MARCH		
	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
1914-15																		
1915-16	705	196	414	1200	163	468	555	375	565	6540	520	2140	4540	470	719	6330	470	1200
1916-17	267	64	115	227	38	111	239	104	159	605	155	250	380	38	116	4770	352	1430
1917-18	78	60	270	510	176	289	404	104	209	176	55	116	6800	19	995	5130	580	2070
1918-19	270	74	128	227	132	174	1650	162	585	2940	167	535	1350	88	318	5200	314	1200
1919-20	[illegible]	68	166	1410	173	314	925	110	260	110	75	87	95	85	93	7810	100	1560
1920-21	[illegible]	52	136	745	188	348	1620	330	625	2160	209	570	570	120	240	3280	200	1280
1921-22	970	80	274	1520	117	449	6340	220	920	2780	150	457	5510	150	940	2080	340	865
1922-23	[illegible]	75	125	169	112	145	301	92	138	840	139	233	138	70	89	4000	105	1670
1923-24	103	59	79	362	91	145	3540	422	1200			880			342	4720		1660
1924-25	414	71	112	147	67	99	266		148			99	7260		1360	7630	540	1800
1925-26	144	55	89	770	104	343	805		247			246			268	9230		2010
1926-27	1610	298	750	4060	705	1690			396			232			665	3630	362	1610
1927-28	215	86	118	3510	95	437			950			705			575	4060		1010
1928-29	635	86	253	2640	252	720			730			850			245			2220
1929-30	157	60	80	395	90	174			93			1620			2130			1020
1930-31	73	54	64	82	54	67			94			69			113	3800		695
1931-32	107	88	94	545	91	197			555			1630			890			610
1932-33	379	111	191	1220	282	675			855			600			520	3630	317	955
1933-34	111	57	74	367	55	157			281			750			341			1240
1934-35	124	54	94	212	89	146			121			725			530	7390	468	1630
1935-36			62	347	31	170			183			126			260	5340	825	1910
1936-37	75	18	40	335	25	90			202			1960			1380	1640	162	409
MEAN			169			337			433			675			595			1370

YEAR	APRIL			MAY			JUNE			JULY			AUGUST			SEPTEMBER			YEAR MEAN
	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	
1914-15							287	68	180	565	60	200	1420	234	578	1530	162	433	
1915-16	2690	520	1230	3120	455	1210	3170	280	935	246	72	145	105	55	124	148	50	72	770
1916-17	3460	396	1080	2450	215	705	3560	307	990	4560	215	1200	321	116	166	191	60	115	545
1917-18	1030	221	453	780	101	246	306	28	115	101	7	37	60	2	26	359	28	161	413
1918-19	2720	300	900	3220	308	1080	320	66	159	100	40	67	90	32	63	239	32	77	443
1919-20	1410	382	660	515	110	228	178	63	113	675	80	165	500	48	138	100	48	71	322
1920-21	5360	329	1050	1060	160	346	269	97	146	6220	67	550	368	67	115	200	85	121	462
1921-22	583	322	1640	402	125	236	2400	105	442	297	83	146	325	70	134	565	58	213	555
1922-23	4590	260	1060	2460	178	487	448	95	195	343	51	110	133	37	69	440	62	141	374
1923-24	2670	382	1120	3500	282	915	426	138	258	263	76	154	730	61	213	207	58	105	600
1924-25	630	182	348	200	84	131	91	45	61	84	45	57	135	45	75	116	42	74	358
1925-26	6770	500	1810	805	135	292	510	93	153	109	40	62	790	58	228	2960	91	540	525
1926-27	1120	302	494	1690	186	635	422	107	218	4270	74	575	318	80	123	114	64	86	620
1927-28	2470	297	860	580	127	241	2260	109	545	760	120	243	685	86	173	120	80	96	496
1928-29	5520	455	1570	2420	262	750	375	90	161	132	90	105	90	60	79	77	53	67	650
1929-30	2540	230	750	477	120	239	710	90	183	116	50	71	65	50	55	91	50	63	530
1930-31	1370	146	615	560	101	239	317	57	106	720	57	182	122	82	100	243	73	107	205
1931-32	1550	203	780	2450	188	670	1070	97	299	367	97	199	310	79	165	570	82	184	525
1932-33	3750	282	1380	355	111	234	134	62	90	118	57	78	107	57	77	88	57	67	477
1933-34	4260	407	1690	435	134	208	134	62	84	122	50	83	101	73	86	218	82	130	427
1934-35	427	102	222	455	77	250			163			69			66			56	340
1935-36	1530	315	750	725	45	256	247	10	64	51	10	22	45	15	26	45	10	32	322
1936-37	22160	307	2710	1830	285	565	550	102	285	190	41	86	365	36	124	297	43	102	655
MEAN			1050			462			258			200			131			135	482

Table III—Thames River (North Branch) near Fanshawe.
Maximum, minimum and mean monthly discharge and mean yearly discharge in second-feet.
Drainage area—585 square miles.

YEAR	OCTOBER			NOVEMBER			DECEMBER			JANUARY			FEBRUARY			MARCH		
	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
1914-15																		
1915-16	542	135	311	2550	60	684	1360	380	864	10840	1100	3540	940	400	540	6270	244	1080
1916-17	58	14	32	279	18	60	279	24	136	1210	48	335	135	44	76	11840	91	2120
1917-18	450	29	101	279	22	145	346	101	162	132	33	74	410	32	149	7530	263	2210
1918-19	36	23	28	246	29	64	6870	49	1080	3340	190	605	1530	100	362	3010	440	1130
1919-20	340	34	81	3560	133	355	1100	84	265	76	52	59	61	58	61	6000	61	1480
1920-21	180	34	83	1530	126	487	3910	405	1050	3450	208	745	286	204	249	5330	348	1750
1921-22	580	47	178	1770	70	419	8900	166	1140	3300	86	362	9420	98	1090	3740	358	1200
1922-23	101	25	60	123	41	73	129	56	75	505	87	151	87	64	72	6360	98	2310
1923-24	99	31	52	433	86	163	4230	498	1370			940			327	6390		1970
1924-25	76	28	40	78	21	40			94			17	5520		940	11050	244	1790
1925-26	115	22	43	3150	58	60	3020		386			245			224	9170		2200
1926-27	3300	157	730	10230		2000			360			203			705	7300	222	2050
1927-28	87	33	52	3960	34	376	2240		960			715			580	12510		2010
1928-29	1950	60	152	5290	331	1260			1240			950			222			3360
1929-30	68	30	39	144	39	66			53			1440			2760			870
1930-31	67	21	44	41	11	30			97			35			59	9240		1130
1931-32	99	45	71	2720	80	510			880			1590			945			770
1932-33	770	104	211	2250	339	925			1100			570			470	2830	221	895
1933-34	102	34	48			194			390			745			223			1250
1934-35																		
1935-36			41	1930	56	500			310			161			198	6220	890	2470
1936-37	91	26	51	443	47	119			665			1680			1060	1210	125	333
MEAN			126			406			605			720			540			1640

YEAR	APRIL			MAY			JUNE			JULY			AUGUST			SEPTEMBER			YEAR MEAN
	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	
1914-15							227	35	80	1015	25	133	2230	135	615	1245	91	243	
1915-16	4000	605	1790	2350	330	920	3300	360	925	412	28	126	37	16	23	30	14	20	900
1916-17	3300	263	980	1330	123	444	1600	138	472	1350	83	1100	87	26	46	83	15	36	491
1917-18	2140	73	520	279	26	68	262	22	54	25	21	22	25	20	22	262	26	69	314
1918-19	4760	260	1210	5880	272	1210	221	33	113	59	11	26	65	13	28	98	2	26	515
1919-20	2800	259	715	471	46	149	81	38	53	810	46	136	118	30	48	65	26	42	288
1920-21	6930	307	1170	1140	113	306	197	42	92	720	28	128	58	24	38	42	28	34	515
1921-22	7250	310	2150	245	55	146	3250	36	436	164	27	62	174	16	51	565	12	117	606
1922-23	6430	301	1590	7390	115	1050	2200	56	390	380	16	62	78	18	38	930	32	128	500
1923-24	5560	269	1450	3850	230	990	274	77	130	337	38	80	456	29	90	89	19	44	635
1924-25	625	93	243	97	43	70	66	21	38	40	14	27	42	13	26	60	9	29	276
1925-26	11890	630	2410	810	53	229	585	40	98	43	18	26	2940	32	319	2690	60	471	610
1926-27	650	157	265	2510	75	575	466	62	158	7950	37	755	292	32	77	71	28	44	660
1927-28	2710	235	900	311	71	144	2540	53	313	1580	87	286	900	58	197	76	34	55	550
1928-29	9650	294	1680	3620	198	835	178	58	94	90	43	61	53	27	38	37	27	32	850
1929-30	4340	248	1030	615	115	256	755	60	191	143	28	65	59	6	27	69	23	45	555
1930-31	5170	188	1310	880	92	303	161	46	79	1260	51	288	1370	28	205	111	25	65	305
1931-32	2250	157	975	2130	93	459	360	57	127	246	49	107	392	35	95	1010	52	166	555
1932-33	7460	202	1620	1450	122	331	146	58	90	65	37	47	85	34	46	63	31	43	530
1933-34	10950	272	1940	197	46	79	70	36	44	53	33	41	39	25	33	50	30	39	419
1934-35																			
1935-36	2600	344	1010	2730	56	376	2280	23	231	33	10	16	25	7	10	46	12	21	447
1936-37	20570	360	2920	1440	203	465	477	86	179	191	21	56	239	16	49	165	27	57	630
MEAN			1330			448			199			166			96			84	530

TABLE VI—GRAND RIVER AT GALT.
Maximum, minimum and mean monthly discharge and mean yearly discharge in second-feet.
Drainage area—1,360 square miles.

YEAR	OCTOBER			NOVEMBER			DECEMBER			JANUARY			FEBRUARY			MARCH		
	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
1912-13																		
1913-14	395	95	243	2710	204	685	485	220	326	2880	169	422	2250	140	445	11700	215	2430
1914-15	272	91	185	1025	180	402	1670	202	460	610	216	334	2890	296	770	5550	780	2180
1915-16	2630	325	980	3950	325	1040	1890	223	645	13710	515	3030	9250	186	955	19700	247	2170
1916-17	460	146	231	400	182	253	530	198	337	680	242	386	420	226	305	25390	450	4500
1917-18	660	203	369	750	203	355	510	182	284	373	131	250	9520	161	2150	21710	760	5760
1918-19	1450	238	485	1530	330	685	10600	413	1920	2040	413	710	695	286	431	30090	845	4990
1919-20	570	99	205	5760	183	580	3020	270	540	270	242	261	240	225	232	20150	235	4740
1920-21	750	162	329	2220	365	895	6480	585	1680	3610	315	1310	1590	288	500	17030	375	4520
1921-22	2400	187	625	4180	292	800	10260	283	1310	835	190	386	4390	287	890	14010	820	4070
1922-23	337	134	211	283	186	258	425	187	263	192	170	188	208	141	158	8560	225	2500
1923-24	350	110	245	530	178	310	5330	224	1220	2800	396	1010	590	345	454	10800	340	2380
1924-25	1250	121	304	335	109	183	580	124	269			155	6280		1400	16660	1020	4870
1925-26	910	109	296	7250	424	2110	4010	305	655	875	290	458	935	244	391	8840	305	2350
1926-27	3040	440	1230	13010	1470	3900	1760		770			441			455	20610		5280
1927-28	496	177	296	2820	160	590	2860		1360			1040			665	26750		4120
1928-29	2090	157	755	6830	675	1970			2070			1430			610	26850		6430
1929-30	545	73	182	1040		410			273			2050			3160	3930	1420	2200
1930-31	174	87	117	181	90	133			195			126			136	4280		645
1931-32	188	100	147	2340	167	760	12400		2170	18300		3420	23120		2400	8450		1940
1932-33	1860	346	540	5620	625	2200			2100			1210			775			1590
1933-34	170	71	115	985	80	212			680			965			310			2820
1934-35	184	63	114	445	115	266	409	83	167			590			455	18630		3530
1935-36	136	65	98	1870	127	580			390			201			313	13150	810	3380
1936-37	364	151	224	1490	112	307			1150			4230			3180	1180	267	595
MEAN			355			830			885			1020			900			1360

YEAR	APRIL			MAY			JUNE			JULY			AUGUST			SEPTEMBER			YEAR MEAN
	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	
1912-13													340	90	154	215	80	129	
1913-14	9050	765	1830	1300	239	530	300	105	236	265	71	178	432	55	174	490	85	215	645
1914-15	8930	635	2210	800	194	436	900	134	272	945	146	359	4370	194	1360	8790	350	1730	890
1915-16	15080	1400	4730	4740	950	700	3340	613	2050	530	148	256	154	104	134	190	92	126	1410
1916-17	10620	820	2630	3070	315	1060	2520	400	910	10450	276	2490	655	190	291	248	144	205	1138
1917-18	9570	555	1870	1130	301	487	530	175	273	264	69	162	210	65	135	1530	161	530	1047
1918-19	9780	685	2290	9040	580	2240	1360	161	374	182	56	114	203	61	120	301	74	140	1220
1919-20	7840	765	2210	1280	288	472	1060	111	418	1690	162	425	415	148	232	253	81	158	875
1920-21	8560	765	2210	5600	333	1130	1570	155	496	3200	173	590	440	111	226	225	90	153	1180
1921-22	23850	885	5360	920	269	615	2060	193	500	455	155	238	380	75	203	770	87	271	1270
1922-23	17400	735	4610	12700	456	2540	1410	261	610	390	86	197	189	77	136	412	178	260	1000
1923-24	16120	800	4270	7880	745	2810	905	269	520	473	196	314	560	160	317	402	139	207	1180
1924-25	2200	530	1100	485	109	300	157	52	87	195	49	99	203	49	119	330	55	143	750
1925-26	14520	2040	7250	4430	515	1280	2200	181	535	170	103	132	5760	95	815	2460	267	750	1410
1926-27	4320	755	1500	5310	500	1530	3810	435	960	6190	151	1030	462	127	223	207	133	168	1460
1927-28	15470	1090	4120	1310	402	680	840	239	510	4010	157	650	1860	136	493	500	106	207	1230
1928-29	29720	1040	5280	5130	825	1640	735	223	383	880	142	319	211	98	142	127	63	95	1790
1929-30	11350	720	4030	5290	414	1260	427	167	298	307	85	178	177	57	93	151	65	104	1170
1930-31	6630	525	3060	1440	259	565	423	148	229	795	142	310	239	100	155	303	69	141	483
1931-32	11100	540	3490	1840	500	910	1930	130	424	465	161	275	2030	157	388	8020	139	945	1430
1932-33	15470	795	5090	4160	414	955	970	103	298	195	41	107	151	52	83	136	38	68	1250
1933-34	15160	980	5440	875	203	486	291	92	146	133	41	80	90	38	61	142	29	99	950
1934-35	940	367	525	1410	369	630	11480	239	1400	1260	148	350	148	36	86	87	44	68	685
1935-36		590	2030	2640	170	650	2380	67	415	97	38	55	77	26	47	188	39	91	740
1936-37	[illegible]	[illegible]	[illegible]	4000	595	1210	520	139	308	423	77	152	409	69	162	207	80	146	1310
MEAN			3330			1050			525			377			254			286	1100

TABLE VII—GRAND RIVER AT GLEN MORRIS.
Mean monthly and mean yearly discharge in second-feet.
Drainage area—1,390 square miles.

Year:	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Mean
1912-13											249	189	
1913-14	274	916	264	416	621	3,797	2,151	741	217	143	158	212	826
1914-15	180	559	490	423	832		7,313	531	378	416	1,927	1,980	
1915-16	1,010	1,602	726	3,305	1,504	2,315	5,312	2,245	2,463	489	347	336	1,805
1916-17	453	253	607	471	292	5,407	3,164	1,274	1,077	3,426	328	196	1,424
1917-18	396	406	443	484	2,235	6,284	2,196	657	282	135	130	635	1,185
1918-19	505	886	2,139	620	367	5,471	2,667	2,439	445	157	158	173	1,347
1919-20	365	730	670	272	241	5,530	2,630	615	535	550	323	207	1,060
Mean	455	765	765	855	870	4,800	2,920	1,210	770	760	453	491	1,260

TABLE VIII—GRAND RIVER AT BRANTFORD.
Mean monthly and mean yearly discharge in second-feet.
Drainage area—2,000 square miles.

Year:	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Mean
1912-13											408	330	
1913-14	516	1,426	707	904	1,760	4,015	3,097	998	485	240	211	341	1,222
1914-15	342	626	834	667	1,672	3,899	3,419	882	721	679	2,359	2,214	1,526
1915-16	1,508	1,645	1,138	6,337	1,918	3,069	6,419	3,284	3,387	633	441	295	2,506
1916-17	498	573	663	799	645	6,550	4,324	1,835	1,788	4,820	487	290	1,951
1917-18	535	639	563	265	5,628	13,895	2,932	860	504	230	197	1,002	2,254
1918-19	857	1,266	3,168	982	657	6,612	3,698	3,898	819	373	352	394	1,938
1919-20	452	895	1,010	417	388	7,301	3,270	765	590	535	392	318	1,375
1920-21	482	1,450	2,740	2,130	930	6,760	3,590	1,830	1,000	1,110	560	404	1,930
1921-22	1,020	1,320	2,050	730	2,190	5,680	7,820	790	990	479	429	473	1,990
Mean	690	1,090	1,430	1,470	1,750	6,420	4,280	1,680	1,140	1,020	585	605	1,850

TABLE IX—GRAND RIVER AT YORK.
Mean monthly and mean yearly discharge in second-feet.
Drainage area—2,280 square miles.

Year:	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Mean
1912-13										477	350	327	
1913-14	419	1,754	913	1,015	1,652	5,848	3,266	1,255	587	350	314	449	1,485
1914-15	375	783	976	788	1,928	3,805	4,050	838	554	545	2,694	2,347	1,640
1915-16	1,658	1,669	1,815	7,565	3,167	4,430	8,369	3,972	4,056	689	373	324	3,174
1916-17	550	640	1,046	832	501	7,080	4,756	2,175	2,331	4,681	750	464	2,166
1917-18	777	859	852	364	4,987	12,958	3,189	1,118	714	432	371	1,106	2,298
1918-19	883	1,301	2,890	2,318	1,084	6,787	3,339	4,765	864	461	401	387	2,139
1919-20	545	880	2,190	491	443	7,920	3,800	1,080	910	1,340	585	397	1,730
1920-21	545	1,480	3,120	2,460	1,160	7,640	4,770	1,940	1,060	1,190	530	491	2,210
1921-22	1,100	1,450	2,340	8,880	2,630	6,820	9,030	960	1,430	520	464	940	2,370
1922-23	457	451	605	720	555	4,770	5,810	3,680	1,080	424	357	479	1,620
Mean	730	1,130	1,670	1,740	1,810	6,800	5,020	2,150	1,350	1,010	655	700	2,060

TABLE X—IRVINE RIVER NEAR SALEM.
Mean monthly and mean yearly discharge in second-feet.
Drainage area—67 square miles.

Year:	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Mean
1913-14		26	12	24	41	195	88	10	1	1	1	2	
1914-15	1	18	17	30	90	189	176	23	9	27	239	193	84
1915-16	86	54	15	461	50	297	560	86	213	6	2		
Mean	29	33	15	172	60	227	275	40	74	11	81	97	93

At the sixth station on the Grand located at the highway bridge in the village of York, daily records of gauge height and discharge commenced on July 1st, 1913, and continued to September 30th, 1923. The drainage area tributary to the river at York is estimated to be 2,280 sq. mi. Table IX lists the mean monthly and mean yearly flows at this station for the period of record.

Records have been secured of the flow of eight tributaries of the Grand river. These are submitted hereunder in the order in which these tributaries enter the main river from source to mouth.

On the Irvine river which enters the Grand at Elora records of daily gauge height and discharge were secured at the highway bridge known as Watt's bridge for the period July 30th, 1913, to August 31st, 1916. The drainage area tributary to Irvine river at this station is estimated to be 67 sq. mi. Table X lists the mean monthly and mean yearly flows for the period of record.

The Conestogo river enters the Grand river at the village of Conestogo. A station was established at the bridge in the village of St. Jacob's and records of daily gauge height and discharge were secured for the period July 16th, 1913, to August 31st, 1916. The drainage area tributary to Conestogo river at this station is estimated to be 305 sq. mi. Table XI lists the mean monthly and mean yearly flows for the period of record.

The Speed river enters the Grand a short distance above the city of Galt. Records were secured at two stations on this river. The upper station was located at Caraher's bridge above the junction of the Speed and Eramosa rivers about four miles from the city of Guelph. Records of daily gauge height and discharge were secured for the period November 1st, 1913, to September 30th, 1917. The drainage area tributary to the Speed at this station is estimated to be 77 sq. mi. Table XII lists the mean monthly and mean yearly flows for the period of record.

The lower station on the Speed was located at a point 100 ft. below the gaol in the town of Hespeler. Records of daily gauge height and discharge were secured for the period November 1st, 1913, to September 30th, 1922, and during the spring freshet period in the years 1923 to 1928 inclusive. The drainage area tributary to the Speed at Hespeler is estimated to be 250 sq. mi. Table XIII lists the mean monthly and mean yearly flows for the period of record.

Galt creek enters the Grand river in the city of Galt. A station was established at Kerr Street bridge in Galt and records of daily gauge height and discharge were secured for the period July 21st, 1913, to August 31st, 1916. The drainage area tributary to Galt creek at this station is estimated to be 45 sq. mi. Table XIV lists the mean monthly and mean yearly flows for the period of record.

The Nith river enters the Grand at the town of Paris. A station was established at the bridge 200 ft. upstream

TABLE XI—CONESTOGO RIVER AT ST. JACOBS.
Mean monthly and mean yearly discharge in second-feet.
Drainage area—305 square miles.

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Mean
1912-13											9	8	
1913-14	22	362	260	174	137	1,491	429	38	4	4	6	7	244
1914-15	6	87	94	56	579	1,437	709	65	18	37	354	548	334
1915-16	229	339	147	1,379	224	732	1,497	234	474	50	5		
Mean	86	263	167	535	313	1,220	878	112	165	30	93	141	334

TABLE XII—SPEED RIVER AT CARAHER'S BRIDGE.
Mean monthly and mean yearly discharge in second-feet.
Drainage area—77 square miles.

Year.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Mean
1913-14		52	24	70	25	26	92	19	2	2	7	23	
1914-15	10	59	37	31	70	137	132	36	27	39	138	121	70
1915-16	67	66	39	196	124	283	295	146	116	17	7	5	113
1916-17	41	19	27	26	39	398	152	73	61	135	11	3	81
Mean	33	49	32	80	64	211	168	68	51	48	41	38	74

TABLE XIII—SPEED RIVER AT HESPELER.
Mean monthly and mean yearly discharge in second-feet.
Drainage area—250 square miles.

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Mean
1913-14		181	120	144	203	406	352	166	103	55	62	82	
1914-15	47	79	77	59	127	284	301	121	104	137	367	426	177
1915-16	219	203	154	500	336	410	906	428	517	121	96	89	332
1916-17	94	105	99	101	98	650	554	279	258	468	117	111	246
1917-18	141	120	62	59	336	997	399	130	96	88	85	144	221
1918-19	113	137	274	163	113	790	419	508	109	82	95	97	243
1919-20	106	152	103	68	64	665	403	118	155	211	121	99	188
1920-21	100	147	204	182	77	615	432	219	165	173	91	67	207
1921-22	159	159	190	89	113	645	955	182	164	116	90	89	247
1922-23							750	381					
1923-24							238	106					
1924-25							720						
1925-26							1,050	245	148				
1926-27							356						
1927-28							625						
Mean	123	140	142	152	163	605	565	240	182	161	125	134	225 (x)

(x) Mean for complete years.

TABLE XIV—GALT CREEK AT GALT.
Mean monthly and mean yearly discharge in second-feet.
Drainage area—45 square miles.

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Mean
1912-13											26	27	
1913-14	37	46	38	38	15	88	46	33	13	9	12	15	33
1914-15	14	29	38	29	44	70	38	20	14	24	58	32	34
1915-16	30	27	23	86	61	64	103	71	55	16	12		
Mean	27	34	33	51	47	74	62	41	27	16	27	25	39

TABLE XV—NITH RIVER NEAR CANNING.
Mean monthly and mean yearly discharge in second-feet.
Drainage area—430 square miles.

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Mean
1912-13										145	140	124	
1913-14	150	442	264	354	326	1,000	542	267	146	88	78	102	315
1914-15	114	246	275	183	606	1,162	607	150	108	119	561	290	368
1915-16	273	417	270	1,239	571		1,148	798	683	131	103	92	
1916-17	124	130	219	182	1,110	1,262	688	481	449	958	140	117	408
1917-18													
1918-19													
1919-20						1,410	610	167	108	108	98	86	
1920-21	123	304	755	510	146	1,220	680	444	248	251	127	104	412
1921-22	244	300	565	204	710	917	1,240	153	277	99	104	135	411
1922-23	94	106	170	146	103	875	945	525	253	73	66	102	289
1923-24							945	615					
1924-25							188	84					
1925-26							1,480	201	102				
Mean	160	282	363	432	367	1,120	825	353	264	219	157	128	388 (x)

(x) Mean for complete years.

TABLE XVI—WHITEMAN'S CREEK NEAR BURFORD.
Mean monthly and mean yearly discharge in second-feet.
Drainage area—154 square miles.

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Mean
1913-14		109	64	77	104	211	240	178	192	35	32	69	
1914-15	36	76	93	94	276	244	135	61	41	39	188	103	115
1915-16	113	117	101	469	267	312	376	271	284	36	25	17	201
Mean	75	101	86	220	216	259	250	170	172	37	82	63	144

TABLE XVII—FAIRCHILD'S CREEK NEAR ONONDAGA.
Mean monthly and mean yearly discharge in second-feet.
Drainage area—115 square miles.

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Mean
1912-13										18	19	15	
1913-14	16	56	25	65	74	286	181	146	23	10	10	13	75
1914-15	12	26	31	21	219	227	57	22	16	12	80	52	66
1915-16	71	52	41	813	208	380	521	268	125	20	13		
Mean	33	45	32	300	174	298	253	145	53	15	30	27	117

TABLE XVIII—BOSTON CREEK NEAR YORK.
Mean monthly and mean yearly discharge in second-feet.
Drainage area—125 square miles.

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Mean
1912-13										14	11	9	
1913-14	14	89	28	82	125	615	247	90	23	10	10	23	113
1914-15	11	26	45	64	256	215	205	40	15	23	78	22	83
1915-16	26	44	56	403	161	240	308	181	234	16	8		
Mean	17	54	41	183	181	357	253	104	91	16	27	28	113

from the Canadian National Railways bridge, one mile from the village of Canning. Records of daily gauge height and discharge were secured for the periods July 5th, 1913, to September 30th, 1917; March 1st, 1920, to September 30th, 1923; March 23rd to May 31st, 1924; March 9th to May 31st, 1925; and April 1st to July 13th, 1926. The drainage area tributary to the Nith at this station is estimated to be 430 sq. mi. Table XV lists the mean monthly and mean yearly flows for the period of record.

Whiteman's creek enters the Grand river between Paris and Brantford. A station was established at the first concrete bridge above its confluence with the Grand and continuous records of daily gauge height and discharge were secured for the period October 15th, 1913, to September 16th, 1916. The drainage area tributary to Whiteman's creek at this station is estimated to be 154 sq. mi. Table XVI lists the mean monthly and mean yearly flows for the period of record.

Fairchild's creek enters the Grand river at the village of Onondaga below Brantford. A station was established at Howell's bridge near Onondaga and daily records of gauge height and discharge were secured for the period July 1st, 1913, to August 31st, 1916. The drainage area tributary to Fairchild's creek at this station is estimated to be 115 sq. mi. Table XVII lists the mean monthly and mean yearly flows for the period of record.

Boston creek enters the Grand river at the village of York. A station was established at the first highway bridge above its confluence with the Grand and was later moved to the second highway bridge known as Anderson's bridge. Records of daily gauge height and discharge were secured for the period July 1st, 1913, to August 31st, 1916. The drainage area tributary to Boston creek at this station is estimated to be 125 sq. mi. Table XVIII lists the mean monthly and mean yearly flows for the period of record.

FLOOD FLOWS

Thames River

An examination of the discharge records secured in the Thames river basin during the past twenty-three years indicates that on the main stream below the junction of the north and south branches, maximum daily flows of less than 10,000 c.f.s. occurred in three of the years; flows of 10,000 to 15,000 c.f.s. in six of the years; flows of 15,000 to 20,000 c.f.s. in nine of the years; flows of 20,000 to 25,000 c.f.s. in three of the years; and flows in excess of 25,000 c.f.s. in two of the years.

The greatest flood in the period of record was experienced in the month of April 1937 when heavy local precipitation occurred on lands previously saturated from the rains and melted snows of a very open winter. The sum of the estimated daily flows of the north and south branches reached a maximum on April 27th with a figure of 38,380 c.f.s. The peaks on the two branches did not synchronize. On the north branch the maximum flow occurred on April 26th with an estimated mean daily discharge of 20,570 c.f.s. and an instantaneous peak of probably 32,000 c.f.s. The south branch reached a maximum on April 27th with an estimated mean daily discharge of 22,160 c.f.s. and an instantaneous peak of probably 25,000 c.f.s. The maximum daily discharge of the north branch indicated a run-off from the tributary drainage of 35 c.f.s. per sq. mi. while on the south branch the corresponding figure was 43 c.f.s. per sq. mi.

Floods on the Thames are of the flashy type, high rates of flow being sustained for relatively brief periods. For example, in the flood of April 1937, the daily flows of the north branch from the 25th to the 30th were as follows: 25th—1,010 c.f.s.; 26th—20,570 c.f.s.; 27th—16,220 c.f.s.; 28th—5,430 c.f.s.; 29th—4,570 c.f.s.; 30th—2,270 c.f.s. Similarly on the south branch the daily flows were: 25th—

2,030 c.f.s.; 26th—11,000 c.f.s.; 27th—22,160 c.f.s.; 28th—8,260 c.f.s.; 29th—5,510 c.f.s.; 30th—3,050 c.f.s.

The maximum flow of the year is usually experienced in the months of March or April, but the records indicate that in addition to these months high flows may be looked for in the months of January, February, May, November and December.

Grand River

During the twenty-four years in which discharge records have been secured of the Grand river at Galt, maximum daily flows of less than 10,000 c.f.s. occurred in two of the years; flows of 10,000-15,000 c.f.s. in five of the years; flows of 15,000-20,000 c.f.s. in eight of the years; flows of 20,000-25,000 c.f.s. in five of the years; flows of 25,000-30,000 c.f.s. in three of the years; and flows in excess of 30,000 c.f.s. for one of the years.

The greatest flood in the period of record was experienced on March 18th, 1919, when a daily flow of 30,090 c.f.s. was recorded, indicating a run-off from the tributary drainage of 22 c.f.s. per sq. mi. A flood of almost as great a magnitude occurred on April 6th, 1929, when a daily flow of 29,720 c.f.s. was recorded.

As in the Thames river basin the floods on the Grand are of the flashy type. For example, in the flood of 1919 the daily flows for the period March 16th-20th were as follows: 16th—3,440 c.f.s.; 17th—13,560 c.f.s.; 18th—30,090 c.f.s.; 19th—10,370 c.f.s.; 20th—8,840 c.f.s.

The maximum flow of the year is usually experienced in the months of March or April. In the period of record it has occurred in March for twelve of the years, in April for eleven of the years, and in February in one year. In addition to the months of March and April when flood flows are normally experienced the records indicate that high flows may be looked for in the months of January, February, May, November and December.

Low Flows

Thames River

The records which have been secured of the north and south branches of the Thames and also of the main stream indicate that this river ordinarily reaches its lowest flow in the late summer or early autumn. On the north branch September is normally the lowest month, the next in order being August, October, July and June. On the south branch August shows the lowest mean flow, the next in order being September, October, July and June.

The most pronounced period of low flow was recorded in 1936, July to October inclusive. The month of August showed a combined mean flow in the north and south branches of 36 c.f.s. indicating a run-off from the tributary drainage of 0.033 c.f.s. per sq. mi. During the three months July, August and September the mean flow was 42 c.f.s. while for the four months July to October it was 54 c.f.s. Other years of low flow in the summer and autumn period were 1918, 1919, 1925, 1929, 1930, 1933, 1934 and 1935.

The lowest yearly mean flow was recorded in the climatic year October 1st, 1930-September 30th, 1931, with a figure of 510 c.f.s. as the combined flow of the north and south branches and 605 c.f.s. on the main stream at Byron. Other low years were 1919-20 with 610 c.f.s. on the two branches; 1924-25 with 634 c.f.s.; 1917-18 with 727 c.f.s.; 1935-36 with 769 c.f.s.; 1933-34 with 846 c.f.s.; 1922-23 with 874 c.f.s.; and 1934-35 in which 340 c.f.s. was recorded on the south branch, records of the north branch being missing in this year.

Grand River

The records which have been secured of the Grand river indicate that it ordinarily reaches its lowest flow in the late summer or early autumn. August is normally the lowest month, the next in order being September, October, July and June.

The most pronounced periods of low flow were recorded in the consecutive years 1933, 1934, 1935, and 1936. August of 1936 produced the lowest mean monthly flow of 47 c.f.s. indicating a run-off from the tributary drainage of 0.035 c.f.s. per sq. mi., and the lowest daily flow of 26 c.f.s. In the three months of July, August and September of 1936 the mean flow was only 64 c.f.s. During August, September and October of 1935 the mean flow was 73 c.f.s. During July, August and September 1934 the mean flow was 80 c.f.s. and during July, August and September of 1933 the mean flow was 86 c.f.s.

The lowest yearly mean flow was recorded in the climatic year October 1st, 1930-September 30th, 1931, with a figure of 483 c.f.s. Other low years were 1913-14 with 645 c.f.s.; 1934-35 with 685 c.f.s.; 1935-36 with 740 c.f.s.; 1924-25 with 750 c.f.s.; 1919-20 with 875 c.f.s.; 1914-15 with 890 c.f.s.; and 1933-34 with 950 c.f.s.

Agricultural Drainage in Southwestern Ontario

Its Effect on Stream Discharge

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Paper presented at the Annual Meeting of The Institute in London, Ont., February 2nd, 1938.

SUMMARY.—After describing briefly the larger drainage schemes in Southwestern Ontario and outlining the legal questions connected with such undertakings, the author concludes that there is little or no indication of increasing flood discharge, subsequent to the active period of drainage construction in the area discussed.

When a flood of unusual magnitude and destructiveness occurs, such as that of the Thames in late April 1937, interest is aroused not only as to what measures can be taken to prevent recurrence of flood damages, but also as to whether the flood is wholly due to the forces of nature or, in part, to the works of men and corporations, for which they may be held responsible. Our present discussion is confined to the nature and extent of agricultural drainage in Southwestern Ontario and its effects, if any, on stream discharge.

Drainage does not include the cutting down of forests, clearing the land, cultivating the soil, removing obstructions to the flow of surface water, or any of the other operations that may properly be done in the course of good husbandry. All these may be done without incurring any liability for increased flow of water and resulting damage to lower lands. It does consist in the construction of artificial channels, whether covered or open, other than mere plough furrows, and it also comprises operations of embanking and pumping. The purpose of drainage is not so much to expedite the flow of surplus water as to lower its surface and carry it off below ground level. Where flat lands have no swales or natural depressions, the effect of ditches is to collect surface water and confine the flow in definite channels, instead of allowing it to pass over the surface of the ground. Where valleys are subject to flooding between the high banks, the construction of ditches or the improvement of the natural watercourses lowers the level of the flood waters and increases the velocity of flow, but diminishes the sectional area.

The smallest drains, and the most numerous, are private ditches or tile drains constructed by individual owners on their own lands. Two Ontario statutes facilitate the construction of drains affecting the lands of more than a single owner. The Ditches and Watercourses Act enables an individual requiring drainage for his land, but affecting the lands of others, to initiate and carry out proceedings for drainage work, with certain limitations. The work may not pass through or into more than seven original township lots; the cost may not exceed $2,500; owners of lands more than one hundred and fifty rods from the drain may not be made liable for its construction; land owners are individually liable for the construction and maintenance of specified portions of the work, and the work as a whole must be continued to a sufficient outlet.

The Municipal Drainage Act aims at drainage for a community rather than for the individual. The basis of all proceedings is the petition of a majority of owners whose lands are to be benefited. The work is undertaken and carried out under by-law, and no limits are fixed as to the area assessable or the magnitude or cost of the work, save only that the benefits to be derived must be commensurate with the cost. When once a drain has been constructed under this Act, it may subsequently be improved and extended without a further petition. This provision is intended to enable a municipality to remedy any defect or insufficiency in the original work and to extend it to a sufficient outlet, instead of being continually liable for damages to low-lying lands along or below the termination of the work. The Municipal Drainage Act is greatly preferred in Southwestern Ontario to the Ditches and Watercourses Act because of its greater flexibility and freedom from limitations. In Central and Eastern Ontario, where municipal councils are not so familiar with drainage procedure, more use is made of the Ditches and Watercourses Act.

Large Drainage Schemes

Municipal drains, as they are called, may be very small drains serving areas of only a few acres, or they may be trunk channels providing outlets for areas extending into the hundreds of square miles. Where a trunk channel costs over $10,000, aid to the extent of twenty per centum of the cost of the work may be granted by the Province.

A trunk outlet drain for one of these large areas may be fed either by a complete system of tributary drains, or almost wholly by natural watercourses. The Raleigh Plains drain in the county of Kent, for instance, receives scores, or possibly hundreds, of smaller drains from the surrounding higher lands. Of the total area of a hundred and fifty square miles it is safe to say that almost every acre is artificially drained. The main channel is constructed through the level plains that comprise about a fourth of the area, and the outlet is into the River Thames not far from its mouth. If it be taken for granted that the surplus water from the whole area reaches the river more rapidly through this system of drains than it otherwise would, the effect on the river floods is beneficial rather than detrimental, as the waters from this area have reached Lake St. Clair well in advance of the flood waters from the upper part of the river.

The so-called Canada Company drain in the county of Lambton differs from the Raleigh Plains drain in that it

Fig. 1—Raleigh Plains Drain at No. 2 Highway (Dec. 1937).

was constructed for the local purpose of reclaiming, or relieving the flooding of, some 17,000 acres known as the drowned lands, rather than to provide an outlet for tributary drains. The drain is in reality a shortening of the course of the River Aux Sables, the new channel four miles in length cutting off a twenty mile loop by way of Grand Bend. The area draining to the cut, or canal as it is sometimes called, is 500 sq. mi., and the discharge capacity is one-third of an inch of run-off in twenty-four hours. The outlet is into the original course of the river not far from Lake Huron. There are no agricultural lands to be damaged between the outlet end of the cut and the lake, but some complaint has been made of erosion and change of the river banks at the summer resort and fishing village of Port Franks. It has not been definitely determined or admitted that damage is directly due to the drainage work.

Fig. 2—Canada Company Drain at Blue Water Highway (1924).

The effect of channel shortening by cutting off a long loop is to lower the water surface throughout the length of the new cut, and for some distance above, without detriment to the stream or the lands further down, provided the supply of water from upstream is a steady flow, but if the flow from above is increasing in volume, the cut-off causes greater flooding than before on the downstream section.

While 500 sq. mi. is about the limit of area for which a trunk drainage channel has been provided, either by original construction or by improvement of a natural watercourse, schemes of greater magnitude have been mooted. The county council of Simcoe and the Provincial Government of Ontario investigated the possibility of improving the Nottawasaga river near its mouth to reclaim 16,000 acres of swamp lands in the townships of Vespra and Sunnidale. The tributary area is 1,000 sq. mi., and the cost of providing a trunk channel twenty miles in length, with capacity of one-fifth of an inch run-off in twenty-four hours, was estimated at $860,000, more than fifty dollars for each acre of swamp land to be benefited. The cost was not considered warranted by any possible results.

The records of the smaller streams, having drainage areas of 100 sq. mi. or less, indicate generally a run-off in the annual floods of a half-inch in twenty-four hours. An occasional record, and some actual gaugings by the author, have shown as high as one inch. Drainage designed for areas of only a few thousand acres usually provides for from one inch to two inches, according to circumstances and the damage that might arise from incomplete drainage.

Legal Responsibility

Any persons or corporations collecting water and causing it by artificial means to flow upon lower lands are liable in common law for resulting damages. The only exception is in favour of riparian owners, who have the right to make reasonable use of natural watercourses through or adjoining their own lands. This use, which may be made without incurring liability to owners downstream, includes the construction of drains and the straightening or otherwise improving of the watercourse. "And what one riparian proprietor may do, several in combination may do with or without an award."

Under the drainage laws of Ontario, proceedings may be taken to construct proper and sufficient outlets for all drains, and land owners may be assessed for the value of outlets so provided for their drains, or, in the alternative, may be assessed for relief from injuring liability. A sufficient outlet is defined as the safe discharge of water where it will do no injury to lands or roads, and a great deal of litigation has arisen in the past over the interpretation of this definition. In one case an engineer's award providing for the drainage of a small area was set aside by the court on the rather technical ground that the river into which the outlet would be made was already subject to overflow, and that the outlet was therefore not sufficient. A more liberal finding in another case and in another court was that a strict interpretation of the drainage laws would put a stop to all drainage work in the Province, and that in theory there was no such thing as a sufficient outlet short of Niagara Falls or the Gulf of St. Lawrence. The courts generally are inclined to be more practical than theoretical in determining the sufficiency of an outlet, and to hold that a drainage work intended to serve only a small area, and not materially increasing flooding upon lower lands, should not be prohibited on technical or theoretical grounds.

The largest complete drainage systems in the Province have grown from the branches rather than from the trunk. The construction of many small drains leads to a demand for an outlet common to, and sufficient for, all the tributaries. The growth of these drainage systems has in general been the result of damage claims, or actions at law, brought by the owners of low-lying lands to compel municipalities and owners of higher lands to continue the drainage works to or towards a sufficient outlet. The complaint of the lower land owner has always been that

Fig. 3 Excavating the Canada Company Drain through the Sand Hills (1924).

the construction of drains upstream has brought water to his land in greater volume and with greater speed than it came naturally. This kind of claim has not been seriously or successfully challenged. Any required number of cases might be cited, but we shall mention only one by way of illustration. A section of the Nottawasaga river in the township of Tecumseh had been artificially improved under the Municipal Drainage Act on petition of owners of lands along the river and on tributary drains. Shortly after completion of the river improvements, a mill dam a mile downstream from the termination of the work was partly washed out by a flood, and the owner recovered damages from the township responsible for the drainage work. The drainage area was 300 sq. mi., and the flood run-off was slightly over an inch in twenty-four hours. This case is typical in one respect of all the suits for damages arising from the construction of drains, in that the damages were sustained within a relatively short distance from the drainage work.

The impossibility of complying strictly with the requirements of the drainage laws as to sufficiency of outlet brought about amendments to the Municipal Drainage Act by which compensation may be determined and paid to owners of low-lying lands instead of continuing drainage works to sufficient outlets. A more recent amendment provides that any drainage scheme may be appealed against on the ground that the benefits to be derived are not commensurate with the estimated cost. As a result of these amendments it is no longer necessary, as it was in the past, to construct outlets costing several times as much as the amount of the damages to be prevented.

Very recently the compensation provision of the Act was applied on a rather extensive scale. The flats of the Maitland river in the county of Huron expand in one place to a swamp of 1,900 acres, and two attempts to drain this swamp by improvement of the river had proved both expensive and unsuccessful. A land owner brought, and succeeded in, an action against the municipality for loss of a crop by flooding. The only way of avoiding a recurrence of such claims was by a further and adequate improvement of the channel, or by compensation under the Municipal Drainage Act, and of these alternatives the latter, virtually an easement in perpetuity, was found the less expensive and the more satisfactory.

Drainage Through Natural Watercourses

Where rivers like the Thames and Grand traverse rolling country it is unusual for drains to be carried to a final outlet into the river. The drains usually have their outlets into natural watercourses flowing in narrow valleys, which, in turn, discharge into the river. The length of natural watercourses varies with the topography. In the comparatively flat lands around the head waters of the River Thames, and also near its mouth, the length of artificial drains is greater than elsewhere. Throughout the greater part of the course of both rivers the lengths of tributary natural watercourses exceed the lengths of the artificial drains that enter them; under these circumstances the effect of the drains upon the river flooding at any time may well be questioned.

The extent to which river floods may be affected by a tributary, whether a natural watercourse or a large drain, will be greater or less according as the tributary enters the main stream nearer its source or its mouth. It is a matter of common observation that any local freshets in the creeks tributary to the lower reaches of the Thames subside before the crest of the flood comes down from the head waters. Floods on the Thames at Chatham are usually two days later than those at London. It would seem then that drainage schemes having outlets into the lower reaches of the rivers have a tendency to diminish rather than to increase the river floods. This cannot be said, however, of the embankments which form a substantial part of drainage schemes in the low lands for several miles along the lower reaches of the Thames. These embankments prevent the river from spreading over the adjoining plains as it would otherwise do, and in this way they increase the height, though not the volume, of the river floods.

Records of Stream Flow

The most direct method of determining the effect of land drainage upon river floods would be by observation of a particular watershed over a period of years, both prior to and subsequent to the construction of drainage systems. The observations would include rainfall as well as run-off. An alternative direct method would be by observation of two watersheds similar in location, topography and rainfall, one of them undrained and the other provided with a fairly complete system of drainage. The records available in this Province are those of the Hydro-Electric Power Commission from 1915 to 1919, inclusive, and of the Dominion Water and Power Bureau from 1919 to the present time. From all records published up to and including the climatic year 1930-31, and those for subsequent years kindly furnished by the Bureau, an analysis has been made of the rate of discharge or run-off at the time of maximum annual floods for all the rivers in Ontario on which records have been kept. A few graphs are presented herewith, and a complete set may be had on application to the Secretary of The Institute. The graphs show the discharge in cubic feet per second per square mile. For comparison with rainfall records, and with the rate of run-off in inches per twenty-four hours used in the design of agricultural drains, it may be stated that one inch of run-off in twenty-four hours is equivalent to 26.89 cu. ft. per sec. per sq. mi.

While the records cover a period of twenty-two years from 1915 to 1937, the most active period known in the construction of drains in the Province was in the prosperous years following the Great War, say from 1920 to 1929. If the construction or improvement of drains during this period had any marked effect on the maximum annual floods one might expect to find some trace of it in the records, particularly in those of the Grand and Thames rivers, both of which traverse rich agricultural land in which there are extensive drainage works.

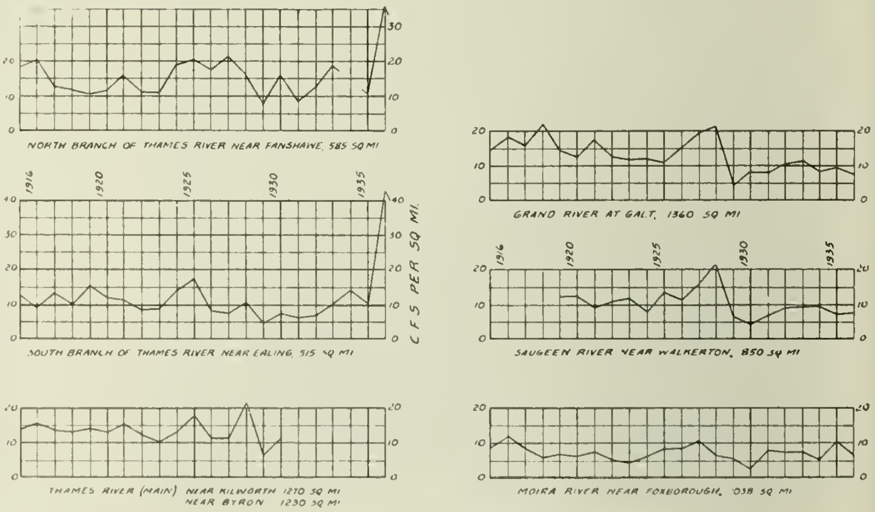

Fig. 4—Maximum Annual Floods (26.89 c.f.s. per sq. mi. equals 1 in. run-off in 24 hrs.).

The South Branch of the River Thames at Ealing, with a drainage area of 515 sq. mi., shows throughout the period a maximum annual flood discharge of about 12 cu. ft. per sec. per sq. mi. prior to 1929, and about 10 cu. ft. per sec. per sq. mi. since then, exclusive of the abnormal flood in the spring of 1937 which reached a peak of 43 cu. ft. per sec. per sq. mi.

The North Branch of the River Thames at Fanshawe, with a drainage area of 585 sq. mi., shows throughout the whole period of record a higher maximum annual flood than the South Branch, but like it, gives no indication of increasing flood discharge subsequent to the active period of drainage construction. The record flood in the spring

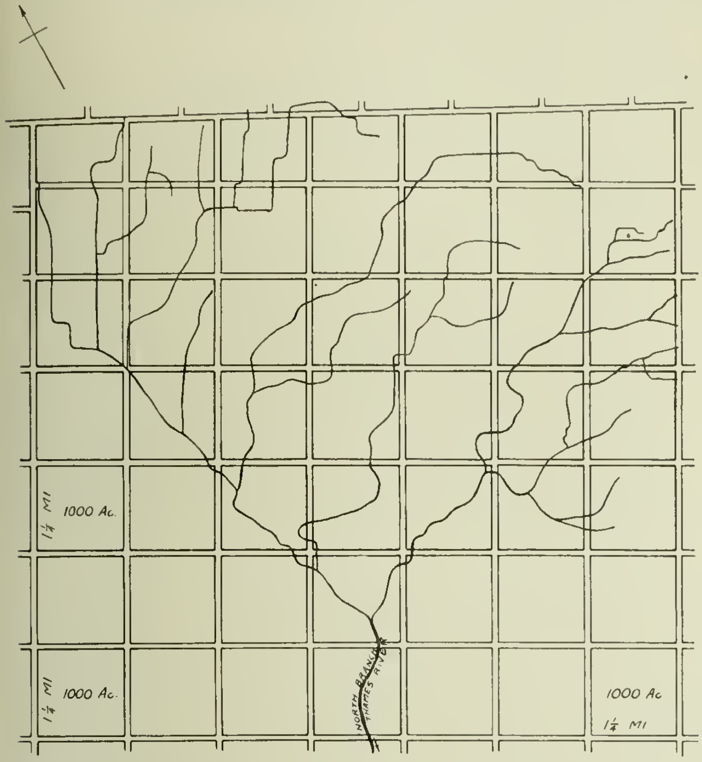

Fig. 5—Agricultural Drains Combining to Form Head Waters of North Branch of Thames River.

of 1937 reached a maximum discharge of 35 cu. ft. per sec. per sq. mi., more than twice the average for a number of years.

The records of the main Thames river near Kilworth, with a drainage area of 1,270 sq. mi., or at Byron, with an area of 1,230 sq. mi., terminating with the year 1930-31, show a fairly regular maximum annual flood discharge of about 13 cu. ft. per sec. per sq. mi. If flooding of either branch or of the main stream has been increased by land drainage, there appears to be no definite indication of it in these records.

The question may arise as to why the North Branch should, over a long period of years, have a relatively greater flood discharge than the South Branch. A more complete study than has been found possible for the present discussion might indicate one or more of the following causes: (1) greater snowfall with more rapid melting on the southward slope, (2) more numerous tributary watercourses, (3) steeper natural slopes, (4) more extensive drainage systems around the head waters. This difference between the two branches of the Thames is very similar to that between the branches of the Maganatawan and between the branches of the Muskoka, the north branch in each case having the greater flood discharge.

The flood discharge reached by the Thames at the end of April 1937 was greater than of any other flood on record of this or any other river in Ontario.

Turning to the Grand river, the record shows no increase in the flood discharge following the active drainage years. On the contrary, there is a marked decline since 1929, due in all probability to lesser precipitation. The maximum annual floods on the Grand river at Galt, with a drainage area of 1,360 sq. mi., are almost identical with those of the Thames river at Byron, with an area of 1,230 sq. mi.

The Thames and Grand rivers both have within their drainage areas, and particularly near their head waters, extensive systems of agricultural drainage, and it is interesting to compare the flood flows of these two rivers with those in other parts of the province where there is a minimum of drainage. The Saugeen river at Traverston, with a drainage area of 850 sq. mi., has an annual flood discharge similar to that of the South Branch of the Thames, but less than that of the North Branch. All other rivers in Northern and Eastern Ontario, whose records are given, have lower flood discharges than the Thames or the Grand in Southern Ontario. All rivers, including those two, seem to have had higher floods than the average in either 1928 or 1929, the years of highest levels of the Great Lakes.

Authorities Cited

From what has been previously said it may be inferred that there always has been, and probably always will be, controversy and litigation between downstream and upstream landowners. The findings and opinions of outstanding authorities as to the effects of agricultural drainage on flood conditions are therefore quoted at some length.

George W. Pickels, Professor of Drainage Engineering, University of Illinois, in his book on Drainage and Flood Control Engineering, 1925, says:

> "There are no valid reasons for believing that recent floods are of greater magnitude than those which have occurred in the past, opinions to the contrary notwithstanding, or that the frequency of great floods is increasing." . . . "Although the flood discharges are not becoming greater, the flood heights are; and the more the river channels and flood plains are restricted, the greater will be the heights to which the flood waters will rise, and the greater the damage caused by flooding." . . . "When shallow ponds and swamps are drained by the construction of drainage ditches, the restricted outlets mentioned above as existing in a state of nature are opened up so that the possible rate of outflow from these areas is as large as the rate of inflow, thus increasing the flood flow and decreasing the low-water flow. The maximum run-off will occur early in the spring when the ground is frozen or saturated, or during extended periods of precipitation in the summer when the ground is again saturated. The purpose of drainage is, however, to lower the water table, thus removing the gravitational water in the soil, and, since swamp soils are usually

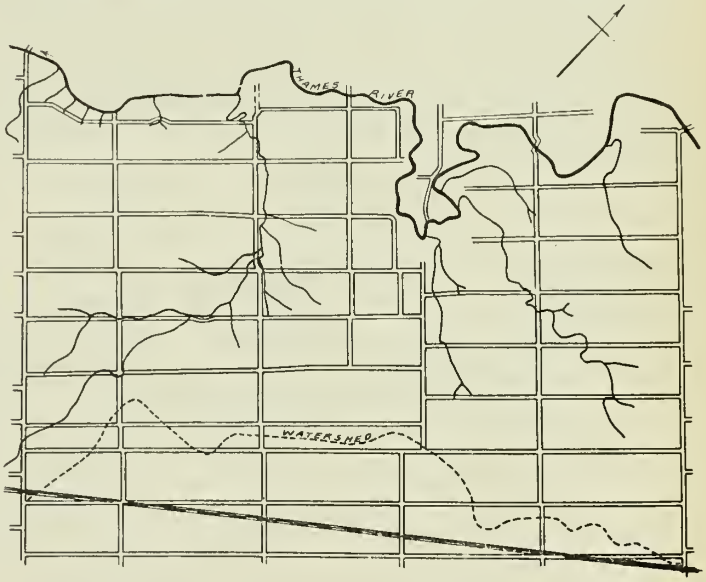

Fig. 6—Artificial Drainage is Confined to the Narrow Area Between the Watershed and the Head of the Natural Watercourses.

loose and porous, providing a large storage reservoir in the soil itself, so that even an intense rainfall of short duration will result in a low surface run-off. While the frequency of floods is thus decreased, the flood run-off from storms of long duration is increased by drainage.

Drainage of the upland level areas has, in general, the same effect. Here the soil is not so open, although cultivation and drainage tend to make it more so, and the surface run-off will be greater than in the case of the more open swamp land soil. Also when the small laterals of the drainage system are open ditches, the flood run-off will be greater than where large tiles are used for the laterals.

In general it may be stated that up to the point of soil saturation the effect of artificial drainage is to decrease flood flows, while beyond this point it is to increase it."

In a University Bulletin of 1931 dealing with run-off investigations in Central Illinois for areas from five to sixty square miles, the same writer says:

"Completeness of drainage is an important characteristic. The more adequate the drainage facilities, the greater the rate of flood discharge during excessive storm periods, especially those occurring during the winter and spring."

Professor S. M. Woodward and the late Professor F. A. Nagler of the State University of Iowa made an exhaustive and scientific study of the effect of agricultural drainage on the flood run-off of the Iowa and Des Moines rivers, and the results are given in the proceedings of the American Society of Civil Engineers for 1929. The study included an analysis of conditions for a four-year period from 1903 to 1906, inclusive, before any drainage work had been done, and for a six-year period from 1918 to 1923, inclusive, after the completion of drainage works aggregating thousands of miles in length and draining millions of acres. The study embraced both precipitation and run-off, the drainage area of the Iowa river at the gauging station being 3,140 sq. mi. and of the Des Moines at three stations being 4,170, 6,180 and 13,900 sq. mi. respectively. The results are summarized as follows:

"A survey of completed drainage enterprises in the Upper Mississippi Valley indicated that a comparison of stream-flow conditions prior and subsequent to extensive drainage could best be made upon the Des Moines and Iowa rivers, a large portion of the water-sheds of which have been covered with artificial drains subsequent to the establishment of stream-gauging stations.

A critical examination of the records of these two streams shows that during flood periods there has been no significant change in their behaviour which may be attributed to drainage. The total run-off from storms of like precipitation, the maximum rates of discharge, and the rain-water storage conditions within the basins seem to have been unaltered by the extensive drainage operations. It is believed that if any of these factors had been changed by a measurable amount, such fact could easily have been detected by the analysis made in this paper.

The drainage operations on the water-sheds of these two rivers involved the construction of tile drains, open ditches, and some straightening of stream channels, typical operations in drainage projects in the Upper Mississippi Valley." . . . "If the carrying out of agricultural drainage affects the flow of streams in any measurable way, such effects must be most conspicuous near the drained areas."

The late Allen Hazen, in his book on Flood Flows, published shortly before his death in 1930, says:

"Apparently other conditions introduced by drainage offset the increased rate of flow directly due to drainage so that the total result of agricultural drainage is not important in maximum flood quantities.

One of the effects of drainage is to create ground storage where none existed before. Wet and marshy soil in swamp areas has no ground storage. There will be temporary storage over the surface of such wet areas in times of heavy rainfall, but where the ground itself is normally water-logged it is without value as a reservoir for holding back flood flows.

The most effective and instantaneous of all reservoirs, so far as flood control is concerned, is the surface soil; and this is available only to the extent that at the beginning of a flood period it is drained and its pores are filled with air which may be replaced with water. Drainage takes the water out of swamp soil and creates a storage space where none had existed. The effect of soil storage is greatest in taking care of run-off from summer or early autumn storms after the soil has been thoroughly dried out, but it may be much less with respect to late winter and early spring flood flows."

Conclusion

The opinions of the authorities above quoted sum up the relations between drainage and floods so well that any addition would seem superfluous. In a rather long experience, the author has found that no two drainage problems are exactly alike, and it is submitted that this statement might apply to flood problems as well. Each should be considered with regard to time, duration, place, distance, area, topography and all other conditions. The solution of a single problem, with all the factors taken into account, will give more satisfaction than attempting to apply a formula or a hard and fast rule to all cases.

Flood Control and Water Conservation in Southwestern Ontario

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Paper presented at the Annual Meeting of The Institute in London, Ont., February 2nd, 1938.

SUMMARY.—After sketching the geology and physiography of the Thames and Grand river watersheds the paper outlines the history of flood control and conservation works in the district and the proposals for further construction, with a brief general discussion of river control methods.

The peninsula of Southwestern Ontario was opened for settlement early in the nineteenth century.

The early settlers found the country covered with hardwood and coniferous forest. Numerous streams taking their rise in the highlands of the interior flowed in all directions to the Great Lakes which form three sides of its boundary.

The larger of the rivers provided ready access to the interior and full advantage was taken of their facilities of transport.

Southwestern Ontario

From the shores of Lake Erie on the south and the shore line of Lake St. Clair and the River St. Clair on the west a gently rolling plain extends northerly and easterly with gradually increasing grades to the height of land in the vicinity of Dundalk.

From this height of land the Grand river flowing in a southerly direction empties into Lake Erie; the Maitland, Ausable and Saugeen rivers flow in a westerly direction to Lake Huron and the Nottawasaga and Beaver rivers flow north into Georgian Bay. The Thames and the Sydenham drain the southwestern extension of the peninsula flowing in a southwesterly direction into Lake St. Clair and River St. Clair respectively.

Rock Structure

The Niagara escarpment forms the easterly boundary of the peninsula. It is a well defined step upward from the lowlying plains to the east and north. Commencing at Niagara Falls on the Niagara river it follows the southerly shore of Lake Ontario to the city of Hamilton, thence in a direction slightly west of north to the town of Collingwood on Georgian Bay. It is the only important rock outcrop in the area under consideration and forms the easterly edge of the Silurian system of sedimentary rock formations which underlie the easterly part of the area. Further to the west, and extending in a line roughly from Southampton on Lake Huron to the city of Woodstock and thence in an easterly direction to Fort Erie on the Niagara river, the later Devonian system of sedimentary rock formation begins and underlies the westerly part of the area. No violent deformations have taken place in the rock structure of the area but gentle structural undulations are in evidence and the general slope of the underlying rock surface is from the northeast to the southwest.

No metallic minerals are obtained from the Silurian rocks but they furnish an ample supply of building stone and road metal, quicklime, gypsum, gas and some oil.

Influence of Glacial Period

The factor which finally determined the course of the rivers, gave to the land its fertility, and provided ground storage for its surplus rainfall, was the great icecap of the glacial period. Two lobes of the glacial ice sheet moved down through the troughs of Lake Erie and Lake Huron, their edges meeting at a line extending in a southwesterly direction through the central portion of the peninsula. As the ice melted the first land to appear was a large area extending along the junction of the two lobes northeast from London, which has been named "Ontario Island." The waters from the melting ice found an outlet along the crease at the junction of the two ice streams and thus the course of the Thames river was determined. Terminal moraines of sand and gravel mixed in some cases with clay were deposited at the edges of the glacier as the ice fields retreated and the location of these moraines shaped the present courses of the rivers and streams.

A map showing the location of the terminal moraines in Southwestern Ontario, prepared by Mr. Frank B. Taylor, is shown in Fig. 1. The heavily drawn moraines are those deposited on land and the lighter hatched portions are those deposited under water, the water-laid moraines being generally smoother and weaker than the land-laid moraines. The redistribution of the land surfaces during the ice age has not only marked out the courses of our rivers but it has affected our public and private water supplies as well.

Municipal Water Supplies

The city of London obtains its supply from the open gravel beds at the junction of the Milverton and Ingersoll moraines. The city of Kitchener obtains its supply from the gravels of the great Paris moraine and from deeper rock wells. The city of Brantford obtains its supply from the Grand river but uses the filtering action of the gravel in the Galt moraine for preliminary treatment of the highly polluted river waters. The open texture of these immense gravel deposits has exercised a controlling influence in conserving the water supplies of Southwestern Ontario.

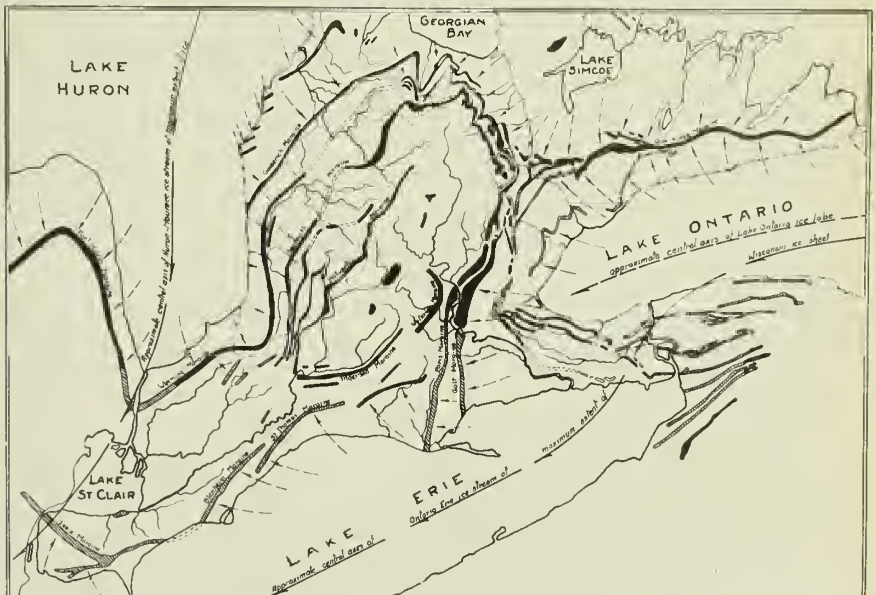


Fig. 1—Map of Glacial Moraines in Southwestern Ontario.

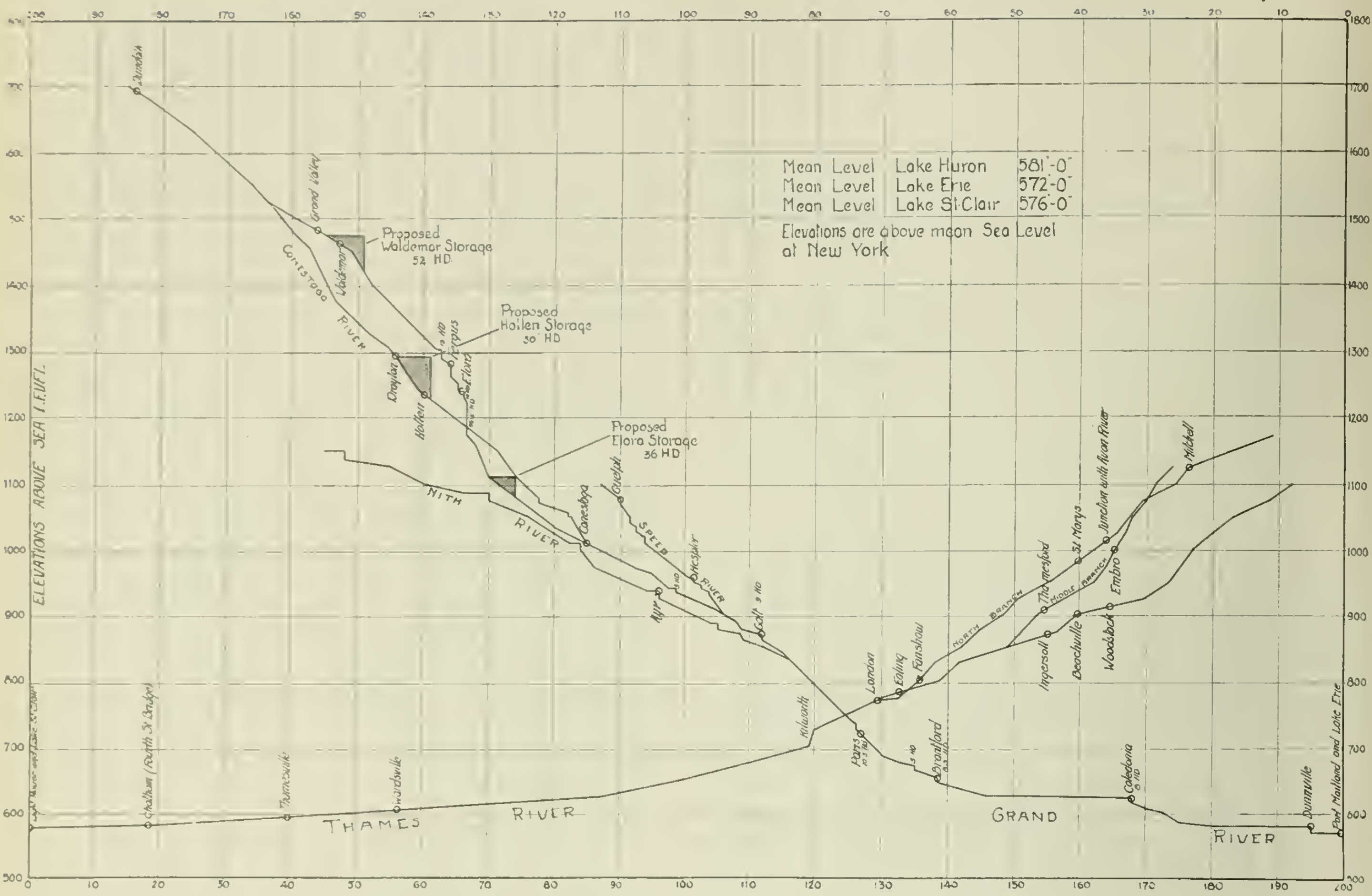


Fig. 2—Profile of Thames River and Grand River with their Tributaries.

Watersheds of the Grand River and Thames River

In discussing water conservation and flood control measures in this area it is proposed to consider the watersheds of its two river systems, considered most important from the size of their drainage areas, the density of population served by them, and the variety and importance of their industries, viz., the Grand and the Thames.

Headwaters of the Grand River

The Grand and its tributary, the Conestogo, take their rise upon the high plateau in the vicinity of Dundalk. Large areas on this plateau are covered by peat bogs which overlie dense impervious clay. Much of the bog has been drained by the construction of deep surface ditches and the land reclaimed for agricultural purposes.

Grades of the Grand River and its Tributaries

The accompanying river profiles show that the upper reaches of the Grand and the full length of the Conestogo have heavy grades averaging about 12 feet to the mile. The stream bed in this part of the main channel of the Grand river is largely composed of rock and in the Conestogo, of clay. The combination of these conditions tends to give a quick run-off and cresting of floods in times of heavy precipitation, the effects of which have a marked influence on the behaviour of the main stream. From the junction of the Grand and the Conestogo to the city of Brantford the grade of the river is about six feet to the mile and in this section it is joined by the Speed and the Nith. The Nith drains a gently rolling watershed with an average grade to the stream of about four feet to the mile. It exercises a moderating influence on the cresting of floods in the main stream and usually provides a steady though diminishing water supply through the dry summer months. Whiteman's creek enters the main stream between Paris and Brantford. It is a stream flowing through a wooded valley and is fed during the summer months from the springs emerging from the gravels of the Paris and Waterloo moraines. It furnishes usually about one-third of the stream flow in the Grand river through Brantford during the dry summer months. From Brantford to its outlet into Lake Erie the Grand river has an average fall of less than one foot to the mile. The watershed narrows rapidly and only two streams of importance, Fairchild's creek and Boston creek, enter the main stream in this portion of its course.

A profile of the Grand and its tributaries and of the Thames and its branches is shown herewith, in Fig. 2.

History of Grand River Improvement Plans

In the year 1912, due to increasing damage from floods, the municipalities of Brantford, Paris, Galt and Preston made representations to the government of the Province of Ontario for relief and asked that a survey of the river be made. Shortly after that date gauging stations were established on the river and its principal tributaries by the Hydro-Electric Power Commission of Ontario, and a preliminary report submitted. No action was taken at this time and the matter rested until the year 1930. At that time the Government asked the Commission and the Department of Lands and Forests to report on suitable works for the control of floods and the increase of summer flows in the river. This report was completed in 1931 under the direction of Dr. T. H. Hogg and Mr. L. V. Rorke and the control works contained therein are those discussed in this paper.

H.E.P.C. Report of 1931

Under this report it is proposed to construct four dams, two on the upper reaches of the Grand river and two on its tributary, the Conestogo. In addition it is also proposed to dam back the outlet draining the unreclaimed portion of the Luther marsh situated near the headwaters of the river. This will affect an area of about 3,000 acres and will furnish about 10,000 acre ft. of storage.

A study of the floods for which records are available shows that quick run-off conditions and consequent cresting occur during the spring breakup of the river while the ground is still frozen and where the melting of the snow is hastened by warm rains accompanied by above-freezing night temperatures. The crests of such floods sweep down the high gradients of the headwaters and carry destruction to the more densely populated cities and towns along its lower reaches. For this reason it is proposed to construct the two first dams well up-stream. An outline drawing showing the type and general dimensions of the dam to be constructed above Belwood is reproduced. This dam is typical of the design adopted for all.

The central section is mass concrete of the gravity type, the crest of the spillway being 44 ft. above the bed of the stream. Stoplogs are provided over the spillway which will enable the reservoir to be raised 9 ft. above the crest of the dam. Three circular conduits fitted with electrically operated control valves are located in the lower section of the dam through which the controlled discharge of the reservoir takes place.

The apron of the spillway extends for about 100 ft.

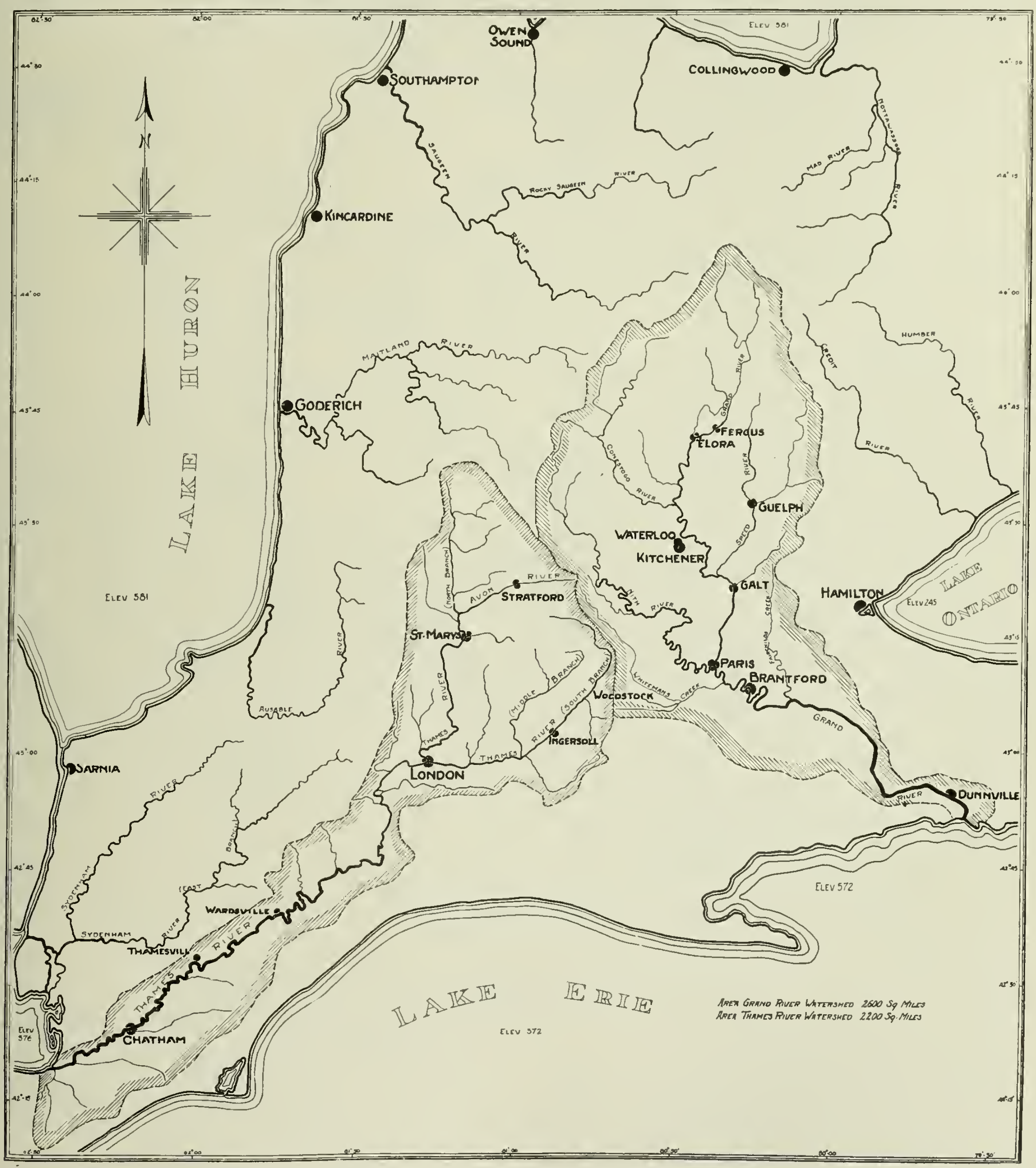


Fig. 3—Watershed of Thames River and Grand River in Southwestern Ontario.

down stream. The toe of the apron is raised three feet above the level to break up the high velocity of discharge.

Each reservoir is designed to provide about 10,000 acre ft. of storage. It is proposed to operate these impounding reservoirs in such a manner that the existing channel of the river will take care of floods but that sufficient water will be stored in them during the wet months of the year to provide a flow during dry periods which will supply the necessities of the several municipalities. It is expected also that the reservoirs will have a beneficial effect on the storage of ground waters in the area through seepage from the reservoirs and increased flow in the streams.

Local Flood Control Works

A number of cities and towns along the course of the Grand river have suffered from periodic floods. Galt, Paris and Brantford have had their streets flooded, their industries crippled and their inhabitants menaced by these visitations. They have endeavoured more or less successfully by the construction of dykes and river walls to confine the river to its natural channel. They have also in some instances endeavoured to improve the river channel, going beyond their corporation limits to accomplish this.

The history of flood prevention work undertaken by the city of Brantford dates from the year 1887, when the late Samuel Keefer, C.E., M.Can.Soc.C.E., was called in to investigate and report on measures which should be adopted to minimize the effects of the floods. He said in opening his report to the city authorities: "I have now procured all the information necessary to enable me to form an opinion on the semi-annual floods from which West Brantford, for years past, has suffered and to suggest the proper means for the protection of that portion of the city from inundation."

This would suggest that even at that early date floods in the Grand river were of common occurrence and had been for many previous years. He recommended that a system of earthen dykes be constructed along the southerly bank of the river and marked out the location and form of these works. The earthen dykes were to be raised to a level 3 ft. above high water, were to be 6 ft. wide on top with both slopes at 1½ to 1. The area enclosed, he said, might need to be provided with a pump to pump out accumulated surface water. This latter recommendation was never carried out, nor was it found to be necessary, as floods were of such short duration that surface water did not prove to be of consequence.

These dykes, however, were breached by a flood which occurred in 1894, and under the direction of the City Engineer, the late Mr. T. Harry Jones, were then raised and strengthened by timber cribs extending a short distance into the stream; also at that time a system of similar dykes was constructed along the north bank of the river to protect Eagle Place, another lowlying section of the city which had suffered from floods. Later on the river channel was widened at Lorne bridge by adding to the existing structure an additional span 100 ft. in length.

One of the measures recommended and carried out at about this time was the digging of an artificial channel for the river below the city limits in an endeavour to improve a sharp bend in its course. This work did not prove effective, the channel silted up and the river resumed its original course. In later years the dyking system has been extended, raised and strengthened; railway and highway bridges have been lengthened. No subsequent floods have broken through these defences.

The present dykes have a minimum width of 8 ft. on top with slopes of 2 to 1 on the river side and 1½ to 1 on the land side. The river faces where necessary are paved with reinforced concrete 6 in. in thickness, resting on low concrete walls or footings. The concrete facings extend to normal high water levels and are provided with expansion joints and are constructed in the same way as

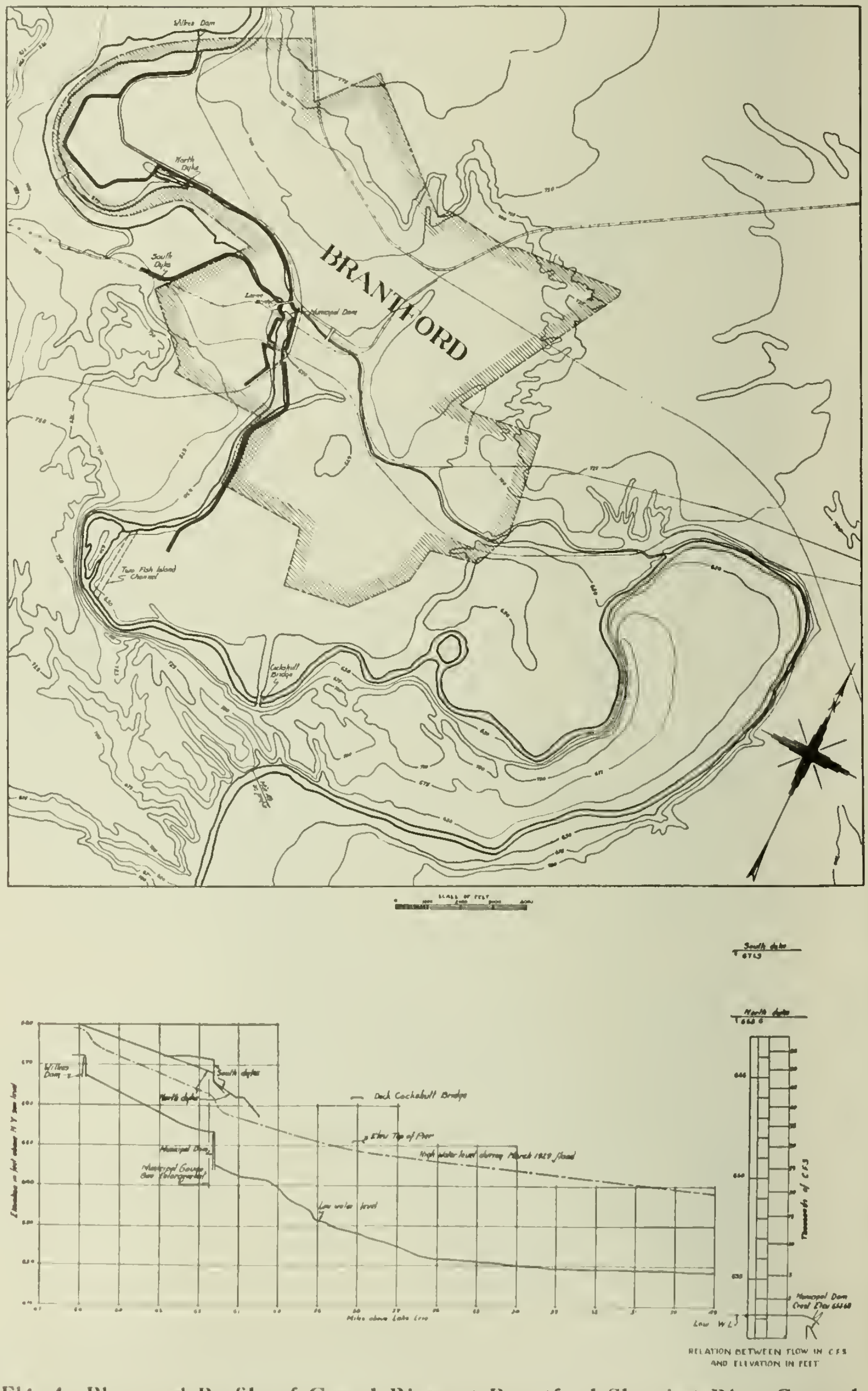


Fig. 4—Plan and Profile of Grand River at Brantford Showing River Control Works and Flood Flow in River During 1929 Flood.

pavements of this type are built. Stone blocks were at first used for this purpose but it was found that the action of ice and river currents displaced them, necessitating frequent repairs.

Maximum floods of about 42,000 c.f.s. have occurred since these dykes were completed and they have provided a freeboard of about 3 ft. under these conditions.

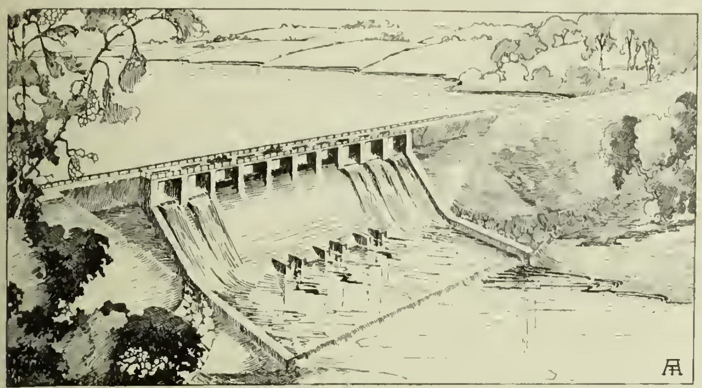


Fig. 5—Grand River Conservation Project. Perspective of Proposed Waldemar Dam.

Storm sewers entering the river in low-lying areas are provided with gate valves which are closed during the peak of the flood.

Flood prevention works in other municipalities on the Grand river are not as extensive as at Brantford but are constructed on the same general lines as those described above.

It is probable that greater floods will occur in the future and it is expected that the construction of the proposed reservoirs in the upper reaches will provide sufficient control of the cresting of these floods to keep them within the present improved channel of the river.

Flood of 1937

On April 26th and 27th of this year, one of the greatest floods on record occurred on the Thames watershed. The run-off on the drainage area of the south branch of the Thames river reached a maximum of 43.03 c.f.s. per sq. mi. of watershed. Had this same run-off occurred on the Grand river watershed above Galt, the flow in the river at Galt would have reached a maximum of 58,500 c.f.s. and at Brantford 73,000 c.f.s., allowing for an increase of 24 per cent in the flow between these two points, which is the usual flood increase. It is estimated that the operation of the proposed control works on the Grand river will make a reduction of 18,500 c.f.s. in the cresting of floods, thus reducing a 73,000 c.f.s. flood to 54,500 c.f.s. The present dykes at Brantford will pass a 55,000 c.f.s. flood but would not take care of a 73,000 c.f.s. flood.

A study of the probable dimensions of future floods is contained in the report and it is assumed that the proposed works when completed will enable the present river channel at Brantford, Paris and Galt to pass them with some margin of safety.

Low Summer Flows

The mean flow of the Grand river at Galt from 1916 to 1937 is 1,134 c.f.s., the yearly mean varying from a minimum of 438 c.f.s. in 1931 to a maximum of 1,790 c.f.s. in 1929. The daily flows, however, are reduced during the summer months in most years to figures well below 100 c.f.s., reaching in 1926 an all time low of 26 c.f.s.

This quantity of water is not sufficient to supply the needs of the population depending upon it for their requirements.

The municipalities of Kitchener, Preston and Galt discharge the effluent from their sewage disposal works into about ten miles of the length of the river above Galt. They have a combined population of 53,000 and empty sewage effluent into the river at the rate of 13 c.f.s. The mean monthly flows at Galt for July, August and September in 1936 and 1937, were as follows:

	1936	1937
	Drainage area 1,360 sq. mi.	
July	55 c.f.s.	152 c.f.s.
August	47 c.f.s.	162 c.f.s.
September	91 c.f.s.	146 c.f.s.

In 1936 the conditions in the river, to say the least, were offensive. In 1937 the increased flow in the river improved the situation to the extent that no complaints were registered with the authorities.

It is not anticipated by the municipalities that the proposed works will relieve them of the responsibility of so treating the effluent from their disposal works that it will not become a nuisance, but the increased summer flow of the river will reduce the amount of treatment to a point that is within reasonable limits and will provide for the requirements of a moderate increase in population.

The regulated low flow of the river at Galt after the proposed works have been constructed is estimated at 350 c.f.s. and at Brantford 500 c.f.s.

The Thames River

The Thames river watershed adjoins that of the Grand river along its southwesterly boundary, the length of the two rivers and the area of their watersheds being about the same.

	Area of watershed	Length
Grand river	2,610 sq. mi.	184 miles
Thames river	2,250 sq. mi.	192 miles

The grades of the Thames, however, are very much less than those of the Grand, it having a total fall from headwaters to outlet into Lake St. Clair of 625 ft. against a fall in the Grand river from headwaters to outlet into Lake Erie of 1,128 ft.

Profiles of the two rivers and their tributaries are shown drawn to the same scales. (See Fig. 2.)

The Thames river watershed comprises a low-lying level plain for the first 90 miles of its course, the river having a fall of only 0.6 ft. per mile in this portion. From this point to the city of London, a distance of 40 miles, the grade increases to 3.5 ft. per mile. From Lake St. Clair to London the watershed has a fairly uniform width of about 12 miles and the river parallels the north shore of Lake Erie at a distance from the lake of about ten miles.

Above London the river branches and the upper portion of the watershed assumes the character of a gently rolling plateau similar to that of the Nith river which it adjoins on the west.

The average grade of the North Branch above London is 6.3 ft. per mile and of the South Branch 5.0 ft. per mile.

The mean rainfall on the watershed of the Thames is somewhat higher than on the Grand, resulting in a higher run-off, these figures being as follows:

	Mean run-off per sq. mi. of watershed
Grand river at Galt	0.84 c.f.s.
Thames river, North Branch	0.87 c.f.s.
Thames river, South Branch	0.93 c.f.s.

Flood Flows of the Thames River

The lower grades of the Thames river have a tendency to reduce somewhat the quick cresting of floods, but they also slow up their velocity and raise their levels. A flood on the Grand discharging 40,000 c.f.s. at Brantford will raise the river level about 12 ft., while a similar flood on the Thames at Chatham, will raise the river level about 18 ft. above normal.

Below the city of Chatham the river overflows its banks during flood periods and inundates large areas of its watershed. Certain lands have been dyked in this area and provided with pumping equipment as a protection against these periodic floods.

It is understood that the Hydro-Electric Power Commission are now making a preliminary survey and investigation of the Thames River Watershed and have been asked to report on suitable measures for controlling floods. It is expected that their report will be available in the near future.

Possible Control Measures

An examination of the contours of the watershed in the upper reaches of the river would indicate that suitable locations for control reservoirs might be available along the North Branch, but along the South Branch would be few and not very suitably placed, on account of road and railway location along the river valley. One measure of relief which will no doubt receive consideration is the cutting of an overflow or relief channel from the main stream below London into Lake Erie. Such a channel would have the effect of increasing the hydraulic grade line of the flood waters, thus increasing the velocity of the stream and lowering the flood levels.

Low Summer Flows in Thames River

The low flow conditions in the Thames river are very similar to those in the Grand. The following table gives a comparison of the mean monthly low flows during 1936 and 1937:—

	North Branch 585 sq. mi. c.f.s.	South Branch 515 sq. mi. c.f.s.	Combined 1,100 sq. mi. c.f.s.
		1936	
July	16	22	38
August	10	26	36
September	21	32	53
		1937	
July	56	86	142
August	49	124	173
September	57	102	159

The extremely low summer flow of the combined streams in 1936 would indicate that trouble from sewage disposal works would develop at London, the total quantity of water passing that city being far short of the quantity required to furnish even a moderate amount of dilution to the effluent from its disposal works.

River Control Methods

In a discussion of river control measures it is well to consider the probable cause of floods and succeeding low flows. It is generally assumed that the transformation of the land from its natural state to that of intensive cultivation has had the effect of increasing the cresting of floods and diminishing the summer flow of the streams.

The cutting down of forest growth has destroyed the highly absorbent forest floor and has removed the protecting shade of the trees from the accumulated winter snows.

The construction of farm and municipal drains has given quick access of rainfall and the water from melting snows to the streams.

There is no reason to doubt that these changes have contributed to low summer flows, but it is open to question whether they have materially increased the cresting of the occasional extremely high flood.

The Thames river flood of this year occurred on April 26th-27th. The ground was well saturated with water from an open winter and wet spring, but all snow had disappeared and the frost was out of the ground.

Had the watershed been covered with a dense forest growth with snow still lying in the forest and frost in the ground, which might well have been the case at this date, then the heavy rainfall of about 4 in. in three days over the watershed would have been augmented by the waters from melting snows and a flood of even greater dimensions would have taken place.

There are no records of the floods which occurred before the land was settled in this part of Ontario, and their height and volume is purely a matter of conjecture.

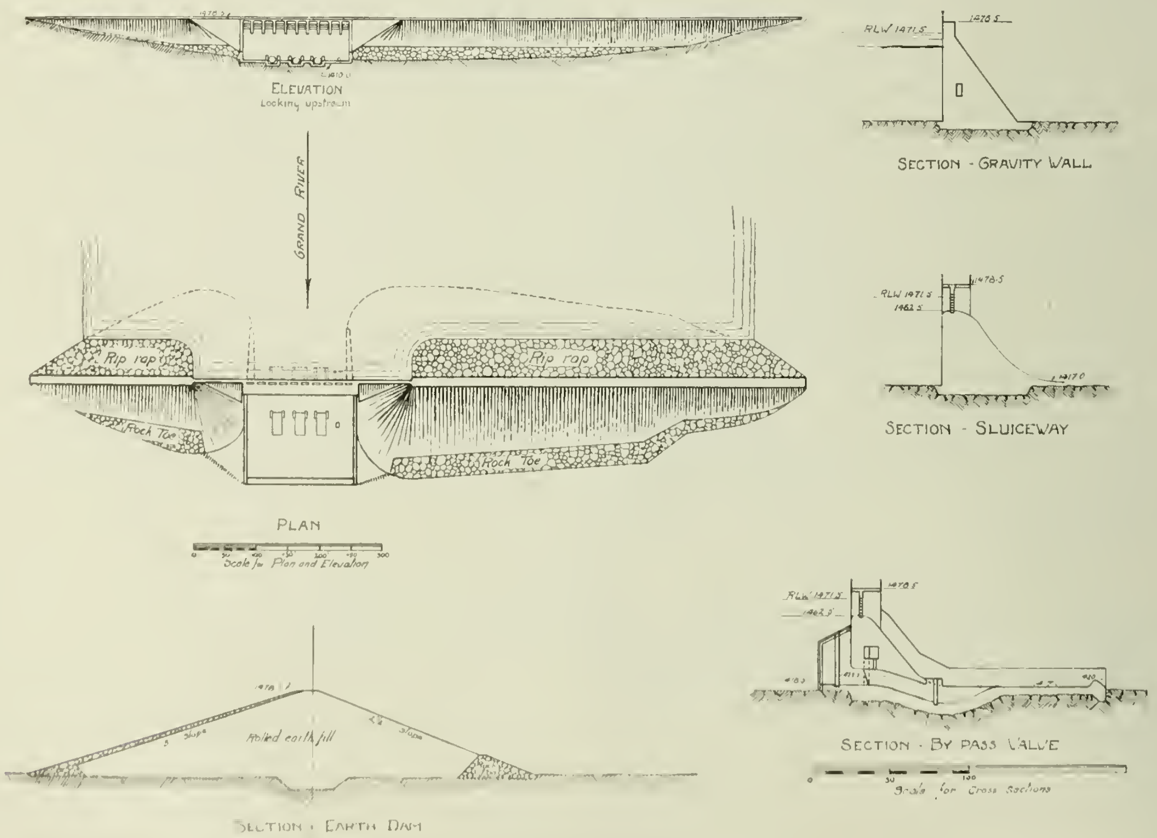


Fig. 6 Grand River Conservation Project. Preliminary Plan of Proposed Waldemar Dam.

It has been suggested that reforestation would regulate stream flows, and no doubt it would to some extent if such a course were practical, but it must be remembered that only about five per cent of the area under consideration is now under forest and to turn back highly productive agricultural lands to the growing of trees would not be economically feasible.

There are, however, considerable areas of swamp lands at the headwaters of our streams that are not suitable for agricultural purposes. Some have been drained, but the top soil is thin and the subsoil cold and wet. These areas might well be returned to their natural state and they would furnish their water quota to the streams during the dry summer months. They should never have been opened for settlement.

There are no lakes of any size upon the watersheds of the rivers in Southwestern Ontario which might serve as reservoirs and give some degree of regulation to the flow of streams. The summer flow is obtained from the few remaining swamp areas and the stored ground waters in the large gravel deposits of glacial moraines. Direct run-off from summer rainfall is almost negligible in many seasons.

It thus becomes necessary to consider artificial storage for the excess run-off during the wet months of the year.

Stream Flow Regulation by Artificial Storage

There are two methods of regulating the flow of streams by means of artificial storage.

First—Storage reservoirs retained by dams provided with openings without control valves designed to release definite calculated quantities of water while discharging under maximum heads.

Second—Storage reservoirs retained by dams provided with control valves or other regulating devices.

Works of the former character have been used successfully to control floods. The discharge openings or conduits through the reservoir retaining dam are of such form and dimensions that while discharging under maximum heads, i.e., while the reservoir is full, they will deliver to the stream a quantity of water that will fill its channel but will not overflow its natural or artificial banks down stream. These openings are not provided with control valves. The reservoir formed by the dam is of sufficient capacity to store the maximum estimated run-off from the watershed, less the quantity of water that is discharging through the openings in the dam from the commencement of the flood until its end. A factor of safety is provided by making the capacity of the reservoir somewhat greater than the estimated requirements. A concrete spillway of sufficient size is provided for the safety of the dam, otherwise the dam would probably collapse through overtopping. If, however, water flowed over the spillway it would add its volume to the discharge through the openings, and if of sufficient volume would destroy the regulating effect of the reservoir on the stream below.

Control works of this character make no effort to retain flood waters for use during dry periods. They level off the flood crests and a short time after the flood has passed, the control reservoir is empty. The ordinary flow of the stream passes through the openings in the dam without restraint and the flooded lands behind the dam drain off their surplus water and are returned to agricultural uses. This procedure is quite possible in Southwestern Ontario as floods usually occur in late winter or early spring when farming operations are at a standstill. The payment of compensation for damage to crops from the occasional summer flood would be necessary, or a release from flood damages would have to be given by the purchaser of such lands.

Works of the above description have been constructed to control floods on the Miami river in Southwestern Ohio. In all, five earth dams were built across the valley of that river and its tributaries to form retarding basins, and the improvement of several miles of river channel within the half dozen largest cities of the valley was undertaken. The work was commenced after the flood of March 1913, which took a toll of 360 lives and destroyed millions of dollars worth of property. Since its completion disastrous floods have swept down the Ohio river, of which the Miami is a tributary, but the Miami valley has been secure from such visitations.

The second method of regulating the flow of streams by means of artificial storage is similar to the method described above, except that the conduits through the reservoir retaining dam are provided with control valves, and are intended not only to control floods but to furnish additional waters to the stream during low summer flows. This method of control depends for its successful operation upon the skill and experience of the operator in charge. In order to obtain the maximum control of floods the reservoir should be empty when the flood period begins, discharging only the volume of water which the stream channel will take during its continuance. To provide water for periods of low flow in the river, the reservoir should be full or nearly so at the end of the flood period.

Probably this method of control could not be operated at more than 80 per cent efficiency.

This method of stream control was adopted for the Grand river project, as the problem in this case was not only to control the destructive spring floods, but to provide a moderate stream flow during the dry months of the summer.

Land for the flooded areas of the storage reservoirs will have to be purchased, and not worked under an agreement as described in the first named method of stream control, since such land will remain flooded during the greater portion of the year.

It is expected that the construction of four such storage and regulating reservoirs and the damming back the drainage from about 3,000 acres of the Luther swamp near the headwaters of the river, will provide sufficient regulation of the stream to guard against destructive flooding in the towns and cities situated upon its banks and give a supply of water sufficient for the needs of the inhabitants upon its watershed.

* * *

Note:—The author desires to express his indebtedness to Mr. F. P. Adams, Jr. for the preparation of the drawings illustrating this paper.

Report of Council for the Year 1937

Your Council has pleasure in reporting upon a year during which the activities of The Institute have continued under generally favourable conditions. The membership has shown a steady though not phenomenal increase, and the financial situation has shown improvement. The year was notable as that of The Institute's Fiftieth Anniversary, which was celebrated in a manner befitting the importance of the occasion.

The outstanding features of the Semicentennial Meetings, which took place from June 14th to 19th in Montreal and Ottawa, were the presentation of greetings and the reception of official representatives from some thirty of the leading engineering societies and organizations in Great Britain, the Dominions, the United States, and the continent of Europe; the conferring of honorary memberships in The Institute upon eight distinguished Canadian, British, American and French engineers; an "Overseas Session" at which three prominent British engineers presented papers; a noteworthy series of nine monographs on The Utilization of Canadian Coals, followed by ten others dealing with characteristic problems in Canadian engineering practice, and the addresses of the Governor-General and other eminent guests at the banquet.

A special June number of The Engineering Journal contained a brief history of The Institute; a record of the many notable figures connected with its foundation and growth, and seventeen historical papers by members of The Institute, each dealing with the work accomplished in some branch of engineering or industrial activity in Canada during the past fifty years.

The whole of the proceedings formed a memorable experience for the members and guests, numbering nearly a thousand, who had the privilege of attending.

As regards The Institute's relations with the Professional Associations, it is gratifying to note that definite progress has now been made towards an acceptable entente. The proposals of the Committee on Consolidation which were discussed at length at the Annual General Meeting of 1937, failed to obtain the approval of the membership on ballot. On consideration of the situation arising from this failure, it appeared to your Council that a less ambitious programme of by-law amendments should be put forward, containing only those provisions necessary to empower the Council to enter into agreements with the Professional Associations, looking towards the attainment of common membership, simplification of admission, and a mutual arrangement as regards fees.

Such provisions, together with a number of other proposals of less importance, were included in a series of amendments put forward by a group of thirty-one corporate members on October 1st. Your Council felt, however, that the situation would be better met by a simple by-law giving Council the power to enter into agreements with the Associations, and accordingly prepared such a by-law. This was accepted by the representatives of the group of corporate members in lieu of their proposals, and your Council desires to express appreciation of this action on their part. It is now possible to submit one brief general new by-law, which it is hoped will enable co-operative agreements to be worked out between The Institute and the Associations. This proposed by-law will be submitted to the Annual General Meeting for discussion and subsequent ballot. It has the support of both Council and the group referred to, and your Council would therefore urge all corporate members to vote in its favour, so as to enable The Institute to bring to a satisfactory close the discussions which have been carried on during the past year with several of the Provincial Associations.

These discussions began in April, as soon as the result of the ballot was known. The President visited Manitoba, and the Treasurer journeyed to the Maritime provinces, to discuss the situation in those localities, in both of which movements looking to closer co-operation between The Institute and the Association were already in existence. At the request of the Nova Scotia committee, representatives of your Council were appointed to confer with the officers of the Association and of the two Institute branches. Later, Council, by letter ballot of its members, expressed its willingness to enter into an agreement with the Nova Scotia Association, this decision applying also to the question of similar agreements with other Professional Associations. The discussions with Nova Scotia have now advanced so far that a preliminary draft of an agreement has been prepared and has been forwarded to Nova Scotia for consideration. Discussions in Manitoba, Saskatchewan and New Brunswick have not yet reached this point.

The Council is greatly indebted to its representatives who took part in the local discussions which have led to such a promising result, and particularly to Vice-President McKiel for his services in connection with the negotiations in Nova Scotia and New Brunswick.

A Plenary Meeting of Council was held on June 14th, 1937, at which the relations of The Institute with the Professional Associations formed one of the main subjects of discussion, a resolution being unanimously passed expressing Council's desire to co-operate with them. On the same date, a Round Table Conference of Branch Representatives was held, at which delegates from all the branches of The Institute discussed matters connected with branch organization, operation and management. Their report, which contained many valuable suggestions regarding the policies and operation of The Institute, was later presented to Council for review and consideration.

In view of the many interesting questions raised both at the Plenary Meeting and at the Round Table Conference, and after presentation of a report from a committee of Council which had been appointed to suggest the best method of dealing with problems relating to professional interests and the management of The Institute, Council decided to appoint a Committee on Professional Interests, and also a Committee on Membership and Management of The Institute. The former Committee, under the chairmanship of Past-President F. A. Gaby, M.E.I.C., will deal, amongst other matters, with those involving negotiations with the Professional Associations. The latter, under the chairmanship of Professor R. A. Spencer, A.M.E.I.C., will investigate problems connected with the internal organization and functioning of The Institute. Following another of the representations of the Round Table Conference, Council has appointed a committee, under the chairmanship of Mr. J. L. Busfield, M.E.I.C., to investigate and report upon the publications of The Institute. All of these committees are at the present time actively at work.

An examination of the technical papers and the records of branch activities published in the past year's issues of The Engineering Journal, will show that the principal object of The Institute, the interchange of professional knowledge, has been energetically promoted, both at The Institute meetings and at those of the several branches. The past year has, in fact, been notable for the quality of the papers contributed by our members and the activities of the papers and meetings committees of the branches.

During the year the cordial relations existing between the great American engineering societies and The Engineering Institute have been evidenced on several occasions.

In May our members, particularly those in Ontario, took advantage of the kind invitation of the American Society of Mechanical Engineers to attend the Semi-Annual Meeting of that body in Detroit, at which a varied programme of papers was presented dealing with many aspects of modern mechanical engineering. In October a most successful joint meeting of The Institute with the American Society of Civil Engineers took place in Boston, and was attended by a large Canadian representation. One of the sessions, at which a number of Canadian papers were presented and discussed, was a joint session conducted by The Institute. Many of the American papers presented at other sessions were outstanding and of great interest as dealing with engineering economic problems of international importance.

The Fifty-first Annual General Meeting convened at Headquarters on January 21st, 1937, and was adjourned to the Windsor Hotel, Montreal, on Friday, January 29th. In view of the many technical papers to be presented at the Semicentennial Meetings in June it was not followed by the usual general professional meeting. After the transaction of the regular business of The Institute, the principal feature of the General Meeting was the reception and discussion of the report of the Committee on Consolidation, the debate on which was of a very detailed nature, and resulted in the adoption of the Committee's report.

Roll of The Institute

During the year 1937, three hundred and twenty candidates were elected to various grades in The Institute. These were classified as follows:—One Honorary Member, nineteen Members, forty-five Associate Members, fifty-two Juniors, two hundred Students, and three Affiliates. The elections during the year 1936 totalled two hundred and fifty-eight.

Transfers from one grade to another were as follows:—Member to Honorary Member, seven; Associate Member to Member, seventeen; Junior to Associate Member, thirty-one; Student to Associate Member, fifty-two; Student to Junior, fifty-two; a total of one hundred and fifty-nine.

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 1937, for non-payment of dues and by resignation, seven Members, twenty-one Associate Members, ten Juniors, sixty-seven Students, and one Affiliate, a total of one hundred and six.

One hundred and seventy-three reinstatements were effected, and eleven Life Memberships were granted.

Deceased Members

During the year 1937 the deaths of sixty-three members of The Institute have been reported as follows:—

Honorary Member

Eddy, Harrison Preseott

Members

Anthony, Frank D.
Armstrong, Henry William Dudley
Blaekburn, Robert Neale
Blaikloek, Norris S.
Bray, Samuel
Chaee, William Gregory
Chambers, Allison Robert
Cole, Francis Thornton
Davy, Riehard Adams
Dessaulles, Henri
Fortin, Sifroy Joseph
Henderson, Samuel Ernest MeMillan
Henderson, Thomas Robert
Humphreys, James John
Lafleehe, Alphonse
Maedonald, Jeremiah James
MaeGregor, J. Grant
MeKinnon, Roderiek Will
MeLaren, William Frederiek
Morkill, John Thomas
Mudge, Arthur Langley
Rolph, Harold
Shanly, Coote Nisbett
Simmons, Thomas Loekwood
Stewart, Alexander F.
Taylor, Thomas

Associate Members

Angel, Frederick William
Angus, John Viekers
Arcand, Charles Louis
Chaloner, Chas. François Xavier
Claxton, George
Daubney, Charles Bruce
Dyer, Arthur F.
Fusey, L. Ernest F.
Hall, John Smythe
Heekman, Joseph William
Heygate, Harold John
Houliston, John
Ingles, Charles James
Joy, Clyde Barber
King, Thomas James Fleming
Knewstubb, Frederick William
Kippen, Horace Bruce
Lueas, Leslie
Munn, William George Quade
Oliver, Stuart Stirling
Pureell, John Wilbert
Rogers, Harry George
Russell, Cyrus James
Seens, John William
Stalker, Andrew Douglas
Toms, Lewis W.
Topping, Victor
Warnock, Charles
Wood, Robert
Workman, Samuel Fraser

Students

Doueet, Rolfe Leigh
Lemieux, Denis
Milne, Geoffrey Robertson
Morrison, Claude Wilson
Roy, Louis Philippe
Raue, Alfred George

Total Membership

The membership of The Institute as at December 31st, 1937, totals four thousand, five hundred and thirty-six. The corresponding number for the year 1936 was four thousand, two hundred and thirteen.

1936		1937	
Honorary Members	9	Honorary Members	16
Members	1,028	Members	1,041
Assoeiate Members	1,988	Associate Members	2,152
Juniors	326	Juniors	422
Students	821	Students	860
Affiliates	41	Affiliates	45
	4,213		4,536

Respectfully submitted on behalf of the Council,

G. J. Desbarats, Hon.M.E.I.C., *President.*
R. J. Durley, M.E.I.C., *Secretary.*

Treasurer's Report

The President and Council:—

Notwithstanding the past year being one of unusual activity, it is very gratifying to note that the Annual Financial Statement, as prepared by The Institute's Auditors, indicates only a small loss in operating expenses. Nevertheless, in view of the fact that for one cause or another, deficits, sometimes small, sometimes large, have been the rule for the last ten years, the situation cannot be looked at with entire equanimity.

As a result of the continuous annual deficits, not only has the liquid reserve been used up, but it has been necessary for some years to hypothecate for several months some of the securities belonging to the special funds in order to make available enough cash to meet ordinary expenditures until fees are paid. This very undesirable position may be justified in an emergency, but should not be tolerated as an habitual occurrence.

Furthermore, it has been impossible to take care of many items which, under ordinary business procedure, would be desirable, for example, the building has depreciated owing to lack of maintenance, The Institute is handicapped in carrying out many possible, and desirable, activities through lack of funds.

What is to be done about it? Although with improved conditions, and renewed activity in The Institute, the revenue from annual fees has increased, nevertheless, the possibility of a substantial increase in revenue from this source is not great. Other sources of revenue should be explored to the fullest possible extent. Similarly, the possibilities of reduction in cost of operation should be carefully studied. It would appear to be very desirable that the budget prepared by the beginning of the year should definitely provide for—(*a*) a reserve for unknown contingencies, and (*b*) a substantial amount for replacement of the working capital. The former being especially desirable, as experience shows that it is not always possible to foresee the necessity and desirability of holding a plenary meeting of Council, or some other special function.

Respectfully submitted,

J. L. Busfield, M.E.I.C., *Treasurer.*

Finance Committee

The President and Council:—

In presenting the Auditor's Statements for the year 1937, your Finance Committee wishes to commend the General Secretary and the Headquarters' Staff for their assistance in operating within a restricted budget in a year whose activities called for a great deal of additional effort on their part. The fact that The Institute is able to show such a good statement is due in no small part to their co-operation.

The Comparative Statement of Revenue and Expenditure we believe clearly sets forth the financial results of the year's operations but we would like to call your attention to one or two points that appear to us to be significant or that may need amplification.

It is cause for gratification that the receipts from fees show an increase over the previous year of almost $3,000. This reflects in part the increase in numbers and in part the improved economic status of our membership. As this is the most important source of our revenue, from more than a financial standpoint, we would like to stress the necessity of rendering all possible assistance to the Membership Committee in their efforts to increase our membership. The Institute has been carrying on under a restricted budget for a number of years and has had to forgo many of its former activities. We believe that a strenuous effort should be made this year to substantially increase our corporate membership.

In comparing Journal advertising and Journal expenses it will be noted that in both cases the items are considerably larger for 1937 than they were in 1936. These increases are largely due to the publication of the Semicentennial number of The Journal. The appearance of this number of The Journal reflects great credit on all those who were concerned in its preparation and deserves the high praise it has received.

The statement shows a profit of $1,331.69 on the 1937 Catalogue. Although this exceeded the budgeted net income from this source by some $500 the results were disappointing to us and to the Catalogue staff in that we had hoped that the year's efforts would result in a considerably greater profit. In this connection we want to

COMPARATIVE STATEMENT OF REVENUE AND EXPENDITURE

For the year ending 31st December

Revenue

	1936	1937
Membership Fees:		
Arrears	$ 2,350.00	$ 3,427.20
Current	24,026.67	25,210.39
Advance	618.86	512.65
Entrance	816.00	1,557.00
	$ 27,811.53	$ 30,707.24
Publications:		
Journal subscriptions and sales	$ 6,681.25	$ 7,052.75
Journal advertising	13,585.41	17,714.98
Catalogue advertising	17,567.82	17,676.57
	$ 37,834.48	$ 42,444.30
Income from Investments	$ 476.81	$ 452.06
Refund of Expenses of Hall	640.00	610.00
Sundry Revenue	112.59	10.80
Total Revenue	$ 66,875.41	$ 74,224.40
Excess of Expenditure over Revenue for Year	$ 1,612.39	$ 240.14
	$ 68,487.80	$ 74,464.54

Expenditure

	1936	1937
Building Expenses:		
Taxes—Property and water	$ 2,081.05	$ 2,035.48
Fuel	411.45	280.80
Insurance	165.75	165.45
Light	262.79	277.78
Caretaker's wages and service	878.00	878.00
Repairs and expenses	526.34	496.23
	$ 4,325.38	$ 4,133.74
Publications:		
Journal—Salaries	$ 5,757.91	$ 5,821.65
Expenses (1937 includes cost of special June issue)	12,338.37	20,217.18
Catalogue—Salaries	5,235.71	5,225.00
Expenses	12,253.40	11,119.88
Sundry printing	437.88	452.75
	$36,023.27	$42,836.46
Office Expenses:		
Salaries	$10,937.11	$10,800.51
Telephone, telegrams and postage	1,516.85	1,750 28
Office supplies and stationery	1,129.22	1,511.65
Audit fees	250.00	300.00
Messenger and express	130.64	83.02
Miscellaneous	293.86	362.97
Depreciation—Furniture and fixtures	....	463.74
	$14,257.68	$15,272.17
General Expenses:		
Plenary Meeting of Council	$ 2,167.93	$ 1,116.50
Annual and Professional Meetings—Net	2,477.47	969.92
Round Table Conference—Net	....	755.46
Meetings of Council	173.53	155.10
Travelling	62.84	111.20
Branch stationery	186.13	244.70
Students' Prizes	77.52	77.76
E-I-C Prizes	288.75	288.75
Gzowski Medal	17.25	17.25
Library—Salary	529.10	666.55
Expenses	467.34	378.18
Interest, discount and exchange	292.59	297.18
Examinations and Certificates	73.00	40.72
Committee expenses	1,104.72	732.68
National Construction Council	100.00	100.00
	$ 8,018.17	$ 5,951.95
Rebates to Branches	$ 5,863.30	$ 6,270.22
Total Expenditure	$68,487.80	$74,464.54

Note:—This Statement does not include the Revenue and Expenditure of the Semicentennial Fund.

express our high regard for the loyalty and unflagging zeal shown by Mr. Sheppard and his staff in connection with the Catalogue and The Journal advertising.

In conclusion we wish to express our thanks to Mr. Durley for his assistance in our work during the past year.

Respectfully submitted,

J. A. McCrory, m.e.i.c., *Chairman.*

Committee on Western Water Problems

The President and Council:—

During the past year your Committee has followed with appreciative interest the work accomplished in the West under the Dominion government in carrying out the provisions of the Prairie Farm Rehabilitation Act. The construction of stock-watering dams and dug-outs on individual farms has been encouraged and a start has been made on a number of minor irrigation projects. In contrast with this sound policy, certain grandiose irrigation schemes have been advocated, that are unlikely to produce benefits commensurate with their cost. Such projects should only be undertaken after thorough study has demonstrated their economic feasibility.

Recurring droughts of greater or less severity are a characteristic of the very lands that produce the best wheat. A large part of the area affected by the present crop failure will, over a period of years, yield the farmer a higher return than most of the agricultural land throughout Canada. Furthermore, the present distress is not all due to drought, but arises in part from the past low price of grain and crop damage from rust infestation. Even if irrigation were available, the application of the water to the land is laborious and the farmer will only undertake it in sections so dry that there would otherwise be little chance of raising a crop. It is idle to irrigate lands other than these.

With lands where there is a reasonable expectation of obtaining a crop the risk of crop failure can be greatly reduced by proper agricultural methods. Therefore, the problem with these is primarily one for the agriculturist, but the engineer can be of service in alleviating conditions in time of drought by providing a water supply for domestic and stock-watering purposes.

The prosperity of many of the irrigated districts in Alberta affords convincing proof of what can be accomplished where the soil is fertile and suitable settlers are available. Furthermore, the stabilizing influence of such districts lessens the burden of drought on the community as a whole. The economic benefits, though they fully

STATEMENT OF ASSETS AND LIABILITIES

As at 31st December, 1937

Assets

Current:		
Cash on hand and in Savings Bank		$ 114.11
Accounts receivable	$ 3,544.58	
Less: Reserve for uncollectible accounts	272.79	
		3,271.79
Arrears of fees—estimated		2,500.00
		5,885.90
Special Funds—Per Statement attached:		
Investments ($5,000.00 pledged with Bank)	$ 9,285.14	
Cash in Savings Bank	1,356.02	
Due by Current Funds	3,314.98	
		13,956.14
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	
2 shares Canada Permanent Mortgage Corp	215.00	
40 shares Montreal Light, Heat & Power Cons. N.P.V	324.50	
		8,558.51
Approximate market value—$9,420.00		
Advances to Branches		125.00
Advance Travelling Expenses		125.00
Deposit—Postmaster		100.00
Prepaid and Deferred Charges:		
Stationery and office supplies	462.65	
Unexpired insurance	117.67	
Expenses incurred on 1938 Catalogue to date	1,848.21	
		2,428.53
Gold Medal		45.00
Library—At cost less amounts written off		1,448.13
Furniture—At cost less amounts written off		4,173.67
Land and Buildings—At cost (Assessed value $57,200)		89,041.64
		$125,887.52

Liabilities

Current:		
Bank Overdraft—Secured		$ 8,422.03
Accounts payable		1,728.86
Rebates due to Branches		574.22
Library deposits		5.00
Amount due to Leonard Medal Fund	$ 500.00	
Amount due to Past Presidents' Fund	2,814.98	
		3,314.98
		14,045.09
Special Funds:		
Leonard Medal	$ 654.34	
Plummer Medal	656.30	
War Memorial	2,131.15	
Fund in aid of Members' Families	2,379.02	
Past Presidents' and Prize Fund	5,684.45	
Duggan Medal and Prize Fund	2,450.88	
		13,956.14
Surplus:		
Balance as at 1st January, 1937	98,126.43	
Deduct: Excess of Expenditure over Revenue for year per Statement attached	240.14	
		97,886.29
		$125,887.52

Audit Certificate

We have audited the books and vouchers of The Engineering Institute of Canada for the year ending 31st December, 1937 and have received all the information we required. In our opinion, the above Statement of Assets and Liabilities and attached Statement of Revenue and Expenditure are properly drawn up so as to exhibit a true and correct view of The Institute's affairs as at 31st December, 1937, and of its operations for the year ending that date, according to the best of our information and the explanations given to us and as shown by the books.

Ritchie, Brown & Co.,
Chartered Accountants.

Montreal, 17th January, 1938.

justify irrigation where conditions are favourable, are far too widespread to be readily assessable, and on this account the work can only be undertaken by the Government.

The past year has seen a rapid expansion in the use of electric pumps in the Eastern Irrigation District of Alberta. There are now ten such installations either pumping water to lands above ditch level or reclaiming drainage from land already irrigated. The extension of existing projects by such means and by the creation of storage can be accomplished at much less cost per acre than for most of the proposed new projects.

The day will come when all the available supply is being utilized and water is at a premium. It would, therefore, seem advisable to proceed with the requisite works to conserve and utilize Canada's share of the boundary waters, such as the St. Mary's and Milk rivers, as also the planning of a comprehensive water conservation programme.

Respectfully submitted,

G. A. Gaherty, M.E.I.C., *Chairman.*

Nominating Committee—1938

Chairman: H. F. Bennett, M.E.I.C.

Branch	*Representative*
Halifax Branch	C. A. D. Fowler, M.E.I.C.
Cape Breton Branch	W. C. Risley, M.E.I.C.
Saint John Branch	V. S. Chesnut, A.M.E.I.C.
Moncton Branch	T. H. Dickson, A.M.E.I.C.
Saguenay Branch	A. I. Cunningham, A.M.E.I.C.
Quebec Branch	L. P. Méthé, A.M.E.I.C.
St. Maurice Valley Branch	A. C. Abbott, A.M.E.I.C.
Montreal Branch	J. G. Hall, M.E.I.C.
Ottawa Branch	E. W. Stedman, M.E.I.C.
Peterborough Branch	W. M. Cruthers, A.M.E.I.C.
Kingston Branch	L. F. Grant, M.E.I.C.
Toronto Branch	G. H. Rogers, A.M.E.I.C.
Hamilton Branch	H. B. Stuart, M.E.I.C.
London Branch	D. S. Scrymgeour, A.M.E.I.C.
Niagara Peninsula Branch	G. H. Wood, A.M.E.I.C.
Border Cities Branch	J. Clark Keith, A.M.E.I.C.
Sault Ste. Marie Branch	A. E. Pickering, M.E.I.C.
Lakehead Branch	E. L. Goodall, A.M.E.I.C.
Winnipeg Branch	F. V. Seibert, M.E.I.C.
Saskatchewan Branch	W. E. Lovell, M.E.I.C.
Lethbridge Branch	J. M. Campbell, A.M.E.I.C.
Edmonton Branch	H. R. Webb, A.M.E.I.C.
Calgary Branch	S. G. Coultis, M.E.I.C.
Vancouver Branch	E. C. Thrupp, M.E.I.C.
Victoria Branch	F. C. Green, M.E.I.C.

SPECIAL FUNDS

As at 31st December, 1937

Leonard Medal Fund:			*Represented by:*		
Balance as at 1st January, 1937	$ 657.97		Cash in Savings Bank	$ 154.34	
Add: Bond interest	5.50		Amount due by Current Funds	500.00	
Bank interest	.77				
Interest on amount loaned to Current Funds	7.35				
	671.59				
Deduct: Cost of Medal	17.25				
		$ 654.34			$ 654.34
Plummer Medal Fund:					
Balance as at 1st January, 1937	650.25		$500 Dominion of Canada 4½% 1959 Bonds	500.00	
Add: Bond interest	22.50		Cash in Savings Bank	156.30	
Bank interest	.80				
	673.55				
Deduct: Cost of Medal	17.25				
		656.30			656.30
War Memorial Fund:					
Balance as at 1st January, 1937	2,046.33		$2,000 Dominion of Canada 4½% 1959 Bonds	2,000.00	
Add: Bond interest	90.00		Cash in Savings Bank	131.15	
Bank interest	.22				
	2,136.55				
Deduct: Expenses re Memorial Tablet	5.40				
		2,131.15			2,131.15
Fund in Aid of Members' Families:					
Balance as at 1st January, 1937	2,287.32		$1,000 Province of Ontario 4½% 1964 Bonds	1,022.17	
Add: Bond interest	90.00		$1,000 Dominion of Canada 4½% 1959 Bonds	972.97	
Bank interest	1.70		Cash in Savings Bank	383.88	
		2,379.02			2,379.02
Past Presidents' and Prize Fund:					
Balance as at 1st January, 1937	5,567.44		$3,000 Montreal Tramways 5% 1955 Bonds	2,490.00	
Add: Donation	50.00		Cash in Savings Bank	379.47	
Bond interest	166.50		Amount due by Current Funds	2,814.98	
Bank interest	1.50				
Interest on amount loaned to Current Funds	34.01				
	5,819.45				
Deduct: Cost of Prize	135.00				
		5,684.45			5,684.45
Duggan Medal and Prize Fund:					
Balance as at 1st January, 1937	2,456.26		$2,300 Dominion of Canada 4½% 1959 Bonds	2,300.00	
Add: Donation	27.00				
Bond interest	103.50				
Bank interest	2.47				
	2,589.23				
Deduct: Cost of Prize and Medal	138.35				
		2,450.88			2,450.88
		$13,956.14			$13,956.14

Past-Presidents' Prize Committee

The President and Council:—

Your Committee has carefully considered the eight papers submitted for the prize year 1936-1937, the subject being "The Need of the Engineer's Participation in Public Affairs." Some members of your Committee feel some doubt as to the eligibility of any of the papers, on the ground that the authors misunderstood the real significance of the title; if, however, Council decides that an award should be made, the Committee is unanimously of the opinion that the paper submitted by W. H. Powell, M.E.I.C., is first in order of merit and that submitted by E. R. Jacobsen, A.M.E.I.C., is second.

Respectfully submitted,

P. H. Buchan, M.E.I.C., *Chairman.*

Note:—In view of this report, the Council, at its meeting on December 20th, awarded the Past-Presidents' Prize to Mr. Powell, and honourable mention to Mr. Jacobsen.

Duggan Medal and Prize Committee

The President and Council:—

Your committee for the year 1936-1937, having read the papers published in The Journal, and those specially submitted, dealing with the subjects for which the prize might be awarded, is of the unanimous opinion that none of these papers is of sufficient merit to justify the award of a prize of this importance. The award of this prize carries with it a distinction to which, in your committee's opinion, none of the authors of the papers submitted is entitled.

Respectfully submitted,

A. H. Harkness, M.E.I.C., *Chairman.*

Gzowski Medal Committee

The President and Council:—

Your Committee on the Gzowski Medal Award, consisting of E. P. Fetherstonhaugh, R. S. L. Wilson, J. M. Robertson, J. N. Finlayson, and the writer, wish to report as follows:—

First—"North Atlantic Air Service, London to Montreal" by J. H. Parkin, M.E.I.C.

Second—"The Adaptation of Rigid Frames to Modern Construction" by E. R. Jacobsen, A.M.E.I.C.

Respectfully submitted,

E. V. Caton, M.E.I.C., *Chairman.*

Note:—In view of the above report, the Council, at its meeting on January 21st, awarded the Gzowski Medal to Mr. Parkin.

Plummer Medal Committee

The President and Council:—

The Plummer Medal Committee recommends that the Plummer Medal for the year 1937 be awarded to J. R. Donald, M.E.I.C., for his papers "Fire and Explosion Hazards from Industrial Products," July, 1936, and "Chemical Engineering," June, 1937. As second choice, the Committee names Professor Edgar Stansfield, M.Sc., M.E.I.C., for his paper "The Burning of Low Rank Alberta Coals, Combustion and Control," July, 1937. The Committee recommends that a silver medal be awarded to Professor Edgar Stansfield.

Respectfully submitted,

Alfred Stansfield, M.E.I.C., *Chairman.*

Leonard Medal Committee

The President and Council:—

The Committee unanimously recommend that the Medal be awarded to T. L. McCall, M.E.I.C., for his paper "Some Coal Mining Practices of the Dominion Steel and Coal Corporation Limited," which was published in the C.I.M. & M. Bulletin, July, 1936.

Respectfully submitted,

J. B. de Hart, 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 21st, 1938, and the following awards were made:—

H. N. Ruttan Prize (Western Provinces) No papers received.

John Galbraith Prize (Province of Ontario)—To D. C. McCrady, S.E.I.C., for his paper "Sanitary Analysis of Drinking Water."

Phelps Johnson Prize (Province of Quebec, English)—To G. Martin, Jr.E.I.C., for his paper "The Elements of Modern Combustion Engineering."

Ernest Marceau Prize (Province of Quebec, French)—No papers received.

Martin Murphy Prize (Maritime Provinces)—No papers received.

Papers Committee

The President and Council:—

Following the procedure of the previous year the Papers Committee of The Institute was composed of the Chairmen of all the Branches. Efforts have been made to establish some method of helping the smaller and more isolated Branches to secure suitable papers but, unfortunately, without much tangible results.

Branches in the larger cities and those near these cities have no trouble in getting papers but the others are greatly handicapped in this respect. The Institute's Papers Committee should, therefore, largely concern itself with the latter. The difficulties are many and they will not be recounted here. The officers of these Branches know them all.

It would seem that it is largely a local problem and if a Branch has an energetic and resourceful Chairman many suitable papers could be secured. The larger manufacturing companies of the Dominion are generally willing to co-operate in sending members of their staff to our Branches and in the past have been very generous in this respect.

However the Chairman of your committee believes that a great deal more should be done by Headquarters, and serious consideration should be given by the Council to the possible setting up of a Department to assist in the supply of papers to those Branches that require them. The strength of The Institute lies in its Branches and anything that can be done to keep them active and enthusiastic will be amply repaid.

In last year's report it was suggested that Headquarters might prepare a list of available 16mm. motion pictures on engineering subjects, but on account of the large amount of detail in connection with the Semicentennial Meeting, this was not done. It should be followed up in 1938 and this very valuable addition to Branch programmes made available.

The Papers Committee regrets that it has not been able to do more for the Branches requiring help, but the handicaps of distance and the financial situation seem to be insurmountable.

Respectfully submitted,

R. L. Dobbin, M.E.I.C., *Chairman.*

Committee on Professional Interests

The President and Council:—

At the Plenary Meeting of Council held in Montreal in June last, approval was given to the recommendations of a special committee appointed by Council on May 28th, 1937, and consisting of J. L. Busfield, M.E.I.C., F. S. B. Heward, A.M.E.I.C., and R. A. Spencer, A.M.E.I.C.

This Committee recommended:—

(*a*) "That a Main Committee on Professional Interests (C.P.I.) be appointed by Council and consist of a Chairman, who shall be a member of Council, and two other members.

"This Committee is to co-ordinate and supervise the activities of the Provincial Committees of The Institute on Professional Interests. More particularly it shall collect, codify and deal with the various matters submitted to it by the Provincial Professional Committee and, following approval by Council, shall issue instructions as to appropriate actions to be taken.

(*b*) "In each province, Council shall nominate a Councillor to act as Chairman of the Provincial Committee of The Institute on Professional Interests, with powers to appoint additional members on sub-committee, subject to the approval of Council.

"The duties of the above mentioned Provincial Committees are to investigate and report on matters relating to:—

1—Salaries and Remuneration
2—Professional Practice
3—Junior Engineers
4—Public Education."

At the Plenary Meeting, the Committee on Professional Interests was appointed as follows:—

F. A. Gaby, M.E.I.C., Chairman,
F. Newell, M.E.I.C., Member,
O. O. Lefebvre, M.E.I.C., Member.

Council at the same time appointed the Chairmen of the Provincial Sub-Committees, as follows:—

P. H. Buchan, M.E.I.C., British Columbia
R. M. Dingwall, M.E.I.C., Alberta
R. A. Spencer, A.M.E.I.C., Saskatchewan
T. C. Main, A.M.E.I.C., Manitoba
J. A. Vance, A.M.E.I.C., Ontario
J. A. McCrory, M.E.I.C., Quebec
E. J. Owens, A.M.E.I.C., New Brunswick
H. S. Johnston, M.E.I.C., Nova Scotia.

The Chairman of each Provincial Committee was asked to organize his own Committee.

All Provincial Committees have not yet been completed. The following is the standing to date in the various provinces:—

British Columbia

P. H. Buchan, Chairman, has selected to act with him:—

H. Nolan Macpherson, M.E.I.C., Vancouver
J. P. Mackenzie, M.E.I.C., Vancouver.

Mr. Buchan has reported that the President of the Association of Professional Engineers of British Columbia, Mr. Vilstrup, has expressed himself as being satisfied that the Provincial Sub-Committee might be in a position to assist his Council in matters of common interest and be of real service to the Association of Professional Engineers of British Columbia.

Alberta

R. M. Dingwall, Chairman of the Sub-Committee, has selected two members of the Lethbridge Branch:—

J. T. Watson, A.M.E.I.C.,
R. F. P. Bowman, A.M.E.I.C.

Two members of the Calgary Branch are yet to be selected.

Saskatchewan

Professor R. A. Spencer, Chairman of the Sub-Committee, has selected the following members:—

From Saskatoon: W. E. Lovell, M.E.I.C.,
A. M. Macgillivray, A.M.E.I.C.,
E. K. Phillips, A.M.E.I.C.

Professor Spencer has not been able to appoint any member from Regina.

Professor Spencer, who is also Chairman of The Institute's Committee on Membership and Management, submitted, in October, a memorandum on Membership Classification and Fees, together with a suggested plan for Provincial Consolidation. A great deal of this material refers to the work of the Committee on Professional Interests, and the Main Committee will investigate the suggestions that Professor Spencer has submitted.

Manitoba

The Manitoba Sub-committee has the following membership:—

A. J. Taunton, M.E.I.C., Chairman
A. E. Macdonald, M.E.I.C.
H. L. Briggs, A.M.E.I.C.

Ontario

James A. Vance, Chairman of the Sub-Committee, has announced the following appointments:—

H. J. A. Chambers, A.M.E.I.C., Border Cities
H. F. Bennett, M.E.I.C., London
R. W. Boyle, M.E.I.C., Ottawa
W. E. Bonn, M.E.I.C., Toronto

This Sub-Committee has been very active, having held many meetings at different points in the province, namely London on September 8th, Peterborough on September 10th, etc.

Quebec

J. A. McCrory, Chairman of the Sub-Committee, has selected as members:—

Arthur Duperron, M.E.I.C.
E. A. Ryan, M.E.I.C.

There was some misunderstanding concerning the respective duties of the Main Committee and of the Sub-Committee. Now that the relations between the two Committees have been clearly set out, it is expected that progress will be made.

New Brunswick

E. J. Owens, Chairman of the Sub-Committee, has appointed the following members to act with him:—

T. H. Dickson, A.M.E.I.C., Moncton
G. A. Vandervoort, A.M.E.I.C., Saint John.

A scheme of co-operation between The Institute and the Provincial Association is now under consideration by the Council of the New Brunswick Association of Professional Engineers.

Nova Scotia

Harold S. Johnston, M.E.I.C., Chairman of the Sub-Committee, has appointed the following members to act with him:—

W. A. Winfield, M.E.I.C., Halifax
S. C. Mifflen, M.E.I.C., Sydney, Cape Breton.

It is to be noted that Council of The Institute, prior to the appointment of the Committee on Professional Interests and the Sub-Committees, had appointed H. W. McKiel, M.E.I.C., and C. A. D. Fowler, M.E.I.C., to act on a Joint Co-ordination Committee made up of representatives from the Halifax and Cape Breton branches of The Institute and the Nova Scotia Association of Professional Engineers, this Joint Committee to investigate the possibility of co-operation between The Institute and the Association of Professional Engineers in Nova Scotia. Proposals of this Joint Committee were submitted to the Council on October 22nd, and it was then resolved that The Institute would be prepared to enter into the proposed agreement, if the proposals were accepted by the membership through letter ballot. Actually a draft of a proposed agreement has been sent to Nova Scotia for consideration.

Your Committee hopes that in considering this report, members of Council and members of The Institute will appreciate that the important work entrusted to the Committee cannot be initiated rapidly and that the organization of the Provincial Sub-Committees is sometimes more involved than would appear to be the case.

The Committee hopes that following the organization of the Provincial Sub-Committees, progress will be made.

Respectfully submitted,
F. A. Gaby, M.E.I.C., *Chairman.*

Board of Examiners and Education

The President and Council:—

Your Board of Examiners beg to report as follows regarding the results of The Institute examinations held in May and November:—

Examined under	*Number of Candidates* May	Nov.	*Number passed* May	Nov.	*Passed in all subjects Completely*
Schedule B (Junior)					
I Elementary Physics and Mechanics	1	3	1	2	..
II Strength and Elasticity of Materials	2	3	2	2	4
Schedule C (Associate Member)					
III A General Electrical Engineering	1	..	1	..	..
III B2 Electric Power Transmission and Distribution	1	..	1	..	1

Respectfully submitted,
R. S. L. Wilson, M.E.I.C., *Chairman.*

Committee on Membership and Management

The President and Council:—

This committee was appointed at the Plenary Meeting of Council in June of this year to examine and report on the following:—

1. Is more local autonomy in the Provinces advisable?
2. Would the setting up of Provincial Divisions be advisable?
3. Can the present organization of Council be improved and is the conduct of Institute affairs efficient and economical?
4. What are the standards of admission and fees in other engineering organizations?
5. Are the present qualifications for admission to The Institute best suited to existing conditions?
6. Are the present classifications of membership in the E.I.C. best suited to existing conditions?
7. Can ways and means be provided under which better knowledge of Institute affairs will be disseminated throughout the membership and particularly with regard to conditions pertaining in the respective Provinces?

Up to the present time considerable information bearing on the above has been collected. Some of this material has been mimeographed and sent to individual members of Council.

Matters of organization of Council, standards of admission, classification of membership and fees, are all to some extent tied up with the proposed changes in by-laws now being discussed. They are also involved in the activities of the Committee on Professional Interests. Our Committee must, therefore, move slowly until the situation in regard to these matters has become clarified.

Respectfully submitted,
R. A. Spencer, A.M.E.I.C., *Chairman.*

Library and House Committee

The President and Council:—

During the year your committee has continued the policy of keeping down expenditures on maintenance and repairs and has been successful in showing a slight reduction over previous years.

Library and Information Service

There has been a falling off in the demands made upon this Department and Service during the past year as will be noted from an examination of the figures tabulated hereinafter for the years 1936 and 1937. To some degree this may be explained in that less publicity was given the facilities afforded, owing to the demands made upon the staff at Headquarters by reason of the holding of the Semicentennial celebrations last June. It may be also an indication of better times in the profession and fewer of our members with time on their hands for reading, etc. In previous years many of those who were out of employment used the service extensively.

Practically no additions were made to the Library other than those volumes presented us by the publishers and it is to be observed that a smaller number was obtained from this source than in previous years. As soon as funds permit, we should again adopt the policy of adding to the Library, at our own expense, such books on engineering subjects as may be considered useful and which are published from time to time. Unless this be done we shall soon reach a point where the information and data available will be obsolete in certain fields.

We desire to refer to the Committee's report for the year 1936 in which certain suggestions were made for improving the facilities afforded the members through the Library and Information Service, to which it has not been found possible to give effect up to the present.

Summaries of the activities of this department for the years 1936-1937 are given herewith for purposes of comparison.

	1937	*1936*
Requests for information	516	861
Requests for textbooks, periodicals, etc.	360	577
Technical books borrowed by members	130	153
Bibliographies compiled for members	27	40
Accessions to library (largely reports, etc.)	554	665
Requests for photoprints	11	22
Total pages of photoprints furnished to members	158	119
Books presented for review by publishers	19	32

Building Repairs and Maintenance

Rather extensive repairs had to be undertaken on the property this year in regard to fences, fire-escape, etc., but notwithstanding same the total cost on this account was less than in the previous year. The comparative figures follow:—

	1936	*1937*
Building maintenance	$526.34	$474.47

On behalf of my Committee I wish to express to the General Secretary and his staff our appreciation of their collaboration and assistance. To their unstinted efforts are due the excellent service afforded and the success attained in keeping operating costs within budgeted figures.

Respectfully submitted,
E. A. Ryan, M.E.I.C., *Chairman.*

Employment Service Bureau

The President and Council:—

The Employment Service Bureau of The Institute is able to report a distinct improvement in employment conditions during the past year, the sixth consecutive year to show such a betterment.

The following figures show the placements effected during the past six years:—

Year	*1932*	*1933*	*1934*	*1935*	*1936*	*1937*
Placements	58	50	70	77	110	181

The extent of the Bureau's work for 1937, as compared with 1936 is shown as follows:—

Number of registrations during the year:	*1937*	*1936*
Members	132	103
Non-members	74	45
Number of members advertising for positions	68	77
Replies received from employers	40	42
Vacant positions registered	275	195
Vacancies advertised in The Journal	69	25
Replies received to advertised positions	380	259
Men's records forwarded to prospective employers	701	746
Men notified of vacancies	355	259
Placements definitely known	181	110

Our active list of men seeking positions now contains 298 names, only some ten per cent of whom are actually unemployed.

Five lists of vacancies were issued during 1937.

A large number of interviews were given in connection with employment, both with employers and those seeking employment.

During a considerable part of the year the demand for engineers exceeded the supply available. This occurred principally in the following classifications:—

Recent graduates in mechanical and civil engineering.
Young mechanical and civil engineers with two or three years experience.
Experienced mechanical and structural designers.
Mechanical and electrical draughtsmen.

During the last two months of the year there was a considerable reduction in the number of positions listed with the Bureau. However, the number of men who during that time advised us that their work had terminated showed a large reduction from previous years.

It should be noted that the known placements for the year are 181, this is only the number who have notified us that they have received positions through the Employment Service Bureau. In many cases where contacts are made through the Service, no definite action may be taken for some months or even longer; or an employer may report that he has engaged a man to fill the position and may later decide that he requires an additional man or two, and he then engages these men from the records we have sent to him in the first instance, and as a rule we are not advised in such cases.

Respectfully submitted,

R. J. Durley, M.E.I.C., *General Secretary.*

Branch Reports

Border Cities Branch

The President and Council:—

On behalf of the Executive committee, we have the honour to submit the annual report for the calendar year 1937.

The Executive committee met seven times during the year for the transaction of Branch business.

Seven regular meetings were held during the year and one meeting on December 10th for the election of officers for the year 1938.

Information on the regular monthly meetings is as follows:—

1937

Jan. 22.—**Some New Things under the Sun**, by S. E. McGorman, M.E.I.C., the Chairman of Windsor Board of Commerce and an engineer of Canadian Bridge Co. Ltd. Attendance 21.

Feb. 12.—**Archery**, by Prof. Geo. J. Higgins, Associate Professor of Aeronautical Engineering, University of Detroit. Attendance 35.

Mar. 19.—**The Future of Aviation**, by Dr. H. F. Gerhardt, Professor of Aero Engineering, Wayne University, Detroit. Attendance 21.

Apr. 19.—**The Human Map Speaks for Itself**, by Prof. J. H. Levy of Toronto.

May 28.—**Air Compressors**, by E. T. Harbert, A.M.E.I.C., Canadian Ingersoll-Rand Co., Sherbrooke. Attendance 14.

Oct. 15.—**Heat Insulation** was a talking film presented by J. Bright of the London office of Johns-Manville Co. Attendance 33.

Nov. 16.—**The Burning of Powdered Fuel**, by Henry Kreisinger of Combustion Engineering Incorporated, New York City. This was a joint meeting with the Detroit Section of A.S.M.E. and the dinner was preceded by an inspection trip through the Ford Motor Company power house and new body plant at Windsor. Attendance 191.
The Border Cities Branch acted as host.

Dec. 10.—**Reminiscences of an Engineer**, by C. M. Goodrich, M.E.I.C., chief engineer of Canadian Bridge Co. The election of officers took place. Attendance 17.

MEMBERSHIP

The membership of the Branch is made up as follows:—

	1936 Resident	*1936* Non-Resident	*1936* Total	*1937* Resident	*1937* Non-Resident	*1937* Total
Members	11	4	15	11	4	15
Associate Members	31	7	38	31	10	41
Juniors	4	2	6	5	4	9
Students	8	6	14	9	4	13
Affiliates	1	..	1	1	..	1
			74			79

FINANCIAL STATEMENT

Receipts

Balance on hand, January 1st, 1937 (including $24.32 unemployment fund)	$185.85	
Rebates on dues, October, November, December, 1936	10.80	
Rebates on Councillors expenses to Plenary Meeting	34.75	
Rebate on representative to Round Table Conference, Montreal	35.75	
Rebates on dues, January, February, March, April, 1937	103.50	
Received from Unemployment loan	100.00	
Rebates on dues, May to September, 1937	26.25	
Dinner receipts	300.50	
Rebates on dues, October to December, 1937	12.60	
		$810.00

Expenditures

Printing expense	$ 53.94	
Stamps, telegrams, stationery, etc	6.47	
Speaker expenses	10.00	
Dinner expenses	340.78	
Travelling expenses	94.56	
Miscellaneous	54.47	
Balance on hand, December 10th, 1937, including $124.32 Unemployment fund	237.18	
Accounts receivable, rebates, October, November, December, 1937	12.60	
		$810.00

OBITUARY

The Border Cities Branch lost a valuable member in the person of J. W. Seens, the President of the Canadian Steel Corporation and Canadian Bridge Company, Walkerville. His influence in this Branch is greatly missed.

Respectfully submitted,
C. F. DAVISON, A.M.E.I.C., *Chairman.*
J. F. BRIDGE, A.M.E.I.C., *Secretary-Treasurer.*

Calgary Branch

The President and Council:—

On behalf of the Executive committee of the Calgary Branch we have the honour to submit the following report covering the activities of this Branch for the year 1937:—

MEMBERSHIP

	Branch Resident *1936*	*1937*	*Branch District* *1936*	*1937*	*Total* *1936*	*1937*
Members	17	19	5	5	22	24
Associate Members	48	49	10	10	58	59
Juniors	6	14	1	3	7	17
Students	13	12	4	2	17	14
Branch Affiliates	6	10	..	..	6	10
Total	90	104	20	20	110	124

MEETINGS

Ten general and special meetings of the Branch were held during the year. The following summary shows the dates, speakers, subjects and attendance at these meetings:—

1937

Jan. 14.—W. J. Gold, Jr.E.I.C., on **Overhead Conductor Vibration.** Attendance 20.

Jan. 23.—Annual joint dinner with Association of Professional Engineers of Alberta and Rocky Mountains Branch Canadian Institute of Mining and Metallurgy. A. E. Ottewell, Registrar, University of Alberta, on **Nothing Remains To Be Done**. Attendance about 100 (aggregate).

Feb. 11.—A. T. McCormick, A.M.E.I.C., on **Sound, Natural and Unnatural.** Attendance 34.

Mar. 4.—F. H. Ballou, M.E.I.C., chief engineer, B.C. Sugar Refining Co., Ltd., and Canadian Sugar Factories Ltd., on **Beet Sugar Refining and Construction of the Picture Butte Sugar Factory**. Attendance 31. This meeting was held in conjunction with the regular weekly luncheon of the Junior Section, Calgary Board of Trade.

Mar. 13.—Annual meeting. Attendance 20.

Sept. 11.—Annual Golf Tournament. Attendance 20.

Sept. 24.—Dr. G. S. Hume, Geological Survey of Canada, on **The World Situation in Petroleum.** Attendance 150 (aggregate). Members of The Oil and Gas Association were invited to this meeting.

Oct. 20.—Informal dinner and entertainment provided by The Canadian Western Natural Gas, Light, Heat and Power Company, Ltd. E. W. Bowness, M.E.I.C., spoke on **A Trip to the Coronation** (illustrated by films) **and Conditions in Europe.** Attendance 60.

Nov. 16.—J. W. Young, A.M.E.I.C., on **The Chemistry of Crime.** Attendance 60.

Dec. 2.—J. S. Neil, A.M.E.I.C., on **Natural Gas Burners**, and J. V. Eckenfelder, S.E.I.C., on **A Hydrographic Survey of Tuktoyaktuk Harbor, MacKenzie River Delta.** Attendance 40.

We are pleased to be able to report that of the seven papers given at Branch general meetings five were given by the younger members of the Calgary Branch.

During the year the Branch Executive committee met seven times for the purpose of conducting the business of the Branch and the other committees held meetings as required for their work. One problem which has been given a lot of consideration during the year is that of attendance at Branch meetings. While some improvement has been achieved the problem is not yet solved.

Finances

Statement of Revenue and Expenditure for year ending December 31st, 1937

Revenue		
Rebates	$201.00	
Branch Affiliates dues	27.00	
Interest	33.36	
Sale of bonds	200.00	
		$461.36
Expenditures		
Branch general meetings	$ 40.92	
Branch annual meeting	16.18	
Branch entertainments	74.01	
Purchase of bond	200.00	
Printing and stationery	18.15	
Postage and revenue stamps	8.00	
Telephone calls and telegrams	8.99	
Stenographic services	5.00	
Gift to Secretary	11.06	
Branch share of expenses re Round Table Conference	18.42	
Miscellaneous expenses	3.00	
	$403.73	
Surplus for year	57.63	
		$461.36

Financial Statement

Cash, as at December 31st, 1936	$141.82	
Rebates, October to December (incl.), 1936	17.40	
Balance, as at December 31st, 1936		$159.22
Surplus for year 1937		57.63
Balance as at December 31st, 1937		$216.85

Balance Sheet

Assets		
Cash	$205.15	
Rebates due from Headquarters	11.70	
Securities at book value	953.82	
Stamps and stationery on hand	2.00	
		$1,172.67

Liabilities
None.

Audited and found correct,
W. St. J. Miller, A.M.E.I.C., Auditor.

Respectfully submitted,
H. W. Tooker, A.M.E.I.C., *Chairman.*
James McMillan, A.M.E.I.C., *Secretary-Treasurer.*

Cape Breton Branch

The President and Council:—

The annual report for the Cape Breton Branch is as under:—

Financial Statement

Receipts		
Balance brought forward	$206.26	
Rebates	119.10	
Receipts, meeting	27.50	
		$352.86
Expenditures		
Meetings	$ 78.53	
Printing	5.03	
Assessment Headquarters re meeting Branch representatives	8.88	
Expenses delegates to Halifax meetings re co-operation with Professional Association	36.80	
Telegrams	1.82	
Postage and secretarial	13.40	
Balance on hand	208.40	
		$352.86

During the year the Branch held but three general meetings at one of which Vice-President McKiel spoke on the success of the Semi-centennial meeting and on the subject of co-operation with the Professional Associations.

The second was the annual meeting which took the form of an afternoon sail on Sydney harbour followed by a picnic lunch and dance at Crawley's Creek.

The third was a reception to meet President Desbarats and was addressed by the President on Institute affairs, following which a very general discussion ensued and there was passed unanimously a resolution of appreciation of the co-operation received from Headquarters and particularly from the General Secretary.

Respectfully submitted,
Sidney 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 wish to submit the following report for the year 1937:—

Membership

Our present membership is as follows:—

	Resident	*Non-Resident*	*Total*
Members	19	2	21
Associate Members	25	7	32
Juniors	5	1	6
Students	28	..	28
	77	10	87

This shows the same total membership for the Branch as in 1936.

Meetings

The Executive committee held four meetings during the year to transact the business of the Branch, and one special meeting at which they entertained one of the visiting Eastern members.

The Branch held five general meetings throughout the year. The following is a summary:—

1937

Feb. 16.—The annual mixed meeting of the Branch, when the members entertained their wives and friends at the Corona hotel. Captain E. R. Gibson, member of the Alpine Club of Canada, gave an address on **Climbing the Great Divide.**

Apr. 9.—Dinner and meeting at Macdonald hotel, addressed by P. L. Pratley, M.E.I.C., who spoke on **The Island of Orleans Bridge.**

Apr. 28.—Dinner and meeting at the Macdonald hotel. Election of officers for 1937-38 session and an address on **Recent Ideas in Earthwork Engineering**, by Professor I. F. Morrison.

Aug. 28.—Luncheon meeting at Macdonald hotel. G. J. Desbarats, C.M.G., Hon.M.E.I.C., President of The Institute, gave a talk on **Institute Matters.**

Nov. 19.—Dinner and meeting at the Macdonald hotel, addressed by J. D. Baker, M.E.I.C., on **Some Phases of Telephone Engineering.**

Financial Statement

Revenue		
Rebates from Headquarters:		
From January to September, 1937, incl.	$129.15	
From October to December, 1937, incl.	13.20	
		$142.35
Expenditures		
General meeting expenses	$ 14.75	
Branch entertainment (mixed meeting)	6.48	
General expenses:		
Postage	5.00	
Honorarium to Secretary	50.00	
Round Table Conference expenses	15.70	
Miscellaneous expenses	5.25	
	$ 97.18	
1937 surplus	45.17	
		$142.35

Financial Statement as at December 31st, 1937

Cash in bank as at December 31st, 1936	$150.58	
Rebates—October, November and December, 1936	20.40	
Balance as at December 31st, 1936	$170.98	
1937 surplus, as per statement	45.17	
Balance as at December 31st, 1937		$216.15

Balance Sheet as at December 31st, 1937

Assets		
Bank balances as at December 31st, 1937	$202.95	
Rebates—October and December, 1937	13.20	
Total assets		$216.15

Liabilities
Nil.

Audited and found correct:
E. L. Smith, A.M.E.I.C. }
J. W. Porteous, Jr.E.I.C. } Auditors.

Respectfully submitted,
W. E. Cornish, A.M.E.I.C., *Vice-Chairman.*
M. L. Gale, A.M.E.I.C., *Secretary-Treasurer.*

Halifax Branch

The President and Council:—

The year 1937 was marked with great activity on the part of the Executive of the Halifax Branch with respect to co-operation and amalgamation with the N.S. Society of Professional Engineers, and several joint meetings were held throughout the year by the executives of both Societies and the members of the Professional Society were invited to all the general meetings of The Institute.

The usual meetings were held during the year as follows:—

1937

Jan.— Annual Banquet in co-operation with the Nova Scotia Society of Professional Engineers was held at the Nova Scotian hotel.

Feb.— J. S. Roper, on **The Relations Between the Engineering and Legal Professions.**

Mar.—A general meeting on subject of **Housing and Housing Conditions.** The following subjects were covered:
Dominion Housing Act—C. A. Fowler, M.E.I.C.
Slum Clearance—Colonel S. C. Oland.
Home Improvement Plan—A. J. Haliburton.

April—I. P. McNab, on the subject of **Depreciation.** This lecture was well attended, especially by several out-of-town members who are interested in public utilities.

Oct.— A Students' Meeting was held at the N.S. Technical College. Chairman, J. B. Hayes, A.M.E.I.C. Speakers, Mr. Hayes, and members of the engineering staff of the N.S. Light and Power Company, Limited.

Nov.—Dr. Allan Cameron, M.E.I.C., Deputy Minister of Mines, Province of Nova Scotia, presented a travelogue on the **McKenzie River Basin.**

Dec.— Annual Meeting of the Branch, addressed by President G. J. Desbarats on the activities of The Institute, and of the Council with respect to amalgamation in Nova Scotia. He advised the Halifax Branch that the Council were definitely going to take steps in accordance with the proposed agreement, presented to Council by the Committee appointed by the Council, The Institute Branches in Nova Scotia and the N.S. Professional Engineers, and that the matter would come before the next Annual Meeting. Officers were elected for the year, 1938.

Executive

The Executive held several meetings during the past year, many of which were held in the evenings. The principal subject under discussion was Amalgamation and Co-operation, and it is hoped that definite action will be taken during 1938.

The financial statement is as follows:—

Income		
Rebates	$207.30	
Bank interest	1.61	
Rebate, banquet committee	5.31	
		$214.22
Expenses		
Annual grant to Secretary	$ 50.00	
Annual banquet grant	60.00	
Harry Cochrane	25.03	
Students' Meeting	7.03	
M.T. & T. Co., mailing list	3.53	
Wm. McNab & Son	36.18	
Stenographic services	10.00	
Grant—Prof. H. McKiel	50.18	
Secretary's office account	37.50	
	$279.45	
Deficit for the year 1937	65.23	
		$214.22
Bank balance from 1936	$416.17	
Deficit, 1937	65.23	
Balance, December 16th, 1937		$350.94

Respectfully submitted,
R. R. MURRAY, A.M.E.I.C., *Secretary-Treasurer.*

Hamilton Branch

The President and Council:—

On behalf of the Executive committee of the Hamilton Branch we have the honour to submit the annual report for the year 1937.

The Executive committee held eight business meetings during the year; the average attendance at these meetings being eight members.

Membership

December 31st, 1936	*Resident*	*Non-Resident*	*Total*
Members	33	5	38
Associate Members	37	11	48
Juniors	11	..	11
Students	30	6	36
Affiliates	2	..	2
Branch Affiliates	16	..	16
	129	22	151

Also 4 Members, 3 Associate Members and 4 Students on the non-active list.

December 31st, 1937	*Resident*	*Non-Resident*	*Total*
Members	26	10	36
Associate Members	41	13	54
Juniors	12	4	16
Students	30	10	40
Affiliates	1	..	1
Branch Affiliates	16	..	16
	126	37	163

Meetings and Papers

1937

Jan. 6.—Annual business meeting and dinner held at the Wentworth Arms hotel. Mr. Patton, entertainer, lectured on **The Tropical Valley of Alaska.** Attendance 75.

Jan. 14.—**Acoustics and Sound Control,** by W. J. Hodge, acoustical engineer, Johns-Manville Co., New York. Attendance 122.

Jan. 20.—Joint meeting with the Hamilton Chemical Association. **The Engineer and Chemist in the Oil Industry,** by Dr. F. A. Gaby, M.E.I.C., Executive Vice-President of the British American Oil Company. Attendance 81.

Feb. 19.—**Vancouver Jubilee Fountain,** by G. F. Mudgett, Manager, Illuminating Division, Canadian Westinghouse Company, and J. T. Thwaites, Jr.E.I.C. Attendance 95.

Mar. 10.—**The Manufacture of Cold Drawn Wire and Some Factors Affecting its Physical Properties,** by A. B. Dove, A.M.E.I.C. Attendance 55.

Apr. 7.—Annual joint meeting with the Toronto Section of American Institute of Electrical Engineers. Held in the Westinghouse Auditorium. **Industrial Progress Through Science and Research,** by Dr. L. W. Chubb, Director of Research, Westinghouse Electric and Manufacturing Company, Pittsburgh. Attendance 193.

May 4.—**Motor Car Engines and Their Fuels,** by P. B. MacEwen, combustion engineer, Ethyl Gasolene Company. Attendance 120.

May 14.—Joint meeting with the Ontario Section of the American Society of Mechanical Engineers, the Grand Valley Group of the Registered Professional Engineers of Ontario and the Niagara Chemical and Industrial Association. Meeting held at Brantford, Ontario, during the afternoon and evening. Visits to plants and local industries, civic welcome by His Worship the Mayor of Brantford, followed by a banquet which was enjoyed by 165 guests.

Oct. 5.—**The Work of the National Research Council,** by Major General A. G. L. McNaughton, C.B., C.M.G., D.S.O., M.Sc., LL.D., M.E.I.C., President of the National Research Council. Attendance 86.

Oct. 21.—**Recent Achievements in Colour Photography,** by Mr. Jackson, Eastman Kodak Company, New York. This meeting was ladies night and was well attended by the wives and friends of the members who were guests of the Branch during refreshments after the meeting. Attendance 180.

Nov. 9.—**The Problem of Braking High Speed Trains,** by W. E. Sprague, Secretary, Canadian Westinghouse Company Limited. Held in the Westinghouse Auditorium. Attendance 220.

Dec. 14.—**Advance Practice in the Use of Automatic Oxy-Acetylene Cutting,** by W. A. Duncan, of the Dominion Oxygen Company. Attendance 78.

W. J. W. Reid, M.E.I.C., chairman of the Meetings and Papers committee, has added another year of valuable service to the Branch by his selection of speakers. Although the lectures have been made as attractive as possible the technical side of the subjects has not been sacrificed in order to attract large numbers to our meetings. Most, perhaps all, of the speakers have given valuable information, such that the average listener would have to spend long and concentrated effort to obtain by ordinary method of study.

Branch lectures are not a study class but rather a period where an engineer may increase his sphere of usefulness by listening to and questioning about the deeper things of another engineer's diverse knowledge.

Except where specially noted these meetings have been held in the Science Lecture Hall, McMaster University, and the Executive wishes to once more record their appreciation of the many favours and conveniences placed at the disposal of the Branch by the Management of the University.

Publicity

The Executive committee wishes to record sincere appreciation for the courtesies extended by the press, especially the "Hamilton Spectator" and the "Daily Commercial News."

Obituary

We record, with deep regret, the passing of W. F. McLaren, M.E.I.C., on August 19th, at his home "Balquhidder," Ancaster, Ontario. Mr. McLaren was secretary-treasurer for six years and later chairman and during those years he gave generously of his time for the upbuilding of the Branch.

General

The Executive wishes to record a sincere appreciation, to members of all grades of the Branch, for the generous support given throughout the year in all the affairs and matters that have been undertaken, also to all other local engineering associations for their co-operation.

By arrangement with the Management of McMaster University, after all meetings, coffee, sandwiches and cake are served and a half hour of pleasantry is enjoyed by all present.

Financial Statement

Income		
Balance in bank, January 1st, 1937	$231.99	
Contributions	394.42	
Rebates on fees	251.10	
Branch Affiliates	9.00	
Bank interest	2.00	
Interest on investments	64.00	
		$952.51
Expenditure		
Printing and postage	$111.46	
Meetings expenses	147.95	
Travelling expenses	242.73	
Stenographic expense	50.00	
Government bonds	279.99	
Sundry	29.39	
Balance in bank	90.99	
		$952.51
Assets		
Bonds at cost	$1,194.99	
Projection lantern less depreciation	60.00	
Office furniture	15.00	
Bank balance	90.99	
		$1,360.98

Audited and found correct:

A. Love, M.E.I.C.
A. Colhoun, M.E.I.C. } Auditors.

Respectfully submitted,

E. G. Mackay, A.M.E.I.C., *Chairman.*
A. R. Hannaford, A.M.E.I.C., *Secretary-Treasurer.*

Kingston Branch

The President and Council:—

During the year 1936-1937 the Branch met five times as follows:—

1936

Nov. 4.—Annual meeting for reports and election of officers, discussion of Branch affairs for the coming year, etc.

Dec. 11.—Dinner and paper by Lt.-Col. N. C. Sherman, R.C.O.C., M.E.I.C., chairman of the Branch, on **Industrial Preparedness.**

1937

Jan. 26.—Meeting at Queen's University. Paper by O. Holden, A.M.E.I.C., chief hydraulic engineer, H.E.P.C., on **Power Development in Northern Ontario.** This meeting was especially for students and cadets and there was an attendance of 175.

Mar. 1.—Professor S. N. Graham, Queen's University, on **The Development of Gold Mining in Canada.** This meeting, which was held in the Sir Arthur Currie Hall, Royal Military College, was also primarily for students and cadets, and there was an attendance of about 235.

Apr. 1.—Dinner and address by Dr. W. A. Jones entitled **Some Remarks on Radiology.** This meeting, which was held at the Badminton Club, was the final one of the season.

Employment

One member of the Branch (non-active list) has been assisted in finding suitable employment.

Chamber of Commerce

No meetings of the Chamber of Commerce have dealt with questions in which the Branch, as such, was interested.

Semicentennial Meeting

Five members of the Branch attended the semicentennial meeting in Montreal. R. F. Legget, A.M.E.I.C., represented the Branch in the Round Table Conference on Branch Affairs.

Membership

The membership for the past five years is given below, and last year shows an encouraging increase:—

	Honorary Members	Members	Assoc. Members	Juniors	Students
1932-33	1	13	16	6	16
1933-34	1	11	19	7	14
1934-35	1	11	18	3	13
1935-36	1	12	18	4	11
1936-37	1	11	25	4	18

Financial Statement

In view of the fact that the Branch repaid $25 of the loan owing to Headquarters, the financial statement is reasonably satisfactory. It is recommended that consideration be given to paying the remaining $25 this year, and thus discharging the debt in full.

Receipts		
Balance forward	$ 63.54	
Nov. 28—Rebates	7.80	
Dec. 31—Interest	.54	
Feb. 2—Rebates	3.90	
June 30—Interest	.11	
Aug. 19—Rebates	86.10	
		$161.99
Expenditures		
Postage and telegrams	$ 3.50	
Dinner (November 4th)	7.70	
Dinner (December 11th)	3.90	
Dinner (January 29th)	6.30	
Dinner (April 1st)	1.00	
Stationery	11.04	
Paid Headquarters	25.00	
Secretary	25.00	
Room rent, Queen's	2.50	
Meeting, Branch Affairs	10.25	
Chamber of Commerce	15.00	
Exchange	.15	
Balance	50.65	
		$161.99
Assets		
Bank balance	$ 50.65	
		$ 50.65
Liabilities		
Loan, Headquarters	$ 25.00	
Surplus	25.65	
		$ 50.65

Respectfully submitted,

L. F. Grant, M.E.I.C., *Secretary-Treasurer.*

Lakehead Branch

The President and Council:—

On behalf of the Executive committee we submit the following report of the Lakehead Branch for the year 1937:—

The following meetings were held:—

1937

Jan. 20.—Dinner meeting at the Provincial Mill, Port Arthur.

Feb. 12.—Dinner meeting at the Royal Edward hotel, Fort William. Guest speaker, J. L. Busfield, M.E.I.C., speaking on **Consolidation and Diesel Engines with Reference to Automatic Applications.**

Feb. 28.—Ladies' Night at Shuniah Club, Port Arthur.

Mar. 17.—Dinner meeting at the Prince Arthur hotel, Port Arthur. Paper by P. E. Doncaster, M.E.I.C., on **Cellular Fills for Retaining Structures.**

Apr. 28.—Annual meeting with election of officers held at the Royal Edward hotel, Fort William.

May 19.—Dinner meeting held at the Prince Arthur hotel, Port Arthur, to welcome the President of The Institute, G. J. Desbarats, Hon.M.E.I.C., and Mrs. Desbarats.

Aug. 20.—Dinner meeting at the Royal Edward hotel, Fort William, in honour of the departing Secretary of the Branch, G. R. McLennan, A.M.E.I.C.

Nov. 17.—Dinner meeting at the Prince Arthur hotel, Port Arthur, four local speakers on Institute affairs.

Nov. 22.—Excursion to Red Rock, Ontario, to inspect the construction of the new mill for the Lake Sulphite Pulp Company.

Financial Statement

Receipts		
Balance in bank, December 31st, 1936	$258.76	
Rebates—October to December, 1936	12.90	
Rebates from Headquarters:—		
January to April, inclusive	63.90	
May to October, inclusive	15.75	
November to December, inclusive	9.15	
Bank interest	.80	
		$361.26

Expenditures

Expenses of meetings	$129.17	
Stamps and incidentals	18.50	
Balance in bank, December 31st, 1937	185.57	
Rebate due, November to December, 1937	9.15	
Parting gift for Secretary	10.00	
Expenses for Round Table Conference	8.87	
		$361.26

Respectfully submitted,
G. R. Duncan, A.M.E.I.C., *Chairman.*
H. Os, A.M.E.I.C., *Secretary-Treasurer.*

Lethbridge Branch

The President and Council:—

The following is a report of the operations of the Lethbridge Branch, of The Engineering Institute of Canada, for the year 1937.

Since January 1st, 1937, 8 regular meetings with an average attendance of 31; 1 corporate members meeting with an attendance of 8; and 4 executive meetings with an average attendance of 8, were held.

All regular meetings have been held in the Marquis hotel preceded by a dinner during which numbers were rendered by George Brown's Instrumental Quartette, followed by vocal or instrumental numbers, interspersed with community singing.

The list of speakers and subjects chosen follows:—

1937

Jan. 16.—R. Randle, Calgary Power Co. Ltd., Calgary, on **Electric Power Engineering Achievements and Operating Facts.** Two reels of motion picture film were also shown through courtesy of the International Harvester Co. Ltd. Attendance 17.

Jan. 30.—Biographies of Eminent Engineers. Prize Competition. R. B. McKenzie, S.E.I.C., Lethbridge, spoke on **Dr. Charles Frederick Burgess**, eminent chemical engineer; R. F. P. Bowman, A.M.E.I.C., Lethbridge, on **Dr. John Alexander Low Waddell**, eminent structural engineer; also E. A. Lawrence, S.E.I.C., Lethbridge, on **Sir William Willcocks**, eminent irrigation engineer. Attendance 16.

Mar. 13.—Annual meeting and election of officers; also joint meeting with the Association of Professional Engineers of Alberta, and the Rocky Mountain Branch of the Canadian Institute of Mining and Metallurgy. A. W. Haddow, A.M.E.I.C., President of the Association of Professional Engineers of Alberta, spoke on **Some Early Examples of Engineering**, illustrated with lantern slides. Attendance 40.

Aug. 14.—G. J. Desbarats, Hon.M.E.I.C., President of The Engineering Institute of Canada, on **Institute Affairs.** During his short stay in Lethbridge, Mr. Desbarats was taken to various points of interest in the district. Attendance 20.

Oct. 9.—J. T. Watson, A.M.E.I.C., Lethbridge City Manager, on **A Brief History of the City of Lethbridge Electric Power Plant**, illustrated with lantern slides. Attendance 24.

Nov. 6.—Jack deHart gave a talk on **A Trip to the Coronation.** Ladies' Night. Attendance 60.

Nov. 20.—J. A. Jardine, Alderman, City of Lethbridge, on **Bus vs. Street Railway.** Attendance 30.

Dec. 4.—Ladies' Night. W. L. McKenzie, A.M.E.I.C., on **10,000 Miles Along the Coast of Asia.** Attendance 40.

At December 31st the membership of the Branch stood as follows:—

	Resident	*Non-Resident*	*Total*
Members	3	..	3
Associate Members	17	7	24
Juniors	1	3	4
Students	2	7	9
Affiliates	29	..	29
	52	17	69

Financial Statement as at December 31st, 1937

Receipts

Rebates received from Headquarters, November and December, 1936	$ 2.70	
Rebates received from Headquarters, January to September, 1937	54.90	
Branch Affiliate fees and Journal subscriptions	54.15	
Bank interest	.08	
P. M. Sauder, share of Semicentennial expenses	6.82	
Advance to Secretary-Treasurer	37.45	
Secretary's honorarium	30.00	
Total revenue	$186.10	
Bank balance as at December 31st, 1936	11.55	
Total receipts		$197.65

Expenditures

Printing and stationery	$ 34.15	
Meeting expenses: dinners, music, etc.	29.88	
Headquarters: Branch Affiliate Journal subscriptions	6.00	
Semicentennial expenses	7.07	
Orchestra	15.00	
Postage	10.18	
Secretary's honorarium	30.00	
Advance to Secretary-Treasurer	37.45	
Total expenditures		$169.73

Assets

Bank balance as at December 31st, 1937	$ 27.92	
Holmes projector (value $360.25 less 70% depreciation)	108.07	
Rebates due from Headquarters, October to December inclusive	5.40	
Total assets		$131.39

Liabilities

Nil.

We have examined the books, papers, vouchers 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.

G. S. Brown, A.M.E.I.C. }
Wm. Meldrum, A.M.E.I.C. } Auditors.

Respectfully submitted,
E. A. Lawrence, S.E.I.C., *Secretary-Treasurer.*

London Branch

The President and Council:—

During the year 1937 the following meetings were held:—

1937

Jan. 20.—Annual meeting and election of officers was held at the Richmond Street Armouries as guests of the Military Engineers Association. The guest speakers were P. L. Pratley, M.E.I.C., Montreal, and R. L. Dobbin, M.E.I.C., Peterborough. Attendance 64.

Feb. 25.—Regular meeting was held in the Public Utilities Commission board room. G. Harold Reaveley, M.A., D.I.C. (London), Assistant Professor of Geology at University of Western Ontario, spoke on **Some Geological Principles Affecting the Engineer.** Attendance 14.

Mar. 18.—Regular meeting held in the Public Utilities Commission board room. C. A. Cline, B.Sc., of Hamilton, spoke on **A Niagara Free Port.** Attendance 19.

Apr. 22.—Regular meeting held in the Public Utilities Commission board room. R. S. Charles, B.Sc., London, gave a travelogue of his experiences encountered while searching for public water supplies in France, Indo-China and Algeria. Attendance 22.

May 20.—Regular meeting held in the council chamber, County Building, London. S. W. Archibald, M.E.I.C., London, gave an illustrated lecture on **Flood Control on Western Ontario Streams.** Attendance 45.

Oct. 20.—Dinner meeting for discussion of 1938 Annual Meeting arrangements. R. J. Durley, M.E.I.C., was the speaker. Attendance 21.

Nov. 15.—Regular meeting held in the Auditorium, City Hall, London, when a talking motion picture was presented through the courtesy of Johns-Manville Company, the machine being operated by Mr. Boyce of Toronto. W. J. Bright, B.Sc., London, was the speaker. Attendance 70.

Average attendance of all meetings 36.

In addition to above eight Executive meetings were held with an average attendance of 7.

Financial Statement
For Year Ending December 31st, 1937
Receipts

Cash on hand, December 31st, 1937	$ 1.87	
Bank balance, December 31st, 1937	154.55	
Rebates from Headquarters:—		
October to December, 1936, received February 3rd, 1937	3.90	
January to April, 1937, received July 30th, 1937	70.20	
May to September, 1937, received November 24th, 1937	16.05	
Annual dinner, 1937	45.00	
Affiliate fees, 1936-1937	10.00	
Petty cash	25.00	
Dinner for discussion on Professional Interests	13.00	
Dinner for discussion of 1938 Annual Meeting	11.40	
Rebates due from Headquarters for October to December 31st, 1937	18.60	
Due from Annual Meeting account	7.83	
		$377.40

Expenditures

Petty cash, secretarial expenses and stenographer for 1936 ($3.53, $5.00, $15.00, $2.90, $2.68, $16.00, $15.37) (including $2.13 for Annual Meeting, 1938)	$ 60.48	
Annual Meeting, 1937	101.10	
Auditorium and janitor for February, April and November meetings	4.00	
Speakers—assistant at February meeting	2.00	
Semicentennial meeting delegates expenses	37.17	
Semicentennial meeting, Headquarters account	9.56	
Dinner on Professional Interest	14.53	
Lunch and dinner discussions Annual Meeting, 1938	17.10	
P.U.C., postage incurred circularizing members	10.42	
Printing	27.05	
Affiliates Journal subscription 1936-1937	4.00	
	$287.41	
Cash and stamps in hand, December 31st, 1937	11.50	
Bank balance, December 31st, 1937	52.06	
Rebates due from Headquarters to December 31st, 1937	18.60	
Due from Annual Meeting account	7.83	
		$377.40

R. W. Garrett, a.m.e.i.c.
Major W. E. Andrewes, a.m.e.i.c. } Auditors.

Respectfully submitted,
A. O. Wolff, m.e.i.c., *Chairman.*
D. S. Scrymgeour, a.m.e.i.c., *Secretary-Treasurer.*

Moncton Branch

The President and Council:—

On behalf of the Executive committee we beg to submit the eighteenth annual report of Moncton Branch.

The Executive committee held five meetings. Four meetings of the Branch were held, at which addresses were given and business transacted as follows:—

1937

Jan. 19.—A meeting was held in the City Hall. Through the courtesy of Noranda Mines Ltd., the motion picture **The Noranda Project** was shown.

Apr. 14.—A meeting was held in the City Hall. Through the courtesy of Cunard White Star, the motion picture **On Wings to Capetown** was shown. At this meeting, Branch officers for 1937-38 were nominated.

May 31.—The annual meeting of the Branch was held on this date.

Dec. 6.—A supper meeting was held in the Y.M.C.A. An address on **Institute Affairs** was given by G. J. Desbarats, Hon.M.E.I.C., President of The Engineering Institute of Canada.

Membership

Our membership at present consists of fifty-eight members, as follows:—

	Resident	Non-Resident
Members	5	1
Associate Members	18	7
Juniors	2	1
Students	6	11
Affiliates	7	..
	38	20

Financial Statement

Receipts

Balance in bank, January 1st, 1937	$134.27	
Cash on hand, January 1st, 1937	1.85	
Rebates on dues	62.40	
Affiliate dues	30.00	
Tickets sold for supper meeting	4.25	
Bank interest	.95	
Rebates due from Headquarters	5.40	
		$239.12

Expenditures

Expenses of meetings	$ 12.00	
Printing	2.89	
Postage	3.55	
Telegrams	1.64	
Rount Table Conference	8.45	
Honorarium to Secretary	25.00	
Miscellaneous	30.58	
Balance in bank	149.00	
Cash on hand	.61	
Rebates due from Headquarters	5.40	
		$239.12

Assets

Balloptican lantern	$ 30.00	
Motion picture equipment	85.00	
Attache case	5.00	
Unpaid Affiliate dues	10.00	
Cash in bank	149.00	
Cash on hand	.61	
Rebates due from Headquarters	5.40	
		$285.01

Liabilities

None.

Audited and found correct:—
James Pullar, a.m.e.i.c.
R. H. Emmerson, a.m.e.i.c. } Auditors.

Respectfully submitted,
E. B. Martin, a.m.e.i.c., *Chairman.*
V. C. Blackett, a.m.e.i.c., *Secretary-Treasurer.*

Montreal Branch

The President and Council: –

On behalf of the Executive committee, we have the honour to submit the twentieth annual report of the Branch.

For the year 1937, the Executive committee consisted of the following members:—

Chairman	Huet Massue, a.m.e.i.c.
Vice-Chairman	Brian R. Perry, m.e.i.c.
Secretary-Treasurer	E. R. Smallhorn, a.m.e.i.c.
Past Chairman	J. B. D'Aeth, m.e.i.c.

Elected Members of Committee

W. F. Drysdale, m.e.i.c.	C. C. Lindsay, a.m.e.i.c.
R. E. Jamieson, m.e.i.c.	T. C. Thompson, a.m.e.i.c.
P. E. Bourbonnais, a.m.e.i.c.	J. A. E. Gohier, m.e.i.c.

Ex-Officio Members of Committee

A. Frigon, m.e.i.c.	A. Duperron, m.e.i.c.
E. A. Ryan, m.e.i.c.	J. A. McCrory, m.e.i.c.
F. Newell, m.e.i.c.	F. P. Shearwood, m.e.i.c.
F. S. B. Heward, a.m.e.i.c.	C. K. McLeod, a.m.e.i.c.

At the meeting held on January 22nd, 1937, the following members were duly appointed chairmen, and vice-chairmen, of the various committees and sections:—

Committees	*Chairmen*	*Vice-Chairmen*
Papers and Meetings	K. O. Whyte	R. E. Jamieson
Membership	T. C. Thompson	
Admission	J. A. E. Gohier	W. F. Drysdale
Reception	C. C. Lindsay	
Nominating	P. E. Bourbonnais	
Town Planning	Leonard Schlemm	
Finance	Huet Massue	C. K. McLeod
Sections		
Civil	R. E. Heartz	L. H. Burpee
Electrical	I. S. Patterson	S. H. Cunha
Mechanical	T. M. Moran	P. E. Poitras
Municipal	J. G. Chenevert	J. G. Comeau
Radio and Communications	D. J. McDonald	S. Sillitoe
Transportation	G. G. Ommanney	H. B. Bowen
Junior	C. E. Frost	P. E. Savage

The outstanding event of the year was the Semicentennial Celebration of The Institute, which brought to Montreal hundreds of engineers from all parts of Canada and other countries. Many members of the Montreal Branch were called upon to help the Chairman, J. L. Busfield, m.e.i.c., to organize and conduct the various activities.

At the beginning of the year, the Branch had the misfortune to lose its Secretary, C. K. McLeod, a.m.e.i.c., who for 12 years had most efficiently conducted its affairs. At the Executive Meeting of January 22nd, E. R. Smallhorn, a.m.e.i.c., was duly appointed as the new Secretary, Mr. McLeod agreeing to attend the Executive Meetings for the current year.

During the year the Executive committee held 10 meetings with an average attendance of 12 members. There were also held two special general meetings of the Branch: on April 1st, for the discussion of consolidation; on October 21st, to appoint three members of the Branch Nominating Committee.

To establish a closer co-operation with the Junior Section, the Chairman of that Section was invited to attend Executive Meetings.

Membership Committee

The membership committee decided that the best way to obtain immediate results from a membership viewpoint would be the thorough consideration of the non-active list. A letter with a form-reply was sent to each person on this list. The results have been such that on December 31st, the non-active list will be discontinued.

The Committee feels that the only way to obtain further constructive results, would be to form a Membership Committee, under the chairmanship of some very active member, consisting of one or two members from each section, in a way similar to the present organization of the Papers and Meetings Committee.

The changes in membership during the year are shown in the following table:—

Montreal Branch Active List:

Membership	*1936*	*1937*	*Change*
Honorary Members	1	2	1
Members	216	212	– 4
Associate Members	498	528	30
Juniors	66	84	18
Students	258	321	63
Affiliates	15	16	1
Totals	1,054	,163	109

Montreal Branch District Active List:			
Members	4	4	..
Associate Members	34	33	− 1
Juniors	7	3	− 4
Students	8	20	12
Totals	53	60	7
Non-Active List:			
Members	3	4	1
Associate Members	48	25	−23
Juniors	14	12	− 2
Students	8	..	− 8
Affiliates	1	..	− 1
Totals	74	41	−33
Summary:			
Total Active Members	1,107	1,223	116
Total Non-Active Members	74	41	−33
Total Membership	1,181	1,264	83

Members Deceased

The Committee deeply regrets the loss by death of the following members:—

Members:

Blaiklock, Morris S.; Fortin, Sifroy Joseph; Humphreys, James John; Lafleche, Alphonse; Morkhill, John Thomas; Rolph, Harold.

Associate Members:

Angus, John Vickers; Fusey, L. Ernest F.; Heckman, Joseph William; Lucas, Leslie; Warnock, Charles.

Students:

Lemieux, Denis; Milne, Geoffrey Robertson; Roy, Louis Philippe.

Admission Committee

During the year, the Committee considered a total of 111 applications for admission or transfer as follows:—

Applications for Admission:		*Applications for Transfer:*	
Members	4	To Member	2
Associate Members	20	To Associate Member	42
Juniors	19	To Junior	21
Branch Affiliates	3		
Institute Affiliates	..	Total	65
Total	46		

In addition, 93 Students were admitted to The Institute at this Branch.

Reception Committee

This Committee sponsored all entertainments undertaken by the Branch.

On January 29th, 1937, a very successful smoker was held under the direction of R. H. Findlay, M.E.I.C., Chairman of the Reception Committee for year 1936. This smoker was attended by some 400 members, the total receipts being $381.00, and the expenditures $282.69, the profit amounting to $98.31.

Owing to the celebrations connected with the Semicentennial of The Institute, no special efforts were made to provide additional entertainment during the spring session. For the fall session, the Committee investigated the possibility of a cruise on the St. Lawrence river. Since this would have necessitated giving a guarantee of $300 to the steamship company, and because the season was rather far advanced, the proposition was abandoned. It is felt that such an outing is well worth considering by the incoming committee.

The Committee wishes to make the following recommendations:—

(1) That the period of tenure of office of the Reception Committee should synchronize with that of the Papers and Meetings Committee.

(2) That the incoming committee consider ways and means to improve the attendance at the courtesy dinners to out of town speakers.

(3) That the length of papers be limited. Without encroaching upon the domain of the Papers and Meetings Committee we venture the suggestion that the papers should not be too long. No paper should last longer than one hour and a quarter, at most an hour and a half. Members lose interest and some always start to go out around ten o'clock. The average engineer is a hard-working man, and he wants to leave The Institute not later than 10.15 in order to get home for 11.00 p.m.

The Reception Committee is now organizing a smoker which will be held on February 17th, 1938.

Branch Nominating Committee

At the Special General Meeting of the Branch held on October 21st, R. E. Jamieson, J. B. D'Aeth and P. E. Bourbonnais were elected members of this Committee. At a meeting held on November 11th, these members, together with H. Massue and E. R. Smallhorn, both appointed by the Executive, nominated the candidates for offices for the following year.

1937 Papers and Meetings

Jan. 7.—Annual Meeting.
Jan. 14.—**Petroleum Products and the Automobile**, by R. S. Weir, A.M.E.I.C., and Gordon M. Connor.
Jan. 21.—**Modern Trends in Illumination**, by A. L. Powell.
Jan. 29, Jan. 30—Annual General Meeting.
Feb. 4.—**Recent Developments in Steam Heating**, by H. F. Marshal.
Feb. 11.—**Transmission over Electric Wave Guides**, by Dr. G. C. Southworth.
Feb. 18.—**Modern Highway Construction**, by Hon. F. J. Leduc.
Feb. 25.—**Non-Ferrous Alloys**, by H. F. Roast, M.E.I.C.
Mar. 4.—**Schorer Method of Analysis Applied to Pipe Line Design**, by A. W. F. McQueen, A.M.E.I.C., and E. M. C. Molke, A.M.E.I.C.
Mar. 11.—**Telemetering**, by Perry Borden.
Mar. 18.—**Application of Negative Regeneration in Communication**, by C. B. Fisher, A.M.E.I.C.
Mar. 25.—**Construction of the Bridge at St. Anne de la Perade**, by P. G. A. Brault, A.M.E.I.C.
Apr. 1.—Meeting of Montreal Branch of The Institute to discuss the question of Consolidation.
Apr. 8.—**Production of Radio Active Substances**, by Dr. J. S. Foster.
Apr. 15.—**The Problem of Economic Stability as Seen by an Engineer**, by P. Ackerman, A.M.E.I.C.
Apr. 22.—**Indeterminate Roof Trusses**, by E. R. Jacobsen, S.E.I.C.
Apr. 29.—**Business Management from a Scientific Point of View**, by Harry A. Hopf.
Oct. 7.—**The Part Played by the Forest Industries in the Economic Life of the Province of Quebec**, by Lt.-Col. L. J. D. Marquis.
Oct. 14.—**Engineering Achievements**, by Dr. Chubb.
Oct. 21.—**Pre-stressing and Erection of Isle of Orleans Bridge**, by D. B. Armstrong, A.M.E.I.C.
Oct. 28.—**Technical Men in Industry**, by Dr. Littler and C. A. Peachey.
Nov. 4.—**Canadian Air Transportation**, by G. A. Thomson.
Nov. 11.—**Operating Problems (Electrical)**, by R. N. Cooke, A.M.E.I.C., J. M. Crawford, A.M.E.I.C., A. Benjamin, A.M.E.I.C., and G. C. Read.
Nov. 15.—**A New Approach to the Industrial Lighting Problem, and Current Trends of School Lighting** (Joint meeting with the I.E.S.), by H. B. Dates.
Nov. 18.—**Trends in Telephone Equipment**, by J. L. Clarke, M.E.I.C.
Nov. 25.—**Sewage Disposal**, by W. S. Lea, M.E.I.C.
Dec. 2.—**Geological Survey of Canada**, by Dr. F. J. Alcock.
Dec. 9.—**Material Handling by Mechanical Equipment of the Conveyor Type**, by W. J. Ramsey.
Dec. 16.—**Trends and Modern Methods of Cities' Assessment and Taxation**, by J. E. Howes.

Your Committee has attempted to inaugurate a type of paper which could be expanded in a series, such as the "Technical Men in Industry" series, and the "Operating Problems" series. The thought behind this attempt being that many subjects cannot be adequately presented in one paper, and could with advantage be expanded into two or more papers. A continuation of this practice is recommended by the Committee. An attempt has also been made to pre-arrange the discussion of papers by members familiar with the subject.

The question of the reporting of meetings has been considered by your Committee. The following procedure is suggested:—

A member should be appointed to make a report of each meeting, his duties to be as follows:—

1. See that an attendance sheet is filled in by all members and guests present.
2. Make a summary of the main paper, and of the ensuing discussion.
3. See that the newspaper reporter gets a copy of the paper or a sufficiently clear summary so that adequate and accurate newspaper accounts are obtained.
4. Send a copy of the report to the General Secretary so that he may have all information about the paper and the discussion, should he wish to publish the proceedings of the meeting. A copy should also be sent to the Branch Secretary, for filing.

The attendance sheet would give the Executive committee the names of members who are taking an active part in the affairs of the Montreal Branch, and who might therefore be suitable members of the various committees.

The average attendance at meetings during the Fall Session was only 107. For a Branch with well over a thousand members on its rolls, this is very disappointing. If the papers presented by the Committee are not the type desired by our members, we would be very glad to have their constructive criticism.

As constituted at present, the Papers committee are trying to obtain papers which will interest six distinct types of engineers, "Civil, Electrical, Mechanical, Municipal, Radio, and Transport." This means that each section can have only two papers per session which are of direct interest to it. Although this method of presenting papers has been followed for a good many years, your Committee feels that the time has come when it should be reconsidered.

Junior Section

Fifteen regular meetings, including five plant visits, were held during the past year as compared with twelve in 1936.

The total attendance at Junior Section meetings was 730, as compared with 588 in 1936, an increase of 24 per cent, reflecting greater activity in arranging meetings. The Junior Section Executive held eight meetings at which the general affairs of the Section were discussed and the programme of meetings arranged.

The following is a list of meetings and plant visits:—

1937

Jan. 18.—Annual Meeting. Address by H. Massue, A.M.E.I.C., Chairman, Montreal Branch, The Engineering Institute of Canada, on **Economic Trends and their Effect on the Employment of Engineers.** Attendance 50.

Jan. 30.—Visit to the Consumers Glass Company Ltd., Ville St. Pierre, Que. Attendance 70.

Feb. 15.—**Some Interesting Features of Inspection and Testing Work,** by J. M. Fairbairn, A.M.E.I.C.
Photo-Elastic Method of Stress Analysis, by Carleton Craig, S.E.I.C. Attendance 46.

Mar. 1.—**L'Application des Relais pour la Protection des Lignes des Transmissions,** by Yvon Deguise, S.E.I.C.
Further Research of the Residual Stresses Set up by Welding, by M. J. Lupton, S.E.I.C. Attendance 31.

Mar. 15.—**The Handling of Concrete in the Field,** by W. E. Griffiths, Jr.E.I.C.
The Theory and Application of Sliding Forms in Concrete Structures Having Thin Walls, by J. M. Cape, Jr.E.I.C. Attendance 39.

Mar. 29.—Visit to the Toll Building of the Bell Telephone Co. of Canada. Attendance 65.

Apr. 5.—**An Actual Case of Research Work on Reduced Models of Spillways,** by Louis Trudel, S.E.I.C.
Gears, by Jacques Hurtubise, S.E.I.C. Attendance 35.

Apr. 19.—**Highway Development in Alberta,** by J. L. Pidoux, Jr.E.I.C.
Elements of Modern Combustion Design, by G. Martin. Attendance 24.

Oct. 2.—Visit to Noorduyn Aircraft Limited, St. Laurent, Que. Attendance 125.

Oct. 13.—**The Engineer as the Citizen,** by David Boyd, A.M.E.I.C. Attendance 49.

Oct. 27.—**Sound Reproduction,** by S. T. Fisher, Jr.E.I.C. Attendance 43.

Nov. 8.—Visit to Ecole Polytechnique, Hydraulic Laboratories. Attendance 20.

Nov. 13.—Visit to the Montreal Locomotive Works, Montreal East. Attendance 80.

Nov. 24.—**Some Aspects of an Electric Mine Hoist,** by D. E. Evans, S.E.I.C.
Mesures de Sécurité Influant la Construction d'une Rurale, by Lucien Perrault. Attendance 25.

Dec. 8.—**The Construction of Log Flumes,** by Graham Treggett.
Etude Comparative de Deux Sources d'Approvisionnement en Eau Potable pour la Ville de Sherbrooke, by Lucien Buteau, S.E.I.C. Attendance 30.

In 1936, the Junior Section Executive requested one of its members to peruse the minutes of all previous Junior Section Executive meetings with a view to consolidating the suggestions and practices which had been found practicable and desirable into a "Code of Procedure," and also to formulate a Statement of Purpose for the Section. At the present time the "Code" is considered as complete, and it is proposed to submit it to the Montreal Branch for approval.

A short talk was given to the Junior and Senior years of McGill University by the Junior Section Chairman, to induce them to attend meetings and join The Institute as student members. No address was delivered to the students of Ecole Polytechnique but Messrs. Decarie and Flahault, the Section's student representatives, approached the members of their respective years personally; also one of the regular meetings of the Section was held at Ecole Polytechnique.

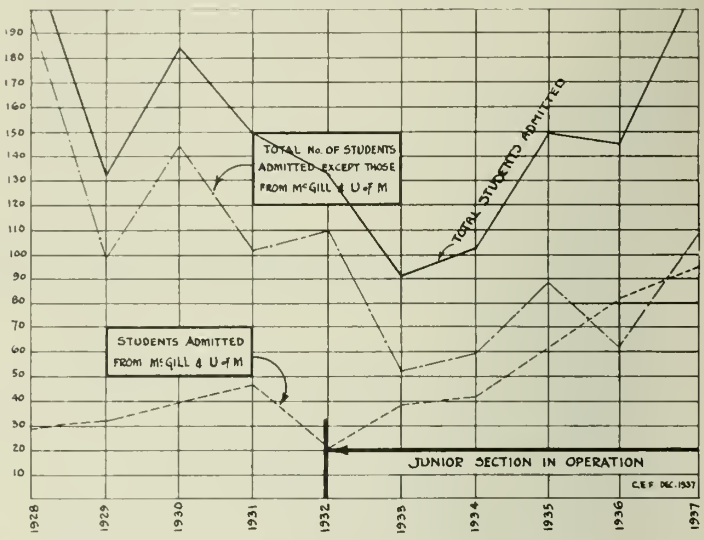
Due to the resignation of V. Upton, S.E.I.C., a vacancy on the Executive occurred early in the year. A by-election was held and R. N. Warnock, Jr.E.I.C., was elected.

Following is a list of University Students admitted to The Institute:—

	1934	*1935*	*1936*	*1937*
Ecole Polytechnique	11	10	43	25
McGill University	28	41	42	68
	39	51	85	93

Figure 1 is a graph showing the number of students admitted to The Institute from the Montreal Branch Area and the number admitted from other Branches since 1928.

Student admissions from the Montreal Branch area have increased every year since the Junior Section came into existence in 1932. During 1933, Student admissions showed a gain of nearly 100 per cent over their 1932 figure, and this, during a year in which student admissions from all other branches dropped to approximately 48 per cent of their 1932 figure. In 1936 approximately 30 per cent more students were admitted from the Montreal Branch area than from all other branches combined. In 1937 there were 93 students admitted from the Montreal Branch area, while there were 108 student admissions from all other branches. That is, the Montreal Branch area contributed 47 per cent of the total number of students admitted to The Institute during this year.



The above figures for student admissions indicate that the Junior Section is an asset to The Institute.

The Executive of the Junior Section wishes to express its appreciation and thanks to the Montreal Branch for its generous support and assistance during the past year.

Financial Statement
for the year ending December 31st, 1937

Revenue

	1936	*1937*
Rebates from Headquarters	$1,499.00	$1,611.30
Rebates due from Headquarters (estimated)	120.90	130.00
Affiliate dues paid	56.03	53.00
Affiliate dues unpaid	.....	10.00
Bank interest	9.16	2.96
Smokers	324.87	381.00
Dinners to speakers	164.00	119.00
Rebate from speakers travelling expenses	.....	10.00
Total revenue	$2,173.96	$2,317.26

Expenditures

Postcard notices	$ 696.02	$ 693.97
Stationery and stamps	22.38	27.70
Secretary's honorarium	300.00	300.00
Stenographic service	120.00	120.00
Telephone and telegraph	62.10	60.00
Lantern operator and slides	83.75	87.57
Subscriptions to Journal	16.00	26.00
Thursday refreshments	70.25	57.78
Speakers travelling expenses	27.50	104.30
Dinners to speakers	174.59	149.30
Smokers	298.24	282.69
Miscellaneous expense	94.03	44.66
Branch conference	.....	211.20
Junior Section	.....	50.00
Total expenditures	$1,964.86	$2,215.17
Excess of revenue over expenditures	$ 209.10	$ 102.09
Surplus from previous year	1,140.11	1,349.21
Surplus at end of year	$1,349.21	$1,451.30

This surplus of $1,451.30 existed in the following form at December 31st, 1937:—

Cash in bank	$1,311.30
Rebates due from Headquarters (estimated)	130.00
Affiliate dues unpaid	10.00
	$1,451.30

(There are no Accounts Payable.)

an Your Secretary-Treasurer wishes to suggest the appointment of auditing committee of one or two members, whose duty it shall be to audit the Branch accounts.

GENERAL

The Executive committee appointed F. S. B. Heward, A.M.E.I.C., and Brian Perry, M.E.I.C., a committee of two to investigate and report on what might be done to improve the activities and organization of the Branch. The report was submitted at the last meeting of the Executive on December 17th, 1937. Owing to pressure of other business, time was available for only a casual discussion. It was decided that it would be desirable to canvass the opinion of all members, and to have the suggestions submitted discussed at the Annual Meeting of the Branch, for the guidance of the incoming executive. A summary of these suggestions will be found on the notice card for this meeting.

At the request of a group of members interested in industrial management and operation, the formation of an industrial or management section was considered and approved. The activities of this section will start in 1938.

The Junior Section, formed some five years ago, has rapidly developed into a very important group. All those who are contributing to the success of this Section are performing a very valuable service to The Institute. To particularly acknowledge the splendid work done by John Plow for the Junior Section—apart from his duties at Headquarters—the Executive committee, at the suggestion of C. E. Frost, A.M.E.I.C., Chairman of the Section for 1937, is pleased to announce that it has unanimously voted to present Mr. Plow with a gift in appreciation of his efforts.

In concluding, the Executive committee desires to thank all those who, either through the presentation of papers, attendance at the meetings, or otherwise, have made possible the successful operation of the Branch in 1937.

Respectfully submitted,

HUET MASSUE, A.M.E.I.C., *Chairman.*
E. R. SMALLHORN, A.M.E.I.C., *Secretary-Treasurer.*

Niagara Peninsula Branch

The President and Council:—

On behalf of the Executive committee of the Niagara Peninsula Branch, we beg to submit this, our annual report for the year 1937.

The Executive held 7 business meetings and one electoral meeting to manage the activities of the Branch.

During the year the following Branch meetings were conducted:—

1937

Jan. 14.—Dinner meeting, Leonard hotel, St. Catharines. Joint meeting with the Niagara District, Chemical and Industrial Association. D. G. Geiger, A.M.E.I.C., transmission engineer with the Bell Telephone Company, on **The Transmission of Speech and Music.** Illustrated.

Feb. 18.—Dinner meeting at Foxhead Inn, Niagara Falls, Ontario. E. T. Harbert, A.M.E.I.C., of the Canadian Ingersoll-Rand Company, spoke on **The Selection and Design of Air Compressors.** Illustrated.

Mar. 18.—Joint meeting with the Niagara District Chemical and Industrial Association at the Leonard hotel, St. Catharines. Mr. McIntyre, chief chemist for Imperial Oils, Sarnia, spoke on **Gasoline Refining.** Illustrated.

Apr. 15.—Afternoon inspection trip through the International Nickel Company plant at Port Colborne and dinner meeting followed by F. L. LaQue of New York on **The Properties and Applications of Nickel and Non-ferrous Alloys.** Illustrated.

May 18.—Annual meeting at Leonard hotel, St. Catharines. Dr. R. W. Boyle, M.E.I.C., Director of Physics and Electrical Engineering Division of the National Research Council, Ottawa, on **Technology and Peace and War.**

Sept. 21.—Dinner meeting at Leonard hotel, St. Catharines. M. P. B. MacEwen, combustion engineer of the Ethyl Gasoline Corporation, on **Internal Combustion Motors and their Fuels.**

Oct. 28.—Joint meeting with the Engineering Society of Buffalo. Inspection trips through the Bethlehem Steel Company new strip mill and the new sewage disposal system under construction in Buffalo followed by a dinner meeting in Statler hotel and illustrated talk on **The Golden Gate Bridge.**

Nov. 9.—Dinner meeting at Foxhead Inn, Niagara Falls, Ontario. R. B. Morley, Manager of the Industrial Accident Prevention Associations, on **Accidents in Industry.**

Dec. 16.—Dinner and joint meeting with the Niagara District Chemical and Industrial Association in the Leonard hotel, St. Catharines. J. H. Cox, of the Westinghouse Electric and Manufacturing Co., East Pittsburgh, spoke on **Rectifiers and Ignitions.** Illustrated.

MEMBERSHIP

Members	18
Associate Members	66
Juniors	5
Students	10
Affiliates	10
Non-Active	10
	119

FINANCIAL STATEMENT

Assets		
Cash (bank balance, January 1st, 1937)		$309.10
Liabilities		
None.		
Revenue		
Rebates (January to October, 1937)	$186.30	
Affiliate dues	29.70	
Interest from bank	.66	
Miscellaneous revenue	7.95	
		$224.61
Expenditure		
General meeting expenses	$ 52.90	
Annual meeting expenses	34.26	
Postage and revenue stamps	.27	
Telephone service	2.20	
Stenographic services	5.00	
Honorarium to Secretary	50.00	
Councillor's expenses	31.35	
Branch Chairman's expenses	41.95	
Branch dues for Round Table Conference	16.37	
		$234.30
Bank balance, January 1st, 1937	$309.10	
Minus deficit	9.69	
Balance, December 31st, 1937		$299.41
Assets		
Bank balance	$299.41	
Liabilities	.....	
Surplus		$299.41

Respectfully submitted,

GEORGE E. GRIFFITHS, 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 1937.

During the year the Managing committee held eight meetings for the transaction of general business. The Proceedings committee arranged ten meetings and there were in addition the annual meeting and an evening meeting in conjunction with the Aeronautical Section when the subject was "Aerodynamic Laboratories of England, Italy and France" with accompanying motion pictures. There was an attendance of approximately 400 at this evening meeting. These meetings were well attended and excellent addresses were enjoyed at the Branch meetings.

It is with deep regret that we report the deaths of eight members: T. L. Simmons, M.E.I.C., R. A. Davy, M.E.I.C., C. B. Daubney, A.M.E.I.C., Colonel J. Houliston, A.M.E.I.C., A. D. Stalker, A.M.E.I.C., C. A. Morrison, S.E.I.C., A. A. Imlach, Branch Affiliate, W. J. Lynch, Branch Affiliate.

As in previous years the Branch donated two sets of draughting instruments to the Ottawa Technical School for presentation as prizes for proficiency in draughting. A copy of "Standard Handbook for Electrical Engineers" was presented to the Hull Technical School to be awarded to one of its students.

SEMICENTENNIAL

The outstanding event of the year in Ottawa Branch was the celebration of The Institute's Semicentennial. The celebrations of this event were held June 15th, 16th, 17th in Montreal and the programme was continued in Ottawa on June 18th and 19th.

Delegates and visitors arriving in Ottawa at noon on the 18th were entertained at a luncheon, J. G. Macphail, the chairman of the Branch, presiding. The speaker was H. Gerrish Smith, Vice-President of the American Society of Marine Architects and Naval Engineers. His subject was "The Engineer in a Century of Marine Progress."

Following the luncheon visitors were given the option of taking four conducted tours by motor-bus:—

(1) Chelsea and Farmers Power Plants of the Gatineau Power Company.
(2) Gatineau Mills, Canadian International Paper Company.
(3) National Research Council Laboratories.
(4) Circle tour, including Central Experimental Farm, Parliament Buildings, Memorial Chamber and Peace Tower, and the Driveway.

In the evening there was held a very successful dinner dance. The chairman for the dinner and reception was our President, G. J.

Desbarats, and the speaker was the Hon. C. D. Howe, Minister of Transport, who spoke on "Recent Developments in Transportation." The dance which followed was thoroughly enjoyed both by out of town visitors and by our own members. On Saturday morning, June 19th, arrangements were made whereby visiting engineers were enabled to meet responsible officials in a number of the Departments of the Government who are carrying on work along lines in which they were interested.

PROCEEDINGS AND PUBLICITY

During the year ten luncheon meetings were held. The dates of the meetings and speakers are as follows:—

1937

Jan. 21.—W. L. Waters, C.E., **Recent Progress of Organized Labour in England.** Attendance 85.

Feb. 11.—Dr. W. H. Cook, **Some New Developments in Refrigeration and Cold Storage.** Attendance 72.

Feb. 25.—G. J. Desbarats, Hon.M.E.I.C., **Institute Affairs.** Attendance 84.

Mar. 11.—Dr. E. S. Hopkins, **Engineering in Agriculture.** Attendance 63.

Mar. 25.—V. L. Eardley-Wilmot, **A Day in the Life of a Miner.** Attendance 84.

Apr. 22.—R. H. Field, A.M.E.I.C., **The Use of Light Waves for Precision Gauge Standardization.** Attendance 57.

June 18.—Semicentennial luncheon and visits to Gatineau Power Co., Experimental Farm, International Paper Company Mills, and National Research Council. Attendance 300 (approx.).

Oct. 14.—M. S. Kuhring, **Some Recent Developments in Aircraft Fuels.** Attendance 55.

Oct. 28.—H. D. Parizeau, **Canadian Hydrographic Service on the Pacific Coast of Canada.** Attendance 107.

Nov. 18.—A. Ernest Thornton, **Bureau of Statistics Tabulating Machines.** Attendance 75.

MEMBERSHIP

With several adjustments during the year the membership roll now shows an increase of 16 during the year, the total now being 332 resident and 86 non-resident members.

The following table shows in detail the comparative figures for the years 1936 and 1937:—

	1936	*1937*
Honorary Members	2	3
Members	82	84
Associate Members	170	180
Affiliates of Institute	3	4
Juniors	17	18
Students	30	21
Branch Affiliates	28	22
Resident Members	332	332
District Members	70	86
	402	418

FINANCES

The attached financial statements show that the Branch closed the year with a balance of $676.73 in the bank, $4.60 cash on hand, and $1,000 in Government bonds. In addition the Branch had assets of $49.50 in rebates due from the main Institute on account of membership fees, and equipment and library with a nominal value of $21.00, an increase of $12.01 over that of 1936.

AERONAUTICAL SECTION

Nine evening meetings were held, when technical papers dealing with aeronautical or related subjects were read and discussions held. With the exception of the first meeting in April when there were over 400 in attendance, the average was 27.

OFFICERS FOR 1938

The annual meeting of the Branch will be held on the 13th of January when the officers and members of the Managing committee for 1938 will be elected.

RECEIPTS AND EXPENDITURES
for the year ended December 31st, 1937
Revenue

Rebates from Main Institute			$ 485.40	
Affiliate dues			66.00	
Interest:				
Dominion of Canada bonds		$ 42.50		
Bank		2.51		
			45.01	
Semicentennial:				
Receipts from luncheon		221.00		
Refund Dinner Dance Committee		36.70		
Dinner Dance Committee, sale of tickets, Montreal		135.00		
			392.70	
Miscellaneous Revenue:				
Receipts from luncheons		454.65		
Refund U.S. Library		.98		
			455.63	
			$1,444.74	
Balance in bank, December 31st, 1936			$648.94	
Cash on hand, December 31st, 1936			10.13	
				$2,103.81
December 31st, 1937:—				
Bank balance as above		$676.73		
Outstanding cheques:				
No. 841	$ 10.00			
No. 842	15.00			
No. 844	5.18			
		30.18		
December 31st, 1937—Balance as per bank book		$706.91		

Expenditure

General Meeting expenses:				
Luncheons	$594.75			
Tickets and post cards	98.04			
		$ 692.79		
Annual Meeting expenses:				
Catering	25.00			
Printing	15.44			
Sundry	2.00			
		42.44		
Semicentennial:				
Luncheon	203.80			
Printing and stationery	70.04			
Motor coach service	38.00			
Telegrams, etc.	15.00			
Advance to Dinner Dance Committee	15.00			
Transferred to Dinner Dance Committee	135.00			
		476.84		
Round Table Conference		69.55		
Printing and stationery		8.64		
Prizes:				
Electrical Engineers Handbook	8.00			
Two sets of drawing instruments	16.00			
		24.00		
Miscellaneous:				
Subscriptions to Engineering Journal	6.00			
Flowers	28.00			
Grant to Aeronautical Section	20.00			
Gratuity for assistance to Proceedings Committee	10.00			
Gratuity for assistance to Secretary's office	15.00			
Petty cash expenditures	28.77			
Sundry	.45			
		108.22		
		$1,422.48		
Cash on hand, December 31st, 1937		4.60		
Balance in bank, December 31st, 1937		676.73		
			$2,103.81	

Assets

Cash:		
On hand	$ 4.60	
In bank	676.73	
Investments—Dominion of Canada bonds	1,000.00	
Rebates due from Headquarters	49.50	
Library	1.00	
Stationery and equipment (nominal)	20.00	
		$1,751.83

Liabilities

Surplus	$1,751.83

Audited and found correct,
B. H. SEGRÉ, A.M.E.I.C., Auditor.

Respectfully submitted,
J. G. MACPHAIL, M.E.I.C., *Chairman.*
R. K. ODELL, A.M.E.I.C., *Secretary-Treasurer.*

Peterborough Branch

The President and Council:—

I am pleased to submit herewith on behalf of the Executive committee, the following report covering the activities of the Branch during the year 1937:—

MEETINGS

1937

Jan. 14.—Supper and social gathering with particular emphasis on Juniors and Students. Attendance 51.

Jan. 28.—H. Thomasson, Canadian Westinghouse Company, on **Electric Welding.** Attendance 40.

Feb. 16 } Feb. 17 } General Electric **House of Magic.** Special open meetings. Attendance approximately 2,200.

Mar. 11.—J. Patterson, Meteorological Service of Canada, on **Weather Forecasting.** Attendance 21.

Mar. 31.—Pros and Cons of Consolidation. Attendance 20.

Apr. 8.—Annual Student and Junior Night. E. L. Toy, **Features of the Sardine Industry**; W. Bergman, Peterborough, **Features of the Petroleum Industry**; C. E. Lewis, Peterborough, **Cylinder Wear in Gasoline Engines.** Attendance 33.

Apr. 22.—W. E. Ross, M.E.I.C., Canadian General Electric Co., Toronto, **Abitibi Canyon—H.E.P. Development.** Attendance 59.

May 13.—Annual meeting. Reports and election of officers. Attendance 34.

Sept. 25.—Annual outing to Kawartha Boys' Camp, Clear Lake. Attendance 26.

Oct. 28.—J. Grieve, M.E.I.C., Imperial Varnish and Color Company, Toronto, **Paints and Varnishes.** Attendance 46.

Nov. 23.—Annual dinner. R. O. Sweezey, M.E.I.C., consulting engineer, **The Drought Situation in Western Canada.** Attendance 75.

Dec. 16.—W. A. Scott, special representative, Canadian Airways, Toronto, **Canadian Aviation.** Attendance 40.

Executive committee meetings held during the year—seven.

Special sub-committees were as follows:

Meetings and Papers Committee	S. O. Shields, A.M.E.I.C.
	B. I. Burgess, A.M.E.I.C.
Branch News Editor	J. L. McKeever, Jr.E.I.C.
Students and Junior Section Chairman	A. L. Malby, Jr.E.I.C.
Membership and Attendance Committee	H. R. Sills, A.M.E.I.C.
Social and Entertainment Committee	A. L. Killaly, A.M.E.I.C.
	A. B. Gates, A.M.E.I.C.
	R. L. Dobbin, M.E.I.C.
Auditor	E. R. Shirley, M.E.I.C.

Membership

January 1st	*1930*	*1931*	*1932*	*1933*	*1934*	*1935*	*1936*	*1937*	*1938*
Members	20	18	15	13	13	11	11	11	10
Associate Members	31	30	34	36	35	30	32	39	42
Juniors	20	20	19	13	11	12	11	9	10
Students	30	23	19	16	16	18	25	23	33
Branch Affiliates	25	17	15	17	14	13	9	9	8
	126	108	102	95	89	84	88	91	103
Institute Affiliates								2	1
Honorary Branch Affiliates								1	1
								94	105

Financial Report

Receipts

Balance, December 31st, 1936	$ 96.21	
Affiliate fees	28.97	
Rebate from Headquarters	133.05	
Annual dinner	109.50	
Express	11.35	
Bank interest	.69	
	$379.77	
Rebate from Headquarters	12.90	
		$392.67

Expenses

Affiliate Journal subscriptions	$ 15.15	
Rent	28.00	
Announcement cards	54.08	
Stamps, envelopes, etc	6.30	
Annual dinner	110.65	
Flowers	4.00	
Lantern insurance	4.80	
Students' badges	4.80	
Semi-centennial expense	16.53	
Annual outing	2.50	
Express	11.35	
Balance, December 31st, 1937	121.61	
	$379.77	
Balance, including rebate from Headquarters	12.90	
		$392.67

Respectfully submitted,
W. T. Fanjoy, A.M.E.I.C., *Secretary-Treasurer.*

Quebec Branch

The President and Council:—

On behalf of the Executive committee of the Quebec Branch we beg to submit the annual report for the calendar year 1937:—

Membership

	Resident	*Non-Resident*	*Total*
Branch Honorary Member	1	..	1
Members	19	2	21
Associate Members	66	12	78
Juniors	6	2	8
Students	15	2	17
Affiliates	1	..	1
Total	108	18	126

It is with deep regret that we report the death of Robert Wood, A.M.E.I.C., T. J. F. King, M.E.I.C., and S. S. Oliver, A.M.E.I.C., all of whom passed away during the course of the year.

Meetings

Four meetings of the Branch Executive committee were held during the year and seven Branch meetings, as follows:—

1937

Jan. 25.—Evening meeting at Chateau Frontenac. René Cyr, C.E., assistant engineer, Provincial Board of Health, on **Les raccordements dans les systèmes d'aqueduc sont-ils un danger?**

Feb. 62.—Luncheon meeting at Chateau Frontenac. J. B. Challies, M.E.I.C., Manager, Water Resources Department, Shawinigan Water and Power Co., spoke on **Canadian Participation in the World Power Conference.**

Mar. 8.—Evening meeting at Chateau Frontenac. Papers by 3 Juniors. Pierre Warren, S.E.I.C., on **Construction de maisons pour une ville moderne;** Maurice Archer, S.E.I.C., **The Construction of a Flume;** Henri Girard, C.E., **L'Exploitation de la tourbe dans la province de Québec.**

Apr. 14.—Luncheon meeting at Chateau Frontenac. Hon. F. J. Leduc, D.Sc., Minister of Roads, Province of Quebec, on **The Engineer's Share in the Road Building Programme of the Province.**

Apr. 27.—Afternoon reception by the council. Guest of Honour: Louis Beaudry, A.M.E.I.C., newly appointed manager of the Harbour of Quebec.

May 3.—Annual meeting and election of officers at Montcalm Hall.

Dec. 13.—Luncheon meeting at Chateau Frontenac. G. J. Desbarats, Hon.M.E.I.C., President of The Institute, gave an address on **Institute Affairs and particularly Consolidation.**

Committees

The Branch committees are the following:—

Nominating	L. P. Méthé, A.M.E.I.C.
	J. O. Martineau, M.E.I.C.
	E. D. Gray-Donald, A.M.E.I.C.
Legislation	T. M. Dechêne, A.M.E.I.C.
	J. O. Martineau, M.E.I.C.
	E. D. Gray-Donald, A.M.E.I.C.
Membership	J. M. Hector Cimon, M.E.I.C.
	O. Desjardins, A.M.E.I.C.
	J. St-Jacques, A.M.E.I.C.
Excursions	T. M. Dechêne, A.M.E.I.C.
	J. L. Bizier, A.M.E.I.C.
	M. Archer, S.E.I.C.

Financial Statement—1937

Receipts

Rebates—June		$180.30	
Rebates—November		19.65	
Rebates—December		13.50	
			$213.45

Expenditures

Meetings		$ 58.75	
Stationery and printing		15.63	
Miscellaneous		32.51	
Round Table Conference:			
Branch proportion of cost	$19.79		
Less special contribution	17.00		
		2.79	
Secretary's honorarium		100.00	
			$209.68
Surplus for 1937			$ 3.77
Cash in bank		$ 39.98	
Accounts receivable		13.50	
Surplus at January 1st, 1937			$ 49.71
Surplus for year 1937			3.77
Surplus at December 31st, 1937		$ 53.48	$ 53.48

Respectfully submitted.
For the President:
Ralph B. McDunnough, A.M.E.I.C., *Vice-President.*
Jean Saint-Jacques, A.M.E.I.C., *Secretary-Treasurer.*

Saguenay Branch

The President and Council:—

The Executive committee of the Saguenay Branch wish to submit the following report for the calendar year 1937.

Meetings

During the year meetings were held as follows:—

1937

June 10.—At Arvida. A paper on **Present-day Theories Regarding the Properties of our Industrial Metals** was presented by Dr. André Hone, member of the technical staff of the Aluminum Company of Canada.

July 30.—At Dolbeau. The annual general meeting and dinner. The members then inspected the Lake St. John Power and Paper Company's plant and the Trappist Monastery at Mistassini.

Oct. 15.—At Arvida. A paper on **The Cost of Power** was presented by Mr. McNeely DuBose, General Superintendent of the Saguenay Power Company.

FINANCIAL STATEMENT

Receipts

Balance at December 31st, 1936	$217.71	
Rebates from Headquarters	92.10	
Accounts outstanding	7.43	
	$317.24	
Rebates payable, December 31st, 1937	6.60	
		$323.84

Expenditures

Stenographic service	$ 10.00	
Postage	8.50	
Expenses of meetings	53.90	
Semicentennial	9.57	
Exchange on cheques	.60	
Printing	3.78	
Bank balance at December 31st, 1937	230.89	
	$317.24	
Rebates payable, December 31st, 1937	6.60	
		$323.84

Respectfully submitted,
C. MILLER, A.M.E.I.C., *Secretary-Treasurer.*

Saint John Branch

The President and Council:—

On behalf of the Executive committee of the Saint John Branch, we beg to submit the annual report for the calendar year 1937:—

MEMBERSHIP

	Resident	*Non-Resident*	*Total*
Members	10	8	18
Associate Members	19	13	32
Juniors	7	10	17
Students	13	26	39
Affiliates	1	..	1
	50	57	107

MEETINGS

Nine meetings of the Branch Executive were held during the year, and seven Branch meetings, as follows:—

1937

Jan. 8.—Evening meeting at Admiral Beatty hotel. The meeting assembled to discuss the proposals of The Institute Committee on Consolidation.

Jan. 27.—Annual joint dinner meeting with the Association of Professional Engineers of the Province of New Brunswick, held in the Admiral Beatty hotel. A. M. Narraway, Department of Mines and Resources, spoke on **The Application of the Aeroplane and Aerial Surveys to the Development of Canada's Resources, particularly Mining.**

Mar. 18.—Evening meeting in the Admiral Beatty hotel. J. R. Stephenson, Excise Tax Auditor, Department of National Revenue, spoke on **Experiences as a Bush Trader in Tropical Africa.** Mr. Stephenson spent four and one-half years in the Congo and Cameroons.

May 10.—Annual dinner and meeting of the Branch at the Riverside Golf and Country Club. Dr. E. C. Menzies, Superintendent of the Provincial Hospital for the Insane, gave an address on **The Mind.**

Oct. 22. Evening meeting in the Admiral Beatty hotel. Col. W. R. McCaffrey, Secretary of the Canadian Engineering Standards Association, and W. P. Dobson, M.E.I.C., Chief Testing Engineer for the Hydro-Electric Power Commission of Ontario, spoke respectively on **The Work of the Association and Laboratory Approval and Research Work.**

Nov. 18.—Evening meeting in the Admiral Beatty hotel. Professor H. W. McKiel, M.E.I.C., Vice-President of The Institute, and Dean of the Faculty of Engineering at Mount Allison University, spoke on **Mineral Resources and World Politics.** Professor McKiel also put forth a scheme for union between the Saint John Branch and the Association of Professional Engineers of New Brunswick, similar to that proposed in Nova Scotia.

Dec. 17.—Dinner meeting in the Admiral Beatty hotel in honour of President G. J. Desbarats, HON.M.E.I.C., who addressed the meeting on Institute affairs. Another guest at the dinner was Brigadier L. F. Page, Officer Commanding, Military District No. 7.

EMPLOYMENT

Employment for engineers of the Saint John Branch is almost 100 per cent, due to the programme of road construction being carried on by the Provincial Government.

FINANCIAL STATEMENT

The financial standing of the Branch is as follows:—

Receipts

Balance at December 31st, 1937	$292 69	
Headquarters rebates—October to December 1936	16.50	
Headquarters rebates—January to April 1937	119.40	
Headquarters rebates—May to October 1937	11.55	
May 10, Annual dinner tickets	46.50	
December 17, Dinner in honour of President Desbarats, sale of tickets	58.50	
	$545.14	
Rebates from Headquarters—November to December 1937	15.00	
		$560.14

Expenditures

May 10, Annual dinner	$ 51.65	
December 7, Dinner in honour of President Desbarats	61.50	
Stamps and post-cards	18.12	
Printing	47.01	
Room rent	30.00	
Lantern rental	6.00	
Part expenses—delegate to Semicentennial	25.00	
Branch share of Semicentennial	19.11	
Stenographer	10.00	
Honorarium to Secretaries	50.00	
Balance at December 31st, 1937	216.75	
	$545.14	
Rebates from Headquarters, November to December 1937	15.00	
		$560.14

Respectfully submitted,
SIDNEY HOGG, A.M.E.I.C., *Chairman.*
L. G. LILLEY, JR.E.I.C., *Secretary-Treasurer.*

St. Maurice Valley Branch

The President and Council:—

On behalf of the Executive committee, we submit the annual report of the St. Maurice Valley Branch for 1937.

Four general meetings were held during the year, two at Three Rivers, one at Shawinigan Falls, and one at Grand'mere, all of which were dinner meetings, the attendance averaging 43.

Papers presented were as follows:—

1937

Apr. 14.—**The Freeman Flash Roaster at St. Lawrence Paper Mill,** by Horace Freeman, in charge of Research Department, Consolidated Paper Corporation, Ltd. Attendance 32.

Apr. 22.—**Gasoline for To-day's Automobile,** by G. M. Connor, field representative, Ethyl Gas Corporation. Attendance 47.

May 20.—**The World Power Conference,** by J. B. Challies, M.E.I.C., assistant general manager, Shawinigan Water and Power Co. Attendance 45.

Nov. 5.—**Recent Developments in Concrete Construction,** by D. O. Robinson, A.M.E.I.C., and R. A. Crysler, A.M.E.I.C., Technical Department, Canada Cement Co. Ltd. Attendance 48.

In addition to the regular meetings, one social function was held in the form of a farewell dinner for Bruno Grandmont, A.M.E.I.C., Past Chairman of this Branch and Councillor of The Institute, who has transferred his headquarters to Rimouski, as District Engineer of the Department of Public Works.

MEMBERSHIP

The membership of the Branch as of December 31st, 1937, is as follows:—

Members	3
Associate members	20
Juniors	12
Students	11
	46

It is with sincere regret that we record the death in April of Charles L. Arcand, A.M.E.I.C.

STATEMENT OF REVENUE AND EXPENDITURES 1937

Receipts

Rebates—up to and including October 1937	$ 74.85	
Deficit on year's operation	71.13	
		$145.98

Expenditures

Postage and telephone	$ 10.80	
Round Table expenses	9.71	
Flowers	10.65	
General meeting expenses	61.12	
Branch entertainment	53.70	
		$145.98

Financial Statement

Balance in bank, December 31st, 1936	$142.19	
Deficit for year	71.03	
Balance in bank, December 31st, 1937		$ 71.06

Assets

Balance in bank, December 31st, 1937	$ 71.06	
Rebates payable, December 31st, 1937	8.10	
		$ 79.16

Liabilities

Nil	.....	
Surplus	$ 79.16	
		$ 79.16

Respectfully submitted,
J. F. Wickenden, A.M.E.I.C., *Chairman.*
C. H. Champion, 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 1937.

MEMBERSHIP

The membership of the branch shows an increase of two over last year, being as follows:—

	Resident	*Non-Resident*	*Total*
Members	20	8	28
Associate Members	26	25	51
Juniors	9	6	15
Students	1	6	7
Branch Affiliates	2	1	3
	58	46	104

COMMITTEES

The Executive committee was elected on April 2nd, 1937, and a number of meetings were held—six (including trip to Fort Peck and a Kipling Camp meeting).

The standing committees are:—

Papers and Library .... P. G. McAra, A.M.E.I.C., Convenor.
Nominating .... D. A. R. McCannel, M.E.I.C., Convenor.
Membership .... J. J. White, M.E.I.C., Convenor.

MEETINGS

There were four regular meetings of the Branch, each being preceded by a dinner at which the average attendance and general interest was good. In addition a general meeting was held during the months of February and October under the auspices of the Association of Professional Engineers.

The trip to **Fort Peck Dam** proved to be of great educational and instructive value.

A new system has been inaugurated with regard to the monthly meetings which are now being held jointly by The Engineering Institute of Canada, the Association of Professional Engineers of Saskatchewan and the American Institute of Electrical Engineers. A common committee has been established being known as a Papers and Meetings committee. The Chairman of each Association will alternate monthly in charge of the meeting and all expenses will be pooled. The identity of each organization will be retained with elections and annual meetings being conducted as in the past.

The programme for the year was as follows:—

1937

Jan. 22.—Meeting of Kipling Camp.

Feb. 19.—Meeting under the auspices of the Association of Professional Engineers of Saskatchewan.

Apr. 2.—Address by Dr. J. W. Healey on **Heredity and Environment.**

Aug. 11.—Visit and address by the President of The Institute, G. J. Desbarats, C.M.G., Hon.M.E.I.C.

Sept. 6.—Members of the Branch visited **Fort Peck Dam,** Montana, U.S.A.

Oct. 23.—Meeting under the auspices of the Engineering Profession of Saskatchewan.

Nov. 19.—Address by Professor A. R. Greig, M.E.I.C., on **Coal and its Combustion.**

Dec. 17.—Address by Dr. J. R. Robertson on **Scheduled Air Line Flying and Bush Flying.**

FINANCES

The financial standing of the Branch is as follows:—

Receipts

Bank balance, December 31st, 1936	$ 90.32	
Rebate from Headquarters	193.65	
		$283.97

Expenditures

Postage	$ 4.75	
Meetings (notices, printing, etc.)	48.47	
Secretarial	75.00	
Miscellaneous	66.58	
Bank balance, December 31st, 1937	89.17	
		$283.97

All of which is respectfully submitted,
Stewart Young, M.E.I.C., *Chairman.*
J. J. White, M.E.I.C., *Secretary-Treasurer.*

Sault Ste. Marie Branch

The President and Council:—

On behalf of the Executive committee we submit the following report of the Sault Ste. Marie Branch for the calendar year 1937:—

The Executive committee met on January 27th and appointed standing committees. The committees and chairmen were as follows:—

Papers and Publicity .... W. A. Dawson, A.M.E.I.C.
Legislation and Remuneration .... F. Smallwood, M.E.I.C.
Entertainment .... John L. Lang, M.E.I.C.
Membership .... A. H. Russell, A.M.E.I.C.

The Executive committee met eleven times during the year to discuss and promote the business of the Branch and The Institute.

Eight dinner meetings were held during the year. No regular meeting date was adhered to rigidly as the executive found that it was necessary to fit the date of the meeting to suit the convenience of the speakers. The average attendance at the dinners was 16 members and guests.

Programmes of the meetings were as follows:—

1937

Jan. 4.—Annual general meeting for 1936. This meeting was followed by a social evening.

Feb. 19.—**The Kanuchan Power Development,** by W. M. Reynolds, A.M.E.I.C.

Mar. 19.—**Teaching Machine Shop Practice,** by H. R. Hipwell, of the Sault Technical and Commercial High School.

Apr. 26.—**The Maintenance of Worn Parts by the Oxy-acetylene Process,** by R. J. Anderson, of The Dominion Oxygen Company, Limited, Montreal, P.Q.

June 16.—This meeting was held at a time which coincided with the main banquet of The Engineering Institute of Canada Semicentennial Celebration. Through arrangements with Headquarters and the Sault Radio Station, C.J.I.C., the members were able to listen to the broadcast of the speech delivered at this banquet by His Excellency Lord Tweedsmuir, the Governor-General of Canada.

Following this speech, a discussion of the work of the Committee of Consolidation of The Engineering Institute of Canada was led by C. W. Holman, A.M.E.I.C., Chairman of the Sault Branch.

Aug. 6.—This was a special meeting which was held to enable our members to meet and hear the President of The Engineering Institute of Canada, C. J. Desbarats, Hon.M.E.I.C. Mr. Desbarats discussed the affairs and problems of The Institute with the members.

Oct. 29.—**Health Service in Industry,** by Dr. H. W. Johnston, M.D., physician at the Algoma Steel Corporation, Sault Ste. Marie, Ont.

Nov. 30.—**Centrifugal Pump Practice,** by G. H. Heyn, engineer, Northern Foundry and Machine Co. Limited, Sault Ste. Marie, Ont.

The membership record of the Branch at the close of 1937 is as follows:—

	Resident		*Non-Resident*		*Total*	
	1936	*1937*	*1936*	*1937*	*1936*	*1937*
Members	9	9	8	8	17	17
Associate Members	10	11	27	30	37	41
Junior Members	3	3	12	14	15	17
Student Members	..	1	14	17	14	18
Affiliate Members	9	9	..	..	9	9
Total	31	33	61	69	92	102

The movement of members during 1937 is summarized as follows:—

	In	*Out*	*Transfer*
Elected to membership	2	..	..
Moved out of Branch	..	18	..
Moved into Branch	25	..	..
Resignations and deaths	..	2	..
Transfer to higher grade	..	..	3
Returned to Active List	3	..	..
Total	30	20	3

Net gain in membership during 1937—10.

Revenue and Expenditures

Financial statement for the year ending December 31st, 1937.

Revenue

	1937	*1936*
Rebates from Headquarters	$150.15	$135.75
Journal subscriptions	10.00	10.00
Affiliate fees	24.00	26.00
Entertainment	68.50	80.50
Interest on savings	1.00	1.50
Total	$253.65	$253.75

Expenditures

Administrative expense	$ 15.00	...
Headquarters expense	15.00	...
Stationery and printing	32.16	32.08
Journal subscription	10.00	10.00
Postage and telegraph	16.41	16.70
Entertainment	118.00	121.45
Miscellaneous expense	6.00	1.75
Honorarium	25.00	25.00
Insurance	2.00	...
Total	$239.57	$206.98
Surplus	$ 14.08	$ 46.77

Balance Sheet for the year ending December 31st, 1937.

Assets

	1937	*1936*	*1937*	*1936*
Cash—Current	$253.45	$221.10		
Savings	204.46	203.46		
Petty cash	.20	1.96		
Stamps	.90		$459.01	$426.52
Receivables—				
Affiliate fees owing		21.00		
Journal subscriptions unpaid		8.00		29.00
Inventory stationery			10.89	9.30
Property			1.00	1.00
			$470.90	$465.82

Liabilities

Honorarium due Secretary	$ 25.00	$ 25.00
Capital surplus	445.90	440.82
	$470.90	$465.82

Respectfully submitted,

C. W. Holman, a.m.e.i.c., *Chairman.*

N. C. Cowie, Jr.e.i.c., *Secretary-Treasurer.*

Toronto Branch

The President and Council:—

We beg to submit the following report of the activities of the Toronto Branch during the year 1937.

The annual meeting of the Branch was held at the Canadian Military Institute on Thursday, April 1st, 1937, and the officers for 1937-38 were elected. The meeting was preceded by a dinner, at which R. L. Dobbin, m.e.i.c., Vice-President of The Institute, E. P. Muntz, m.e.i.c., Councillor of the Hamilton Branch, Colonel E. G. MacKay, a.m.e.i.c., Chairman of the Hamilton Branch, W. T. Fanjoy, a.m.e.i.c., Secretary of the Peterborough Branch, Past-Presidents Brig.-General C. H. Mitchell, m.e.i.c., and Dr. F. A. Gaby, m.e.i.c., were present.

Following the dinner, the meeting was called to order by the chairman of the Branch, O. Holden, a.m.e.i.c., and the undermentioned were named chairmen of the standing committees:—

Papers	A. U. Sanderson, a.m.e.i.c.
Finance	C. E. Sisson, m.e.i.c.
Press Relations	D. D. Whitson, a.m.e.i.c.
Meetings	W. P. Dobson, m.e.i.c.
Membership	W. E. P. Duncan, a.m.e.i.c.
Student Relations	W. S. Wilson, m.e.i.c.
Branch Editor	A. E. Berry, m.e.i.c.
Social	Nicol MacNicol, m.e.i.c.

During the year the Executive committee has held twelve meetings for the transaction of Branch business, with an average attendance of about nine at each meeting.

The following regular meetings were held during 1937:—

1937

Jan. 10.—**Land and Water Transportation**, by D. Forgan, a.m.e.i.c.; **Air Transportation**, by W. A. Scott. Attendance 60.

Jan. 21.—**Power Development in Northern Ontario**, by Dr. T. H. Hogg, m.e.i.c. Attendance 75.

Feb. 4.—**Arc Welding—Its Testing and Inspection**, by W. D. Walcott, a.m.e.i.c. Attendance 50.

Feb. 18.—**Generating Equipment of the Abitibi Canyon Development**, by W. E. Ross, a.m.e.i.c. Attendance 40.

Mar. 4.—**Some Vital Economic Developments in Relation to Engineering**, by McKenzie Williams, b.a.sc. Attendance 40.

Apr. 1.—Annual Branch meeting. Attendance 50.

Oct. 21.—**Recent Advances in Civil Engineering at the University**, by Professor C. R. Young, m.e.i.c. Attendance 70.

Nov. 4.—**The Metallurgy of Metallic Arc Welding and its Applications**, by C. R. Whittemore, a.m.e.i.c. Attendance 180.

Nov. 18.—**The Engineer's Training for and Opportunity in Industry**, by Professor R. W. Angus, Hon.m.e.i.c.

G. J. Desbarats, Hon.m.e.i.c., President of The Institute, also spoke on **Institute Affairs.** Attendance 45.

Dec. 2.—**The Present Status of Air Conditioning**, by M. Barry Watson, a.m.e.i.c.

E. V. Buchanan, m.e.i.c., of the London Branch, also spoke and outlined the programme of the General Annual Meeting to be held in London on January 31st, February 1st and 2nd, 1938. Attendance 65.

Previous to each regular meeting, dinners were held and while the numbers attending have been most encouraging, it is regretted that more members do not avail themselves of these pleasant gatherings.

The Branch contemplate holding a social evening early in the new year at the Engineers Club, to which members will bring their wives.

The Toronto Branch Loan Fund, established five years ago, for the assistance of members, is in a satisfactory condition and during the past three years no application for help has been received. At present there is a balance of $299.48 in the Fund.

The membership of the Branch as at December 31, 1937, is as follows:—

	Resident	*Non-Resident*	*Total*
Members	127	5	132
Associate Members	206	8	214
Juniors	42	1	43
Students	57	9	66
Affiliates	4	1	5
	436	24	460

It is with very deep regret that we record the death of the following members of the Branch during the year: H. W. D. Armstrong, m.e.i.c., W. G. Chace, m.e.i.c., S. E. M. Henderson, m.e.i.c., H. G. Rogers, a.m.e.i.c., A. L. Mudge, m.e.i.c. Our sympathy is extended to their families in their loss.

Financial Statement

Receipts

Bank balance, December 30th, 1936		$504.55	
Rebates	$608.10		
Interest	6.19		
Proceeds of dinners, Engineers Club	97.50		
		711.79	
			$1,216.34

Expenditures

Flowers	$ 15.00		
Notices, printing and posters	168.76		
Engineers Club—Dinner	103.45		
A.S.M.E. joint meeting	30.45		
Room rental	9.00		
Councillors expenses	60.00		
Chairman's expenses	10.90		
Publicity	35.00		
Hart House—Christmas gratuities	20.00		
Stenographic services	40.00		
Secretary—honorarium and expenses	105.80		
Angus luncheon	2.50		
D. D. Whitson—London expenses—Vance	6.20		
Headquarters—Re Semicentennial expenses	82.98		
Transactions	20.00		
Council meeting	23.50		
		$733.54	
Bank balance, December 30, 1937		482.80	
			$1,216.34

The Branch also holds a Dominion of Canada 4½ per cent $100 bond.

Respectfully submitted,

A. U. Sanderson, a.m.e.i.c., *Chairman.*

J. J. Spence, a.m.e.i.c., *Secretary-Treasurer.*

Vancouver Branch

The President and Council:—

On behalf of the Executive committee of the Vancouver Branch, we beg to submit the following report of the activities of the Branch for the year 1937.

Meetings

Eleven meetings of the Branch and one inspection trip were held during the year and are herewith enumerated.

1937

Jan. 26.—Joint meeting with the A.I.E.E. (Vancouver section). J. F. Lincoln, President of the Lincoln Electric Co., Cleveland, on **Modern Developments in Electric Arc Welding.**

Feb. 11.—Dinner meeting. Inspector Harold Mortimer, of the Traffic Department of the Vancouver City Police, on **Vancouver's Traffic Problems.**

Feb. 25.—Evening meeting. R. Weir, Local Manager of the Pressure Pipe Co. of Canada, on **Capilano Water Lines Replacement.**

Mar. 9.—Evening meeting. A. G. Zima, development and research metallurgist of the International Nickel Co., on **The Role of Nickel in the Development of Modern Cast Iron.**

Mar. 22.—Dinner meeting. F. Vernon Jones, B.C. Board of Fire Underwriters, on **How Construction Affects Insurance Rates.**

Apr. 5.—Evening meeting. C. E. Webb, M.E.I.C., District Chief Engineer, Dominion Water Power Bureau, on **The Grande Coulee Dam.**

May 4.—Dinner meeting. W. J. Johnston, Surveyor, B.C. Board of Fire Underwriters, on **Automatic Sprinkler Equipment.**

Aug. 25.—Luncheon meeting in honour of the President, G. J. Desbarats, C.M.G., Hon.M.E.I.C.

Oct. 19.—Dinner meeting. J. W. Roland, M.E.I.C., resident engineer for Montserrat and Pratley, on **The Foundations of the First Narrows Bridge.**

Nov. 16.—Annual dinner and meeting. J. N. Finlayson, M.E.I.C., Dean of the Faculty of Applied Science and head of the Department of Civil Engineering, University of British Columbia, on **Engineering Education.**

Dec. 6.—Joint meeting with the A.I.E.E. (Vancouver section). Major J. C. MacDonald, M.E.I.C., Comptroller of Water Rights, Province of British Columbia, on **The Significance of the Tennessee Valley Authority.**

Oct. 30.—Inspection trip. An inspection trip to the foundation work of the First Narrows Bridge project was arranged by courtesy of the contractors of the foundation work, Messrs. Stuart and Cameron Co. Sixty-five members and friends sat down to luncheon in the mess room located near the bridge site and after luncheon inspection of the foundation work of the bridge in its various stages was made.

Executive

The Executive committee held thirteen meetings during the year. The Executive were pleased to have as ex-officio members Dr. E. A. Cleveland, M.E.I.C., and P. H. Buchan, M.E.I.C., immediate Past-President and Councillor respectively. As in previous years, the Registrar of the Association of Professional Engineers of British Columbia, E. A. Wheatley, M.E.I.C., was also elected an honorary member of the Executive. The presence of these three gentlemen at the deliberations of the Executive on numerous occasions was very much appreciated.

Membership

The resident membership of the Branch District shows a net increase of five during the year 1937 and the non-resident membership an increase of fourteen. The membership of the Branch now stands as follows:

	Resident		Non-Resident	
	December, 1937	December, 1936	December, 1937	December, 1936
Members	69	64	22	16
Associates	49	44	35	31
Juniors	1	2	7	6
Students	8	12	12	9
Affiliates	1	1	..	..
	128	123	76	62
Non-Resident	76	62		
Total	204	185		

Obituary

We regretfully record the passing of two members of the Vancouver Branch during the year 1937:—

Samuel Fraser Workman, M.C., A.M.E.I.C., on March 19th, and John Grant MacGregor, M.E.I.C. (Life member), on October 10th.

Walter Moberly Book Award

The Walter Moberly Book prize award (value $30) for the year 1937 was divided equally between Kenneth DePencier Watson and Phillip C. B. Emery, engineering students in the graduating year of the University of British Columbia.

Visit of the President

The Branch was very pleased to be honoured with a visit from the President, G. J. Desbarats, C.M.G., Hon.M.E.I.C., and Mrs. Desbarats on their western tour during August. The Branch's official function took the form of a luncheon on August 25th at which about fifty members welcomed the President who spoke to the gathering on "Institute Affairs."

Semicentennial Celebration and Round Table Conference on Institute Affairs

The Vancouver Branch was well represented at the Semi-centennial Celebration held in Montreal in June. As official delegate to the Round Table Conference the Branch was represented by its Chairman, H. N. MacPherson, M.E.I.C. The Branch was also represented by Past Presidents Walkem and Cleveland, Councillors P. H. Buchan, J. N. Finlayson, and Col. H. F. Letson. Reports made by some of these representatives later to the Executive and the Branch membership indicate the Semicentennial Celebration to have been a milestone in Institute progress. The deliberations and subsequent report of the Round Table Conference on Institute Affairs indicates the gathering to have been very worth while and one from which have already emanated many ideas for the improvement of branch activities and branch to branch relations.

Financial Statements

Audited financial statements covering the Branch activities for the period November 20th, 1936, to October 31st, 1937, are appended hereto.

General Account

Cash in bank and on hand—November 20th, 1936:			
Canadian Bank of Commerce	$122.07		
Secretary's fund	2.88		
		$124.95	
Surplus for period November 20th, 1936, to October 31st, 1937, in accordance with Statement of Revenue and Expenditures		74.50	
			$199.45
Cash in bank and on hand—October 31st, 1937:			
Canadian Bank of Commerce		$195.29	
Secretary's fund		4.16	
			$199.45

Revenue

Rebates from Headquarters, Montreal, May, 1936, to April, 1937			$309.23

Expenditures

Expenses incurred in connection with meetings and trips:			
Printing and mailing notices and addressograph plates	$ 64.66		
Rental of Auditorium for meetings	26.25		
Hire of projecting lantern	6.00		
Miscellaneous expenses incurred in respect of meetings	15.80		
		$112.71	
General Expenses:			
Stenographic services	20.00		
Secretary's honorarium (1936)	50.00		
Telegrams	4.97		
Stamps	7.95		
Miscellaneous	6.35		
		89.27	
Expenses re Semicentennial Celebration:			
Vancouver Branch share of cost of Round Table Conference held in Montreal during June		32.75	
			234.73
Surplus for period November 20th, 1936, to October 31st, 1937			$ 74.50

Walter Moberly Memorial Fund

Bank balance, November 20th, 1936			$111.70

Revenue

Interest received on:—			
$500 City of Vancouver 5% Bond, due 1964		$ 25.00	
$100 Dominion of Canada 5% Bond, due 1943		5.00	
Bank interest on balances		1.76	
			31.76
			$143.46

Expenditures

Charge by bank safekeeping of securities		$ 1.00	
Walter Moberly Book Prize award for year 1937		30.00	
			31.00
Balance in Canadian Bank of Commerce, October 31st, 1937			$112.46

Audited and found correct and the above securities verified by letter from Canadian Bank of Commerce:

H. P. Archibald, A.M.E.I.C., Auditor.

Respectfully submitted,

H. N. Macpherson, M.E.I.C., *Chairman.*

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

Victoria Branch

The President and Council:—

On behalf of the Executive committee we have the honour to submit the following report on the activities of the Victoria Branch for the year 1937.

Meetings

Three general meetings of the Branch were held during the year, one of which was a dinner meeting and one a luncheon meeting with an average attendance of 23. On August 20th the Branch tendered a reception for President Desbarats and Mrs. Desbarats at the home of Mr. and Mrs. F. C. Green when 25 members, their wives and friends attended. An enjoyable social evening resulted during which President Desbarats spoke for an hour reviewing Institute activities.

Seven meetings of the Executive committee were held with an average attendance of 70%, which is considered to be good.

MEMBERSHIP

The total membership of the Branch stands at sixty-four, which is the same figure as for the preceding year. One new Member was received and one Member resigned. One Associate Member was transferred to Halifax and one Associate Member transferred to Victoria from Port Arthur. Two Students were transferred to Victoria from other parts of Canada. The Branch had the misfortune to lose by death during the year two valuable and respected members: L. W. Toms, A.M.E.I.C., Life Member of The Institute, and F. W. Knewstubb, A.M.E.I.C. Two resignations are at present pending.

The Branch membership is made up as follows:—

	Resident	Non-Resident	Total
Members	23	1	24
Associate Members	21	5	26
Juniors	3	3	6
Students	7	..	7
Affiliates	1	..	1
Total	55	9	64

FINANCIAL STATEMENT

Receipts

Balance in hand, December 10th, 1936		$ 51.61
Rebates from Headquarters	$108.75	
Branch Affiliate's dues	3.00	
Total receipts		111.75
		$163.36

Disbursements

Lantern slides	$ 5.25	
Mimeographing and letter service	20.28	
Stamps and stationery	8.65	
Stenographic service	4.72	
Telegrams	2.70	
Entertainment of guests	12.90	
Flowers	2.50	
Branch's share of representation at the Semicentennial Round Table Conference	9.70	
1936 honorarium to Secretary	25.00	
Total disbursements		$ 91.70
Balance in hand, December 16th, 1937		71.66
		$163.36

Audited and found correct,
F. W. KNEWSTUBB, A.M.E.I.C., Auditor.

ANNUAL MEETING

The annual meeting of the Branch was held on December 16th. and was preceded by a dinner and followed by a general technical meeting. The total attendance was 31. The election of officers for 1938 followed.

Following the business the Branch enjoyed a technical meeting when A. L. Carruthers, M.E.I.C., bridge engineer for the Provincial Government, gave a talk on the construction of the new Pattulo bridge at New Westminster, which was well illustrated by several reels of motion pictures. Also there were on exhibit nineteen illuminated addresses presented to The Institute on the occasion of its Semicentennial Anniversary last June by the engineering societies of Great Britain, Europe, and the United States.

In conclusion this Executive committee wishes to sincerely thank the General Secretary and the Assistant Secretary at Headquarters for their generous assistance and unfailing courtesy throughout the year.

Respectfully submitted,
J. C. MACDONALD, M.E.I.C., *Chairman.*
KENNETH REID, Jr.E.I.C., *Secretary-Treasurer.*

Winnipeg Branch

The President and Council:

The following report of the Winnipeg Branch for the year ending December 31st, 1937, is respectfully submitted.

MEMBERSHIP

The membership of the Branch stands as follows:—

	Resident	Non-Resident	Total	Change from 1936
Members	36	3	39	..
Associate Members	76	12	88	..
Juniors	22	6	28	+11
Students	38	7	45	+ 2
Affiliates	2	..	2	..
Branch Affiliates	3	..	3	+ 1
	177	28	205	+14

MEETINGS

There were nineteen general meetings of the Branch throughout the year, the attendance at the regular evening meetings averaging 75.

1937

Jan. 7.—James Gilchrist, **Shelling of Tires.** Attendance 52.
Feb. 4.—Annual meeting. Dean E. P. Fetherstonhaugh, M.E.I.C., **The Cathode Ray Oscillograph.** Attendance 53.
Feb. 11.—Luncheon. J. L. Busfield, M.E.I.C. Attendance 22.
Feb. 18.—Dr. Alexander Gibson, **Color Photography.** Attendance 175.
Mar. 4.—Student's Prize papers. S. V. Antenbring, **Locating the Control for a Detailed Geological Survey;** J. J. Miller, **Air Conditioning in Railway Cars.** Attendance 75.
Mar. 25.—Dr. F. D. White, **The British Programme of Protection Against Aerial Gas Attack.** Attendance 150.
Apr. 1.—Flt.-Lt. D. Edwards, **The Technique of Modern Flying.** Attendance 60.
Apr. 15.—C. S. Landon, **History of the Association of Professional Engineers of Manitoba.** Attendance 36.
May 20.—President G. J. Desbarats, **Consolidation.** Attendance 35.
June 8.—Luncheon. Mr. Johnstone Wright, **The Central Electricity Board.** Attendance 41.
July 12.—Luncheon. Brigadier-General Magnus Mowat. Attendance 9.
Aug. 30.—Dinner. President G. J. Desbarats. Attendance 40.
Aug. 31.—President G. J. Desbarats, **Institute Affairs.** Attendance 22.
Oct. 15.—Visit to plant of the Greater Winnipeg Sanitary District. Attendance 125.
Oct. 21.—Dr. W. J. Hodge, **Acoustics.** Attendance 140.
Nov. 4.—G. E. Cole, A.M.E.I.C., **The Cyanide Process.** Attendance 93.
Nov. 17.—T. Sellar Cook, **The Edinburgh War Memorial.** Attendance 29.
Nov. 26.—Luncheon, Alan Ferrier, A.M.E.I.C. Attendance 40.
Dec. 2.—Film night. **Nickel Tales, Rhapsody in Steel.** Attendance 54.

Throughout the year the Executive committee held twelve meetings.

FINANCIAL STATEMENT

Receipts

Balance forward, December 31st, 1936		$177.40	
Headquarters rebates		254.75	
Branch Affiliate dues		10.00	
Bond interest		22.50	
Grant, Association of Professional Engineers of Manitoba		50.00	
Refund of duty on film		9.15	
			$523.80

Expenditures

General meeting expense—notices, etc		$159.50	
Annual meeting expense—ballots, notices, etc		13.29	
Refreshments at meetings		35.67	
Entertainment expense—luncheons, etc		11.85	
Printing, stationery, etc		10.44	
Postage and revenue stamps		11.00	
Branch assessment re conference on Branch affairs		33.40	
Telegrams		4.84	
Student's prizes		20.00	
Deficit on dinner—share paid to A.P.E.M.		71.06	
Miscellaneous expense		19.21	
		$390.26	
December 31st, 1937:			
Balance in bank	$126.12		
Balance in petty cash	7.42		
		133.54	
			$523.80

Accounts receivable: Rebates due from Headquarters .... $ 31.12

The Branch owns a fully registered Dominion of Canada bond, face value $500.

Certified a true and correct statement:
G. L. SHANKS, A.M.E.I.C. } Auditors.
D. M. STEPHENS, A.M.E.I.C. }

Respectfully submitted,
A. E. MACDONALD, M.E.I.C., *Chairman.*
H. L. BRIGGS, A.M.E.I.C., *Secretary-Treasurer.*

Local Committees in Charge of Arrangements

D. S. Scrymgeour, A.M.E.I.C.,
Secretary,
Annual Meeting Committee.

For the Successful
Annual Meeting
Held in London, Ontario
On January 31st, February 1st
and 2nd, 1938

A. O. Wolff, M.E.I.C.,
Chairman,
London Branch,

E. V. Buchanan, M.E.I.C.,
Chairman,
Annual Meeting Committee.

J. A. Vance, A.M.E.I.C.,
Vice-Chairman,
Annual Meeting Committee.

H. F. Bennett, M.E.I.C.,
Chairman,
Papers of Meetings Committee.

General Committee

Chairman.......................... E. V. Buchanan, M.E.I.C.
Vice-Chairman.......................... J. A. Vance, A.M.E.I.C.
Secretary.......................... D. S. Scrymgeour, A.M.E.I.C.
Members: S. W. Archibald, M.E.I.C. H. L. Hyman, A.M.E.I.C.
F. C. Ball, A.M.E.I.C. W. C. Miller, M.E.I.C.
F. A. Bell, A.M.E.I.C. V. A. McKillop, A.M.E.I.C.
H. F. Bennett, M.E.I.C. H. A. McKay, A.M.E.I.C.
D. M. Bright, A.M.E.I.C. J. R. Rostron, A.M.E.I.C.
J. Ferguson, A.M.E.I.C. W. R. Smith, A.M.E.I.C.
G. J. Forristal, S.E.I.C. W. M. Veitch, A.M.E.I.C.
R. W. Garrett, A.M.E.I.C. W. H. Wood
A. O. Wolff, M.E.I.C.

Chairmen of Sub-committees

W. C. Miller.......................... *Finance*
H. F. Bennett.......................... *Papers*
V. A. McKillop.......................... *Entertainment and Visits*
W. M. Wood.......................... *Publicity*
W. M. Veitch.......................... *Hotel and Reception*
R. W. Garrett.......................... *Registration*

Ladies' Committee

Chairman.......................... Mrs. E. V. Buchanan
Members.......... Mrs. H. F. Bennett Mrs. V. A. McKillop
Mrs. W. C. Miller Mrs. W. M. Veitch
Mrs. A. O. Wolff

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."

VOLUME XXI FEBRUARY, 1938 No. 2

Additional Authority Essential

The open discussions at the recent Annual General Meeting on January 31st, and the deliberations of an unusually well attended meeting of Council the same evening, indicated not only unanimity, but enthusiasm for positive and prompt action on the part of Council whenever and wherever an opportunity is offered for collaboration with a Provincial Association. At the same time, it was realized that as a definite programme for this desired co-operation could not be launched by Council under the existing by-laws of The Institute, additional authority in the form of a new by-law must be obtained for this purpose.

A new enabling By-Law, No. 76, is being submitted at once to the corporate membership. The importance of this new By-Law cannot be emphasized too strongly, as without the authority it conveys Council will continue to be impotent to meet the general demand of the corporate membership throughout the Dominion for a close constructive co-operation between The Institute and the Provincial Professional Associations. For instance, the strongly expressed desire of the engineers in Nova Scotia for an agreement between The Institute and the Professional Association that will unify the Profession in that province cannot be definitely satisfied without just such additional authority as the new By-Law will confer upon Council. Furthermore, active negotiations between the Council and the governing bodies of associations in other provinces that promise much for the Profession cannot be proceeded with effectively until this new enabling By-Law has been approved. In brief, as was stated at London by both the outgoing and the incoming presidents, this new enabling By-Law will open an era of greater usefulness for The Institute, and therefore deserves to be endorsed by the heaviest plurality vote of any By-Law change in the history of The Institute." To ensure this desirable result, all corporate members are urged to vote in favour of this new section and to do so promptly on receipt of the ballot.

The E.I.C. Engineering Catalogue

Acting on the recommendation of the Committee on Publications, Council has concluded arrangements for the transfer of the rights to the E.I.C. Engineering Catalogue to N. E. D. Sheppard, A.M.E.I.C., who will continue the publication under the name "The Engineering Catalogue." In taking this step Council has been guided by the desire to have the Catalogue continued under such auspices as will ensure the same high standard as has characterized this publication in the past.

Concurrently, an agreement has also been entered into whereby Mr. Sheppard will act as sole agent for the sale of advertising space in The Journal, and will supervise the production of the advertising section. Mr. Sheppard will have associated with him the same organization as has been responsible in the past for The Institute Catalogue and Journal advertising.

Entrance Fees Revised

The Annual General Meeting has approved a recent decision of Council that for the current year the entrance fees will be as follows:—

For admission as Student.................no entrance fee
For admission as Junior..................Five dollars
For admission as {Affiliate / Associate Member / or Member}......Ten dollars

The By-laws provide that the transfer fee shall be the difference between the entrance fees of the two classes of membership.

R. J. DURLEY,
General Secretary.

February, 1938.

From Square Timber to Pulpwood

During the economic development of Canada, the country's prosperity has largely depended on the export of a series of commodities, each characteristic of some phase of industrial growth. For example, the products of our forests have formed the background of Canadian industrial activity for a long period. Their export began before Confederation, and even now they constitute a large proportion of our exports, approaching our agricultural produce in value. Indeed, as Professor Lower has remarked, "it would be difficult to overestimate the influence of the forest upon the settlement and development of the North American Continent . . . Utilization of the forest for human need—in other words the lumber industry—naturally began with the building of the first log cabin." Thus the history of that industry begins with the very early settlers, who with the lumber jacks, succeeded the voyageurs and trappers.

The lumber industry started in the eighteenth century in the lower St. Lawrence valley and in the Maritime Provinces. As settlement extended, forest operations spread, first to the Ottawa valley and later further to the north and west. Lake Timiskaming was reached about 1835. As the timber cutters sought new areas the settlers followed close behind them. In many cases the settlers themselves combined lumbering with farming.

It is not generally realized that the first active development of the Canadian timber trade was due to Napoleon Bonaparte. The "Continental System," by which he attempted to destroy England's trade with all European countries, was so far successful that it practically stopped all importation of timber from the Baltic, the source from which Britain had been obtaining her naval supplies. But oak, pine and spruce had to be obtained for the hulls, masts and yards of the warships which formed Britain's great weapon against the Napoleonic Empire. In this emergency, the forests of Canada were made available. High duties were placed on the import of foreign woods to Great Britain. British timber firms began to operate in Canada, and by 1812 the trade was so extensive that five hundred timber ships loaded at Quebec for the voyage to England. Mast pine as much as 120 feet long and four feet in diameter at the butt, and sticks of square timber up to 70 feet long and 24 inches square, hewn with the broad axe, were to be found in their cargoes, together with a proportion of "deals" and other sawn lumber.

The rafting of square timber (largely white or "Quebec" pine) to Quebec for export, began with the nineteenth century. The first raft floated down the Ottawa and St. Lawrence in 1807, making its journey in thirty-seven days. The square timber industry reached its peak about fifty years later, gradually diminishing from that time until the last rafts passed down the St. Lawrence in the nineties, and the river lost one of its most picturesque forms of traffic.

As the settlements spread, big timber became more difficult of access. The farmer-lumberman became the farmer, the returns from the square timber industry dwindled, and activity in sawn lumber increased. As the export of sawn lumber developed, Quebec gave place to Montreal as the centre of its export activities. The square timber trade had however done much to provide the capital needed for the development of the young country and for the construction of its roads, railways, canals and public works.

During the first seventy-five years of the nineteenth century shipbuilding took an important place as an industry in Nova Scotia, New Brunswick and Quebec. Its most active period began about 1820; the industry was at its height in the sixties. In 1865, 294 vessels, aggregating over 56,000 tons, worth nearly $2,500,000, were built in Nova Scotia. In the same year in New Brunswick, 148 new vessels were launched, with a tonnage of more than 65,000. By that time Canadian-built wooden vessels were to be found in all parts of the world. At first they had been largely built for the builder-owners' use, and were often employed in the fish and lumber trade between the Maritimes and the West Indies. Later their moderate cost secured for them, in Great Britain, a ready sale for use in the timber trade, on other trade routes, and for the run to Australia. During the seventies the iron steamer began to supplant the sailing ship, and the industry did not outlast the century.

The sawn lumber trade received a great impetus during the early part of the period of railway development in Canada which began in the fifties, the railways themselves using large quantities for ties and bridge timbers. The completion of the Canadian Pacific Railway opened the way for the utilization of the vast timber resources of the Pacific coast, much of the cut of British Columbia lumber being required for the needs of the rapidly increasing population of the Prairie Provinces. During the past twenty years the immense stands of Douglas fir in the west have increasingly supplied the large sizes of saw-timber which the depleted forests of the east can no longer furnish. After the War, taking advantage of the Panama Canal, the Atlantic coast became an important market for British Columbia lumber.

Thus the eventful story of the Canadian lumbering industry pictures several periods, during each of which our forest resources have been utilized along some characteristic line. These periods naturally overlap, and it may be noted that the latest phase, the development of the pulp and paper industry, had its beginnings as long ago as 1866, when both ground wood and chemical pulp were first manufactured on a small scale in the Province of Quebec. The early growth of the industry was very slow and it was not until about 1900 that it became firmly established. From that time an era of active hydro-electric power development (from an installed capacity of 173,000 hp. in 1900 to 8,100,000 hp. in 1938) provided the large supply of power needed for its growth, while the forests of the east, though much of the large timber had been cut, continued to furnish ample supplies of the smaller sizes of spruce and balsam, the species most suitable for pulp making.

Compared with other forest products industries, it seems that pulp and paper manufacture has elements of permanence which were lacking in some of its predecessors. It is less seasonal, and wood pulp can be transformed into a variety of materials which are now indispensable for other branches of industry and trade. For example, ground wood pulp is the basis of newsprint and the other cheaper grades of paper and is used in large quantities for box boards and wall boards. Sulphite pulp is also used in newsprint, and for the finer grades of white paper and boards. It plays an important part in industry by furnishing the raw material for rayon, cellophane, certain of the plastic resins, duco and for many explosives. Soda pulp is used for book, magazine and writing paper; sulphate or kraft pulp, with its long fibre, is the basis of strong wrapping paper.

With such products, whose annual value is over 160 million dollars, the pulp and paper industry is of primary industrial importance to Canada. Pulpwood, pulp and newsprint form one of our principal items of export, amounting annually to some 600,000 tons of pulp, 2,000,000 tons of pulpwood and 2,500,000 tons of newsprint.

This great industry has had its ups and downs, upon which it is not necessary to enlarge here. It will be sufficient to note in passing, that Canadian pulp and newsprint has to be sold outside of Canada and in a highly competitive market. Quite apart from its value as one of the leading contributors to the commercial prosperity of Canada, however, the industry has had a profound influence upon the general development of the country and its manufacturing facilities. It has given rise to notable advances in the theory and technique of many chemical engineering processes, and provides the raw material for a host of subsidiary industries which could not exist without cellulose. Its technology has been built up by extensive research, in which the government has co-operated with the industrialists. The technical men in the industry may be regarded as practising a special division of engineering, drawing upon civil, mechanical, electrical, metallurgical, and chemical engineering for their technical contributions to a common end.

OBITUARIES

Arthur Frederick Dyer, A.M.E.I.C.

The death of Arthur Frederick Dyer, A.M.E.I.C., occurred in Halifax on December 19th, 1937, after an illness of several months. Mr. Dyer was born at Giridih, Behar, India, on December 7th, 1875. He received his early education and technical experience in England. In 1909 he came to Canada, joining the Dominion Bridge Company as a draftsman, later becoming manager in Montreal for the Clinton Fireproofing Company. Mr. Dyer acted as resident engineer for Sir John Kennedy on the construction of the new Pier No. 2, Halifax, N.S. He was later in charge of new construction for Messrs. Furness, Withy and Company, Halifax, and for a time was in general consulting work in Halifax. At the time of his death he was chief engineer of the McDonald Construction Company. He joined The Institute as an Associate Member in 1918.

Frederick William Knewstubb, A.M.E.I.C.

It is with deep regret that we record the passing of Frederick William Knewstubb, A.M.E.I.C., in Victoria, B.C., on December 16th, 1937. Mr. Knewstubb was born at Carlisle, England, on December 12th, 1874, receiving his technical education at Glasgow Technical College. He received his early engineering experience in England, coming to Canada in 1908, his first position in this country being that of inspector for the city of Port Arthur. He was later employed by the Grand Trunk Pacific and Canadian Northern Pacific Railways and in 1911 was appointed engineer and later chief field engineer, Water Rights Branch, Province of British Columbia. Mr. Knewstubb served overseas in the Great War. He joined the Canadian Society of Civil Engineers as an Associate Member in 1915.

Lt.-Col. Cecil George Porter, D.S.O., A.M.E.I.C.

Members of The Institute will learn with regret of the death of Lt.-Col. Cecil George Porter, D.S.O., A.M.E.I.C., on January 12th, at his home in Montreal. Col. Porter was born at Saint John, New Brunswick, on October 9th, 1887, and attended McGill University where he received the degree of B.Sc. in 1911 and M.Sc. in 1913, and a research fellowship in metallurgy. Mr. Porter's early experienced was obtained with the Nova Scotia Steel and Coal Company and other steel companies in the United States and Canada. He went overseas in 1914 with the Canadian Expeditionary Force, later commanding a battalion of infantry. He was wounded several times and was discharged with the rank of Lieutenant-Colonel at the end of the War. He was awarded the D.S.O. and mentioned four times in despatches. On his return to Canada in 1919 Colonel Porter was appointed manager of Douglas, Milligan Company Ltd. He later established the firm of C. G. Porter and Company, building contractors, of which he was head at the time of his death. Colonel Porter joined The Institute as a Student in 1907 becoming an Associate Member in 1921.

Victor Topping, A.M.E.I.C.

We regret to announce the death of Victor Topping, A.M.E.I.C., who died December 27th, 1937, at his home in Toronto. Mr. Topping was born in Hartlepool, England, on February 21st, 1896, and came to this country in 1912. He received his technical education at the University of Toronto from which he grdauated in 1917 with honours and the degree of B.A.Sc. He went overseas with the Royal Flying Corps in 1917 and in the following year was severely injured when his machine took fire and crashed. This resulted in his being confined to the hospital for some four years. In 1922 he was appointed engineer of traffic analysis with the Toronto Transportation Commission. Mr. Topping secured the degree of M.A. from Toronto in 1923 and in 1924 was awarded the degree of C.E. He was awarded the first Strathcona Memorial Fellowship for research work in transportation at Yale University. Mr. Topping later took up consulting work in Toronto and also studied law, graduating as a barrister in 1934 at Osgoode Hall.

Edward Augustus Wheatley, M.E.I.C.

As we go to press, word has been received of the death in Vancouver on February 2nd of Edward Augustus Wheatley, M.E.I.C., Registrar of the Association of Professional Engineers of the Province of British Columbia. An obituary notice will appear in our next issue. A consistent advocate of professional registration, he was able also to render valuable services to The Institute in British Columbia.

PERSONALS

F. O. Condon, M.E.I.C., has been appointed chief engineer of the Atlantic Region, Canadian National Railways. Mr. Condon was born in Moncton in 1878 and was educated in the public and high schools of that city. In 1893 he entered the service of the Intercolonial Railway as a messenger in the engineering department. He became a draftsman in 1899, and in 1912 was appointed division engineer. In 1923 he was made engineer, maintenance of way, Canadian National Railways; principal assistant engineer in 1927, and office engineer in 1932. As a member of The Engineering Institute of Canada, Mr. Condon has rendered faithful and devoted service. He has filled the office of vice-president of The Institute representing the Maritime Provinces in 1928 and 1929 and has also acted in the capacity of councillor for and chairman of the Moncton Branch.

F. O. Condon, M.E.I.C.

Dr. Augustin Frigon, M.E.I.C., has recently left for Europe where he will represent the Canadian Broadcasting Corporation in particular, and Canada in general, at the World Radio Conference, in Cairo, Egypt, commencing on February 1st, 1938. He was one of the official delegates from Canada attending the American Regional Conference in Havana in preparation for the World Radio Conference. Dr. Frigon, who is assistant general manager of the Canadian Broadcasting Corporation, is a past chairman of the Montreal Branch of The Institute.

George P. Hawley, M.E.I.C., has retired as resident engineer of the Rivière-des-Prairies power house of the Montreal Light, Heat and Power Consolidated. He joined this company in 1912 as resident engineer at the Cedars power house and in 1927 was appointed to the position from which he has just retired.

Philip Reynolds, M.E.I.C., has retired from the position of chief engineer of the Shell Company of Canada Limited of Toronto, Ont., and is now residing in Wiltshire, England. Mr. Reynolds was chief engineer of the Shell Oil Company in Canada from 1923 until 1937. He received his early technical experience with the Great Western Railway in England, the Canadian Pacific Railway in Vancouver and in the mechanical department of the same company in Montreal.

Gilles E. Sarault, S.E.I.C., is now chief engineer of the Canadian Broadcasting Corporation Station, C.B.F., Montreal. Mr. Sarault graduated from McGill University in 1924 and was for a time engineer in the special products department of the Northern Electric Company, Montreal.

John Stadler, M.E.I.C., has been appointed president of the Lake Sulphite Pulp Company. Mr. Sadler is a well known consulting engineer in Montreal who specializes in pulp and paper mill work. He was at one time general manager of the Lake St. John Power and Paper Company, Limited.

Thomas Henry White, who joined the Canadian Society of Civil Engineers as a Member at the original organization meeting held on January 20th, 1887, had his ninetieth birthday on January 27th, 1938.

He celebrated it in his retirement in Vancouver, receiving a host of messages of congratulation from his many old friends, who recall his long and distinguished career as an engineer, and his achievements as one of Canada's pioneer railway builders.

It gave the Council of The Institute great pleasure to send to Mr. White—who must be one of the oldest, if not the oldest, of our members—a sincere expression of their best wishes for his continued health and happiness.

N. E. D. Sheppard, A.M.E.I.C., manager of The Institute Publications Department, is severing his immediate connection with The Institute in order to continue the publication of The Engineering Catalogue.

Mr. Sheppard graduated from the University of Toronto in 1914 with the degree of B.A.Sc., and received an appointment to the staff of the Dominion Water Power Branch of the Federal Government, in Ottawa, as assistant to the chief hydraulic engineer on water power investigation. In 1916 he was transferred to Nova Scotia, and later returned to Ottawa where he was engaged on the preparation of the first edition of the Directory of the Central Electric Stations in Canada and on a detailed analysis of this industry in Canada. In 1920 Mr. Sheppard accepted the position of secretary to the vice-president and technical director of the Riordon Company Limited at Hawkesbury, following which he was appointed in 1922 assistant to the secretary on the Headquarters staff of The Institute. In that position, and as assistant secretary, he was responsible for the efficient handling of the affairs of The Institute. In 1930 Mr. Sheppard left to accept a position in Toronto and in 1932 returned as manager of The Institute Publications Department.

N. E. D. Sheppard, A.M.E.I.C.

In addition to producing The Engineering Catalogue, Mr. Sheppard will be in charge of the production of the advertising section of The Engineering Journal.

ELECTIONS AND TRANSFERS

At the meeting of Council held on January 21st, 1938, the following elections and transfers were effected:

Members

LeCOINTE, Pierre Leon Paul, C.E. (Ecole Nationale des Ponts et Chaussées, Paris), consltg. engr., F. J. Leduc & Associates, 354 St. Catherine Street East, Montreal, Que.

LEDUC, Hon. Francois J., B.A.Sc., D.A.Sc. (H.C.), (Ecole Polytechnique, Montreal), Minister of Highways, Province of Quebec, Montreal, Que.

Associate Members

CARLEY, Forest Cecil, B.A.Sc., (Univ. of Toronto), Montreal manager, Affiliated Engineering Corpns. Ltd., Montreal, Que.

HARTMANN, Nicholas Leopold, Dipl. Ing. (Technical College, Stuttgart, Germany), dftsman., Steel Company of Canada, Hamilton, Ont.

PERRAULT, Lucien, B.A.Sc., C.E., (Ecole Polytechnique, Montreal), chief engr. and manager, Industrial and Commercial Laboratories Ltd., Montreal, Que.

Juniors

BURLTON, George Arnold, B.Eng., (N.S. Tech. Coll.), 5245 Cote St. Luc, Montreal, Que.

CHAPLIN, Herbert Elliott, B.Eng., (McGill Univ.), asst. factory engr., Imperial Tobacco Co. Ltd., Montreal, Que.

GODFREY, William Robert, B.Sc. (E.E.), (Univ. of N.B.), asst. highway engr., Dept. of Public Works N.B., Chatham, N.B.

HAINES, Neil St. Clair, B.A.Sc., (Univ. of Toronto), 1311 Pape Ave., Toronto, Ont.

MILLER, Charles Arthur, B.A.Sc., (Univ. of Toronto), engrg. dept., Canadian Industries Limited, Montreal, Que.

PREVEY, Warren Harry Preston, B.Sc. (E.E.), (Univ. of N.B.), student engr., Can. Gen. Elec. Co. Ltd., Peterborough, Ont.

TRUDEL, Alphonse, B.Eng. (M.E.), (McGill Univ.), engr. dftsman., Canadian International Paper Co., Three Rivers, Que.

Affiliate

DYSON, Vincent Seddon, supt., heavy forging plant, Canada Foundries and Forgings Ltd., Welland, Ont.

Transferred from the class of Associate Member to that of Member

WEBB, Harry Randall, B.Sc., M.Sc., (Univ. of Alta.), associate professor of civil engrg., University of Alberta, Edmonton, Alta.

Transferred from the class of Junior to that of Associate Member

DesBRISAY, Aretas William Young, Capt., R.C.S., B.Sc., (McGill Univ.), Ph.D. (Univ. of London), chief technical instructor, Canadian Signal Training Centre, Barriefield, Ont.

FARRELL, Alfred James, B.Sc., (McGill Univ.), inspr., Real Estate Dept., The Royal Trust Company, Montreal, Que.

GRANT, Alexander George, B.A.Sc., (Univ. of Toronto), field engr., mill constrn., Lake Sulphite Pulp Co. Ltd., Red Rock, Ont.

PIDOUX, John Leslie, B.Sc., (Univ. of Alta.), M.Eng., (McGill Univ.), struct'l. designer, Dominion Bridge Co. Ltd., Montreal, Que.

RACEY, Herbert John, B.Sc., (Queen's Univ.), asst. mgr., Canadian Potteries Ltd., St. Johns, Que.

Transferred from the class of Student to that of Associate Member

BRITTAIN, Norman Westaway, B.Sc. (C.E.), (Univ. of N.B.), private practice as civil engr., Minto, N.B.

COOPER, Lawrence O'Toole, B.Sc., M.Sc., (McGill Univ.), asst. to master mechanic of mines, International Nickel Company, Sudbury, Ont.

EVANS, Delano Ernest, B.Sc., M.Eng., (McGill Univ.), designer. Dominion Engineering Works, Lachine, Que.

HEENEY, Carden Thomas, B.Sc., (McGill Univ.), res. engr., Ottawa Water Purification Plant, Ottawa, Ont.

LUNN, Frederick Richard, B.Sc. (Mech.), (McGill Univ.), manager, G. J. Lunn & Co., Montreal, Que.

MACPHERSON, Donald Cecil, B.Sc., (Queen's Univ.), factory supt., Canadian Marconi Company, Montreal, Que.

MANNING, Walter John, B.A.Sc., C.E., (Ecole Polytechnique, Montreal), res. engr., Dept. of Public Works, Rimouski, Que.

MURRAY, William MacGregor, B.Eng., (McGill Univ.), M.Sc., D.Sc., (Mass. Inst. Tech.), instructor, dept. of mech. engrg., Massachusetts Institute of Technology, Cambridge, Mass.

McQUEEN, Duncan Roderick, B.A.Sc., (Univ. of Toronto), quarry foreman, Canadian Gypsum Co. Ltd., Guelph, Ont.

PIMENOFF, Clement John, B.Sc., M.Eng., (McGill Univ.), struct'l. designer, Dominion Bridge Company, Ltd., Montreal, Que.

ROTHWELL, James Moscrip, B.Sc. (Civil), (Univ. of B.C.), senior instr'man., city engr.'s office, Vancouver, B.C.

SMITH, Adam W. Simpson, B.Sc., (McGill Univ.), asst. engr., H.E.P.C. of Ontario, Toronto, Ont.

WALLACE, Keith B., B.Sc., (McGill Univ.), chief engr., Barry & Staines Linoleum (Canada) Ltd., Farnham, Que.

WINTER, Francis Edward, B.Sc., (McGill Univ.), technical asst., Canadian Electrical Association, Montreal, Que.

Transferred from the class of Student to that of Junior

ALLAIRE, Lucien, B.A.Sc., C.E., (Ecole Polytechnique, Montreal), surveyor, Dept. of Agriculture, Prov. of Quebec, Montreal, Que.

BENOIT, Jacques, B.A.Sc., C.E., (Ecole Polytechnique, Montreal), district sales mgr., Wallace & Tiernan Ltd., Montreal, Que.

BUCHANAN, Edward Trevor, B.Sc., (McGill Univ.), asst. master mechanic, Consolidated Paper Corpn., Shawinigan Falls, Que.

GORDON, Hugh John, B.Eng., (McGill Univ.), dftsman., C.P.R., Montreal, Que.

JOLLEY, Malcolm Porter, Lieut., R.C.O.C., B.Eng., (McGill Univ.), Assistant to Director of Artillery and Mechanization, National Defence Headquarters, Ottawa, Ont.

LEMIEUX, Gilbert, B.A.Sc., C.E., (Ecole Polytechnique, Montreal), engr., Dept. of Highways, Prov. of Quebec, Quebec, Que.

LIND, Walter John, B.A.Sc., M.A.Sc., (Univ. of B.C.), test course student, Can. Gen. Elec. Co. Ltd., Peterborough, Ont.

ORR, Walter Alyn, Flying Officer, R.C.A.F., B.Sc. (E.E.), (Univ. of Alta.), Adjutant, Wireless School, R.C. A.F., Trenton, Ont.

PAQUET, Jean M., B.A.Sc., C.E., (Ecole Polytechnique, Montreal), engr., J. A. Y. Bouchard Ltee., Quebec, Que.

PEREGO, Henry Anthony, B.Eng., (McGill Univ.), struct'l. designer, Dominion Bridge Co. Ltd., Montreal, Que.

PHILLIPS, Robert Weston, B.Eng., (McGill Univ.), sales-service and combustion engr., Bailey Meter Co. Ltd., Chambly Canton, Que.

ROSE, Alexander, B.Eng., (McGill Univ.), junior research asst., National Research Council, Ottawa, Ont.

ROSS, Donald, B.Sc. (Civil), (Univ. of N.B.), asst. engr., Price Bros. & Co. Ltd., Riverbend, Que.

THOMAN, Russell Kenneth, B.Sc., (Queen's Univ.), production mgr., Remington Rand Ltd., Hamilton, Ont.

TUCK, Joseph Howard, B.Sc., (Queen's Univ.), Whitehead Metal Products of Canada, Port Colborne, Ont.

Students Admitted

CONNELL, Edwin Allison, (Univ. of N.B.), Fredericton, N.B.

DAVIS, Edgar Hawkins, (Univ. of Alta), Edmonton, Alta.

DUNPHY, Kenneth Rae, (Univ. of N.B.), 230 Regent St., Fredericton, N.B.

LOGIE, William Alexander, (Univ. of N.B.), 809 George St., Fredericton, N.B.

MORAZAIN, Jules Fernand, (Queen's Univ.), 185 Brock St., Kingston, Ont.

McBRIDE, James Wallace, (Univ. of Man.), 402 The Ambassador, Winnipeg, Man.

McGINNIS, Arthur David, (Queen's Univ.), King Street W., Kingston, Ont.

REYNOLDS, George Gilbert, (Grad. R.M.C.), (Queen's Univ.), 430½ Alfred St., Kingston, Ont.

BULLETINS*

Corrugated Pipes.—A 12-page bulletin has been received from the Canada Ingot Iron Co. Ltd., Guelph, Ont., describing their new asbestos bonded corrugated pipe.

Rock Drill Steel.—Canadian Ingersoll-Rand Co. Ltd., Montreal, Que., have issued a 44-page booklet describing a new line of IR-SKF drill steel. Some of the important sections included are those on dimensions; sections and weights of drill steel; forging and heat treating instructions; applications and tests; avoidance of steel failures; suggestions for prolonging the life of steel; effect on steel of damaged rock drill pistons, chuck bushings, etc.

School Lighting.—Trends in school lighting is the subject of a 16-page pamphlet received from the Edison Electric Institute, 420 Lexington Ave., New York. The material combines information obtained from a report of the Lighting Sales Committee of the Institute covering replies to a questionnaire received from 98 companies.

Insulation.—A 32-page booklet has been received from the Canadian Johns-Manville Co. Ltd., Toronto, Ont., containing specific information on sheet, block and pipe insulation developed by the company for service on various types of heated and refrigerated equipment in industry. A section is included on insulating brick.

Electrical Conductors.—Phillips Electrical Works Ltd. have just issued a 150-page catalogue containing detailed particulars of the various products of the company. This contains sections on Bare and Tinned Copper Wires, Magnet Wires and Radio Wires; Flexible Cords; Telephone Wires and Cables; Telephone and Switchboard Cords; Rockbestos Wires and Cables; Power Cables.

*Copies of these bulletins may be obtained by writing to the companies mentioned.

RECENT ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

American Institute of Electrical Engineers: Transactions, Vol. 56, 1937.

American Society of Civil Engineers: Proceedings, Vol. 63, No. 8, pt. 2, Oct. 1937 (Transactions Number 102, 1937).

Canadian Institute of Mining and Metallurgy: General Index of the Journal 1908-11 and Transactions 1912-20 of the Canadian Mining Institute and the Transactions of the Canadian Institute of Mining and Metallurgy and of the Mining Society of Nova Scotia, 1921-35.

Institution of Engineers Australia: List of Members, 1937.

Institution of Mining Engineers: List of Members, Royal Charter of Incorporation and Bye-Laws, November 1937.

International Conference on Soil Mechanics and Foundation Engineering, June 22-26, 1936: Vol. 1-3, 1936. (Graduate School of Engineering, Harvard University).

Reports, etc.

Canada Department of Mines and Resources: Geodetic Service Publication No. 7, Geodetic Position Evaluation, W. M. Tobey, revised and enlarged by J. E. R. Ross. Ottawa, 1937.

Canada Department of Mines and Resources, Bureau of Mines: Gasoline Surveys for 1935 and 1936 by P. V. Rosewarne and H. McD. Chantler.

Canada Department of Trade and Commerce Dominion Bureau of Statistics: Report on the Construction Industry in Canada 1936. Ottawa, 1938.

Canada Minister of Public Works: Report on the Works under his Control for the fiscal year ended March 31, 1937.

Canada National Research Council: The Action of Saturated Steam on Dicalcium Ferrite and on Tetracalcium Aluminoferrite by D. T. Mather and T. Thorvaldson (Canadian Journal of Research, B 15: 331-39, 1937).

Electrochemical Society: Preprint 73-1 to 73-4, Commercial Electrodeposition of Cobalt-Nickel Alloys; Electrodeposition of Copper-Nickel-Zinc Alloys from Cyanide Solutions, Pt. 3; Effect of Applying a Counter E.M.F. to a Leclanché Cell; Overvoltage, 1938.

Panama Canal, Governor of the: Annual Report 1937.

U.S. Department of the Interior, Geological Survey: Bulletin 880-D, The Eska Creed Coal Deposits, Matanuska Valley, Alaska; 895-A, Geophysical Abstracts 88, Jan.-March 1937.
Water-Supply Paper 778, Geology and Ground-Water Resources of Webb County, Texas; 796-C, Flood in La Canada Valley, California, Jan. 1, 1934; 797, Selected Bibliography on Erosion and Silt Movement; 804, Surface Water Supply of the United States, 1936: pt. 4 St. Lawrence River Basin, pt. 8 Western Gulf of Mexico Basins, pt. 9 Colorado River Basin, pt. 12 Pacific Slope Basins in Washington and Upper Columbia River Basin, pt. 13 Snake River Basin.

Victoria County Roads Board: Report by W. T. B. McCormack on his Investigation of Road Problems in the United States of America and Canada in 1937. Melbourne, Australia, 1937.

Technical Books, etc.

Biography of Benjamin Smith Lyman by Gonpei Kuwada. (*Sanseido, Tokyo, 1937.*)

Engineering Law by R. E. Laidlaw and C. R. Young. (*Univ. of Toronto, 1937.*)

Motorways, Flyovers and Mountain Roads with Details of Location by F. G. Royal-Dawson. (*Spon, London, 1938.*)

Segmental Functions Text and Tables by C. K. Smoley (*Smoley, Scranton, 1937.*)

Steel Construction, 3rd edition. (*American Institute of Steel Construction, N.Y. 1937.*)

BOOK REVIEWS

Motorways, Flyovers and Mountain Roads

By F. G. Royal-Dawson, E. & F. N. Spon, London, 1938. 176 pp., 7½ by 4¾ inches, cloth, 8/6.

This book is a sequel to "Curve Design" and "Road Curves." It deals with the technique of motorways as compared with ordinary arterial roads, the essential characteristics of both types being clearly differentiated. The use of flyovers, or grade separations, as adjuncts to motorways, or as alternatives to roundabouts, is fully explained, and many foreign examples given. Detailed calculations are supplied for the design and setting-out of flyovers, horse-shoe curves, and mountain bends in all situations, on transitional principles.

A special feature is a simplified resumé of the author's basic method of laying out any curve, for ready reference and guidance, in a self-contained chapter.

This book contains many worked-out examples, with illustrations, tables, and an index. A number of the chapter headings which may be mentioned are: Evolution of the Motor Road, Camber versus Side-slant, Terminal Junction, Mountain Roads, etc. The series of which it forms the concluding volume comprises a complete textual exposition of the new science of road curvature in all its aspects, and is adapted for college, office, and field use.

Segmental Functions Text and Tables

By C. K. Smoley, 1st edition, C. K. Smoley and Sons, Scranton, 1937. 184 pp., 7 by 4½ inches, leather.

This handy book offers simple methods of solving a circular segment and computing its area when the segment is given with any two of its five parts, viz., the arc, chord, radius, central angle and height, with numerous examples illustrating the application of these methods.

An introduction of some 40 pages gives numerous examples and a description of the use of the tables. The book is divided into two parts.

Part 1 covers logarithms of function $a = \frac{A}{R}$ by intervals of 10 seconds from 0 to 10 deg. with proportional parts for additional seconds; table of logarithms of segmental function; lengths of arcs by steps of 1 minute with P.P. for seconds; logarithms of areas, etc. Part 2 covers logarithms of numbers from 1 to 1000; logarithms of feet, inches and fractions for 0 to 200 ft., etc.

A Statical Determination of the Reactions at the Points of Contra-flexure in the Columns of a Steel Mill Building Bent Due to an External Wind Load

The columns are fixed at their base and fastened to the truss with knee braces.

NOTATION

Bent as shown in Fig. 1 with span = S.

R and L are the points of contra-flexure in the columns taken as at one-third the distance from base to knee brace connection.

P_1, P_2, P_3, and P_4 the external loads on the bent.

R_2 = the resultant load of P_1, P_2, P_3, and P_4 as determined in Fig. 2 in direction, magnitude and sense.

O the point (Fig. 1) through which R_2 acts.

H = the horizontal component of R_2.

R_R and R_L = the right and left reactions at points R and L.

V_R and V_L = vertical components of R_2 and R_L.

H_R and H_L = horizontal components of R_R and R_L.

Assume H_L = 0.6 of H

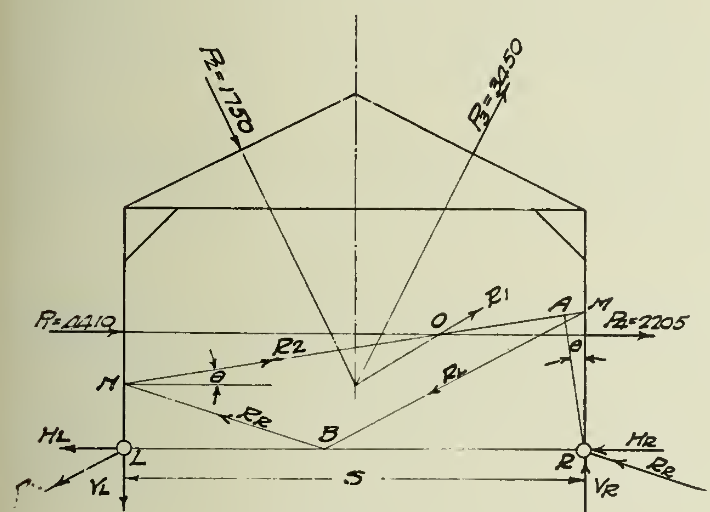


Fig. 1

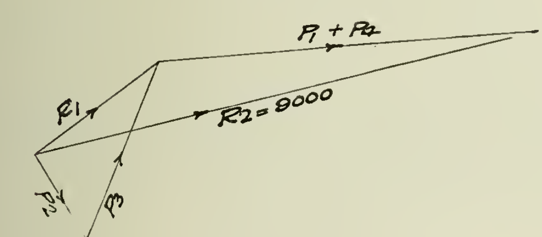


Fig. 2

CONSTRUCTION

Through O draw NOM parallel to R_2 intersecting the columns at N and M.

Let $NM = R_2$.

Then the scale for all vectors will be R_2 divided by the length NM.

Then $LN = V_R$ and $MR = V_L$.

Join L to R then $RL = H_L + H_R = H$.

Make RB = 0.6 of RL.

Join N and M to B.

Then $MB = R_L$ and $BN = R_R$ in direction, magnitude and sense.

PROOF

From R draw RA perpendicular to NM.

Then angle $ARM = \theta$ and θ is angle of inclination of NM to the horizontal.

$\therefore NM = R_2 = S \times \sec\theta$.

And $RA = MR \times \cos\theta$.

Take moments about R.

$V_L \times S = R_2 \times RA = S \times \sec\theta \times MR \times \cos\theta$

$\therefore V_L \times S = S \times MR$

$\therefore V_L = MR$

The direction of V_L and V_R may be found by going around the closed vector diagram N to M, M to R down, R to L, and L to N up.

NOTE

The above has been submitted by W. J. Smither, Assistant Professor of Structural Engineering, University of Toronto, who states that:

"This solution is entirely original on my part and under search of text books and inquiry of those who should know, I have been unable to find its previous use. It is more simple to construct and prove than the method most generally used. Also I find in teaching the subject the results as obtained by this method are more easily understood by the student. I will be indebted to any reader who can advise me of previous use of this method."

A Model Building Code for Canada

A conference called by the National Research Council was held in Ottawa on December 10th, 1937, which had as its object the formation of an organization to prepare a model building code for Canada. Associated with the National Research Council in the effort were the Dominion Housing Administration and the Dominion Fire Commissioner.

The key-note address was given by the Honourable C. A. Dunning, Minister of Finance, who was introduced by General A. G. L. McNaughton, President of the National Research Council. The conference was called in recognition of representations that had been made by many national organizations in Canada over a period of years that the condition of municipal building codes throughout the country was in general chaotic and that there was urgent need for leadership by a central authority in providing municipalities with authoritative information that they could use in revising or reconstructing existing codes.

Following the address by Mr. Dunning, statements were made by representatives of a number of national organizations and the meeting proceeded with the consideration of ways and means of bringing about its object. Committees were named to study various phases of the project and to prepare recommendations for submission to the National Research Council for approval at its meeting next week.

Organizations represented at this meeting included the following:

The Royal Architectural Institute of Canada
Canadian Construction Association
Canadian Engineering Standards Association
Association of Canadian Fire Marshals
Canadian Manufacturers' Association
Department of Mines and Resources of Canada
Department of Pensions and National Health of Canada
Canadian Housing and Planning Association
Engineering Institute of Canada
Dominion Board of Insurance Underwriters.

The organization contemplated for actually carrying out the work of preparing the model building code will embrace representatives of a large number of associations, government bodies, and municipal authorities in Canada.

Standards on Electrical Insulating Materials

In addition to the current report of Committee D-9 on Electrical Insulating Materials, this 1937 compilation includes all of the thirty-seven A.S.T.M. specifications and test methods covering the various types of insulating materials. These standards, given in their latest approved form, are grouped in the following manner: insulating varnishes, paints, lacquers, etc.; moulded insulating materials; plates, tubes, and rods; mineral oils; ceramic products (porcelain, glass); solid filling and treating compounds; electrical tests; papers and fabrics; mica products; rubber products and textile materials.

In addition, there are two proposed standards covering tests for neutralization number of petroleum products and specifications for rubber insulating blankets.

Also, three discussions on significance of tests involving dielectric strength tests, resistivity tests, and impact tests.

Copies of this 373 page publication can be obtained from the American Society of Testing Materials, 260 S. Broad St., Philadelphia, at two dollars per copy.

BRANCH NEWS

Hamilton Branch

A. R. Hannaford, A.M.E.I.C., Secretary-Treasurer.
W. W. Preston, S.E.I.C., Branch News Editor.

The Hamilton Branch, holding its monthly meeting on December 14th, 1937, in McMaster University, heard an illustrated lecture on the oxy-acetylene process of cutting steel and its latest applications in industry. The speaker was Mr. W. A. Duncan of the Dominion Oxygen Company. He was introduced to the 67 present by A. B. Dove, A.M.E.I.C.

Oxy-acetylene Cutting of Steel

Mr. Duncan explained that the flame method of cutting steel is primarily a chemical process. He showed the chemical reactions that take place as the gases burn, and described what happens. The first function of the flame is to preheat the metal to its kindling temperature. At or near this temperature oxygen has great affinity for ferrous metal, and as a result the metal is burned away. There is also a mechanical or eroding action due to the bombardment of the oxygen molecules. The flaming acetylene preheats the metal and the oxygen burns it away.

Use of the term "Burning" for "Flame Cutting" may lead one to assume that a flame-cut edge is damaged. In fact, it is not injured if done by a skilled workman, and with low carbon steel the edge is actually toughened.

The speaker displayed samples and lantern views of various kinds of cut edges. The smooth machined edge was the basis of comparison. A sheared edge was rough and curved. A friction-saw cut was ribbed and had a burr. A flame cut edge made by manual control was slightly rough, but one made by machine controlled equipment approached the smooth machined edge both in smoothness and squareness. Even in uniformity of hardness across the cut edge, the machine flame cut approximated the machined edge. Other samples showed the effect of faulty operation of cutting equipment on the appearance of the edge. When the preheat is excessive the top part of the cut is pitted; with deficient preheat the cut is irregular. When the torch moves too fast the edge has a flowing appearance and may not be cut through; insufficient speed results in a fluted edge. Examples of cuts made with the flame too close, too far away and with a dirty nozzle were also shown. To obtain good results, an operator should follow the specifications given with each torch. For each thickness of plate to be cut there is a specific nozzle size, speed of cutting, volume of oxygen and of acetylene required.

The concluding portion of the paper emphasized types of flame cutting machines, and their performances. Three reels of motion pictures showed, among others, the following operations—cutting circular plates, cutting by template, multiple use of torches, stack cutting (piled plates cut in one operation), cutting slabs to be used as frames for heavy machinery, and cutting of irregular shapes with varying thicknesses.

Following the final reel the chairman, Col. E. G. McKay, A.M.E.I.C., introduced a thought provoking discussion. Mr. H. Thomasson proposed the vote of thanks and the members retired to an adjoining room for the usual refreshments.

Lakehead Branch

H. Os, A.M.E.I.C., Secretary-Treasurer.

A dinner meeting was held at the Prince Arthur hotel on November 17th, 1937. Twenty-five members and guests were present.

G. R. Duncan, A.M.E.I.C., the chairman, called the meeting to order. Four short talks on Institute affairs were given.

The first speaker, P. E. Doncaster, M.E.I.C., District Engineer, Dept. of Public Works of Canada, prefaced his remarks by a short summary of his activities in connection with organized engineering. Mr. Doncaster's speech is given below in full:

"The following views may be faulty and the conclusions unsound. I sincerely hope some of them will prove to be so. If not, I am afraid you as engineers, and especially you younger engineers, will have a far way to travel before you catch up with much good work which has now been left behind.

"The result of the recent ballot to amend The Institute by-laws to facilitate consolidation of the profession in Canada was a setback to the advancement of the profession and to every one of the younger engineers now in it, or yet to enter it, from which it may take years to recover. The action was definitely a retrograde step, not having even the saving element of a 'stand pat' or 'as you were' result. That action (for which I regret to say the older and well situated engineers within The Institute were responsible) not only closed the door to a much needed consolidation of all the different branches of engineer interests in Canada but drove wedges in the gaps between them which had been for some years gradually closing in. Practising engineers in the electrical, mining, civil, chemical and other fields were never further removed from a point of common contact and interest than they are today. Like the spokes of a wheel that radiate from a common centre or hub, all these special branches of engineering have a common source in which the fundamentals and ground work of all engineering science lies. At this point there is common meeting ground and a community of interest for all engineers which, in their own interest and that of the profession, should never be allowed to disappear. Now, the spokes can only function effectively as parts of the wheel of this profession when they each and all find again a common, circumscribing and controlling bond in the rim and tire which binds them together and to which each contributes its measure of support. Such a bond was rejected by the recent ballot.

"My constructive suggestion to the younger members of this Branch is to start again and at once to build up a weight of opinion and action which will regain the lost position and see consolidation is successfully effected.

"There is no occasion for giving up the efforts to improve conditions within the profession. There remains much good already accomplished within The Institute and other organized professional bodies. The challenge to you as individual engineers and as members of this branch is clearly defined. Interest yourself in its problems, study them and, having come to a conclusion or conclusions, right or wrong, give voice to them in the local branch meetings and see to it that the best of these, by resolution, are sent on to Headquarters for its consideration. If they do nothing else they will keep Headquarters stirred, uneasy and fully alive to the fact that there are many thousands of engineers across the length and breadth of Canada who have opinions of their own and who are fully alive to the problems confronting the profession as a whole and them as individuals within the profession. Contrary to the admonition directed to speakers in other walks of life, it is well known that engineers generally need to give more frequent and forceful verbal expression of their views."

The second speaker on the programme was J. M. Fleming, A.M.E.I.C., manager of the C. D. Howe and Company. Mr. Fleming offered some criticism of the magazine in its present form and would like to see shorter news items and articles. He contended that many things that happened in this district, would, presented in short form, be of interest to the membership at large. He supported Mr. Doncaster's view that the membership should hammer on consolidation until some acceptable formula could be found for bringing it about. With regard to branch meetings, Mr. Fleming urged that they should be made as interesting as possible and also suggested that, although a Ladies' Night held last year was not a financial success, a social affair should be staged after the New Year.

Mr. Bird, manager of the Kam Power Company, expressed his pleasure at being present. In a short address Mr. Bird dealt with the various problems confronting engineers in their organization. He complimented Mr. Hurter on the progress made on the construction of the Red Rock plant and thought that the members of the branch would find it interesting to visit and look over this extensive building project.

The last speaker on the programme, F. C. Graham, A.M.E.I.C., Assistant City Engineer, Port Arthur, in a short address dealt with the small remuneration received by engineers in some responsible engineering endeavours.

Montreal Branch

Annual Meeting

The annual general meeting of the branch was held January 6th, 1938, at which was discussed the general business of the branch, the report of the retiring executive, financial statement, installation of new officers. Bryan Perry, M.E.I.C., was elected chairman for the ensuing year and C. K. McLeod, A.M.E.I.C., vice-chairman. Vacancies on the committee were filled by K. O. Whyte, A.M.E.I.C., R. E. Heartz, M.E.I.C., and Jules A. Beauchemin, A.M.E.I.C. F. S. N. Heward, A.M.E.I.C., chairman of the committee formed to discuss the activities and organization of the branch, advocated the encouragement of sections as a means of increasing an interest in membership. Considerable discussion ensued regarding this report.

Through the kindness of the Crane Company, an excellent motion picture film was shown at the end of the meeting, after which refreshments were served.

Alternating Current Network Analyzers

On January 13th, Mr. R. G. Lorraine, engineer of the General Electric Company, Schenectady, presented a paper which discussed briefly the history and development of network analyzers, giving a discussion of recent installations and their applications. Prior to the meeting a courtesy dinner was held at the Windsor hotel.

Chairman: Prof. C. V. Christie, M.E.I.C.

Junior Section

The annual meeting of the Junior section of the Montreal Branch took place on January 17th. A report of the retiring executive was followed by the election of officers: L. Jehu, A.M.E.I.C., chairman; L. Trudel, S.E.I.C., vice-chairman; P. E. Savage, A.M.E.I.C., secretary. Vacancies on the exectuive were filled by G. N. Martin, Jr.E.I.C., C. Craig, Jr.E.I.C., and R. Boucher, Jr.E.I.C., the latter two representing the universities.

Following this meeting Mr. M. C. R. Armstrong, M.A., safety supervisor for the Bell Telephone Company of Canada, spoke on applying for an engineering job. The attendance was 65 and refreshments were served following the meeting.

Technical Men in Industry

The second of a series of talks on technical men in industry took place on January 20th. The speakers were: Mr. L. St. J. Haskell, Assistant to Vice-President, Bell Telephone Company of Canada, on "Recruiting Technical Men for Industry"; H. R. Wake, Secretary, Aluminum Company of Canada, Ltd., A. J. Hill, Director of Personnel, Canadian National Railways, E. R. Complin, Industrial Relations Manager, Canadian Industries, Ltd., spoke briefly on the past, present and future of technical men in their respective organizations.

Dean Ernest Brown, M.E.I.C. was chairman.

Ottawa Branch

R. K. Odell, A.M.E.I.C., Secretary-Treasurer.

Annual Branch Meeting

The twenty-eight annual meeting of the Ottawa Branch of The Engineering Institute of Canada was held at the Auditorium of the National Research Laboratories, Sussex Street, on the evening of January 13th, 1938.

In his address, J. G. Macphail, the retiring chairman of the Branch, outlined the events of the past year, mentioning particularly the work in connection with the Semicentennial celebrations of The Institute last June, and the activities of the aeronautical section, which had had a year of progress under the chairmanship of Dr. J. J. Green.

G. J. Desbarats, President of The Institute, spoke briefly congratulating the Ottawa Branch on its fine showing in 1937 and also reviewed the efforts made to bring The Institute into closer relationship with the professional engineering associations in the various provinces.

J. L. Busfield of Montreal, who was present at the meeting, expressed the appreciation of the Council for the work of Mr. Desbarats as national president especially in connection with the Semicentennial of The Institute and over which he presided. He screened pictures of the celebrations, showing various groups of international visitors.

The report of R. K. Odell, Branch secretary-treasurer, showed that the Branch was in sound financial condition, and that membership had increased by 16 to a total of 418. Of this number 332 are resident, and 86 non-resident.

In accordance with a motion passed at the last annual meeting, the Branch donated two sets of draughting instruments to the Ottawa Technical School for presentation as prizes for proficiency in draughting. F. H. Peters, on behalf of the Branch, personally presented the prizes to the successful students. A copy of "Standard Handbook for Electrical Engineers" was sent to the Hull Technical School to be awarded to one of its students. It was decided to continue this procedure for next year.

Other reports presented were: Proceedings, Squadron Leader Alan Ferrier; Membership, P. Sherrin; Semicentennial Committee, Alan K. Hay; Aeronautical Section, Dr. J. J. Green. A vote of thanks was extended to the auditor B. H. Segre; also to the press. The vote of thanks to Mr. Macphail and the executive was moved by C. McL. Pitts.

Officers for the ensuring year follow: chairman, W. F. M. Bryce; secretary-treasurer, R. K. Odell; managing committee, R. A. Strong, Dr. R. Meldrum Stewart, W. H. Munro, Squadron Leader Alan Ferrier and P. Sherrin. The three last-mentioned members of the managing committee were elected at the 1937 annual meeting and have still one year each to serve. The other two have two years each to serve.

Following the meeting the Museums of Aeronautics and Surveys were visited and there was an exhibition of illuminated addresses which had been presented to The Engineering Institute at the Semicentennial. Refreshments were also served.

Peterborough Branch

W. T. Fanjoy, A.M.E.I.C., Secretary-Treasurer.
J. L. McKeever, Jr.E.I.C., Branch News Editor.

The outstanding function of the Peterborough Branch, the annual dinner, was held on Tuesday, November 23rd, 1937, at the Empress hotel. We were fortunate in having with us on this occasion our President, G. J. Desbarats, Hon.M.E.I.C., as well as the representatives of a number of other Ontario branches, while the main speaker of the evening was R. O. Sweezey, M.E.I.C., who chose as the subject of his address "The Drought Situation in Western Canada."

The toast to The Institute and its Branches, very ably proposed by H. R. Sills, A.M.E.I.C., was replied to by the President, Mr. Desbarats, and in the course of his address on the present state of The Institute, he made appropriate reference to the illuminated addresses received by The Institute from other engineering societies in connection with the recent Semicentennial Celebration. These addresses were on display in the main hall of the hotel, and were the occasion of considerable interest and comment.

Following Mr. Desbarats' address, a humorous skit was put on by the Junior and Student Section, the title of which might have been "She Done Him Wrong" or perhaps "And Still the Villain Pursued Her."

The Drought Situation in Western Canada

Mr. Sweezey advocated a project for control of moisture in the West, where he claimed drought areas of 40 million acres cost Canadians 300 millions of dollars this year. Total drought loss in the past nine years he estimated at close to one and a half billions of dollars.

The speaker's projected plan included control of the South Saskatchewan river by dam and ditch, of that portion above Medicine Hat, including main tributaries; control of the South Saskatchewan by a large dam near Elbow with canals and ditches; control of the North Saskatchewan and Red Deer rivers by dams and ditches; and control of small streams and lakes throughout an area under drought conditions.

He urged that those in authority forget political pettiness and appoint a competent group of men to study the question, not men of mere political and legal sagacity, but men of technical and commercial skill.

The subject was one which should be of great interest and concern to all Canadians, and the Branch greatly enjoyed the sincere and forceful way in which he delivered his case for irrigation.

After hearing a few words from each of the representatives of the other Branches, the meeting closed with the singing of "Auld Lang Syne." Attendance—75.

A meeting of the Peterborough Branch was held on Thursday, December 16th, at which the speaker was W. A. Scott, special representative of Canadian Airways, Montreal, and the subject of his paper "Canadian Aviation."

Canadian Aviation

Mr. Scott, who was well versed in his subject, gave an extremely interesting account of the development of civil aviation in Canada from its beginning shortly after the war up to the present time. He quoted figures showing the leading position Canada holds with regard to freight transportation, and mentioned the numerous obstacles which had been met with and surmounted in the development of this form of transportation.

The speaker mentioned, as he went along, the various types of planes which had been tried out, and he stressed the difficulty Canadian companies had in securing planes properly designed for the service. Flying in the "North Country" demands planes of special design, but the market for such planes in Canada is too small to interest the manufacturers in undertaking the study and special development.

The latter part of Mr. Scott's paper was taken up with a very complete specification of the type of plane most suitable to Canadian conditions, in the course of which the speaker made particular reference to the various types of skis which have been tried.

Mr. Scott's wide knowledge of his subject and the thoroughness with which he covered it, gave the members of the Branch a most interesting and instructive evening. Attendance 40.

Students' Junior Section

Since the inaugural meeting reported some time ago, three more meetings of the Discussion Club have been held, and it is hoped to continue with an active programme of probably two meetings per month, in the New Year.

The speakers at the last three meetings were as follows:—

November 8th:
E. W. Henselwood—"Live Line Testing of Transmission Insulation."
J. L. McKeever—"Commutation in Large D.C. Generators."

November 22nd:
A. J. Girdwood—"Small Sine-Wave Generators."
B. K. Scarlett—"Fluorescent Lighting."

December 13th:
B. Blanchard—"High Voltage D.C. Commutation."
R. E. Edson—"High Voltage D.C. Transmission."

Saskatchewan Branch

J. J. White, M.E.I.C., Secretary-Treasurer.

The meeting held in the Kitchener hotel on December 17th, 1937, was the second of a series of meetings under the joint auspices of the Saskatchewan Branch of The Engineering Institute of Canada, the Association of Professional Engineers of Saskatchewan and the Saskatchewan Section of the American Institute of Electrical Engineers.

The Chairman of the meeting was J. W. D. Farrell, M.E.I.C., Vice-President of the Association of Professional Engineers of Saskatchewan.

The meeting proper was preceded by a dinner at 6.30 p.m., at which there were present sixty-eight engineers. The attendance at both this meeting and the November meeting indicates a stimulating increased interest in the joint efforts of the Saskatchewan Engineering Associations.

After dinner the meeting was addressed by J. R. Robertson, Superintendent of Western Trans-Canada Airways, and his subject was "Scheduled Air Line Flying and Bush Flying." Mr. Robertson is an experienced pilot and his treatment of the subject was very interesting and instructive. In addition to dealing with air line and bush flying he also dealt at length with the proposed set up of the Trans-Canada Airways.

Following the address a general discussion took place with a number of members eager to get further information, all of which provided continued interest for a lengthy period.

M. J. Spratt, M.E.I.C., and D. W. Houston, M.E.I.C., moved a hearty vote of thanks to Mr. Robertson for his enlightening address.

Vancouver Branch

T. V. Berry, A.M.E.I.C., Secretary-Treasurer.

Luncheon in Honour of Percy Sandwell, M.E.I.C.

The Vancouver Branch said farewell to one of its members when about thirty-three members and friends met at an informal luncheon on Wednesday, January 5th, 1938, in the Hudson's Bay dining room in honour of Percy Sandwell, M.E.I.C., who is leaving Vancouver to take up an appointment as chief engineer of the Derwent Valley Newsprint project in Tasmania.

The luncheon was presided over by Vice-Chairman C. E. Webb, M.E.I.C., who expressed regret at losing Mr. Sandwell from the province and from the activities of the Vancouver Branch and wished him every success and good luck in his new field of endeavour. Mr. Sandwell replied in a short address of thanks and outlined briefly the details of the plant to be constructed under his supervision for the manufacture of newsprint from a species of eucalyptus in the Derwent Valley, Tasmania.

Short expressions of goodwill and farewell were also contributed by R. Bell-Irving, M.E.I.C., Powell River Power Co., L. Killam, Managing Director of the B.C. Pulp and Paper Co., and Dr. E. A. Cleveland, M.E.I.C.

Winnipeg Branch

H. L. Briggs, A.M.E.I.C., Secretary-Treasurer.

Air Conditioning

On January 6th, 1938, D. C. Brooking, air conditioning engineer, Canadian General Electric Company, Winnipeg, spoke with reference to "comfort" air conditioning which has to do with the health, comfort and welfare of human beings, as contrasted with industrial air conditioning which has to do with industrial processing.

Comfort air conditioning suitable for year round operation has to do with the heating, humidifying, cleaning, circulating, ventilating, cooling and dehumidifying of air. Winter air conditioning was concerned with the first five of these, summer air conditioning with the last five items.

Mr. Brooking proceeded to show by slides and by displays of apparatus, the types of equipment that are used and how various schemes of achieving these several requirements have been developed for home, store and office installation.

Among those taking part in the ensuing discussion period were A. E. Macdonald, M.E.I.C., W. D. Hurst, A.M.E.I.C., J. T. Rose, A.M.E.I.C., G. H. Herriot, M.E.I.C., C. V. Antenbring, A.M.E.I.C., T. C. Main, A.M.E.I.C., G. P. Morse, A.M.E.I.C., D. A. Ross, M.E.I.C., and E. P. Fetherstonhaugh, M.E.I.C.

The report of the nominating committee for branch officers for 1938 was presented by G. E. Cole, A.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 Vacant

MECHANICAL ENGINEER, for assistant in sales, design, and production supervision, with an Ontario manufacturer of wood and stainless steel tanks and industrial equipment. Must possess tact and initiative, knowledge of latest shop practices and ability to organize and direct. Applicants should state age, experience, salary expected, etc., in detail. Apply to Box No. 1715-V.

DRAUGHTSMAN, experienced in plant layout and design. Building construction would be an asset. Work will last about six months, but probability of permanency. Location northern Ontario. Apply to Box No. 1716-V.

MECHANICAL ENGINEER, with pulp and paper mill experience in actual operations, as well as some construction and rigging experience. Capable of handling men particularly labourers, and able to organize and install systems which would be of benefit in routine operations. Apply giving full particulars of experience to Box No. 1721-V.

Situations Wanted

INDUSTRIAL ENGINEER AND SUPT. Age 32, A.M.E.I.C., with combined electrical, mechanical and steel industry experience in several plants. Experience includes design and testing of various types of industrial electrical equipment, supervision of production and cost reduction, heat treating of steel, time study application in several plants, in United States and Canada. At present supt. of modern factory. Apply to Box No. 132-W.

SALES ENGINEER seeks position with a future. A mechanical engineer, JR.E.I.C., with thorough training in England and wide experience for past 8½ years in Canada is seeking a permanent position as sales engineer for manufacturer of industrial equipment, etc Has had varied experience in sales work, mechanical engineering, heating, ventilating and power plant equipment. Of good appearance, ambitious, intelligent. Excellent references. Apply to Box No. 270-W.

INDUSTRIAL ENGINEERING EXECUTIVE, with wide experience including fourteen years in design, construction, maintenance and operation of pulp and paper mills and power developments. Now employed, desires change of location. Apply to Box No. 320-W.

STEAM POWER PLANT DESIGNER, with wide experience on high pressure steam-electric plant. Available at once. Apply to Box No. 525-W.

MECHANICAL ENGINEER, JR.E.I.C., university training, age 28, Married. Four years experience in administration and operation of business. Two years experience construction as instrumentman and field control, and inspection of concrete. Experience assembly line supervision one year. Read, write and speak French. Will go anywhere. Available immediately. Apply to Box No. 551-W.

Situations Wanted

ELECTRICAL ENGINEER, B.SC., E.E., age 38. Married. Ten years electrical experience; including, one year operation, one year maintenance, and four years on construction of hydro-electric plants and sub-stations. Four years electric maintenance and construction in pulp and paper mill. Also experience on highway construction and Geological Survey Available at once. Apply to Box No. 636-W.

MECHANICAL ENGINEER, JR.E.I.C., technical graduate, bilingual, age 35, married, experience includes five years with firm of consulting engineers, design of steam boiler plants, mechanical equipment of buildings, heating, ventilating, air conditioning, plumbing, writing specifications, etc. Five years with large company on sales and design of power plant, steam specialties and heating equipment. Available on short notice. Apply to Box No. 850-W.

NOTICE

In future, notices appearing in the Situations Wanted column will be discontinued after three insertions. If a request is received for an advertisement to be re-inserted this will be complied with after the advertisement has been omitted for one month.

* *

Members desiring a new connection, unemployed members, and employers, are reminded that advertisements are inserted free of charge, and that the names of those advertising may be kept confidential, if desired.

ELECTRICAL ENGINEER, B.SC. (McGill '28), age 34. Experience includes transmission line and rural distribution construction and design. Some installation of motors and equipment, also house wiring. Available immediately. Apply to Box No. 940-W.

ELECTRICAL AND RADIO ENGINEER, S.E.I.C., B.SC. (Elec.) '32, M.SC. '34. Experience includes four years part time operator for radio broadcast station, repairs to radio receivers and test equipment, design and construction of amplifiers and inter-office communication systems. Available on short notice. Apply to Box No. 1283-W.

Situations Wanted

CONSTRUCTION SUPERINTENDENT, M.E.I.C. Age 49. Married. Twenty-two years experience as engineer, superintendent and manager in charge of hydro-electric, mechanical production, structural steel erection, also considerable experience in steam plants, combustion, transmission lines, millwright work, complete mine installations, rock work, rock crushers and conveyors. Executive ability. Speaking French fluently. Location immaterial. Apply to Box No. 1482-W.

RESIDENT ENGINEER, familiar with all types of surveys and construction work including, railway, roads, irrigation, drainage, buildings and air ports. Executive ability. Had charge of several large projects. Intimate knowledge of reports and estimates. Available immediately. Any location. Apply to Box No. 1567-W.

ELECTRICAL ENGINEER, B.SC. '27 (McGill), A.M.E.I.C. Age 36. Married. Bilingual. Three years experience in telephone work (installation of manual and automatic exchanges). One year electrical prospecting. Nine years experience with electrical power company. Apply to Box No. 1601-W.

CHEMICAL ENGINEER, graduate McGill '36. Eight months experience in commercial laboratory of large industrial plant. Knowledge of coal chemistry and boiler water treatment. Also some experience in pulp and paper control work. Location immaterial. Apply to Box No. 1617-W.

CIVIL ENGINEER, B.SC. in C.E., A.M.E.I.C. Age 32. Married. Three years of pulp and paper mill experience, draughting, instrumentman and maintenance. One year as instrumentman on highway construction. Five years checking and designing reinforced concrete and steel. Apply to Box No. 1658-W.

ELECTRICAL ENGINEER, B.A.SC., U. of T. '24, A.M.E.I.C., single, age 44. Ten years in supervisory operating office and two years in construction division (office and field) of large city electrical utility commission. One year factory supervision and tool design in manufacture of small electrical equipment. Wide experience with internal combustion engines. Experience handling heavy machinery. Private pilot's license for light aircraft. Full details on request. Available on short notice. Apply to Box No. 1693-V.

MECHANICAL ENGINEER, young graduate with six years diversified experience in the pulp and paper industry. JR.E.I.C. Desires position as master mechanic, or, as assistant in large mill. Apply to Box. No. 1694-W.

MECHANICAL AND ELECTRICAL ENGINEER, age 47, graduate University of Toronto, 1911. Machinist's trade. Two years tool design and quantity production in the U.S.A. Twelve years Canadian shop experience design and producing heavy equipment. Twelve years as chief sales engineer and field man for one of the largest Canadian national concerns. Experience in manufacturing and sales of pumps, engines, paper mill equipment, power plant equipment and specialties, electrical machinery etc. Clean record, excellent connection. Apply to Box No. 1699-V.

ELECTRICAL ENGINEER, B.SC., E.E. (Univ. of Man. '37). Experience in highway construction as inspector. Available at once. Apply to Box No. 1703-W.

ELECTRICAL ENGINEER, B.SC., A.M.E.I.C., age 44, married. Experience includes draughting, construction and maintenance. The last eight years holding the position of electrical superintendent, of a fair sized industrial plant. Apply to Box No. 1718-W.

Preliminary Notice

of Applications for Admission and for Transfer

January 29th, 1938.

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 1938.

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

ALLWRIGHT—ERNEST GILBERT, of 2217 Hingston Ave., Montreal, Que., Born at Deptford, Kent, England, Oct. 15th, 1886; Educ., 1931-32, Montreal Technical Institute. I.C.S. Engrg. Course; 1909-10, rodman, chainman, G.T.P. Ry.; 1926-27, rodman, instr'man., Candn. International Paper Co. Ltd., also Jan.-Oct. 1928; 1927 (Apr.-Dec.), topogr., prelim. and location surveys, C.P.R.; 1929-31, instr'man., gas distribution dept., Montreal Light, Heat and Power Cons.; 1931-32, engr., subways and bridges dept., City of Montreal; March 1937 to date, engr., Aluminum Co. of Canada Ltd., Arvida, Que.

References: E. V. Gage, D. Hillman, D. O. Wing, W. J. Yorgan, J. L. Leroux, M. G. Saunders.

BLONDEAU—JEAN LOUIS, of 2 Tessier St., Chicoutimi, Que., Born at Black Lake, Que., May 9th, 1897; Educ., Electr'l. Meter Engrg., Fort Wayne Corres. School, Indiana; 1917-18, night foreman, Levis Tramways Co.; 1918-21, Shawinigan Water and Power Co.; 1921-27, inspr., electricity and gas, Dept. of Trade and Commerce, Dom. of Canada; 1927 to date, supt., Saguenay Electric Company. Work includes responsiblity for two hydraulic power plants, 90 miles of transmission line, 150 miles of distribution lines, 17 substations, and distribution of power for 32 towns and villages.

References: F. L. Lawton, J. R. Hango, C. Miller, G. E. LaMothe, R. Belanger.

CAMPBELL—WILLIAM FISHER, of Cayuga, Ont., Born at St. John's, Nfld., Oct. 12th, 1900; Educ., 1916-18, St. Andrews College, Toronto. Private study of engrg. subjects; R.P.E. of Ontario; 1919-21, chainman, levelman, Reid Newfoundland Co., St. John's, Nfld.; 1922-23, timekpr., levelman, transitman, Sir W. G. Armstrong Whitworth & Co.; 1923-26, level, transit, party chief, Reid Nfld. Co.; 1926, appointed Deputy Crown Lands Surveyor for Nfld.; 1926 (3 mos.), general exploration of the Lapoile River area of Nfld. for A. H. Means of the American Smelting and Refining Co., reporting on timber, geology, waterpower, road and rld. possibilities; 1927-30, cruising timber, running contour lines, supervising cutting of channels in areas to be flooded for the Forest Engrg. Dept., Canadian International Paper Co.; 1930-33, general practice with Lee and Nash, Brantford, Ont.; 1934 to date, field and office work of a technical nature for A. L. S. Nash, county engr., Cayuga (Haldimand Co.). Work includes design and preparation of plans for two 3 span rigid frame bridges, also smaller structures.

References: G. R. Marsten, F. P. Adams, A. Vatcher, H. G. Acres, J. W. Morris, F. H. Midgley.

CARTER—THOMAS ALLEN, of 906 Moissan St., Arvida, Que., Born in Haldimand Co., Ont., Feb. 20th, 1908; Educ., B.Sc. (E.E.), Queen's Univ., 1931; 1928, lineman, 1929, asst. to suprvr., Welland Hydro Electric Commn.; 1930, junior engr., Duke Price Power Co. Ltd.; 1931-33, res. engr. at Isle Maligne, 1933-37, asst. to the elect'l. engr., and 1937-38, electr'l. engr., Saguenay Power Co. Ltd., Arvida, Que.

References: F. L. Lawton, M. G. Saunders, D. M. Jemmett, N. D. Payne, C. Miller.

COMMINS—JOHN THOMAS, of 1309 St. Joseph Blvd. East, Montreal, Que., Born at Bath, N.B., Dec. 17th, 1901; Educ., 1925-28, completed electrical course, Lowell Institute School, under the auspices of the Mass. Inst. Tech.; 1920-25, paper millhand, electric lineman, etc., Canada and U.S.; 1925-30, electrician, elect'l. foreman, General Electric Company, Lynn, Mass.; 1930-32, proprietor, Commins Electrical Engineering and Contracting Co., Presque Isle, Maine; 1932-35, mgr., Consolidated Telephone Co., Bath, N.B.; 1935, levelman, N.B. Highway Dept.; 1936, inspn. engr. on asphalt paving in N.B. for Milton-Hersey Company, and 1937, inspr. in charge, for same company; 1932-38, consltg. engr. for Bath, Bristol and Florenceville hydro district, Bath, N.B.; at present, lubricating engr., Imperial Oil Ltd., Montreal, Que.

References: C. G. Grant, G. M. MacPhail, S. R. Weston, M. F. Macnaughton, J. R. Scanlan.

GRANT—WILLIAM ROY, of Port Arthur, Ont., Born at New Glasgow, N.S., Oct. 23rd, 1891; Educ., B.Sc. (Civil), McGill Univ., 1915; 1911-12, rodman, Read Nfld. R.R.; 1917-18, R.A.F.; With Barnett-McQueen Co. Ltd., engineering contractors, Fort William, Ont., as follows: 1912-13, timekpr., 1914-15, instr'man., 1916-17, gen. foreman constrn., 1919-21, asst. supt., constrn., 1922-23, supt., constrn.; 1924-25, gen. supt., constrn., 1925-26, asst. mgr. and chief engr., 1927-29, director, president.

References: P. E. Doncaster, A. T. Hurter, F. C. Graham, E. L. Goodall, C. D. Howe.

KEITH—JAMES PETER, of 5196 Durocher Ave., Outremont, Que., Born at Montreal, Oct. 10th, 1894; Educ., 4 years, Commercial Technical School, Montreal. One year, McGill Univ. extension course in physics, English, and business correspondence; 1 year, field constrn. work on power plant constrn., heating, plumbing and ventilating; 4 years apticeship. in consulting engrs. offices, Huey & Stetson, Boston, and Woodwell & Buckley, New York; 1927 to 1937, in charge of preparation of heating, plumbing, ventilation and electrical works in connection with hospitals, schools and public institutions for Canadian Domestic Engineering Co. Ltd., designing and consltg. engrs., Montreal, Que.; at present, designer of mechanical works for above company, and associated with P. P. Vinet, A.M.E.I.C., in consltg. engrg. practice.

References: A. Mailhiot, A. Frigon, J. G. Hall, E. H. Darling, deG. Beaubien, P. P. Vinet, A. F. Byers, J. M. Robertson, J. A. Beauchemin, A. D. Ross, W. W. Timmins.

LEEBOSH—ILJA, of Walkerville, Ont., Born at Libau, Latvia, Mar. 15th, 1898; Educ., Mech. Engr., Polytechnical Institute, Coethen, Germany, 1924. R.P.E. of Que.; 1922, shop clerk, "Torpedo" machine shop, Germany; 1924-25, milling machine operator, Ludwig Loewe & Co., Germany; With the late F. B. Brown, M.E.I.C., consltg. engr., Montreal, 1926-27, dftsman. and rodman, and 1927 to 1932, on hydraulic studies and investigations for the Beauharnois power project and other hydro-electric developments; canal location, excavation quantities, hydraulic losses, backwater and ice effect, regimen of St. Lawrence river, dam design, cost estimates and reports; highway and rly. diversions; design and layout of transmission lines, etc.; 1932-37, with the Beauharnois Light, Heat and Power Co., 1932-34, transmission line work, real estate record, field surveys; 1934-35, progress of canal excavation, hydraulic studies, design of discharge and overflow weirs, scows, stone crusher plant; 1935-37, transmission line design, title record plans, of property and servitude rights, field surveys; at present, engineer, Canadian Bridge Company, Walkerville, Ont.

References: R. A. C. Henry, L. L. O'Sullivan, J. W. McCammon, S. S. Colle, M. V. Sauer, G. J. Dodd, G. P. Hawley.

McKINNEY—JOHN E., of Toronto, Ont., Born at Littleton, N.H., June 13th, 1893; Educ., 1911-13 (3 years), Toronto Technical Schools evening classes, mech. dfting., maths., etc. I.C.S., mech. engrg.; 1915-19, overseas; With the Bell Telephone Company of Canada as follows: 1912-15 and 1919-21, dftsman., 1922-23, fieldman, 1923-25, field engr., gathering data and preparing estimates for plant constrn.; 1925-27, district plant engr., supervn. of a section of Toronto divn. from an outside plant engrg. standpoint; 1927-30, transmission engr.; 1930-37, exchange engr., on staff of chief engr., special studies relating to plant constrn. projects; 1937 to date, division plant engr., in charge of staff in engrg. for the plant dept., Toronto Divn.

References: D. G. Geiger, G. H. Rogers, L. G. Buck, M. A. Stewart, A. M. Reid, J. L. Clarke.

McMANAMNA—THEODORE LOUIS, of Fort Erie North, Welland, Ont., Born at Mulberry, Kansas, May 13th, 1903; Educ., B.S. in C.E., Univ. of Kansas, 1932. A.M.Am.Soc.C.E.; 1924 (summer), dftsman., Carter-Waters Corpn., Kansas City; 1926 (June-Aug.), asst. in hydraulic lab., Layne & Bowler Inc., Memphis, Tenn., testing vertical turbine pumps; With Layne-Bowler Chicago Co., Chicago, Ill., as follows: 1926-27, asst. field engr., supervising constrn. and tests; 1927 (Feb.-July), asst. field geologist; 1927-29, field engr. i/c hydrological surveys, constrn. of well water supplies and pumping stations for municipalities and industries; 1929-32, field engr. and western mgr., Layne Canadian Water Supply Ltd., hydrological surveys, constrn. of well water supplies; 1933 to date, hydrologist and manager for International Water Supply Ltd., hydrological surveys, design and constrn. of well water supplies and water treatment plants.
References: A. E. Berry, E. V. Buchanan, D. H. Fleming, V. A. McKillop, M. Pequegnat.

TATE—GEORGE HAROLD, of Toronto, Ont., Born at Holland Landing, Ont., July 4th, 1903; Educ., B.A.Sc., Univ. of Toronto, 1926; 1925-30, instructor in stationary engrg., night school, Central Technical School, Toronto; 1924-25 (summers), shift engr., steam plant, Bigwin Inn; 1921-24 (summers), clam shell and steam road roller operation, Jupp Constrn. Co.; 1926-28, design of steam power plant equipment, Combustion Engineering Corpn.; 1928-32, design of steam plants, sales, service, Foster Wheeler Ltd.; 1932-33, service and erection, Detroit Stoker Co.; 1933-37, design, constrn. and operation of steam power plant equipment, Canadian Kodak Co. Ltd., and from 1935 to date, power engr., responsible for operation, mtce., etc.
References: R. E. Smythe, H. G. Thompson, W. L. Thompson, E. A. Allcut, R. W. Angus.

SKERRY—FRANCIS STEPHEN, of 172 Windsor St., Halifax, N.S., Born at Waverly, N.S., Dec. 16th, 1912; B.Eng. (E.E.), N.S. Tech. Coll., 1935; 1936 (3 mos.), Provisional Signal Officer, Camp Borden; 1936-37 (summers), inspr., Milton Hersey Company.
References: S. Ball, G. H. Burchill, J. R. Kaye, P. A. Lovett, R. R. Murray.

FOR TRANSFER FROM THE CLASS OF ASSOCIATE MEMBER TO THAT OF MEMBER

FARROW—RICHARD CHARLES, of Victoria, B.C., Born at Hornsey, Middlesex, England, Aug. 11th, 1892; Educ., Articled to Humphreys & Tupper, Vancouver, B.C. Studied under a coach until 1913. R.P.E. of B.C.; 1913-15, private practice as B.C.L.S., misc. surveys and engrg. work, highway, standard and incline logging rlys.; 1919-23, partnership in Tupper & Farrow, Vancouver, land surveys and misc. engrg. practice; 1923-24, South California Edison Co., Los Angeles, civil engrg. divn., 1924-27, i/c checking dept., and 1927-28, i/c civil divn. office, as engineer-supervisor; 1928-33, and 1934-1937, hydraulic engr., power investigation divn., Water Rights Branch, Province of British Columbia. Dec. 1937 put in charge of power investigation divn., also i/c B.C. Snow Surveys; at present, district engr., Water Rights Branch, Province of British Columbia. (*A.M. 1933.*)
Reference: J. C. Macdonald, E. Davis, H. L. Swan, F. C. Green, N. A. Yarrow, E. A. Wheatley.

FLEMING—JOHN MURRAY, of Port Arthur, Ont., Born at Winnipeg, Man., July 16th, 1899; Educ., B.Sc. (Civil), Univ. of Man., 1921. Post Graduate in struct'l. engrg. and demonstrator, Univ. of Man., 1922; 1922-23, designer and dftsman., Manitoba Power Co.; 1923 (Feb.-Sept.), res. engr., temp. rly. constrn., Tulsa Aqueduct, Walbridge Aldinger Co., Tulsa, Okla.; 1923 (Oct.-Dec.), inspr. on constrn., coke plant, Winnipeg Electric Railway; 1924-32, struct'l. designer, on grain elevators, docks and heavy structures, and 1933-35, chief engr., C. D. Howe & Company; Jan. 1936 to date, president and general manager, C. D. Howe & Co. Ltd., carrying on business of former company. (*St. 1919, A.M. 1928.*)
References: C. D. Howe, R. B. Chandler, P. E. Doncaster, H. G. O'Leary, J. N. Finlayson.

KETTERSON—ANDREW ROBERT, of 3652 Northcliffe Ave., Montreal, Que., Born at Greenock, Scotland, June 24th, 1881; Educ., Associate, Royal Technical College, Glasgow, 1902. R.P.E. of Quebec; 1902-04, designing, estimating shops, A. Findlay & Co. Ltd., Bridge Builders, Motherwell, Scotland; 1904-07, designing structures and setting out in field, Babtie & Brown, consltg. engrs., Glasgow; 1916-19, overseas, Major, D.S.O.; With the C.P.R. as follows: 1907-10, bridge inspr., 1910-13, dftsman. and asst. engr., 1913-16, asst. engr., Winnipeg; 1919-28, asst. engr., supervn. of bridge design, etc.; 1928-37, asst. engr. of bridges, and 1937 to date, engr. of bridges, Montreal. (*A.M. 1908.*)
References: J. M. R. Fairbairn, P. B. Motley, J. E. Armstrong, F. W. Alexander, D. Hillman.

FOR TRANSFER FROM THE CLASS OF JUNIOR

McDONALD—DONALD JOHN, of Montreal, Que., Born at Glen Nevis, Ont., Dec., 7th, 1903; Educ., B.Sc., Queen's Univ., 1926; 1926-27, test course, General Electric Co., Schenectady, N.Y.; With the Bell Telephone Company of Canada, Montreal, as follows: 1927-30, on staff of foreign wire relations engr., and from 1930 to date, foreign wire relations engr. for eastern area. (*Jr. 1930.*)
Feferences: J. L. Clarke, C. L. Dewar, T. C. Thompson, A. S. Runciman, L. E. Ennis, K. O. Whyte.

PATTERSON—IAN STEWART, of Montreal, Que., Born at Thomson, N.S., Sept. 21st, 1907; Educ., B.Sc. (E.E.), N.S. Tech. Coll., 1928; With the Canadian General Electric Co. Ltd., as follows: 1927 (summer), factory work, Peterborough; 1928-29, test course, Peterborough; 1929-30, training in industrial control engrg., at Peterborough, Toronto and Schenectady; 1930 to date, sales engr., specializing in industrial control engrg., Montreal. (*St. 1928, Jr. 1931.*)
References: R. H. Findlay, R. E. Heartz, B. R. Perry, J. L. Busfield, C. K. McLeod.

RICHARDSON—WILLIAM GORDON, of 256 Wilbrod Street, Ottawa, Ont., Born at Watford, Ont., Dec. 5th, 1903; Educ., B.Sc. (E.E.), Queen's Univ., 1926; 1926-27, with the General Railway Signal Co., Rochester, N.Y., elect'l. and mech'l. tests of transformers, relays, A.C. and D.C. motors, etc.; 1927-28, research work, Carborundum Co., Niagara Falls, N.Y.; 1928-29, demonstrator, elect'l. lab., Queen's University; 1929-33, development branch, Northern Electric Co. Ltd., elect'l. and mech'l. methods used in manufacture of relay coils, repeating coils, transformers, retardation coils, carrier telephone and telegraph equipment, development of new methods and equipment; 1935 to date, engr., transmission and development branch, Canadian Broadcasting Corporation, Ottawa, Ont. (formerly the Canadian Radio Broadcasting Commission). (*Jr. 1930.*)
References: D. M. Jemmett, A. Jackson, L. T. Rutledge, W. H. Eastlake.

FOR TRANSFER FROM THE CLASS OF STUDENT

BONNELL—ALEXANDER ROBERTSON, of 161 Argyle St., Fredericton, NB., Born at Sussex, N.B., April 13th, 1913; Educ., B.Sc. (Civil), Univ. of N.B., 1935; 1935, inspr., asphalt paving, Milton Hersey Co. Ltd.; 1935 (Fall), asst., Geol. Survey; 1936 (summer), foreman, highway constrn., Rayner Constrn. Ltd.; 1936 (Fall), inspr., asphalt paving; 1937 to date, instr'man., N.B. Highway Divn., Dept. of Public Works, Fredericton, N.B. (*St. 1935.*)
References: J. R. Scanlan, M. F. Macnaughton, E. O. Turner, A. F. Baird, C. G. Grant, E. B. Allan, J. Stephens.

CUNNINGHAM—DONALD DAVID MacCOUBREY, of Newcastle Creek, N.B., Born at Round Hill, N.S., Sept. 17th, 1913; Educ., B.Sc. (E.E.), Univ. of N.B., 1936; With the N.B. Electric Power Commission during college vacations as inspr. and tester, June to Dec. 1936, asst. to constrn. supt., and Dec. 1936 to Dec. 1937, switch board operator, Grand Lake power plant, and at present, test engr. at same power plant. (*St. 1937.*)
References: A. F. Baird, E. O. Turner, J. Stephens, G. A. Vandervoort, E. J. Owens.

HAYES—HERMAN RUTHERFORD, of 7102-111th Ave., Edmonton, Alta., Born at Gleichen, Alta., Dec. 23rd, 1908; Educ., B.Sc. (Civil), Univ. of Alta., 1934; 1929-33 (summers), and 1934 to 1937, mtce. dept., C.P.R.; at present, industrial engr., Burns & Co. Ltd., Edmonton, Alta. (*St. 1933.*)
References: F. W. Alexander, T. Lees, R. S. L. Wilson, H. R. Webb.

JARVIS—GERALD WALTER, of Montreal, Que., Born at Hamilton, Ont., Sept. 30th, 1907; Educ., B.Sc., Queen's Univ., 1930; 1930-32, lecturer and demonstrator, mech. engrg. dept., Queen's University; 1934 to date, dftsman., general refinery design and constrn., McColl Frontenac Oil Co. Ltd., Montreal, Que. (*St. 1931.*)
References: E. R. Smallhorn, G. V. Roney, J. E. Goodman, L. T. Rutledge, C. Miller.

LAWSON—GEORGE WHYTALL, of 37 Fleming Crescent, Leaside, Ont., Born at Bradford, Ont., July 28th, 1910; Educ., B.A.Sc., Univ. of Toronto, 1933; 1935, laborer, International Nickel Co.; March 1937 to date, designer and dftsman, Dufferin Paving and Crushed Stone Ltd. (*St. 1935.*)
References: A. B. Crealock, C. R. Young.

LYON—GRANT MacKENZIE, of Red Lake, Ont., Born at Winnipeg, Man., Aug. 10th, 1910; Educ., B.Sc. (C.E.), Univ. of Man., 1931; 1927-28 (summers), chainman, rodman, C.N.R.; 1936 (8 mos.), office asst. on constrn., C.N.R.; 1928 (5 mos.), bridge inspr. on constrn., C.N.R.; 1930 (5 mos.), res. engr. on reinforced concrete bridge constrn., and 1931 (6 mos.), contractor on highway constrn., Dept. of Highways, Prov. of Sask.; 1933-34, inspection engr., Dominion Water Power Branch; 1935-36, junior engr., conducting hydrometric surveys in Man. and Sask., Dom. Water Power Branch, Winnipeg; 1937 (June-Sept.), asst. on land subdivision survey, municipal district of Flin Flon; Sept. 1937 to date, engr. i/e surveying, mapping and other engrg. work, Red Lake Gold Shore Mines, Ltd. (*St. 1929.*)
References: W. Walkden, J. N. Finlayson, G. H. Herriot, A. P. Linton, J. T. Rose, A. E. Macdonald, A. Taylor.

MACDONALD—JOHN ERNEST, of South Slocan, B.C., Born at Vancouver, B.C., Sept. 30th, 1906; Educ., B.A.Sc., Univ. of B.C., 1931; 1927-28, constrn. and elect'l. inspn., Conowingo, Md., for Stone & Webster, Mass.; 1929 (summer), rly. location, surveying and bridge constrn., C.P.R., Vancouver; 1930 (summer), elect'l. design, Ruskin hydro-electric development, B.C. Electric Rly. Co.; 1931-34, hydro-electric constrn., operation and mtce., West Kootenay Power and Light Co., and Sept. 1935 to date, in charge Okanagan Division of same company, transmission line constrn. and substation constrn. (*St. 1929.*)
References: P. H. Buchan, L. A. Campbell, A. E. Wright, E. E. Carpenter, W. H. Powell.

SCHNYDER—MAX, of 1865 St. Catherine St. West, Montreal, Born at Biel, Switzerland, Aug. 5th, 1908; Educ., B.Eng. (Mech.), McGill Univ., 1935; 1935-36, dfting. and shop experience, Linde Canadian Refrigeration Co. Ltd., Montreal; 1936-37, mech'l. development engr., Jos. Stokes Rubber Co. Ltd., Welland, Ont.; at present, layout and design of mech'l. equipment for John Stadler, M.E.I.C., Montreal, Que. (*St. 1934.*)
References: C. M. McKergow, O. Biedermann, J. H. Ingham, J. F. Plow.

SHARP—WILLIAM GRAY, of Calgary, Alta., Born at Indian Head, Sask., Mar. 12th, 1910; Educ., B.Sc. (E.E.), Univ. of Alta., 1933; 1929-33, general theatrical management and mtce. of equipment; 1933 to date, servicing and mtce., and full charge of installns. of complete equipment, including arc lamps, rectifiers, projectors, and complete sound equipment for theatres supplied by Sharp's Theatre Supplies in Alberta, Eastern B.C. and Western Saskatchewan. (*St. 1933.*)
References: H. J. McLean, J. McMillan, J. Dow, P. F. Peele, R. S. Trowsdale.

SMITH—OWEN LEONARD, of Baie Comeau, Que., Born at Twillingate, Notre Dame Bay, Nfld., Aug. 25th, 1910; Educ., Lacking one subject for B.Eng., N.S. Tech. Coll., 1937; Summers 1929 and 1931, chainman, Anglo-Newfoundland Development Co., Grand Falls, Nfld.; 1929-30, electrn., International Power & Paper Co., Deer Lake, Nfld.; 1936, relieving engr., Anglo-Newfoundland Development Co., Grand Falls, Nfld.; at present, improver, elec. dept., Canadian Comstock Co., in the erection of paper mill at Baie Comeau. (*St. 1935.*)
References: H. S. Windeler, S. Ball, D. Anderson, A. D. Ross.

STIERNOTTE—ALFRED, of Turner Valley, Alta., Born at Couillet, Belgium, June 29th, 1908; Educ., B.Sc. (Chem.), Univ. of Alta., 1935; 1935 to date, lab. asst., Royalite Oil Company, Turner Valley, Alta. (*St. 1936.*)
References: W. H. Broughton, S. G. Coulter, J. H. Parks, F. K. Beach, R. S. L. Wilson, W. E. Cornish.

TAYLOR—FREDERICK WILLIAM, of 1198 Woodbine Ave., Toronto, Ont., Born at Toronto, Aug. 23rd, 1913; Educ., B.A.Sc., Univ. of Toronto, 1936; 1934 (summer), asst. on camp engrg. staff, Dept. of Northern Development road work; 1936 to date, dfting., designing and inspecting struct'l. work, for E. A. Cross, M.E.I.C., consltg. engr., Toronto, Ont. (*St. 1936.*)
References: C. R. Young, W. J. Smither, W. B. Dunbar, E. A. Cross, T. R. Loudon.

THOMAS—JAMES MACLEOD, of 236 Waterloo Row, Fredericton, N.B., Born at Fredericton, N.B., January 8th, 1910; Educ., B.Sc. (E.E.), 1932, B.Sc. (C.E.), 1933, Univ. of N.B.; Four summers course with R.C.C.S., Camp Borden; 1934, chainman and rodman, 1935, instr'man., 1936, senior instr'man., and at present, res. engr., highways divn., Dept. of Public Works of N.B. (*St. 1935.*)
References: J. Stephens, A. F. Baird, E. O. Turner, M. W. Black, E. B. Allen, G. Macleod, C. G. Grant.

TRUDEL—LOUIS, of Montreal, Que., Born at St. Stanislas, Que., May 16th, 1910; Educ., B.A.Sc., C.E., Ecole Polytechnique, Montreal, 1936; R.P.E. of Que.; 1931, electrn. helper; 1929-30 and 1932-35 (summers), surveying with Quebec Streams Commission; 1936-37, asst. engr., Quebec Electricity Commission; 1937 to date, asst. engr., Provincial Electricity Board. (*St. 1934.*)
References: A. Frigon, O. O. Lefebvre, J. W. McCammon, J. A. Beauchemin, H. Massue, C. E. Frost, L. Jehu.

FOR TRANSFER FROM THE CLASS OF AFFILIATE

JOYCE—ALEXANDER GEORGE, of Arvida, Que., Born at Inverness, N.S., April 23rd, 1909; Educ., course in combustion and steam engrg. with Hays Institute, Chicago, Ill. Home study in steam engrg. and mtce. 1st Class Stationary Engineer's Certificate; 1925-27, fireman and 3rd engr., Inverness Railway and Coal Co.; With Aluminum Company of Canada as follows: 1927-31 and 1933-35, boiler operator in charge of shift, 1935 to date, chief boiler operator, i/c operation and mtce. layout and installn. of power plant equipment. (*Affiliate 1936.*)
References: A. W. Whitaker, Jr., M. G. Saunders, A. C. Johnston, J. W. Ward, R. H. Rimmer, H. R. Wake, C. Miller.

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Engineering Efficiency into the Highways

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Address delivered at the Annual Meeting of The Institute in London, Ont., February 1st, 1938

SUMMARY.—The principles of 'limited way' construction are discussed, based on the idea that "The solution for the problem of traffic congestion and a large part of the problem of traffic safety lies in a revision of the structural rather than the operating elements of the automotive transportation system." Actual examples of 'limited way' design in Chicago and San Francisco are described.

The street and highway traffic problem in the United States and Canada today is a universal problem. Every man, woman and child has a definite stake in the solution of the problem, both for reasons of personal protection as well as from motives of economic self-interest.

Because of the universal demand for solution and because of the gigantic size of the joint problem of traffic accidents and traffic congestion, it is necessary that the engineering profession assume its full responsibility to bring to bear upon the problem every scientific technique available. You have heard from your colleague, Mr. C. A. Robbins, the principles which are being followed by highway engineers in an attempt to build more inherent safety into the automotive roadbed. In a very real sense these remarks must serve as a confirmation of those principles which he has set forth. While these remarks are to be addressed primarily to the problem of engineering efficiency into the highway structure, it should be noted that this term "efficiency" incorporates, not only the concept of free and orderly movement, but, likewise, the concept of safe movement, for without reasonable safety there can be no reasonable efficiency.

Many of the proposals which have been made by Mr. Robbins would have been considered by earlier engineers and, indeed, by contemporary laity as radical in character, but constructive engineers have never been noted for following the crowd. It is the very essence of their profession that they should be leaders in thought. What the speaker has to say will parallel Mr. Robbins' remarks in the sense that they, too, will propose basic changes which in all probability would have been considered as radical proposals even a few years ago. Of necessity, attention will be directed principally to urban problems, for it is under conditions of urban congestion that one finds the most important illustrations of lack of efficiency today. It is under urban conditions that there is the greatest opportunity for the improvement of roadway efficiency.

Whenever proposals are made for basic changes in the methods for the handling of any broad human problem, these proposals are always subjected to acute criticism. This is as it should be. It is only through a vigorous exchange of facts and conclusions that the advantages or disadvantages of the proposed changes may be evaluated. Enthusiasts for change are notably over-optimistic with respect to the advantages of their plans and, equally, those who oppose change for various reasons are unwilling to admit that the old methods should not be perpetuated. These two schools of thought appear before the moderate jury of public opinion to submit their cases.

This is precisely what has happened and is now happening with respect to the basic issue as to the future character of our street and highway facilities. You will observe from the content of this address that its author is a proponent of change, that he is dissatisfied with conditions as they are, and that he believes that the whole future of automotive transportation is predicated, to a considerable degree, upon our ability to recognize and adopt certain physical changes, basically necessary for a better adjustment of the various factors which compose our automotive system.

In the consideration of proposed changes in policy and plan, one issue should be avoided and yet it is, unhappily, an issue which all too frequently distorts judicial consideration. A proposal to move to new and perhaps advanced ground does not, of necessity, imply a criticism of the past or those individuals who have achieved notable leadership in the development of past policies. Leadership can be lost only when it becomes so inflexible that it cannot adjust itself to new requirements. This is particularly true in a problem which has grown and changed as rapidly as has the traffic problem in the United States and Canada. If to have advocated different policies and plans in the past than those which ought to be followed in the future were a cause for criticism, the speaker, himself, would be most blameworthy. With his associates, he has been directly or indirectly responsible for the expenditure of many scores of millions of dollars for public works, the character of which he could not approve today.

The question of what has been should, therefore, with all of its surrounding inertia and personalities, be laid aside and attention should be given solely to what ought to be.

Some years ago a simple formula for the construction of street and highway facilities was proposed. Most of you are so familiar with the elements of this formula that no detailed description is necessary. Under the descriptive title of "limited way construction" it recommended that major traffic facilities should have in the future four physical elements:

(1) A complete and continuous physical separation of opposed streams of traffic;

(2) No direct access to abutting property and with all entries and exits to and from the structure by especially designed connections;

(3) A continuous separation of all intersections with no cross movement of any kind across the operating lanes of the Limited Way;

(4) A cross-section design to permit an adequate segregation of relatively fast and relatively slow vehicles and with retarding lanes at exits and accelerating lanes at entries.

The proponents of this proposal deserve no credit for originality. There is not a single one of the four elements of design that has not been known and used by the highway

Fig. 1—Henry Hudson Parkway in Borough of Bronx, New York City. Looking from Riverdale Avenue, showing four lane divided roadway in centre with service roads on each side.

engineering profession for many years. Such originality as may be involved lies exclusively in the combination of the four factors, each of which is individually essential, to formulate the concept of a structure functionally designed to carry modern automotive traffic with maximum safety and maximum efficiency.

No tedious arguments need be advanced at this stage of development to support the correctness of the formula, itself. The adherence of eminent public and private agencies and leaders and the practical demonstration of the validity of the formula in traffic facilities now in use, and some of which were indeed in use before the formula was proposed, give adequate support. This is by no means all of the story of progress. Many thousands of people recognized the basic necessity for good roads in the beginning of this century long before any adequate action was taken. The principle had to be sold to the public and, indeed, to many who were in presumed positions of leadership.

America will not have a safe and adequate system of major traffic facilities merely because you and I believe that there should be basic improvements. There are powerful influences which must be changed and imponderable barriers of inertia which must be moved. To merely say and, perhaps, even to prove that our problem of traffic congestion and traffic accidents create today an almost insufferable social and economic burden is not enough to achieve action. A score of different types of resistance must be overcome. The one which has been met most frequently in this particular movement is that of cost. Many are willing to agree with the almost axiomatic conclusion that the proper application of limited way principles of construction will, in fact, largely solve the problems of accidents and congestion insofar as the traffic thus carried is concerned. The retort is made, however, that such types of facilities cannot be afforded. There are others who agree that no matter how sound the principles may be it would be foolhardy to attempt any major application in view of the fact that the character of our traffic problem may alter in the future and, therefore, render the expenditure wasteful. How frequently were both of these arguments supported in the early days of the "good road movement." They are supported with equal vigour today and if they are true they should prevail, but if they are not true they should not be permitted to stand in the way of progress.

This address is directed, primarily, to an introductory analysis of the economic factors controlling the urban planning of major traffic facilities. The subject is limited to the urban problem because it is there that the most critical aspects of the congestion and accident problem is found and it is there that one may expect the largest share of relief through proper building for the future.

Before this urban problem can be considered intelligently, from an economic viewpoint, it is necessary to have a competent understanding of the facts and character of urban growth. The entire trend in the United States has been toward a greater and greater urbanization of our population so that at the present time substantially more than half of our people are city dwellers. It would be difficult for one to point to any basic changes in our social economy which would be likely to stop or reverse this cityward trend. It may be that our people would have been a happier and more prosperous people if the great majority of them had continued to live on the farm. This question, however, is an academic one for we are confronted with realities.

In their growth, all American cities have followed a typical pattern. There is, at that most accessible centre of city life, a highly concentrated business district, usually called the central business district. This area incorporates the principal executive, clerical, retail trade and related activities. Manufacturing and heavy industrial activities are located in the community largely in accordance with the availability of adequate transportation facilities. The population of the city forms a residential pattern largely controlled by the location of the central business district and the principal areas of industrial employment. No person can live farther away from his work than a distance which can be travelled twice each day with reasonable ease and economy. Since the central business district and the industrial areas are the principal sources of livelihood for the population of the community, they naturally control, together with available traffic and transportation facilities, the pattern and distribution of residential population.

There are some persons who are offended not only by the urbanization of our population but, likewise, by the typical pattern of the American city. They are particularly offended by high concentration of business activity in central business districts and, especially, by tall buildings. Seeing the greatest concentration of business activity and the greatest congestion of traffic, they assume that the cure for the problem of congestion lies in a decentralization of business activity. They believe that our cities should be forced to spread out and, again, there may be some idealistic merit in their proposals, but there is not a great deal of practical aid in the suggestions. American cities have not taken their present form because of any idle whim on the part of tradespeople, building owners and managers, or land speculators. There are, today, highly concentrated business districts because such concentration has, in itself, great economic advantages in the efficient conduct of business. To spread all of the existing business activity in Manhattan thinly and equally over the entire area from 125th Street southward to the Battery and for the full width of the island, would not add to the efficiency of business activity in New York City, nor would it, by any means, solve the street traffic problem. Rather, it would aggravate it many fold by multiplying the mileage of street travel required for the exchange of essential services and commodities. To tear all of New York City apart and spread it equally along a hundred mile stretch of the Atlantic seaboard, would not increase the efficiency of the people in their economic activities, nor would it do other than multiply the breadth and character of the problem of traffic movement. But such magic, even though it were useful, is not likely to be applied. Those who believe that America is shortly to return to a pastoral existence and that therein we will find a solution for our urban traffic problem are doomed to disappointment. Even those who believe that by fiat it would be possible to level the concentrations of business activities, even though this change should bring great traffic relief, are likewise to be disappointed. Those who believe in the efficacy of building height restrictions as a panacea for the traffic problem, are largely deluding themselves. One need only look at traffic conditions in Boston, Los Angeles or Washington, D.C., to know that low buildings, long required by law in these communities, bring no solution for the problems of traffic congestion.

If these conclusions be true, one is confronted with a realistic situation of fact rather than an academic one of ideals.

There is one form of urban decentralization that everyone would believe both desirable and possible. City dwellers should be permitted to live under conditions that are healthful and these can be achieved only where a reasonable wide and low intensity of population concentration is possible. If traffic and transportation facilities are so poor that people must live in close proximity to their work, there will continue to be congested residential and tenement areas. The degree to which a reasonable decentralization of residential population can be obtained, and the attendant staple and sustenance trade activities, is dependent almost exclusively upon the efficiency of urban mobility.

Here it may be wise to note another basic trend which is taking place in all urban areas. You are, of course, familiar with the degree to which the automobile has been adopted by urban as well as rural dwellers throughout our nation. The automobile is increasingly used by all classes of our population for personal workaday transportation. One need only look at the parking lots in any central business district and the parking areas surrounding our great factories, or even in the accumulation of cars near relief projects, to have adequate proof of this conclusion. What is not so clearly seen is that mass transportation, too, is trending definitely toward free wheel transportation units. In other words, it, too, is becoming automotive in character. Cities such as Los Angeles, Detroit, Cleveland and Chicago that once, at their current stage of development, would have been looking inevitably toward expensive systems of subway or elevated railway construction have now suddenly realized that their population is no longer street car population. Thus, the solution of the traffic problem involving the private passenger car and the commercial vehicle now has added to it the very great and real problem of an adequate provision of rapid transit facilities for automotive mass carriers.

In no place in the United States is this as clearly and conclusively shown as in the Chicago metropolitan area. The public officials have recognized that a city-wide rapid transit rail system proposed and, indeed, approved prior to the depression at a total cost of more than $300,000,000 would today be unsuited to the travel needs of the Chicago people. Except for a limited development of rapid transit facilities in the central area, Chicago has turned away from rapid transit and has developed consolidated plans for the joint carriage of major traffic streams and rapid transit automotive public carriers upon a comprehensive system of limited way construction.

A basic economic issue which confronts every great American city today, and, indeed, many of the smaller ones, is this: shall we subsidize, at great and continuing expense to the public treasury, rapid transit rail facilities affording comparatively low-grade and unprofitable mass transportation, or shall we, out of public funds made available by the generous contributions of street users themselves, provide adequate, safe, efficient and modern traffic facilities so that automobile owners will provide their own transportation of a high character at their own operating costs and so that such part of our people as may desire or find it necessary to use the facilities of mass transportation may have the type of transportation which they obviously desire and deserve and at a fraction of the cost which would otherwise be required? This is no hypothetical question. It is as real a problem and as critical a problem as has ever faced American cities. Upon its solution will depend the future and efficiency of the city itself, and the degree to which urban civilization may profit and not continue to suffer from the effects of the automotive revolution.

Assuming that city dwellers are not going to abandon urban areas and return to a rural existence in the near future, and assuming that those normal factors which have built our cities and have determined their character and pattern are still to remain effective in the future, it is apparent, to even the casual observer, that something must be done and done quickly. Relief actions of the so-called operating type are not without their value. Here,

Fig. 2—Newark Junction, Essex County, N.J. State Routes No. 21, 25 and 29. Showing rotary traffic circle in connection with two grade separations.

of course, reference is to a better education and direction of automobile drivers and other street users and a better regulation and control of traffic movement. Both education and enforcement have proved their ability to bring some substantial relief to the problem of traffic accidents. In the Harvard Bureau for Street Traffic Research we have studied and used these techniques for almost fifteen years and shall probably always study and use them as an

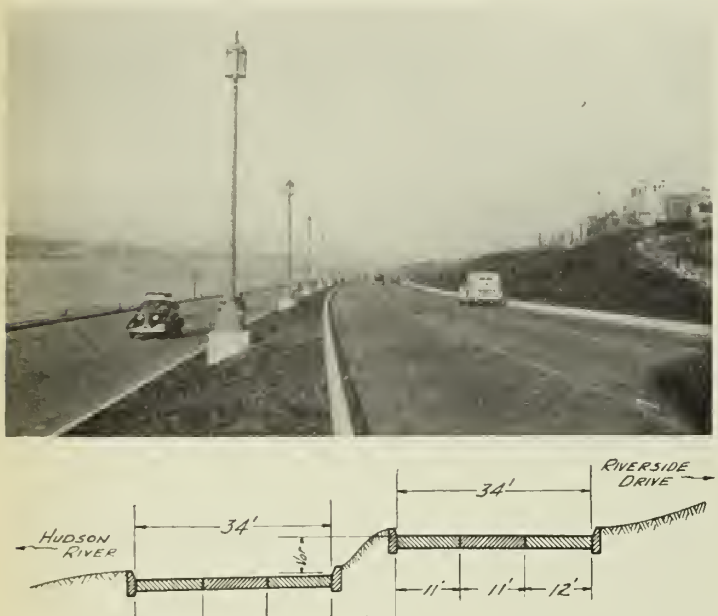

Fig. 3—West Side Express Highway, New York City, N.Y.

This project is an extension of the West Side Express Highway located in Riverside and Ft. Washington Parks and extends from 72nd Street to Dyckman Street, a total distance of 6.7 miles. The pavement consists of two 34 ft. roadways with variable width dividing strip in the centre. For that part of the pavement immediately adjacent to the Hudson River, the elevation of the northbound roadway is 4 to 6 ft. higher than the adjacent roadway, thereby affording an unobstructed view of the river for all motorists. Total cost of this improvement was approximately $24,000,000. The new highway was opened to traffic on Columbus Day, October 12th, 1937.

essential part of safe and efficient traffic operations. This reference is made to indicate that we believe in education and enforcement and also to indicate that we are, perhaps, in some position to appraise the limitations of this approach, so far as the major aspects of the safety problem are concerned, and almost all aspects of the problem of congestion. There is no magic by which two entirely safe drivers can put their automobiles on a crowded street in the same place at the same time, nor is there any magic by which any number of police officers, no matter how highly trained, can force traffic volume over a street system incapable of carrying the load, nor any formula by which the traffic engineer can change the basic elements of time and distance.

The solution for the problem of traffic congestion and a large part of the problem of traffic safety lies in a revision of the structural rather than the operating elements of the automotive transportation system.

At the present time there is not a single current automobile in production that cannot achieve speeds of sixty miles per hour safely under safe operating conditions. It is not, however, excessive crest speeds in which one should be interested in discussing the problems of automotive economics. The great achievement of the automotive engineer has been to build into his vehicle higher and higher optimum speeds. This means, of course, the speed at which the vehicle operates most economically and most effectively. There is no way of determining current optimum speeds, but the best advice available is that in the past fifteen years they have risen from somewhere around twenty miles per hour to substantially more than forty miles per hour. Notwithstanding what other assets the automobile may have, the primary investment of the American public in automotive equipment lies in these optimum speeds. One cannot look at any American or Canadian city today without realizing that a large part of the tremendous investment in the rolling stock of street and highway transportation is being wasted. Average over-all speeds of traffic in typical American cities are approximately seventeen miles per hour and in those areas where traffic has the greatest economic significance, average over-all speeds frequently fall as low as five or six miles per hour. But bear in mind that these ridiculously low speeds are achieved only under conditions of the greatest hazard and there is created, in turn, an economic load which is a severe burden to the entire public. It is not uncommon in studies of commercial traffic operation to find that more than fifty per cent of the operating truck day is spent standing entirely still in traffic jams. This is a sad commentary upon our vaunted efficiency. Let no one believe for a moment that, leaving out of consideration entirely the social and humanitarian aspects of traffic accidents, there is not here an economic waste that justifies the most serious consideration.

The classical approach to the problem of traffic congestion, and the speaker is willing to bear his full part in having formulated and promulgated it, was to widen streets. It followed logically out of early street and highway planning and design. The first objective was to make the roadway hard enough to hold vehicles up and the second objective was to make the roadway wide enough to accommodate them. Thus, during the decade of the twenties when the first full repercussions of traffic volume were felt, our cities were busy with vast programmes for major street improvements. No planner or engineer should be ashamed of his activities, for he was being guided by the best lights available. It was hoped that by widening streets, making them straight and providing them with adequate traffic rules and control devices the problem of congestion and accidents would disappear. All know now that that was a false hope, and that the orthodox street, no matter how wide, how straight or how well controlled, cannot be other than highly hazardous and highly inefficient. It was only natural, therefore, that engineers, seeking a satisfactory, functional solution of the problem, should have turned their attention to the design of traffic facilities mechanically and physically competent to absorb safely a reasonable part of the efficiency built into the rolling stock itself.

Again arises the question of cost. Even those who were most enthusiastic for the great expenditures necessary to bring about the good roads movement or who were the most enthusiastic leaders in major street planning of the last decade are often prone to look with resistance and scepticism upon these new types of development. Even the most sceptical, however, would not be willing to support a programme of inactivity. In this they would be wise, for unless the handwriting already on the wall is entirely misleading all American cities are confronted in the immediate future with an exceedingly critical problem of internal congestion and even stagnation. This, when it comes, and it has already made itself apparent in many of our metropolitan centres, will seriously distort the normal and healthy development of all phases of community activity, will place increasingly heavy burdens upon the machinery of distribution, will destabilize established business and residential property values and will thwart the natural development of automotive traffic and transportation.

So far as it is possible to know, there are only two ways of providing new traffic capacity to give any relief to the problems of increasing volume. One is through the widening of existing streets and the other is through the construction of special types of major traffic facilities. To get down to a "dollar and sense" basis, one can take an illustration from the city of Chicago. In that community three major traffic routes were widened. They were Ashland Avenue, Western Avenue and La Salle Street. They were the outstanding examples in the twenties of traffic benefits to be derived by the widening process. Actually, it should be noted in passing that Ashland Avenue and Western Avenue, as widened, now produce 16 per cent of all of the traffic fatalities in the entire city of Chicago. These consolidated widenings cost $384,000 per average mile for each additional ten-foot lane gained by the improvements. The estimated cost of a four-lane limited way structure was $431,000 per mile. This figure includes $100,000 per mile for ramps, street adjustments and accessories. With four new lanes in the structure, this estimate results in a cost of $107,750 per mile lane of limited way. Leaving entirely out of consideration relative safety factors and relative speed of traffic, each of these lanes has an 80 per cent greater traffic capacity per hour than that of a comparable surface route. Thus, in order to acquire an equal traffic capacity by surface route construction, it would be necessary to build 80 per cent more surface route lanes, which would bring the cost of street widened lanes, equal to the capacity of one limited way lane, to a total of $691,200 per mile. Or to obtain, by street widening improvements, the discharge capacity provided by one mile of limited way lane costing $107,750 it would be necessary to build $691,200 worth of widened street improvements. Lest there be any misapprehension as to these cost ratios, it is emphasized that the cost estimates and comparisons indicate that a given number of units of traffic capacity can be acquired by limited way construction at a cost of 15.5 per cent of the cost of equal traffic capacity in street widening as illustrated by the additional traffic lanes which were obtained in the Western Avenue, Ashland Avenue and La Salle Street projects.

Now turn briefly to a consideration of the economic value of the greater speed of travel afforded by limited way construction in comparison with that available upon the best of widened routes. A mile of surface route operating at an average over-all speed of twenty miles per hour, or at a rate of three minutes per mile, and carrying a daily traffic of 50,000 vehicles requires an expenditure of 150,000 vehicle minutes per twenty-four hour day. A mile of limited way operating at an average over-all speed of forty miles per hour, or at a rate of 1.5 minutes per mile, and carrying a daily traffic of 50,000 vehicles requires the expenditure of 75,000 vehicle minutes per twenty-four hour day. The daily time saving of the limited way as compared with the surface is 75,000 minutes, or a money saving to operators of $937.50 per day, computed at the rate of 1.25 cents per minute. On the basis of 365 days, the annual saving is $342,187.50 which may be capitalized at five per cent giving a total of $6,843,750 or the capital expenditure justified per mile for limited way construction over and above that required for surface route construction. This is without any consideration of the economic gain achieved through the fact that limited way construction renders physically impossible approximately 98 per cent of typical surface street accidents. Lest anyone believe that the use of the factor of 1.25 cents is hypothetical, it should be stated that it was derived from the actual experience of the Holland tunnel where more than ten million motorists each year go down in their pockets to pay in cash an even greater price per minute saved in the Holland tunnel in comparison with the service rendered by slower ferry facilities.

Where traffic facilities have been urgently needed to reduce congestion and increase convenience, they have been notably successful from the economic standpoint. This applies to facilities of the most costly character and even where the relative convenience afforded is limited in extent. The Holland tunnel, to which reference has just been made, is an excellent example. Though it cost more than $50,000,000 to construct it, the investment is being liquidated at a far faster rate than had been anticipated. So successful, indeed, has this structure proved from the financial standpoint, that the Port of New York Authority was encouraged to build the George Washington bridge, and now has under construction the Mid-Town Vehicular tunnel.

It may be said, of course, that the New York metropolitan area is an unusual one and, therefore, that structures which might be economically sound in New York could not be contemplated elsewhere. To disprove this position, one could turn to many scores of smaller communities throughout the United States. Perhaps the best and most recent example is to be found in San Francisco, which is more or less typical of the average American city except for its peculiar topographical location. In San Francisco, two great bridges have been opened within the past year—the Oakland-San Francisco Bay bridge and the Golden Gate bridge. The former cost approximately $77,000,000 and the latter approximately $60,000,000. They give San Francisco a direct vehicular connection with the populous areas of the East Bay district and with the sparsely populated territory to the north in Marin and adjacent counties. Certainly the expenditure of $140,000,000 for two bridge structures for the handling of the comparatively light traffic loadings to be anticipated in a metropolitan area such as San Francisco is a tremendous expenditure and one which might readily be questioned. Indeed it was seriously questioned, but the results have given a conclusive answer.

Fig. 4—Route 23, Morris County, New Jersey. Divided Lane.

At nominal tolls of 50 cents per trip, these structures are adequately taking care of their carrying charges and the total income promises a reasonably speedy liquidation of the investment.

As consultant to the city and county of San Francisco, it was the speaker's good fortune to have an opportunity to prepare comprehensive plans for the internal handling and distribution within San Francisco of the traffic volumes generated by these two bridge structures and to, concurrently, prepare for the other basic traffic problems of the community itself. To this end there was prepared for San Francisco a limited way plan, partially through elevated construction and partially through special treatment of grade routes and through depressed limited way design. This plan was formulated in such a manner as to provide a system of major traffic facilities for all functional parts of the city with almost complete safety protection and with relatively high safety speed potentials.

Since this limited way plan for San Francisco is the most recent application of these principles to urban planning and since it was possible to incorporate in the plans and designs all of the currently available techniques and materials, the economic factors are worthy of consideration.

The San Francisco limited way plan could be constructed for a total cost of approximately $26,000,000. The system would be 64.5 miles in total length. Parenthetically, it may be interesting to note that San Francisco has just defeated by a two to one vote a $50,000,000 bond issue for the construction of five miles of two-track subway.

Were it not for the fact that San Francisco is already provided with many of the elements of a basically sound street pattern the construction estimates as given above would be much higher. It has been possible, therefore, to provide a limited way system with a total mileage of more than sixty-four miles, almost all of which may be constructed in existing right of way. This is due to the fact that many of the logical routes for limited way construction are of such width that this construction can be undertaken without the acquisition of private property. Furthermore, most of the mileage proposed lies upon routes and in areas where the character of the occupancy would not be detrimentally affected considering the character of structure proposed and the width of the existing street.

It has been possible to provide most of the benefits of true limited way construction by a special treatment of existing wide, grade streets. Thus 26.9 miles of the total 64 mile system are of this character of construction obtainable at an estimated cost of only $32,000 per mile which is approximately 50 per cent of the normal cost of curb setbacks for widening purposes under current conditions.

Elevated limited way construction constitutes 33.6 miles of the total 64 mile system or slightly more than 50 per cent of the total. This construction is estimated at a cost of $525,000 per mile. It should be noted that this elevated street limited way construction is not converted street capacity but is 100 per cent new street capacity and the cost factors should, therefore, be compared not with typical street widening costs but with alternative methods of entirely new street construction through the acquisition of right of way, grading, paving, lighting and the provision of other accessories. The elevated limited way construction proposed for San Francisco does not disturb the continued use of any existing route over which it may be built. Because of this condition it may be considered as entirely new or superimposed traffic capacity.

In considering cost factors, due attention must be paid to the relative capacities provided by widened grade routes or by newly constructed grade routes and by limited way construction. Exhaustive studies of relative discharge capacities of various types of roadway construction lead to the conclusion that unobstructed, free-flowing traffic lanes such as those automatically provided by limited way construction, have a discharge capacity, at speeds of 40 miles per hour or better, of as many as fifteen hundred vehicles per hour. It is believed more conservative, however, to estimate limited way capacity, under normal operating conditions, at 1,200 vehicles per hour. Typical urban grade routes operated under either uncontrolled heavy traffic conditions or under traffic signal control rarely show a discharge capacity in excess of 600 vehicles per lane per hour. Thus, a four lane limited way, that is two lanes in each direction, may be estimated as having a total discharge capacity of 4,800 vehicles per hour or a traffic carrying capacity equivalent to a newly constructed grade route with eight operating lanes.

Fig. 5—Sunrise Highway, Suffolk County, L.I., N.Y. Highway Grade Separation at Deer Park Ave., Babylon.

An examination of traffic volume requirements in the city and county of San Francisco has led to the conclusion that all of the current demands, or those of the reasonably near future, can be accommodated satisfactorily upon four lane limited way construction. There are, indeed, certain portions of the proposed limited way system that could be adequately serviced so far as gross discharge capacity is concerned and, at least, for the present with two lane construction. This, however, is not recommended for two reasons. In the first place, in a two lane divided limited way any vehicle failure would result in a complete blocking of one direction of flow. In the second place, a four lane roadway is the minimum roadway that will provide for the normal functional requirements of traffic flow, as it is the least width of roadway that will provide for a segregation of relatively fast and relatively slow traffic moving in the same direction without an impingement upon the opposed roadway.

With respect to weight capacities, the use of the standard H 10 load factor in design and construction is proposed. The use of the limited way system should be restricted to the vehicles of the private passenger car type or other passenger or commercial vehicles of similar weight and speed characteristics. With this class of traffic the H 10 construction is more than adequate in strength. There has been no failure to give due consideration to trucking and other heavy commercial operations. This type of traffic will benefit directly and materially from limited way construction which will remove from main routes of travel, and related parallel streets, the principal load of present private passenger car and light commercial volume. The segregation of the light, passenger car and commercial operation from trucking and heavy commercial operation is one of the fundamental steps in a complete solution of the problem of traffic accidents and traffic congestion and both classes of traffic will instantly and materially benefit from the separated operating routes.

Upon the major street system of San Francisco, as it exists today, there is daily operated in the twelve-hour day, from 7 a.m. to 7 p.m., a total of 900,000 car miles. the twenty-four hour day shows an average increase of 50 per cent over the twelve-hour day, making a total of 1,350,000 car miles per day. This is exclusive of traffic movements in the triangle bounded by Harrison Street, the Embarcadero, California Street and Van Ness Avenue. There is no way of giving a highly accurate estimate as to what percentage of this total of car miles will be transferred to the limited way routes as proposed in the San Francisco plan. With due elimination of local traffic and heavy commercial traffic, it may be safely computed that the balance of the through movements along the limited way routes will utilize the new structures and that the major proportions of other traffic originating within or destined to points within one-half mile of limited way routes will use those routes. Some proportion of this traffic at present follows existing grade routes parallel to those proposed for limited way construction and may be properly included in an estimate of total limited way utilization. This fact is clearly illustrated in customary practice in the East Bay district where substantial volumes of traffic between Oakland and Berkeley or more remote points follow a longer mileage route over the East Shore highway rather than the shorter mileage although more time-consuming route over existing streets. On the basis of the above considerations, it may be estimated that the comprehensive limited way plan as proposed for San Francisco, when constructed, will carry 670,000 car miles per twenty-four hour day or 49.6 per cent of the present total car mile movements in San Francisco. The traffic not carried will be primarily local in character or that traffic feeding to or being distributed from the limited way system. All of this residual volume of traffic as well as trade and residential locations will be benefited greatly by the transfer of large volume, high speed movements, from grade routes to the limited way system.

The above computations are based exclusively upon a logical conversion of existing traffic from present grade route operation to the higher efficiency limited way operation. It does not attempt to credit to limited way movements future normal increases in traffic volume throughout the community, though these will undoubtedly be substantial and will add materially to the percentage of total car mileage carried by the limited way system.

Now to consider what may be termed "induced traffic." It has been experienced universally throughout the United States that wherever an unsatisfactory traffic facility was replaced with a higher type facility the latter converted traffic volume from the former, and, in addition, generated a substantial volume of entirely new traffic commonly called "induced traffic." This results from the fact that many users of motor vehicles, having found the former low-type facility too inconvenient to warrant use, either did not make the trip between the points connected or used forms of transportation other than automotive.

In no place is the capacity of an improved traffic facility to induce traffic more clearly illustrated than in the case of the San Francisco-Oakland Bay Bridge. An examination of Chapter VII, "Estimate of Vehicular Traffic Available for the Bridge," in a "Report on Estimated Traffic and Earnings, San Francisco-Oakland Bay Bridge," July, 1936, by Coverdale and Colpitts, indicates that in the maximum year, 1930, the transbay ferries carried a total of 4,544,000 automobiles though by the year 1935 the transbay automobile ferry crossings totaled only 3,937,000. If the San Francisco-Oakland Bay bridge traffic were composed exclusively of converted ferry traffic, it is apparent that it could not exceed the total of that traffic. The volume of "induced traffic" on the bridge is indicated by the fact that it is now operating at a rate of approximately 10,000,000 vehicles per annum. Of this present total, 5,500,000 must be considered as entirely new or induced automobile traffic. In other words, the superior facilities provided by the bridge structure converted almost 100 per cent of the ferry traffic into bridge traffic and, in addition, created or induced a new volume of traffic equal to more than 100 per cent of the converted traffic. It is impossible to project a confident estimate of the amount of traffic by automobile not now existing, which would be induced by the limited way system. It would unquestionably be large and, in considering the relative facility provided, might readily equal the "induced traffic" performance of the San Francisco-Oakland Bay bridge. Automotive traffic has everywhere shown a startling vitality wherever obstructions to its free use have been removed. Large portions of the population in all cities have demonstrated their eagerness, and their economic ability, to provide their own private means of transportation and at their own cost wherever reasonably efficient facilities have been afforded. Naturally, any traffic volume induced by the limited way system would add to its relative importance as a carrier of the total car mileage of the community.

Comprehensive studies of speed and obstruction in current traffic involving more than 2,200 miles of test observations show that the average overall speed of vehicular traffic, during off-peak hours, is at present 17.35 miles per hour. The limited way structures proposed for San Francisco should be designed for safe operating speeds of 60 miles per hour, with the exception of those locations, comparatively few in number, where existing physical conditions or necessary connections require a type of construction placing a limitation upon maximum speeds. It is not recommended that traffic be permitted or required to operate at the full designed speed capacity as there should be a reasonable factor of safety. It is proposed, therefore, that a fixed speed, both minimum and maximum, be set for normal operating sections at 45 miles per hour. Vehicles incapable, or drivers unwilling to operate at this speed should not be permitted the use of the limited way facilities. Designated speeds of less than 45 miles per hour should be indicated for the comparatively few and short sections of the system where conditions of safety require lesser speeds. The 45 mile per hour operating speed will deliver an overall operating average speed of 40 miles per hour which is more than a 100 per cent increase over existing average experience. In terms of time, for the entire limited way system, and with an estimated daily volume of 670,000 car miles, this will result in a daily saving of 21,860 car hours, or on an annual basis in a saving of 7,978,900 car hours. There is here an interesting analogy. The San Francisco-Oakland Bay bridge is at present operating at the rate of 10,000,000 vehicles per year with an estimated saving of 26.4 minutes per trip, or, on an annual basis, in a saving of 4,400,000 car hours. Considering the investment of $77,000,000 in the bridge structure, which motorists have so generously indicated their willingness to repay, and considering the estimated cost of a comprehensive limited way system at $26,000,000, economic conclusions are obvious. Over and above all of these considerations, however, must be the recognition that even the present low facility of movement over grade streets is bought at a tremendous sacrifice in safety.

The prime consideration in any public improvement is that of the preservation of life and limb. Important as economic considerations may be, they become negligible in comparison with humanitarian considerations.

It might be possible, through elaborate and costly methods of education, enforcement and control, to bring some further reduction in the rate of traffic accidents and fatalities in San Francisco. It is to be doubted, however, in the light of experience in San Francisco and other American cities, if any of these remedies can materially affect the problem. Such gains as may be achieved can scarcely be other than at the cost of a further retardation in facility of movement.

Accidents and congestion arise from identical casual friction in traffic movement. Roadway design which eliminates the causes of congestion automatically eliminates the causes of accidents. An analysis of traffic accidents and fatalities clearly supports the conclusion that limited way construction would largely eliminate the present causes of accidents.

For that portion of the total major city traffic flow, or approximately 50 per cent of the whole, there would be no pedestrian accidents or fatalities as the limited ways are reserved exclusively for vehicular traffic and pedestrians have no reasonable access to the structures. (This statement does not apply completely to routes given limited way treatment at grade, to which pedestrians will still have access, though under protected conditions.) Of the total persons annually killed in San Francisco traffic accidents, 71 per cent are pedestrians struck by vehicles.

Turning now to personal injury accidents, including fatalities, current records show 71.5 per cent take place at intersections. As there are no intersections on any limited way route, this great group of accidents disappears insofar as the movements of traffic upon limited way structures are concerned. In addition to the elimination of intersectional accidents, however, it is apparent that no head on collisions would be possible as vehicles moving in opposite directions are physically separated. There could be no collisions with parked vehicles, persons, or fixed obstructions along the margin of the roadway, and the only classification of accidents of which any trace of cause remains is the so-called rear end collision. This type of accident would be eliminated almost entirely because of the free flowing character of the operating lanes, the provision of retarding and accelerating lanes, the segregation of relatively fast and relatively slow vehicles, the elimination of street cars and heavy commercial vehicles from the limited way routes and the resultant possibility of establishing a uniform rate of operation. These conclusions are fully verified by the almost perfect safety record of the Holland tunnel and the elevated Westside highway in New York City.

It seems probable that all or a substantial part of the proposed limited way system will be constructed in San Francisco. If it is, San Francisco can have a permanent congestion and accident solution for the major part of its traffic problem in the very near future, and at a cost of $26,000,000. As a pure matter of dollars and cents, let us see what will happen if the limited way plan is not executed. At the present time, San Francisco is spending approximately $2,000,000 per year in street widenings and related grade street improvements in an attempt to gain added traffic capacity and safety. Even though there be no increases in these expenditures in the future, at the end of twenty-five years San Francisco will have expended $50,000,000 and will have to show for it a street system which, with all of the possible improvements, will be inherently congested and hazardous. In limited way construction there are related economies over and above those involved in the capital expenditures for the structures themselves. A comprehensive system converts all existing streets into district routes largely of the feeder or access type and thereby eliminates the necessity for further costly improvements upon such streets and should indeed materially reduce current maintenance costs.

Even though the problem of urban accidents were considered unimportant and even though anyone were bold enough to believe that American cities can continue to carry the burden of increasing street congestion, it would appear that the mere consideration of dollars and cents would lead inevitably to the adoption of more economic and efficient planning and designing of traffic facilities.

It is the speaker's firm belief that in America we have never had a real opportunity to understand or appreciate the benefits of an automotive age. Automotive transportation in all of its forms has such a tremendous vitality that wherever it is permitted to operate with reasonable safety and decent convenience it has demonstrated enormous capacity for growth. Those of us who hold this firm belief can afford to be bold.

Note.—For Fig. 2 we are indebted to the New Jersey State Highway Department, and for Figs. 1, 4 and 5 to the Portland Cement Association, New York, N.Y.

Engineering the Highways for Safety

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SUMMARY.—A brief discussion of the principal factors of highway design and construction which make for the safety of motor traffic.

No matter what engineers do to make the highways safe, by adopting the features of highway design and construction that contribute to the security of motor traffic, the final factor of safety rests with the driver of the motor vehicle. A road can be well designed for safety and volume, and yet can be made a veritable death trap by the reckless or careless driver. After studying data on the causes of accidents it becomes evident that in the final analysis the underlying cause of most accidents is not to be found in the design of the road or car, but in the incompetence of the driver.

Roads designed a few years ago for the lower speed limits then in force, are not now safe in all of their essentials for the present day limits. That is why roads which are but a few years old are so liberally sprinkled with caution signs. If the driver watches these signs and is guided by them, his trip will be safe, but if he chooses to ignore them, tragic fate surely awaits him not far away.

The design of highways is a new science, and, due to the extremely rapid increase in the number of cars and consequent demand for new roads, the engineer has had but little opportunity to develop designs that did not follow the cut and dried methods of the horse and buggy days. During the years of the depression, while road building was drastically restricted, engineers had time to think, and the results of that thinking are now becoming apparent in the new developments that are taking place. The new designs that are appearing stress three factors, namely, capacity, free movement, and last, but not the least important, safety.

Capacity and free movement play an important part in the safeness of our roads. Roads that are congested and with limited free movement tend to cause accidents through the lack of patience displayed by many of our drivers. Capacity and free movement are obtained in our modern roads by correct design of alignment, grades and widths.

The first element to be considered in design is, of course, alignment, and under present day conditions, curves are eliminated in so far as possible, but where necessary, designed with a radius of not less than 1,400 ft., and with sufficient tangent distance between the end of one curve and beginning of the next to permit of easy passing by fast moving vehicles. To obtain this condition it has been found necessary to construct long diversions, and in many cases to completely abandon existing routes. In Ontario new routes are being constructed between Gananoque and Brockville, and between Burlington and Niagara Falls, largely because the curvature on the existing routes made it impossible to rebuild them without almost completely destroying the present surface. There are other reasons for these relocations but a discussion of them has no place in a paper of this nature.

The spiralling of curves has become standard practice as it tends to easier and safer driving. All curves of 3 deg. and over should be banked to a fixed formula. It appears that the practice followed in Ontario is quite satisfactory, which is as follows:—

> "Super-elevation to be 4 in. per deg. of curve to a maximum of 30 in. starting at the beginning of spiral and increasing at the rate of one inch per 10 ft. reaching the maximum at the beginning of circular curve."

Vertical and horizontal sight distances are being steadily increased to provide a minimum clear view of 1,000 ft. Dead spots, due to dips in the grade line should be avoided by the use of long sweeping grade lines. On a first class road the maximum permissible grade should not be over 4 deg. This requirement is, of course, subject to drastic revision upward if the country is difficult.

Drainage has always been a serious consideration in road building, and the highway engineer has, for many years, followed the practice of the railroad engineer and established deep ditches just outside the travelled way. This practice leads to many serious accidents and the modern highway cross sections have eliminated these ditches almost entirely as is well illustrated in Fig. 1.

Fig. 1—Dual Highway—Toronto to Hamilton.

Fig. 2—Dual Highway—Toronto to Hamilton.

Subgrade drainage is provided where necessary by the installation of field tile in the shoulders outside of the pavement line.

Shoulders along pavements are now recognized as a very important factor from the safety standpoint, and have been steadily increasing in width until now it is conceded that a less width than ten feet is not desirable.

On our modern cross sections it is difficult to tell where the shoulders stop and the side ditch begins. On the more densely travelled roads the earth shoulder is being gradually hard surfaced for a width of three to ten feet from the edge of the pavement, materially adding to the safety of the road.

In the past there seems to have been an intense desire on the part of road officials to economize on the width of bridges. It is now recognized that the above ground part of these structures forms a serious menace to passing traffic and we now find that our bridges are being built to a width considerably greater than that of the adjacent pavement. Culverts are gradually disappearing from sight by the elimination of dangerous head walls. Head walls were never necessary, and the culvert, as now constructed, is simply extended to a length that takes it beyond the toes of the road fills.

Due to the increasing number of accidents at railway crossings a good deal of study is being devoted to their elimination, either by subways or overheads, or by diversions of roadways. On more lightly travelled roads, or on sections where it is not possible to otherwise eliminate the railway crossings, we find it advisable to install the standard type of bell and wig-wag warning. The design of subways and overheads has been discussed many times, and needs no elaboration here. By a careful study of routes, it is often possible to completely eliminate railway crossings from our trunk routes by means of a diversion which, upon final analysis, will be found cheaper to construct than the structures that would have been necessary on the original route.

Road intersections are danger points which require careful consideration in preparing road designs. Ontario has recognized this danger and, at the present time, is constructing grade separations. Two of these are in operation and are giving excellent service, and several others will be completed early next year. The large expenditure necessary to construct grade separations can, of course, only be justified by dense traffic. A simpler, less expensive, and yet a very satisfactory arrangement at busy intersections can be provided by the traffic circle. The diameter of the circle is very important, as too small a diameter results in congestion. The general rule to be followed is that there must be room to permit the sorting of traffic between the intersecting roads and it is felt that a diameter of less than 300 ft. can not be satisfactory. The success of a

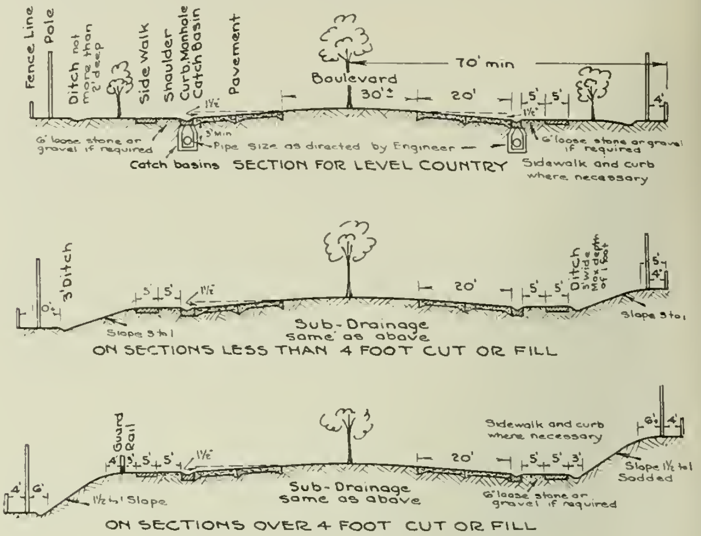

Fig. 3—Four Lane Construction.

circle or oblong island also depends on careful direction signing. In the United States, it has been found that circles otherwise well built were poorly signed with the result that considerable confusion developed.

The three-lane highway is used to a considerable extent, but from a safety standpoint is not desirable. When using the three-lane type—financial considerations force its use at times—it is desirable to add another lane on hill crests. The four- and six-lane highways have had such a disastrous record from an accident standpoint on high speed roads that they are being given but little consideration in the plans of the various Highway Departments. Every road authority is now either studying or actually constructing a new type of road, which is commonly called the "dual highway."

The dual highway can be compared to a double-track railroad and follows, of course, the same principle that

Fig. 4—Cloverleaf on the new Dual Highway between Toronto and Hamilton, underpassing King's Highway No. 10, Brampton to Owen Sound.

opposing traffic is separated. The separation of traffic may be by a narrow curb or by a grass plot of varying widths. The narrow curb is effective in that it separates traffic, but is not satisfactory for night driving, nor does it provide a solution of the difficulties of a car that wishes to make a left turn. It has been well established that 30 ft. is the narrowest width of centre strip that at least partially solves the question of night driving as well as solving the problem of the left turn. A dual highway with a 30 ft. boulevard is quite easy to drive at night, but if property damages are not too heavy, a greater width is desirable. The 30 ft. boulevard does solve the problem of the left hand turn except for probably the largest trucks. The percentage of this type of trucks is so small that they do not need to be given much consideration by the designing engineer. Cross-overs through the centre boulevard should be limited to cross-roads, with others at such intermediate points that the general spacing will average up at about fifteen hundred feet. The type of planting to be used in the central boulevard is of vital importance and if snow conditions will permit it should be continuous so as to effectively bar head-light glare from the cars on the opposite lane. Before leaving this particular subject, it may be pointed out that Ontario has approximately one hundred and twenty miles of dual highway either completed or under construction.

Too often the road authorities forget the pedestrian, and, in consequence, the death toll from cars striking pedestrians is appalling. In preparing any road design, provision should be made on the right-of-way for side-walks, and the necessary grading should be done at the time of the original construction. The correct location of side-walks with reference to the pavement in rural districts is, as yet, a controversial subject. Some engineers contend that it should be near enough to the pavement so that it would be illuminated by passing cars. Others contend that this location is dangerous, and that the side-walk should be placed at the outer limits of the right-of-way.

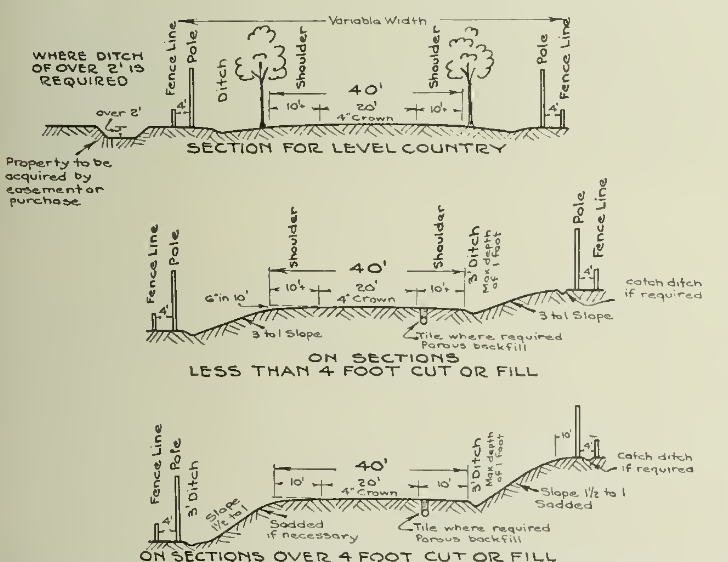

Fig. 5—Class A Earth Grading. (Note—For fills over 4 ft. in height, the width to be increased 1 ft. for every 3 ft. rise, maximum extra width not to exceed 10 ft.)

The author is inclined to agree with the latter contention. Pedestrian under-passes are of great value, particularly where there is concentrated foot traffic, such as at schools or at roads leading to play-grounds. The under-pass should be thoroughly lighted and provided with winter doors at the exits in order to eliminate snow difficulties in the winter time. Ontario has a few of these under-passes in operation opposite schools, and it is found that with the co-operation of the school principal the children use these passes faithfully.

The road surface has given the engineer great concern due to the increasing number of accidents from slippery pavements. In the case of concrete pavement the anti-skid properties have been very materially increased by a final brooming of the surface, which has not reduced the riding quality. In the case of asphalt pavements anti-skid surfaces have been developed to a point that is almost entirely satisfactory. This has been achieved by constructing a fairly open surface with asphaltic concrete containing a large percentage of very hard rock. Older asphalt or tar surfaces have had their anti-skid properties immeasurably improved by reducing the amount of bitumen used in the treatment, together with a drastic increase in the amount of stone cover.

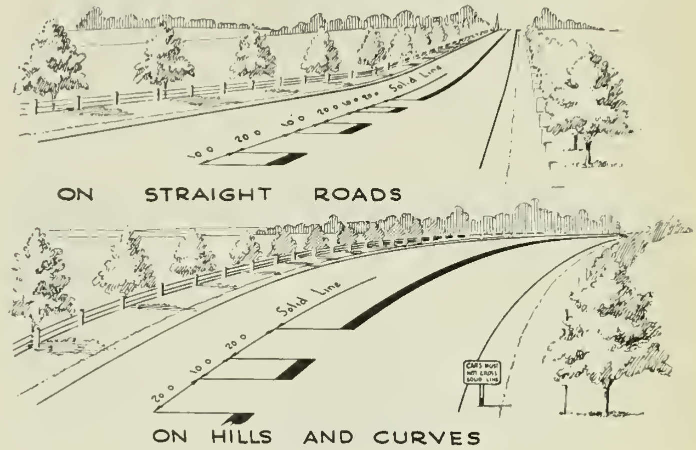

Fig. 6—Zone Painting.

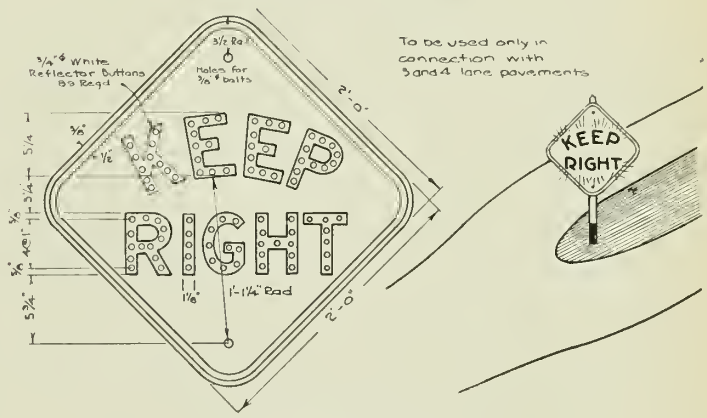

Fig. 7—Standard Sign.

The time is not far distant when our main highways will be fully lighted, so that night driving will no longer be a nightmare. At the present time Ontario is experimenting on a fairly large scale with both the incandescent and sodium type of lighting. These experiments have not proceeded sufficiently far for a definite expression of opinion as to which system will eventually be adopted.

There are just two things that an engineer does for the motor car operator: the first is to provide a safe and comfortable road surface; the second to direct the motorist safely to his destination by means of warning and direction signs. Discussing the latter feature for a few moments, it may be said that generally speaking road signs fall naturally into the following classifications: prohibitory, warning, and direction. The first class is well illustrated by the all too prevalent "Stop" sign. Personally the

Note—Figs. 5, 6, 7 refer to the standards of the Ontario Dept. of Highways.

author believes that the erection of "Stop" signs is very much over-done, and that, instead, a sign of cautionary nature would, in many cases, serve the purpose and not interrupt the steady flow of traffic as does the "Stop" sign. At several rather busy intersections within the author's knowledge fifteen mile per hour signs have been used to replace "Stop" signs with excellent results. The tendency of the motorist on the through highway is to

Fig. 8—Dual Highway—Toronto to Hamilton.

ignore the driver attempting to enter from side streets, whereas it is set forth very definitely in most Highway Traffic Acts that once the motorist on the side street has come to a full stop, the rule of the road applies. It is understood that Milwaukee has removed the "Stop' signs on one of their arterial highways with the result of a large reduction in the number of fatal accidents. Warning signs are of many types and character, but possibly the most successful one of this type is the one outlined in reflector buttons. This type of sign not only warns the driver well in advance, day and night, but indicates exactly what to expect, which is the function of a perfect sign. Warning signs of an indefinite nature are to be avoided, as they lead to congestion and confusion. Directional signs would seem hardly to have a place in a paper written around safety features, but many collisions and accidents are caused by strangers trying to find their way through areas of congested traffic. Direction signs are a study in themselves; the underlying principle is that there should be an advance warning, a definite direction sign at the point of change of direction, and finally a re-assurance sign after the turn has been made. If these simple directions are followed, no difficulty will be found in signing the most difficult intersection. One of the most effective methods of signing now in use is provided by the zone strip, which is painted on a "hit-and-miss" system where overtaking and passing is permitted. On hill crests, curves, and other points where overtaking and passing is not desirable, the zone strip is painted solid and signs erected at the ends of the solid line prohibiting crossing of the white line. Just recently a new sign has been introduced in the form of "road-bugs," which are used to mark the centre line of the road. These road-bugs consist of a cast iron frame in which is mounted reflector buttons. The cast iron frame is fastened to the concrete or asphalt pavement by means of expansion bolts, and can be removed for the winter months. Traffic lights are being used to a limited extent on highways in Ontario. All of the installations that are being made now are traffic operated, as the fixed time type of lights is found to be a hindrance rather than a help to traffic. A timely word of caution in regard to signing is given by Stanley Gale in a late issue of "Highways and Bridges," in which he says:—

> "As a means of improving traffic conditions and reducing accidents, traffic signs through indiscriminate and excessive use have defeated their object. Much more practical and bolder methods will have to be devised to make the highways adequate and safer to the needs of the increasing traffic volume."

In conclusion, it should be realized that while highway engineers seek safety on our roads, today as in the past, rapidly changing conditions as to speed and density of traffic make the problem an extremely difficult one. It is only necessary to pick up the daily papers and scan their records of the death and disaster that overtake our car drivers every day, to realize that the task set for the engineer is one of no mean proportions.

Canadian Steam-Electric Power Plants

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Paper presented at the Annual Meeting of The Institute in London, Ont., February 2nd, 1938.

SUMMARY.—This paper deals with the development and performance of Canadian power plants, with particular reference to the performance of steam stations, outlines developments in recent years and offers a comparison of the practice in Canada with that in other countries.

Steam central stations in Canada have not received the serious consideration which their possibilities would warrant, the popular imagination having been impressed by the abundance of presumably inexpensive water power. The purpose of this paper is to exemplify the possibilities of fuel driven stations in Canada, not only in areas where fuel is readily available, but also, it may be, at points to which fuel has to be brought.

In 1934 Canada led the world with an average of 1,950 kw.h. per capita as compared with 670 in the United States and 462 in the United Kingdom (excluding North Ireland).[1]* In 1935 the total energy generated in all stations was 23,283,033,000 kw.h. The revenue from sale of electric energy was $127,177,954 or 0.546 cents per kw.h. The average kw.h. per kva. of capacity was 3,858. This value shows a large variation between provinces. Quebec, 4,213, maximum; Prince Edward Island, 1,030 minimum; Saskatchewan, 1,184; Alberta, 1,685. This may be compared with 3,500 kw.h. per 1 kw. in the United States[2] for 1937. Total hydraulic stations had an output per kva. of 3,956 kw.h. and total fuel stations only 1,334 kw.h., showing that the hydraulic stations operate at a much higher plant capacity factor.†

The average cost per kw.h. for domestic service shows a wide variation from the national average of 2.08 cents; Prince Edward Island, 7.82, maximum; Manitoba, 1.01, minimum; Ontario, 1.68; Quebec, 3.22.

The total output of Canadian central stations has increased by 114.6 per cent during the past decade.

1. Steam Station Performance

The thermal performance of modern steam power stations was discussed[3] in 1929 and may be expressed as the annual average station performance (net output) in B.t.u. per kw.h. It will be convenient, for comparing the performance of Canadian stations with those of other countries, to adopt a station heat rate for standard plant represented by the formula:—

$$\text{B.t.u. per kw.h.} = 13{,}600 + \frac{100{,}000}{\text{Annual load factor (in per cent)}}$$

This has been represented by the curve shown in Fig. 1, which will serve as a basis of reference. The performance of Canadian and American stations, plotted in Fig. 1, may be identified from the details given in Table I. Two of the latter, Lauderdale and Trinidad, have maximum loads of 50,000 kw. and 86,000 kw. Trinidad burns high moisture Texas lignite in pulverized form. This interesting station has been described.[6] Stations in Great Britain[4] having a maximum net load of under 50,000 kw. have been selected for comparison and are plotted in Fig. 1. The three South African stations,[5] also shown, have the following maximum loads, one-half hour: Natal Central, 24,240 kw.; Durban, 33,000 kw.; Witbank, 89,954 kw.; and annual average load factors of 50.3, 41.7 and 77.3 per cent respectively. Canadian stations, plotted in Fig. 1, do not occupy a favourable position on the basis of thermal efficiency. Performance data of typical Canadian power stations and some American stations of comparable size are given in Table I (see Appendix).

†See Appendix, Table I.

*References to the bibliography at the end of the paper are indicated by superscript numbers thus [1].

Developments of the past twenty years have been reflected in the improvement of the station performance. Some American stations of 60,000 kw. and higher, placed in service in 1915, required 20,000 B.t.u. per kw.h.; stations of 1925 required 15,000; and an 80,000 kw. station placed in service in 1935 has achieved a record of 11,166[7] B.t.u. per kw.h. for the first six months of operation. One station, placed in service in 1920, which required 20,000 B.t.u. per kw.h. for the first year of operation, had reduced this figure to 13,300 by 1932.

Of the large stations in Great Britain, Battersea[4] (L.P.C.L.) had the highest thermal efficiency in 1936 and a performance of 12,350 B.t.u. per kw.h. Certain Canadian stations[8] have shown improvement in their thermal performance in recent years, notably since 1930. The percentages of auxiliary power and feedwater make-up have been reduced. Higher pressures have been adopted. In certain stations superposed turbines have been installed from which the exhaust is discharged to the low pressure steam mains of old plant, through any or all of the old low pressure turbines and their respective condensers. New high pressure steam-generating plant is required and the arrangement has the advantages of providing increased output and of approximating the performance of high pressure plant of equivalent capacity. Larger turbines have warranted two, and, where fuel cost is high, three extraction heaters. In certain cases heat recovery devices have been used in the turbine heat balance to heat the feedwater. In many cases the practice of providing heat exchangers to recover the waste heat from the generator air-cooler, bearing oil-cooler, steam-jet vacuum pumps and heater drips has not been adopted nor have its possibilities,

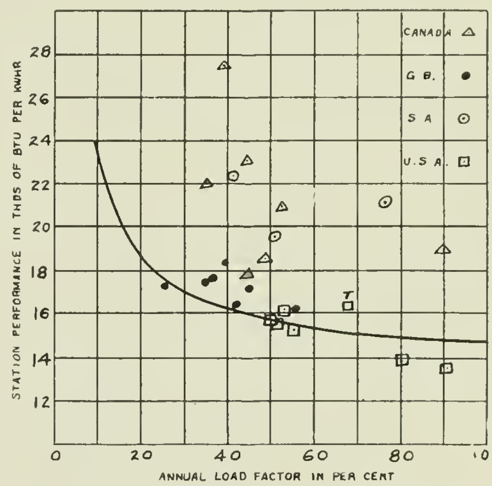

Fig. 1—Thermal Performance of Central Stations in Canada, Great Britain, South Africa and the United States of America.

maybe, been fully appreciated. Feedwater temperatures tend to fall below the standard set up by Reynolds[9] in 1929. Since the feedwater temperature is determined by the extraction point of the final feedwater extraction heater, the choice must be made at the time of purchasing the turbine. In regard to the above devices for recovering waste heat, however, it is possible, in certain cases, to substitute the condensate for the raw water formerly served to the bearing oil-cooler and other devices. In this way the temperature of the condensate can be served to the first extraction heater at a temperature of about 100 deg. F. In the case of new turbines the practice of providing sufficient capacity in the generator air-cooler to permit complete heat recovery by the condensate has the advantage that, in an emergency, a slightly higher capacity can be obtained from the generator by by-passing the condensate and serving cold water to the air-cooler. The regenerative cycle was used on turbines on this continent about 1922 and its possibilities have been discussed.[10] With the adoption of higher pressures and temperatures, turbine and plant heat rates obtainable in large modern power plants have been compared over a wide range of the pressure-temperature cycle realm.[11]

Power development in Canada has been rapid. New thermal plants will be built and new equipment added to present plants. Station performance may be expected to show notable improvement. Larger fractions of the stations will operate at higher pressures and temperatures as units under construction are placed in service and old plant is modernized by the installation of superposed turbine units and interposed feedwater heaters. Obsolete turbine heat balance arrangements will be remodelled by converting present heat exchangers to serve as heat recovery devices.

Interconnection and interchange of power between thermal and hydro systems will tend to reduce the reserve capacity presently required and the capacity of spinning reserves which are expedient in certain cases. It may be that the difference in performance of the large American and British stations can be accounted for by the urgency of interconnecting the various British systems which has tended to divert attention from possible improvements in individual stations. Interconnected steam stations may be operated on base load and it is usual for the most efficient stations to carry a larger fraction of the load.

The size of stations will increase with normal growth of load and comprehensive studies will be required to insure the best possible engineering design and construction of new plant. Before starting construction of a recently built station, over 150 studies on important subjects were made

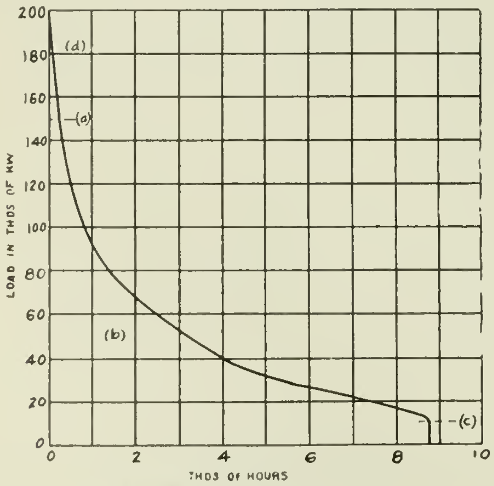

Fig. 2 Load Duration Curve.

on the basis of pure economics in order to assure the designers that they were not being blinded by prejudice in making their decisions. Comparisons were based upon fuel cost per hundred million B.t.u. and fixed charges of 13 per cent.

With the growing importance of this field, periodic interchange and publication of significant engineering data and round-table discussion of operating difficulties by station executives may be expected.

2. Cost of Power

The cost of generating steam power is vital in any proposals for interconnection of power systems and interchange of power. The effect of the annual load factor on the cost of generating steam power is not always well understood and there is often a lack of uniformity of practice in regard to fixed charges. The cost of steam power includes items for fuel, maintenance, operating labour and fixed charges. The trends of these separate items of cost and of total cost have been discussed.[12]

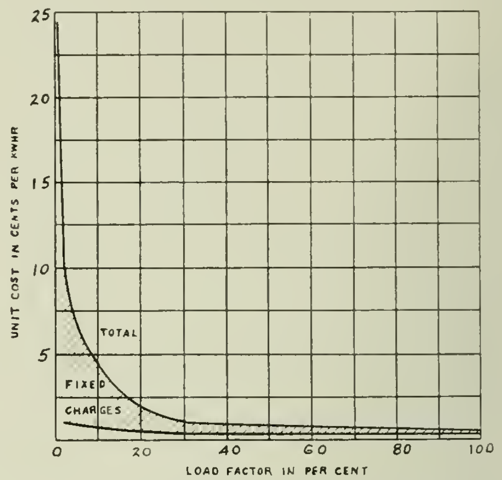

Fig. 3—Relation of the Annual Load Factor to the Unit Cost of Steam Power.

The relation of fuel cost and fixed charges to total cost may be seen from an example for which the load duration curve is given in Fig. 2. It is proposed to consider the cost of generating certain parts of the total load: (*a*) the top 25 per cent of the load; (*b*) the bottom 75 per cent; (*c*) full base load; (*d*) the upper 10 per cent. Plant cost may be taken at $100 per kw. Coal having a heating value of 13,500 B.t.u. per lb. costs $5 per ton. Fourteen per cent of the capital cost is provided to cover fixed charges. The station performance in B.t.u. per kw.h. may be calculated from the formula already discussed and the fuel cost per kw.h. determined. The peaks (*d*) and (*a*) are considered as on demand for two and three months of the year respectively. Labour and maintenance are functions of the total fuel consumed. The unit cost for energy for each case is shown in Table II (see Appendix) and Fig. 3.

It will be seen that at low load factors the burden of expense rests with the fixed charges.

Steam station investment and operating costs have been discussed.[13] Stations to produce a kw.h. for 12,000 to 13,000 B.t.u. have been built for the same price—including the cost of special engineering studies and in the design and manufacture of special equipment—as those built a decade ago, to operate at 15,000 to 20,000 B.t.u. per kw.h. New developments in the art and changed price levels have made this possible. Many of the older stations were designed for load factors not realized at present. In a representative group of modern stations, about 60 per cent of the total cost of power is in the fixed charges, and fuel alone represents about 27 per cent. Developments favourable to improvement in the performance of stations of moderate size are the improved performance of high heat-drop, high speed turbines, and improved generator efficiency in high speed units through the use of hydrogen as the cooling medium. High pressure non-condensing turbines, when used as superposed units, serve to bring usable low pressure condensing turbine equipment back into service as modern plant and give added capacity at a low investment cost. An industrial plant or group of plants, requiring steam at a moderate pressure for processing and heating, is enabled to produce power at a cost which is not available to the large stations which have to absorb the heat loss which characterizes condensing plant. A 3,500 kw., 3,600 r.p.m. turbine, operating at a throttle pressure of 430 lb. per sq. in. gauge and 750 deg. F., exhausting at 100 lb. per sq. in. gauge, in conjunction with steam-generating plant having an efficiency of 80 per cent, will produce a kw.h. at the switchboard for about 5,000 B.t.u. at the coal pile. The illustration is indicative of the saving which may be effected by superposition of high pressure units exhausting into the low pressure mains of obsolete plant.

3. Interconnection of Power Plants

Interconnection of power plants and interchange of power are notable developments in Canada, Great Britain and the United States. The history of water-power development in Canada[14] is a record of interconnection and interchange. The total turbine installation has increased from 173,323 hp. in 1900 to 7,945,590 hp. at the end of 1936. Development of the British grid system[15] has been described. A total of 539 separate systems were giving supplies in Great Britain in 1925, each relying entirely on their own individual stations. By a policy of concentrating the production of electricity in the more efficient stations, and interconnection of over 150 generating stations, it has been possible to reduce the annual fuel consumption over the old system by 2 million tons[16]—equivalent to 9 million dollars.

It is significant that, by 1934, over one-half of the total output was generated in 25 of the more efficient stations and nearly one-quarter more in 28 other stations. Thus, one-fifth of the stations accounts for three-quarters of the total output.[18] Total costs of energy sent out on local distribution systems[15] show provisional values for 1935-36 of 41.3 per cent for fixed charges and 30.9 per cent for fuel. It is stated that since 1914 the price of electricity in Great Britain has fallen more than in any other country.[17]

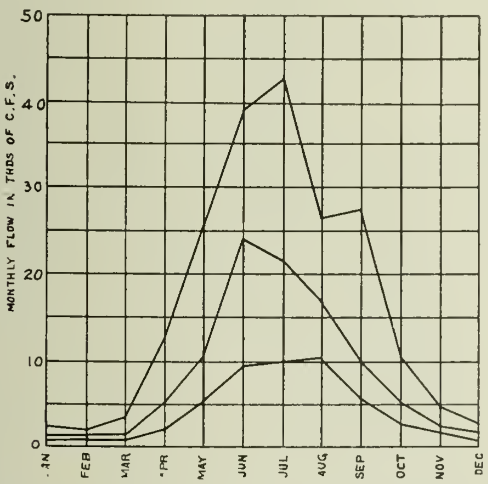

Fig. 4—Monthly Mean, Maximum and Minimum Flow of the North Saskatchewan River at Edmonton for the Years 1911-12 to 1934-35.

The output of electricity by the supply industry to March 31st, 1937, has shown an average rate of growth[19] of 16.7 per cent per annum on the figures for 1932-33.

Interconnection offers certain possibilities particularly favourable to steam-generating stations. The more efficient stations may expect improved annual load factors and, as smaller reserves are required, improved annual use or capacity factors. Reduction in the spinning reserves leads to improved station performance. Location of steam stations at strategic points where fuel is abundant, and where concentration of load is good, effects a saving by reducing transmission losses and may eliminate the expense involved in duplication of long transmission lines. New plant, to operate at high load factor, may be constructed as a one-turbine, one-boiler station.

It has been stated[20] that engineers no longer consider hydro and steam power as competitors but rather as complementary sources of power. Each should be developed as component parts of a system to the extent that such

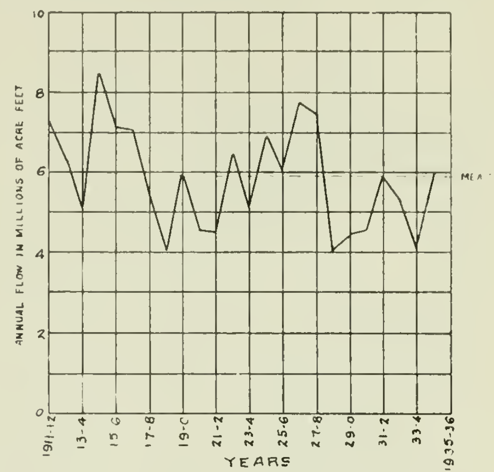

Fig. 5—Annual Flow of the North Saskatchewan River at Edmonton.

additions would result in lower total system costs for a given output.

Rivers which have their source in the mountains, as in Western Canada, present certain difficulties for normal hydro development. Flood conditions tend to prevail in spring, and normal full flow in summer when the electrical load is light. The normal run-off is small in winter when the load is heavy. Moreover, the monthly flow shows a wide variation from year to year. The monthly mean, maximum and minimum flow of the North Saskatchewan river at Edmonton is shown in Fig. 4 for the years 1911-12 to 1934-35, and the annual flow in Fig. 5.

When the added cost for summer storage of water in mountain lakes to care for the winter deficiency in run-off is excessive, periods of low flow may be taken care of by auxiliary steam plants. The total installed capacity of fuel-electric stations in Canada, operated as auxiliary to hydro, was 206,831 hp. in 1935,[14] of which steam turbines accounted for 178,453 hp. and oil and gas engines 9,069 hp.

4. Steam Power Plants

In 1935, there were 566 electric generating stations in Canada,[1] of which 397 were commercial stations and 169 were municipal stations. The former number is made up of 213 hydraulic and 184 fuel stations, the latter 103 hydraulic and 66 fuel stations. The total capital invested was $1,459,821,168 Revenue from the sale of electric energy was $127,117,954 including $79,341,554 for commercial stations and $47,836,400 for municipal stations. Taxes accounted for 9.45 per cent of the total expenses for all stations as compared with 8.02 in 1931; 20.7 per cent of the total expenses for commercial stations as compared with 16.5 in 1931; and 1.12 per cent of the total expenses for municipal stations as compared with 1.53 in 1931. The total number of persons employed was 15,342.

New plant has been installed recently or is under construction in public utility and industrial stations. The largest steam turbine in Canada was put in operation during 1937, replacing a 5,000 kw. low pressure unit at the Ford plant,[21] Windsor, Ontario. The unit has a capacity of 20,000 kw. This turbine, and a 5,000 kw. superposed turbine, are served with steam at 800 lb. per sq. in., 800 deg. F., by two new steam-generating units. At Glace Bay, a 7,500 kw., 3,600 r.p.m. superposed turbine to operate at 440 lb. per sq. in., 740 deg. F., and two steam-generating units having a capacity of 185,000 lb. per hr. each are in operation as No. 3* plant of the Dominion Steel and Coal Corp. At the Regina† station,[22] new steam-generating plant, capacity 150,000 lb. per hr., at 450

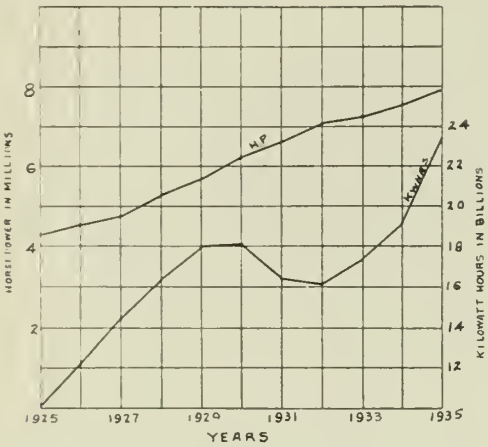

Fig. 6—Installed Hydraulic Horse Power and Energy Generated in Central Electric Stations 1925-1935.

lb. per sq. in., 825 deg. F., was installed and in operation in 1937. A new 15,000 kw., 3,600 r.p.m., turbine, to operate at 400 lb. per sq. in., 800 deg. F., vacuum 29 in., is under construction.

A 15,000 kw., 3,600 r.p.m. turbine, 375 lb. per sq. in., 750 deg. F., vacuum 29 in., and a steam-generating unit having a capacity of 155,000 lb. per hr., are under construction for Edmonton. In 1936, at the Grand Lake Station, a 6,250 kw., 3,600 r.p.m. turbine, 410 lb. per sq. in., 650 deg. F., vacuum 28.35 in., and steam-generating plant having a capacity of 100,000 lb. per hr., were placed in service.

The new steam-generating unit of the Bathurst Power and Paper Co., Bathurst, N.B., designed for 110,000 lb. per hr., 650 lb. per sq. in., 725 deg. F., is the first modern high capacity, high pressure unit in the Canadian paper industry. Power is produced and the back pressure steam is used for process work.

A record, maybe, for the engineering and construction, in a six months winter period, of a steam-generating plant to provide 300,000 lb. of steam per hr., on the site from which the old building and equipment required to be demolished, was accomplished by the Ontario Paper Co. at Thorold,[24] Ontario, in 1935-36. The installation replaced electric boilers installed in 1933 to utilize excess hydro power. Steam conditions were 450 lb. per sq. in. and 680 deg. F. Two 5,000 kw., 5,000 r.p.m, geared turbines, were installed[25] later to operate at 420 lb. per sq. in., 670 deg. F. Steam for process work is extracted at 125 lb. per sq. in., 40 per cent of the total steam being extracted at full load. The balance is exhausted at 30 lb. per sq. in.

A small plant was constructed at Picture Butte in 1936, consisting of a 1,250 kw. turbine,[26] 250 lb. per sq. in., 510 deg. F., and steam-generating plant[8] to provide 60,000 lb. per hr.

Seaboard‡ Power Plant,[27] and Harrison Lake Plant,[28] were completed in 1930 and 1931 respectively. Both burn high ash refuse coal in pulverized form.

*See Fig. 8 for details.
†See Appendix, Table III for details.
‡See Appendix, Table I.

Economic Factors

The output of Canadian Central Stations has resumed the upward trend of the 1926-29 period. The relation of installed hydraulic horsepower and energy generated in central electric stations[29] is shown in Fig. 6. The energy, in kw.h., is increasing in relation to the installed capacity.

General problems connected with the future growth of power load, and means for meeting such an increase, have been discussed,[30] and a steam station cost survey has been presented.[13] With the return to normal prosperity and the resumption of load growth, American manufacturers of steam power plant equipment are busy.[2] British manufacturers are offering later delivery dates than formerly, due, maybe, to preoccupation with extensions to the larger, more efficient stations which serve the "Grid" and the rapidly increasing penetration of electricity in Great Britain. The indications are that a substantial increase in generating capacity must shortly be provided in Canada by utilities and industries with small spare capacity, and that this new capacity must be installed at low cost and designed to give the greatest possible return per dollar invested.

The consumption of electricity for lighting and domestic services in Canada is about normal for this continent; however, the enormous consumption for industrial purposes is influenced by its large pulp and paper industries.[31] These industries require steam at moderate pressure for process work as well as power. Recent construction includes modern high-pressure, high temperature steam power stations at Thorold, Ontario; Baie Comeau, Quebec; Bathurst, N.B., and Liverpool, N.S.

The expensive pioneer work in high pressure, high temperature equipment has been done. Engineers have succeeded in constructing steam power stations with high thermal performance for about the same cost as the old low pressure stations. Substantial advances have been made in the art of station design. The cost of future equipment, its probable life, its overall station economy, and probable fuel prices, will govern the final decisions on new plant and reconstruction of old plant. These developments should be given consideration in projected load studies.

Superposition

Superposition consists in the addition of new high-pressure, high-temperature, low-heat-drop turbines which receive high-pressure steam from new high-pressure boilers, exhaust into the old low-pressure mains and through the serviceable old low-pressure turbines to the condenser. A feedwater heater may be provided to operate at the throttle pressure of the low-pressure turbine. Superposition has the advantage of increasing station capacity and improving station performance. Throttle pressures of 400 and 600 lb. per sq. in. are favoured in Canada. Extraction turbines supply steam for process work. These pressures provide a suitable margin for superposition in the rehabilitation of old plants. At the Dosco No. 3 station, a 7,500 kw., 440 lb. per sq. in., 740 deg. F. superposed turbine operates against a back pressure of 150 lb. per sq. in. and provides sufficient steam to serve all low-pressure turbines of the old station. At the Ford station, a 5,000 kw., 800 lb. per sq. in., 800 deg. F. superposed turbine operates against a back pressure of 175 lb. per sq. in. and is compounded with the present 10,000 kw. low pressure unit. In the United States, 28.6 per cent of the capacity of the new central station installations[2] were topping units. Recent rehabilitation of the Fisk station, first operated in 1903, and the earliest steam plant designed solely for steam turbines, has added 30,000 kw., to capacity, has salvaged much of the old equipment, and reduced the heat rate from 24,000 to 12,150 B.t.u. per kw.h. The Conner's Creek station,[33] Detroit, is an interesting example of the modernizing of old plant and of the accuracy with which engineers to-day can predict the average annual performance. The old station operated at 220 lb. per sq. in., 600 deg. F.; station performance, 19,000 B.t.u. per kw.h.; boiler efficiency, 78 per cent. The new plant operates at 600 lb. per sq. in. and 825 deg. F.; station performance, 12,800 B.t.u. per kw.h. (design), 12,560 B.t.u. per kw.h. for the year 1935; boiler efficiency, 86 (design) and 85.9 per cent for the year 1935.

The pause in steam power station construction in the years from 1931-1935, caused by reduced load and other factors, has given an exceptional opportunity for public utility engineers to review the economic aspects of past trends and accomplishments and to prepare for the future in an orderly manner by a study of new or improved methods of providing for future growth. The net results of the experiences of the past and thoughts for the future indicate that superposition of high-pressure equipment on existing stations will play a dominant part in the economical development of power supply, at least in the immediate future. Data on existing superposed installations have been tabulated.[34] At Battersea, two new boilers, having a capacity of 500,000 lb. of steam per hr. each, at 1,420 lb. per sq. in., 965 deg. F., will serve a compound unit. The 16,000 kw., 3,000 r.p.m., high-pressure turbine, will reduce the pressure to 600 lb. per sq. in., at which it will be supplied to the 84,000 kw., 1,500 r.p.m. turbine. Arrangements will be made to operate the high and low pressure units independently and the low-pressure unit can be operated from the existing boiler plant. There is much usable low-pressure turbine plant in Canada which warrants consideration in connection with proposed extensions and modernization. The operating conditions, 400 lb. per sq. in., 700 deg. F. were adopted in larger stations[32] in 1924, and by 1926 the conditions 600 lb. per sq. in., 750 deg. F. were available.[32]

Station Buildings

Station buildings require to be substantial, well lighted and clean. Architectural design has produced pleasing lines and landscaping of grounds has added beauty and charm. Public consciousness is becoming appreciative of beauty in the appearance of industrial plant which in pioneer days has tended to be drab. It has been stated that Battersea station is more photographed than St. Paul's Cathedral. Aluminum paint for equipment and light colours for walls and partitions facilitate lighting. Partitions are omitted between the boiler and turbine rooms. Vacuum cleaning has been adopted in some cases. Galvanized expanded metal gratings are used for stair treads and operating galleries. Heating and ventilation are required and roofing materials which inhibit condensation are needed when extreme winter temperatures are encountered. Chimneys are high to secure ample dispersion of the discharged gases.

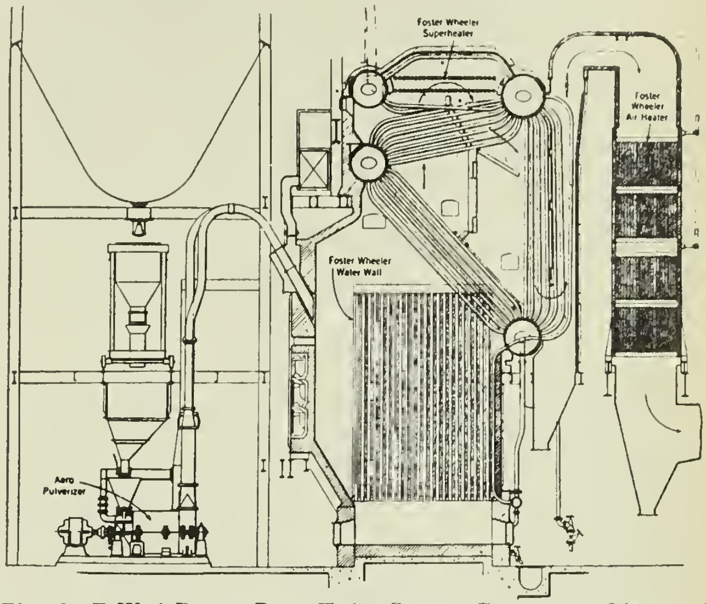

Fig. 8—F-W 4-Drum Bent-Tube Steam Generator, Liverpool Station, Mersey Paper Company, Liverpool, N.S.

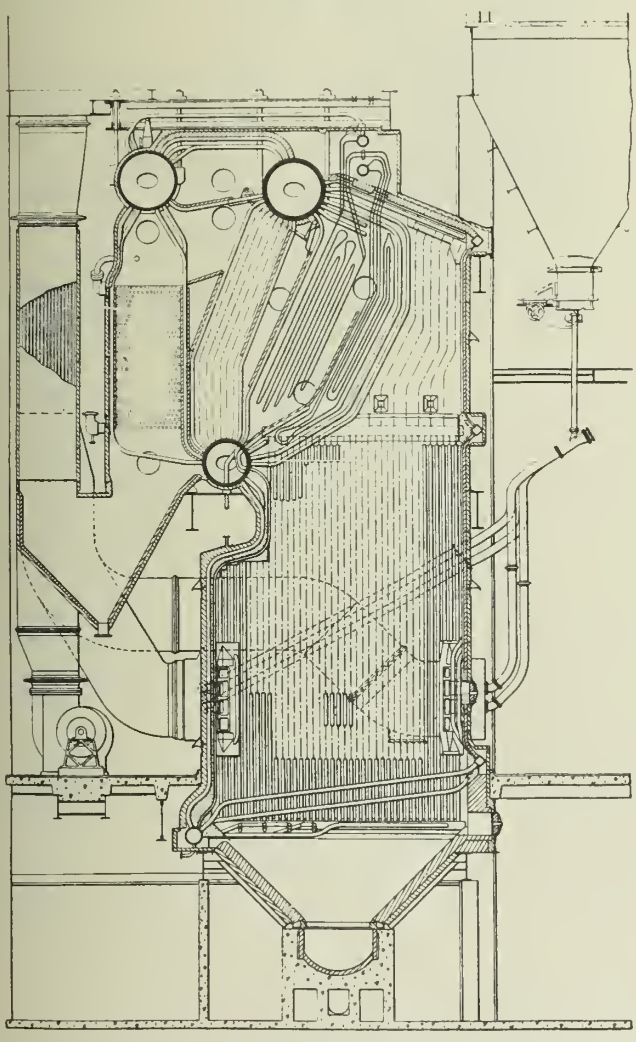

Fig. 7—C-E 3-Drum Bent-Tube Steam Generator for Windsor Station, Ford Motor Co., Windsor, Ont.

Fly-Ash Handling and Disposal

Coal and ash handling have been discussed.[8] Dust removal from flue gases is a recent development. Since 1931, as a result of public demand, new stations located within city limits or adjacent to other industrial plant, are usually provided with equipment for removing a satisfactory proportion of fly-ash. Electrostatic precipitators are expensive, but have an efficiency of from 90 to 95 per cent with a draft loss of 0.1 to 0.5 in. of water. Dust catchers of the cyclone type are less costly and have an efficiency of 70 to 90 per cent. Cyclones of newer design, it is claimed, will remove 70 to 80 per cent of the fine dust and almost 100 per cent of all larger than 325 mesh. Erosion of metal surfaces in contact with flow of dust, and possible corrosion of cyclones by sulphurous moisture in the flue gas, have been overcome to a considerable extent in one type of cyclone by the use of cast iron construction for the upper sections and inlet head of the cyclone, while another uses heavy steel plate. Data on fly-ash characteristics and the performance of dust catchers has been published.[35] British practice[36] has been summarized.[37]

The Brooklyn Edison Co. was one of the first in the central station field to begin an investigation of fly-ash control. The method and apparatus, developed for investigating the effectiveness of different types of dust separating equipment, have been described.[38]

A recent development in ash disposal[8] is reported,[35] in which fly-ash is used as a replacement for Portland cement in concrete. In the reconstruction of a dock at the Chester station, one bag of fly-ash having the same capacity as a cement bag, and weighing 45 lb., replaced one bag of cement, weighing 94 lb., in the mix, which thus contained 413 lb. of Portland cement, 45 lb. of fly-ash, 1,240 lb. of sand, and 2,100 lb. of $\frac{3}{4}$ in. graded pebbles per yard. Thirty U.S. gallons of water were found to be sufficient. The test cannot be used as a definite criterion of the value of fly-ash as a replacement for Portland cement in concrete, but the results are indicative of the truth of statements made that fly-ash can be used to replace Portland cement within certain limits without reducing the strength of concrete, and be effective in reducing the amount of mixing water required and improving its workability.

Steam-Generating Plant

Modern high-pressure high temperature steam-generating plant is characterized by large capacity, high effciency and an availability about equal to that of the turbine. Moderate pressures and temperatures prevail in Canada. The Ford station at Windsor is an exception and here two steam-generating units, having a capacity of 200,000 lb. per hr., operate at 900 lb. per sq. in., 820 deg. F. This is the highest pressure plant in Canada, is the first Canadian application of controlled superheat and the first to use tangential type burners. The units consist of a 3-drum boiler, convection and semi-radiant type superheater, plate type air preheater and water-cooled furnace. A sectional view of this unit is shown in Fig. 7. The heating surface, in square feet, in each of the units is 9,010, plus 4,325 in the water walls; economizer, 4,229; air preheater, 9,940. The most economical point of operation is at 62.5 per cent of capacity, which requires 11,270 lb. per hr. of 14,200 B.t.u. Pennsylvania and West Virginia bituminous coals. At 82.5 per cent of capacity, 14,930 lbs. of coal are required per hour.[21] Certain of the larger stations in the Maritime provinces burn high ash, 20-24 per cent, coals. These include Grand Lake,[23] Minto, N.B; Harrison Lake,[28] Maccan, N.S; Seaboard;[27] which has been described, and Dosco. No. 3 at Glace Bay, N.S. At this No. 3 station of the Dominion Steel and Coal Corp., two steam-generators having a capacity of 185,000 lb. per hr. each, have been in operation for a few weeks. The units consist of 4-drum, bent-tube boilers with pendant type superheater, economizer and tubular air preheater. Details are given in Table IV, contract "D." Operating conditions are 475 lb. per sq. in., 750 deg. F. and feedwater temperature 300 deg. F. The Liverpool, N.S., unit, capacity 60,000 lb., 420 lb. per sq. in., 553 deg. F., of the Mersey Paper Co., is shown in Fig. 8, and the Thorold, Ontario, unit, capacity 150,000 lb., 450 lb. per sq. in., 680 deg. F., of the Ontario Paper Co., in Fig. 9. A third and duplicate unit has been ordered for Thorold which will provide an independent steam supply with a total capacity of 450,000 lb. per hr. At Baie Comeau, Quebec, a 350-ton newsprint mill is under construction along the most advanced lines. The design for the mill power plant equipment is based upon experience gained at the Thorold, Ontario, plant. For Baie Comeau, two coal-fired boilers of similar design are being installed. One of the boilers is to be fired in the conventional way with pulverized coal and the other is equipped to burn either coal or wood or both. The combined capacity of the two units will be about 150,000 lb. per hr. The heat content of the bark is about 8,500 B.t.u. per lb. (bone dry weight). It is expected that about 40,000 lb. per hr. of steam will be developed from 10,000 lb. per hr. (dry weight) of wood alone, at an efficiency of 50 per cent. The unit is capable of burning 31,300 lb. of spruce bark per hr., containing 68 per cent moisture. Steam generating plant in Western Canada has been discussed by the author,[8] and elsewhere.[22]

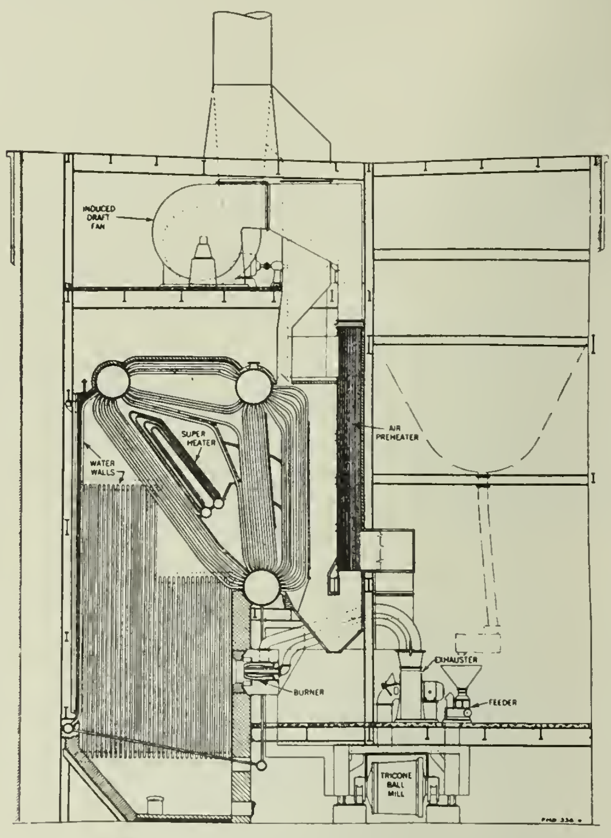

Fig. 9—F-W 3-Drum Bent-Tube Steam Generator, Thorold Station, Ontario Paper Company, Thorold, Ont.

Boilers

Boilers of the bent-tube type are favoured. Seventy-four per cent of the capacity in new central station installations in the United States were of this type.[2] The trend is toward a smaller number of drums and more and smaller tubes. A recent development, which has been favourably received in Canada where a compact, pulverized coal, gas or oil-fired unit is required, is the two-drum boiler in which integral waterwalls are provided. Two types are available, in one of these the circulation is crosswise, in the other, endwise of the drum. Nearly all high-pressure, high-capacity boilers are fitted with a furnace having waterwalls; and in the latest designs, the waterwalls are integral with the boiler circulation. The furnaces are also in most cases supplied with water-cooled furnace floors. Steam scrubbers or dryers are used to reduce the moisture content and carry-over to the superheater. The portion of waterwalled furnaces which require to be hot for ignition purposes are lined with plastic refractory. The trend is away from slag screens formerly used to inhibit "whiskers" or accumulation of slag among the boiler tubes. Furnaces are now designed on a basis which prevents molten ash entering the tube bank. Pulverized coal units predominate. Seventy-four per cent of the capacity in new central station installations in the United States were pulverized coal units, 16.3 per cent stoker fired, and the balance for oil and gas firing.[2] The temperature of the preheated air for pulverized coal units ranges from 350 to 450 deg. F. The highest efficiency of units using coal is obtained when the coal is burned in pulverized form and the efficiencies range from 84 to 87 per cent, depending upon the amount of air-heater and economizer equipment installed.

Treatment of boiler feed-water has been discussed briefly by the author.[8] Canadian central stations in Canada are increasing in size and importance. New operating conditions, introduced by higher pressures and temperatures, tend to emphasize the function of the chemist whose work has contributed largely in certain developments. Current problems, as, for example, turbine blade deposits, coal classification and spontaneous combustion in coal storage, boiler corrosion wherein copper is involved, and test methods for evaluating turbine oil, have been considered and reported upon.[39]

Fuels

The recent symposium on the burning of Canadian coals,[40] held at Montreal under the auspices of the Engineering Institute of Canada in connection with the Semicentennial meeting, will perhaps serve as a turning point in the economic utilization of fuel in the central stations in Canada. Canada has an abundance of fuel of varying types and grades. Transportation of the fuel presents certain difficulties. Nova Scotia has large supplies of bituminous coals. The larger central stations burn the refuse fuel called "splint" coal. This contains 20-24 per cent ash and is burned in pulverized form.[27,28] New Brunswick has supplies of low rank, high ash coal.[23] Coal is relatively expensive in Quebec and Ontario, due to transportation and other factors. As limitations are placed on the use of so-called "excess power" in electric boilers, the economic possibilities of refuse from pulp mills as fuel for steam boilers will receive consideration. Production of the high moisture lignites of Saskatchewan has increased in recent years. The necessary pioneer development work in the burning of high moisture, 31 to 34.5 per cent, lignite in pulverized form, has already been overtaken in connection with one of the Texas stations.[6] Similar development may be expected in Saskatchewan in future years. Saskatchewan central stations burn bituminous coal in pulverized form with oil as an alternative; Alberta lignites containing 18 to 24 per cent moisture are burned on chain grate stokers. The Moose Jaw station of the National Light and Power Co. has burned Alberta lignite coal in pulverized form from time to time since 1928. Alberta has an abundance of bituminous and lignite coal. Alberta lignite slack containing 24 per cent moisture was burned for the first time on chain grate stokers in 1914. No installations have been made in the central stations of Alberta for burning lignite in pulverized form. Development of fuel technique in connection with Alberta coals has been of a high order.[40] Methods are available which facilitate the determination of the heating values of coal, with sufficient accuracy for central station work. Periodic samples are analysed for ash and moisture content only and the heating value is determined from a coal chart. It has been found that with Alberta coals the heat value, proximate analysis, and ultimate analysis, vary in a regular manner with the ash and moisture percentages. It is therefore possible to prepare a set of charts, for any coal, from which can be read the heat value and analysis corresponding to any particular ash and moisture.[41] The expense for an analysis of ash and moisture only is a small fraction of that involved for even a proximate analysis and heat value determination.

Fuel costs in cents per million B.t.u. for certain stations are approximately as follows:—Edmonton, Alberta, 10.0; Saskatoon, Saskatchewan, 20.5; Regina, Saskatchewan, 21.25; Glace Bay, N.S., 15.8; Minto, N.B., 15.19. These values may be compared with the 14.82 given for the most efficient steam central station in the world.

5. Steam Turbines

Typical examples of Canadian central station turbine installations are given in Table I and their performance has been plotted in Fig. 3. The 15,000 kw. Parsons unit at the city of Regina station, installed in 1930, was the first condensing turbine of this capacity to operate at 3,600 r.p.m. Throttle conditions are 350 lb. per sq. in. and 725 deg. F. Three extraction heaters provide a final feedwater temperature of 280 deg. F. The Regina station has the best average annual station performance, 17,800 B.t.u. per kw.h., in the utility field in Canada for 1936. Old 200 lb. per sq. in. boilers were operated for 34 days, and the 400 lb. per sq. in. boiler was operated at a reduced pressure of 200 lb. per sq. in. for an additional 17 days. The station has an installed capacity of 28,000 kw. The Grand Lake station of the New Brunswick Power Commission, Minto, N.B., consists of two 2,500 kw. Oerlikon turbines and one Parsons 6,250 kw. turbine, making an installed capacity of 11,250 kw. This station had a performance in 1936 of 18,600 B.t.u. per kw.h. with coal containing 22 per cent ash, 8 per cent moisture, and having a heating value of about 11,200 B.t.u. per lb.

Canada is dependent upon other countries for large central station turbines, although steam-generating plant and other central station equipment are produced in this country. The turbine heat balance is the dominant factor in station design and the performance of modern turbines can be predicted with a high degree of accuracy. In addition to high turbine efficiency, the regenerative cycle and heat recovery devices in the turbine heat balance have contributed largely to the fine performance of modern stations of all sizes. Recovery of generator losses by the

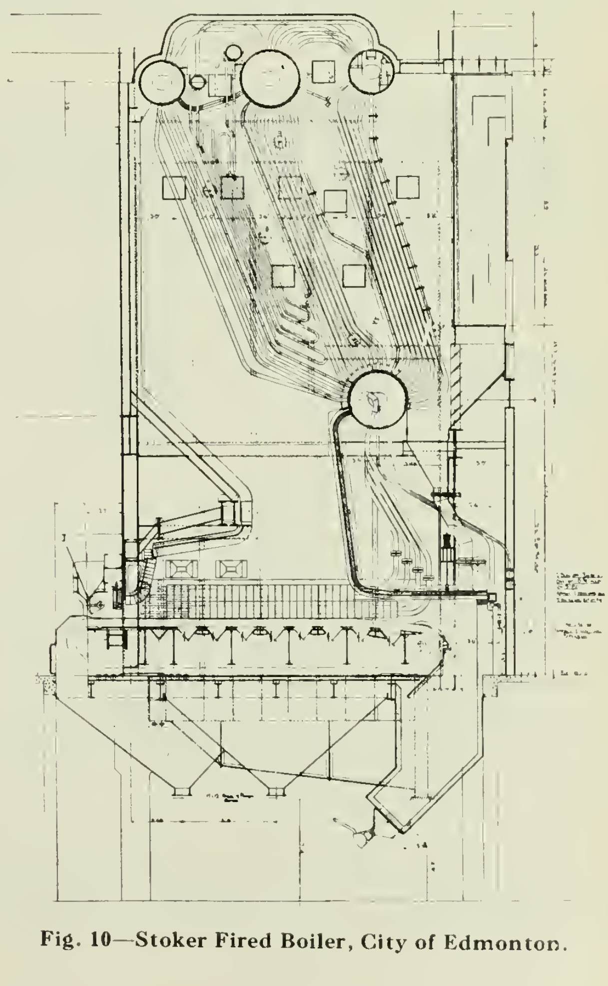

Fig. 10—Stoker Fired Boiler, City of Edmonton.

generator air-cooler, the mechanical losses of the turbine by the bearing oil-cooler, and application of the condensate as the cooling medium for the steam-jet vacuum ejectors, evaporator condenser and heater drips, are usually warranted and have the advantage in operation of keeping these devices scrupulously clean and free from scale.

Turbines received their full share of the discussion at the World Power Conference of 1936. American practice has been ably presented.[7] The tendency in Great Britain[42] is to stabilize steam pressures for units of 30,000 and 50,000 kw. at from 600 to 650 lb. per sq. in. and temperatures at 800 to 850 deg. F. For units of about 20,000 kw., 300 to 400 lb. per sq. in. and 730-775 deg. F. are favoured. Higher pressures are reserved for future base load plants. Increases of steam temperature above 850 deg. F. introduce more difficulties than further increases of pressure. The use of the regenerative feedwater heating is almost universal in present-day power plants, as it results in lower heat consumption, reduced wetness loss, and a smaller condenser for a given output.

Steam turbine condensing units having a speed of 3,600 r.p.m. and a capacity of 25,000 kw. have been offered in Canada.[30] While condensing units of this capacity have not been manufactured in the United States, 56 per cent of the capacity of their new central station installations were of this high speed. Hydrogen has been used as the cooling medium in 56 per cent of the capacity of all of these new installations.

In recent years initial steam conditions are usually chosen so that with the given turbine efficiency, the moisture content at exhaust does not exceed 12 per cent on the Mollier diagram. In many turbines, renewal of the last row of blades has been required, due to erosion caused by high moisture content in the steam at this point. Shrouding of the last row of blades with material developed to inhibit erosion has proved effective for the few years

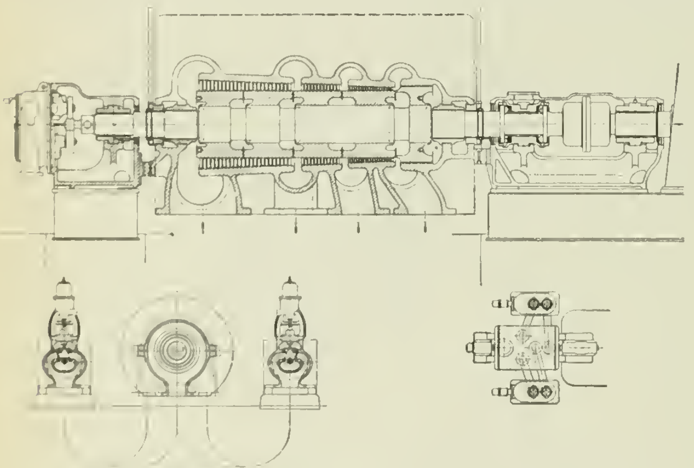

Fig. 11—Brown Boveri Topping Turbine, No. 3 Power Plant, Dominion Steel and Coal Corporation, Sydney, N.S.

in which satisfactory material has been in service. A British manufacturer has adopted hollow, forged blades, which give added stiffness. Water-sealed glands are standard on the vacuum ends of American turbines. They are also frequently used outside the regular high pressure steam glands to prevent leakage into the turbine room. Such leakage increases humidity and causes roofs to sweat in winter. In the earlier designs, water glands effected a small improvement in thermal performance. Condensers are also used to control humidity.

Recently built turbines of over 15,000 kw. capacity are provided with turning gears to rotate the spindle on starting up or shutting down. Rotation at 1 to 5 r.p.m. avoids harmful deflections or distortions which would otherwise cause rubs or vibration.

An open deaerator heater operating at slightly above atmospheric pressure is usual at one extraction point with a system of closed heaters. This deaerator reduces the oxygen content of the feedwater to about .03 cc. per liter. Feedwater storage combined with this heater is recirculated to prevent reabsorption of oxygen. Sodium sulphite is added to the feedwater to remove the last traces of oxygen. An evaporator, fed from an extraction point of the turbine, provides distilled water as feed make-up for the boiler.

Condensing surface in new units has been decreased to 0.562 sq. ft. per kw. Provision is made to reheat the condensate entering the hotwell to vacuum temperature. Retubing and relaning of old condensers has reduced the pressure drop and the undercooling of the condensate.[43] In one case the undercooling was reduced approximately 5 deg. F.

Circulating water to condensers is chlorinated to prevent the growth of algae and slimes inside the tubes. The heat of the steam supplied to steam-jet vacuum ejectors is recovered by inter- and after-condensers cooled by condensate.

6. Conclusions

The thermal performance of Canadian steam-electric plants does not compare favourably with that of plants of comparable size in some other countries.

Steam and hydro should be considered as complementary sources of power. A greater measure of uniformity of practice in connection with taxes and fixed charges will facilitate unbiased consideration of proposals for interconnection of power stations and systems and interchange of power. Development of these two sources of power should be on a basis which will result in the lowest total system cost. The situation in certain areas of Canada warrants study of the correlation of these two sources of power with a view to lower rates to customers.

Studies, based upon minimum system costs, reveal in true perspective the possibilities of steam-electric power plants and the significance of high thermal performance.

New plants and additions to present plants will be constructed, on the unit system (one turbine, one boiler), for operation at high pressure and temperature, equipped with extraction heaters and heat recovery devices, with due consideration for safety, reliability, and comfort, to generate electrical energy at a minimum unit cost.

BIBLIOGRAPHY

1. Central Stations in Canada, Dom. Bur. Stat., Ottawa, 1937.
2. Power, mid-Sept., 1937.
3. The Peak-load Problems in Steam Power Stations, by A. G. Christie, Trans. A.S.M.E., 1929.
4. Generation of Electricity in Great Britain, H.M. Stationery Office, London, 1937.
5. Ten Years, Electricity Commission, Johannesburg, 1923-33.
6. Operating Experience with Pulverized Texas Lignite in a Large Central Station, by N. G. Hardy, Trans. A.S.M.E., 1936.
7. American Power Plants, by A. G. Christie, Mechanical Engineering, Sept., 1936.
8. The Burning of Low Rank Alberta Coals, The Steam Generating Plant, by C. A. Robb, The Engineering Journal, July, 1937.
9. Calculation of the Gain from Feedwater Heating, by R. L. Reynolds, Electric Journal, April, 1929.
10. Reheating and Regenerating for Steam Power Plants, by C. F. Hirshfeld and F. O. Ellenwood, Trans. A.S.M.E., 1923.
11. A Thermal Study of Available Steam Power Plant Heat Cycles, by G. A. Hendrickson and S. T. Vesselowsky, Trans. A.S.M.E., 1934.
12. The Trend of Steam Power Plant Development, by A. G. Christie, Trans. E.I.C., Vol. XXXVI, 1926 to 1930.
13. Steam Station Cost Survey, by L. W. W. Morrow, Electrical World, Nov. 23, 1935.
14. Hydro-Electric Progress, by J. T. Johnston, The Engineering Journal, June, 1937.

15. The British Grid System, by Johnstone Wright, The Engineering Journal, May, 1937.
16. The Engineering Journal, May, 1937.
17. Engineering, Nov. 12, 1937.
18. Combustion, June, 1935.
19. The Engineer, Nov. 12, 1937.
20. Discussion of Reference No. 8, by A. G. Christie, The Engineering Journal, Jan., 1937.
21. First High Pressure Unit now in Operation at Ford Plant, Modern Power and Engineering, Sept., 1936.
22. Experience in Burning Western Canadian Coals, by E. W. Bull, The Engineering Journal, July, 1937.
23. An Economic Use for New Brunswick Coal, by John Stephens, The Engineering Journal, July, 1937.
24. New Steam Plant Designed and Placed in Operation in Six Months, by E. J. Calnan, Modern Power and Engineering, July, 1936.
25. Ontario Paper now Obtaining Power from Steam Turbine Plant, by W. L. Eliason and A. D. Harrison, Modern Power and Engineering, Nov., 1937.
26. The Beet Sugar Factory at Picture Butte, Alberta, by F. H. Ballon, The Engineering Journal, Nov., 1937.
27. The Seaboard Power Plant, Glace Bay, N.S., by K. H. Marsh, The Engineering Journal, Nov., 1932.
28. Harrison Lake Steam Plant, by G. T. Medforth, Electrical News and Engineering, Sept. 1, 1932.
29. Hydro-Electric Practice in Canada, by T. H. Hogg, The Engineering Journal, Dec., 1936.
30. When the Load Grows, by A. G. Christie, Combustion, June, July, 1935.
31. Electricity, Economic Background, by Hugh Quigley, Architectural Review, 1933.
32. Post-war Land Turbine Development, by C. D. Gibb, Proc. Inst. Mech. Eng., 1931.
33. Modernizing the Conner's Creek Power Plant, by Sabin Crocker, Combustion, Feb., 1936.
34. Superposition of High Pressure Non-condensing Equipment on Existing Power Stations, Pub. No. D8, Edison Elect. Inst., 1936.
35. Combustion, 1937, Pub. No. E11, Edison Elect. Inst., 1937.
36. Removal of Smoke and Acid Constituents from Flue Gases by a Non-effluent Water Process, by Pearson, Nonhebel and Ulander, Trans. Inst. of Fuels, London, 1935.
37. Daily Telegraph, London, July 5, 1937.
38. Cinder and Fly-Ash Measurements, by P. H. Hardie, Combustion, March, 1935.
39. Power Station Chemistry, Pub. E10, Ed. Elect. Inst., 1937.
40. Symposium on the Burning of Canadian Coals, The Engineering Journal, July, 1937.
41. Report of Fuels Division, by E. Stansfield, W. H. Lang and K. C. Gilbart, Report No. 33, Research Council of Alta., 1935.
42. The Influence of Operating Experience on the Design and Construction of Turbines and Alternators, by C. D. Gibb, Journal, Inst. of Eng., Australia, July, 1936.
43. Turbines, Condensers and Pumps, Pub. No. E14, Edison Elect. Inst., 1937.

APPENDIX

(For Tables I and III see pages 138-143)

TABLE II

COST OF STEAM-POWER IN CENTS PER KW.H AT VARIOUS LOAD FACTORS

	Station Capacity kw.	Annual Load Factor (Per cent)	Costs per kw.h.		
			Fixed Charges	Fuel	Total
(c)	11,000	100 (base)	0.1597	0.277	0.5255
(b)	150,000	32.8	0.488	0.3152	0.9042
(a)	50,000	1.6	10.0	0.553	10.73
(d)	20,000	0.68	23.5	0.722	24 45

TABLE IV

APPROXIMATE PERFORMANCE DATA FOR CERTAIN NEW STEAM-GENERATING INSTALLATIONS IN CANADA

	Boiler						Superheater		Air Heater		Economizer		Fans		Steam		Air	Gas	How Fired				Efficiency	
Contract	No.	Type	Heating Surface Sq. ft.	Max. Output Lb. per hr.	Designed Pressure Lb. per sq. in.	Water Walls	Type	Heating Surface Sq. ft.	Type	Heating Surface Sq. ft.	Type	Heating Surface Sq. ft.	Forced Draught	Induced Draught	Working Pressure Lb. per sq. in.	Max Temp. Deg. F.	Max. Temp. Deg. F.	Max. Temp. Deg. F.	Stoker	Pulverized Coal	Oil	Gas.		Max. Per cent
A	2	2 Drum. Vert.	3,978	6,300	200						B&W				200			630				Gas		
B	1	I.F.B.		45,000	450	Yes	B&W	592	B&W	3,630			Yes	Yes	450	610	380	420		P.C.				83.5
C	2	Stirling	4,648		200								Yes		150			640	U.F. Stoker					76.2
D	2	Stirling	14,756		500	Yes	B&W	4,100	B&W	12,300	B&W	2,570	Yes	Yes	500	750	420	460		P.C.				84
E	3	Stirling	2,900		200										30							Gas		[illegible]
F	1	I.F.B.		70,000	450	Yes	B&W	Future	B&W	4,900			Yes	Yes	450	650	390	385		P.C.				85.5
G	3	I.F.B.		60,000	485	Yes	B&W		B&W	6,590			Yes	Yes	200	650	395	376		P.C.				86.76
H	1	I.F.B.		150,000	630	Yes	B&W		B&W	15.690			Yes	Yes	135	720	434	341		P.C.				86.94
I	1	I.F.B.		150,000	135	Yes	B&W		B&W	15,690			Yes	Yes	135	720	434	341		P.C.				87.5
J	1	I.F.B.		120,000	630	Yes	B&W		B&W	11,730			Yes	Yes	135	720	434	341		P C				86.94
K	1	I.F.B.		120,000	135	Yes	B&W		B&W	11,730			Yes	Yes	135	720	434	341		P.C.				87.5
L	1	Stirling	18,124	67,000	250										150			640				Gas		
M	1	I.F.B.		60,000	450	Yes	B&W		B&W	5,850			Yes	Yes	200	640	420	410		P.C.				86
O	1	Stirling	8,597	80,000	200	Yes					Stirling	3,535	Yes	Yes	180			420	C.G. Stoker					82.1

Note:—Boilers with type designation "I.F.B." are integral furnace boilers.

NOTE.—While the author's intention was to deal with stations of 50,000 kw. capacity and under, the importance of the material so kindly submitted by Mr. Johnstone Wright, Chief Engineer, Central Electricity Board, Great Britain, and the significance of these stations made its inclusion seem imperative.

Table I—Performance
Period January 1936 to

		Canada		
1	Name	Regina	Grand Lake	Lethbridge (1935)
2	Owner	City of Regina	New Brunswick Electric Power Commission	City of Lethbridge
3	Location	Regina, Sask.	Minto, N.B.	Lethbridge, Alta.
4	Operating pressure gauge ..... lb. per sq. in. Operating temperature ..... deg. F.	400 p.s.i., 750 deg. F. 200 p.s.i., 600 deg. F.	440 p.s.i., 650-700 deg. F.	150 p.s.i., 580 d g F.
5	Total installed capacity ..... kw.	28,000	11,250	5,075
6	Unit capacity of turbines ..... kw and r.p m.	1—15,000 kw., 350 p.s.i., 725 deg. F. 2— 5,000 kw., 200 p.s.i., 550 deg. F. 1— 3,000 kw., 200 p.s.i., 550 deg. F.	2—2,500 kw., 3,600 r.p.m. 1—6,250 kw., 3,600 r.p.m.	3,375 kw., 3,600 r.p.m. 1,200 kw., 3,600 r.p.m. 500 kw., 3,600 r.p.m
7	Spinning reserve carried on system	Only when load is liable to exceed base load — turbine	None	
8	Type and size of steam reheater—Surface ..... sq. ft.			
9	Number of extraction heaters	3 on 350 p.s.i. turbine	2	None
10	Final temp. feedwater, full load ..... deg. F.	280	260	207
11	Total number of boilers	8—500 hp.—200 p.s.i. press. 1—400 p.s.i.—750 deg. F.	3	2
12	Boiler surface, per unit ..... sq. ft	8— 4,928 1—16,500	2—6,900 1—8,000	5,040
13	Economizer surface, per boiler unit ..... sq. ft.	8—1,928 at 200 p.s.i. none on 400 p.s.i. boiler		1,100
14	Air preheater surface, per boiler unit ..... sq. ft.	400 p.s.i.—20,368	2— 3,900 1—10,900	None
15	Max. steam generator output per boiler unit, lb. per hr.	8 at 35,000 1 at 175,000	1—100,000 2— 60,000 (have been exceeded 20 per cent in emergency)	
16	Average boiler plant efficiency per unit ..... per cent	81.55 (for whole plant)	88.0 (approx.)	78.6 (1936)
17	Furnace equipment	4-6 retort and 1-7 retort Riley stokers. 2-Pul. fuel Riley Attrita (2 burners per blower) 1-400 p.s.i. 13,000 cu. ft. furnace, 6 Foster Wheeler intervane burners 27 in.	Finwalls—All walls cooled—4 Foster Wheeler and 3 Combustion Engineering burners—All mills impact—7 mills	Stoker
18	Ash handling equipment	400 p.s.i. Newveyor suction 200 p.s.i. drag chain and elevator	Allen-Sherman—Hoff.—Hydro jet	
19	Condenser surface per unit ..... sq. ft.	15,000 kw.—19,700	Unknown	4,332
20	Max cooling-water temperature ..... deg. F.	75	80 extreme—65 summer average	80
21	Min cooling-water temperature ..... deg. F.	34	33 winter	32
22	Gross annual output ..... kw.h.	54,476,300	43,230,000	8,550,975
23	Auxiliary use ..... kw.h.	3,377,470	2,838,420	531,670
24	Net annual output ..... kw.h.	51,098,830	40,394,980	8,019,305
25	Auxiliary use ..... per cent	6.1	7.02	
26	Average cost of coal per ton (2,000 lb.)	$5.35 f.o.b.	$3.40 in bunker	$1.48
27	Heating value of coal ..... B.t.u. per lb.	Coal—12,580 Oil —19,200	11,200	
28	Average annual station performance (net output) B.t.u per kw.h.	17,800 on basis operating old boilers at 200 p.s.i. 34 days—8 high press. boilers reduced to 200 p.s.i. on 17 additional days.	18,600	25,900 22,500 (1936)
29	Annual load factor—*a* ..... per cent	42.5	44.0	50.0
30	Annual use or capacity factor *b* ..... per cent	22.0	40.9	29.0

a Annual load factor = The ratio of the gross annual output in kw.h. to the product of the maximum peak load of the year and the total hours of operation per year.
b Annual use or capacity factor = The ratio of the gross annual output in kw.h. to the product of the rated capacities of the units in the station and the hours of the year (8,760).

Data of Central Stations
December 1936 inclusive.

Canada

Saskatoon (1935)	Seaboard	Moose Jaw (1935)	Edmonton (1935)	Harrison Lake	Prince Albert	Picture Butte
Saskatchewan Power Comm.	Seaboard Power Corpn.	National Light and Blower	City of Edmonton	Canada Electric Co.	Canadian Utilities Ltd.	Can. Sugar Factories Ltd.
Saskatoon, Sask.	Glace Bay, N.S.	Moose Jaw, Sask.	Edmonton, Alta.	Maccan, N.S.	Prince Albert, Sask.	Picture Butte, Alta.
400 p.s.i., 700 deg. F.	400 p.s.i., 630 deg. F.	275 p.s.i., 700 deg. F.	165 p.s.i., 550 deg. F.	240 p.s.i., 600 deg. F.	300 p.s.i., 620 deg. F. 200 p.s.i., 500 deg. F. 200 p.s.i., 500 deg. F.	250 p.s.i., 545 deg. F.
20,000	2—6,000	21,000	21,000	11,850	5,700	1,250
10,000 kw., 3,600 r.p.m. 5,000 kw., 3,600 r.p.m. 3,200 kw., 3,600 r.p.m. 2,000 kw., 1,800 r.p.m.	2—6,000 kw., 3,600 r.p.m.	10,000 kw., 3,600 r.p.m. 5,000 kw., 3,600 r.p.m. 3,500 kw., 3,600 r.p.m. 1,500 kw., 3,600 r.p.m. 1,000 kw., 3,600 r.p.m.	10,000 kw., 3,600 r.p.m. 5,000 kw., 3,600 r.p.m. 4,000 kw., 1,800 r.p.m. 2,000 kw., 3,600 r.p.m.	6,250 kw., 3,600 r.p.m. 4,000 kw., 3,600 r.p.m. 1,600 kw., 3,600 r.p.m.	3,200 kw., 3,600 r.p.m. 1,500 kw., 3,600 r.p.m. 1,000 kw., 3,600 r.p.m.	1,250 kw., 4,500 r.p.m.
						None
	2,050	None				None
2	2	None	None	1		None
300	320	200	250	212		250
10	2	6	17	3	3	2
A. 8— 4,928 B. 2—10,628	9,219	2—6,010 4—3,750	A. 8—4,050, B. 8—4,780 C. 1—12,907	1—7,550 2—3,500		7,075
A—Serves 2 units B—None		None	None			None
A—None	5,000	7,040	10,136	8,660		None
A—30,000 B—85,000	11,000	60,000	86,000	64,000		63,630
A—67.0 B—72.0	81.0	81.0	A and B — C 76.0	74.2		75.0
Stoker	Combustion Engineering Fin tube walls	Pulverized coal	Stoker	Pulverized coal	Chain grate stoker, retort, A.C. Jones stoker with C.C. automatics	Babcock-Wilcox chain grate
	Allen-Sherman-Hoff jet system			Water-jet sluices	Stephens Adamson 2,000 cu. ft. 6 in., skip hoist	Water flume 8 pump
10,000	9,400	10,900	12,700	8,000	2,850; 2,560	None
72	74	90	70	82		
32	32	40	34	34		
39,217,800	80,000,000	28,192,200	32,033,400	18,475,700	7,492,780	1,440,000 (1,920 hrs. at 750 kw.)
3,937,740	5,600,000 ±	3,169,397	2,523,100	1,580,900	457,639	220,800
35,280,060	74,400,000	25,024,803	29,510,300	16,894,800	7,035,041	1,219,200
	7.0			8.5	6.1	15.4
$3.58	$4.00	$3.40	$1.75 (1936)	$3.30	$4.13	$1.25
	11,900 to 13,500		8,700 (1936)	10,415	9,100	9,080
22,200 (unofficial) 23,000 (1936)	19,000	21,400 (1936)	— —43,180 D—27,115 2,760 (1936) E—79,050	24,400	37,175	
42.2	Not known yet	61.6	23.8	52.5	42.8	21.9
22.4	Not known yet		17.4	17.7	15.0	13.0

TABLE I (Concluded)—PERFORMANCE
Period January 1936 to

		U. S. A.				
1	Name	Dresden	Kalamazoo	Lauderdale	Mad River	Rio Grande
2	Owner	New York State Electric and Gas Corporation	Consumers Power Co.	Florida Power and Light Co.	Ohio Edison Co.	El Paso Electric Co.
3	Location	Dresden, N.Y.	Kalamazoo, Mich.	Fort Lauderdale, Fla.	Springfield, Ohio	El Paso, Texas
4	Operating pressure gauge ... lb. per sq. in. Operating temperature ... deg. F.	650 p.s.i., 825 deg. F.	400 p.s.i., 700 deg. F.	400 p.s.i., 725 deg. F.	400 p.s.i., 700 deg. F.	450 p.s.i., 750 deg. F.
5	Total installed capacity ... kw.	20,000	20,000	50,000	20,000	43,000
6	Unit capacity of turbines ... kw. and r.p.m.	20,000 kw., 3,600 r.p.m.	20,000 kw., 1,800 r.p.m	2—25,000 kw., 1,800 r.p.m.	20,000 kw., 1,800 r.p.m.	25,000 kw., 1,800 r.p.m. 18,000 kw., 1,800 r.p.m.
7	Spinning reserve carried on system		35,000 kw.		12,000 kw. (interconnection)	None
8	Type and size of steam reheater—Surface ... sq. ft.	None	None	None	None	None
9	Number of extraction heaters	3	3	3 (per machine)	2	4
10	Final temperature feedwater, full load ... deg. F.	329.6	300	340	220	300
11	Total number of boilers	2	3	3	2	2
12	Boiler surface, per unit ... sq. ft.	8,750	15,360	17,400	12,757	15,253
13	Economizer surface, per boiler unit ... sq. ft.	2,304	None	None	4,608	None
14	Air preheater surface, per boiler unit ... sq. ft.	10,560	21,600	82,000	14,220	19,450
15	Max. steam generator output per boiler unit, lb. per hr.	110,000	150,000	240,000	200,000	184,500
16	Average boiler plant efficiency per unit ... per cent		86.3	86.5	86.6	80.0
17	Furnace equipment	Pulverized coal 2 burners in front wall of each boiler	Simplex pulverizers Bailey-Tenney burners Combustion Engineering Co. walls	Peabody oil burners water walls	Taylor stokers	Bailey water walls
18	Ash handling equipment	Allen-Sherman-Hoff hydraulic sluice system	Beaumont Mfg. Co.—sluice	None	Allen-Sherman-Hoff — sluice	None
19	Condenser surface per unit ... sq. ft.	16,850	25,000	20,000	27,000	25,000
20	Max. cooling-water temperature ... deg. F.	79	90	92	78	85
21	Min. cooling-water temperature ... deg. F.	35	34	65	32	42
22	Gross annual output ... kw.h.	140,000,000 (approx.)	129,557,600	230,000,000	93,527,600	118,801,970
23	Auxiliary use ... kw.h.	6,000,000 (estimated)	7,826,000	11,000,000	4,654,900	5,439,800
24	Net annual output ... kw.h.	134,000,000 (assumed)	121,731,600	219,000,000	88,872,700	113,362,170
25	Auxiliary use ... per cent	6.0 (not over)	6.0	4.9	4.98	4.79
26	Average cost of coal per ton (2,000 lb.)		$4.70		$3.60	Gas per 1,000 B.t.u. $0.17
27	Heating value of coal ... B.t.u. per lb.	13,900	13,640 (as fired)	18,500	13,359 (as received)	Gas 1,093
28	Average annual station performance (net output) B.t.u. per kw.h.		15,300	14,700	15,763	16,106
29	Annual load factor—a	80.0	55.3	50.0	51.2	52.2
30	Annual use or capacity factor—b		55.4	53.0	50.6	31.5

a Annual load factor = The ratio of the gross annual output in kw.h. to the product of the maximum peak load of the year and the total hours of operation per year.
b Annual use or capacity factor = The ratio of the gross annual output in kw.h to the product of the rated capacities of the units in the station and the hours of the year (8,760).

Data of Central Stations
December 1936 inclusive

U. S. A.				England		
Rochester	Trinidad	Cedar Rapids	Pasadena	Battersea	Barking "B"	Dunston "B"
Rochester Gas and Electric Corp.	Texas Power and Light	Iowa Electric Light and Power Co.	City of Pasadena	London Power Co Ltd.	County of London E. S. Co. Ltd.	North Eastern Electric Supply Co. Ltd.
Rochester, N.Y.	Trinidad, Texas	Cedar Rapids, Iowa	Pasedena, California	River Thames at Battersea, Eng.	River Thames at Barking, Eng.	River Tyne above Newcastle, Eng.
650 p.s.i., 750 deg. F. 210 p.s.i., back pressure superimposed	375 p.s.i., 725 deg. F.	700 p.s.i., 775 deg. F.—H.P. 200 p.s.i., 500 deg. F.—L.P.	400 p.s.i., 750 deg. F.	600 p.s.i., 800-850 deg. F.	600	600
6,000	75,000	5,000 kw.—H.P. 37,000 kw.—L.P.	50,000	243,000	150,000	152,500
6,000 kw., 3,600 r.p.m.	2—20,000 kw., 1,800 r.p.m. 1—35,000 kw., 1,800 r.p.m.	1— 5,000 kw., 3,600 r.p.m.—H.P. 2—10,000 kw., 1,800 r.p.m. conden. 1—6,000 kw , 3,600 r.p.m. n.-con. 1— 3,500kw., 1,800r.p.m., conden. 1— 7,500 kw., 1,800 r.p.m.—L.P.	10,000 kw., 1,800 r.p.m. 15,000 kw., 1,800 r.p.m. 25,000 kw., 1,800 r.p.m.	2—69,000 kw., 1,500 r.p.m. 1—105,000 kw., 1,500 r.p.m.	75,000 kw., 1,500 r.p.m.	50,000 kw., 1,500 r.p.m.
		None	None; interconnection with Boulder Dam	5-10 per cent	5-10 per cent	5-10 per cent
None	None	None				115 p.s.i., and 800 deg. F. outlet
1	3 (per machine)	None	4			
389.9	330	380	385	340-350	340-350	340-350
1	6	L.P. 14 H.P. 1	4			
15,300	4—18,800 2—32,000	9,104 for L.P. units	15,000 (approx.); not including water walls			
20,808	None	None				
None	None		Ljungstrom regenerative			
230,280	180,000; 325,000	45,000	210,000			
74.1	76.2	80.0	85.0 (estimated)	89.0 (approx.)		
Pulverized coal 4 Combustion Engineering Co. burners	Downshot pulverized coal burners—water walls	Water-cooled underfed stokers	Peabody combination; oil and gas burners			
Allen-Sherman-Hoff—sluice	Drag chain in trench	Link-Belt conveyors	None		·	
Superimposed turbine	20,000		10,000 kw. unit—14,250 sq. ft. 15,000 kw. unit—16,250 sq. ft. 25,000 kw unit—26,000 sq. ft.			
	93	95	100	66	66	66
	38	32	60	34	34	34
52,500,000	535,000,000	128,000,000	80,700,000	1,050,147,270	918,652,000	673,330,100
3,412,000	28,000,000	11,000,000	5,700,000	54,397,770	38,839,000	38,181,990
48,000,000 (est.)	507,000,000	117,000,000	75,000,000	995,749,500	879,813,000	635,148,110
6.5	5.1		7.0	5.2	4.2	5.7
$5.00		$3.00	Oil per 42 gal. bbl. $0.70	2,240 lb. at 18/0.8d *	2,240 lb. at 14/10.1d.*	2,240 lb. at 13/2.4d*
13,612	7,000 (lignite)	10,400	Oil 18,500—19,000	12,740	11,046	11,258
	16,300		16,000	12,349	12,911	12,700
90.5	67.0		42.0 (approx.)	60.85	68.2	63.2
	81.0		Varies with amount of hydro power used.	(*Excludes handling charges)		

Table III—Data on Recent

		Canada				
1	Name	Regina	No. 3 Boiler Plant	Grand Lake	Harrison Lake	Prince Albert
2	Owner	City of Regina	Dominion Steel & Coal Corporation	New Brunswick Electric Power Comm.	Canada Electric Co.	Canadian Utilities Ltd.
3	Location	Regina, Sask.	Sydney, N.S.	Minto, N.B.	Maccan, N.S.	Prince Albert, Sask.
4	Date of installation	1937	1937	1936	1931	1936 (Dec.)
5	Builder of boiler Type—*a*	F.W. Bent tube	B.-W. & G.-M. 4 drum Stirling	Can. Vickers Ltd. Kidwell	Can. Vickers Ltd. Kidwell	B.-W. & G.-M. Stirling—water tube
6	Operating pressure.......lb. per sq. in.—gauge	430	475	440	240	325
7	Steam temperature.......deg. F.	825	750	650–700	600	620
8	Type of firing equipment	1—F.W. Intervane burners—27 in. 1—B. & W. pulverizer type B—14,000 lb. con. 2 burners 1—Riley Attrita—5,000 lb. con. 1 burner. 1 cross connection to Aero 8,000 lb. hr. pulverizer on other boilers to 1 burner.	B. & W. type B mills 2 per boiler 3—24 in. gas (blast furnace) burners per boiler	Pulverized fuel	Pulverized coal	B.-W. & G.-M. chain grate stoker 8 by 8.5 ft.
9	Furnace volume.......cu. ft.	10,300	11,400	6,220	7,650	
10	Maximum rating steam.......lb. per hr.	150,000 at 825 deg. F.	185,000 (rated max.) 250,000 (actual)	120,000	64,000	44,000
11	Feedwater temperature—*b*.......deg. F.	200–280 (dependent on extraction pressure on turbine served by boiler.	300	260	212	195
12	Heating surfaces.......sq. ft.					
	(*a*) Boiler proper	13,500	14,756	8,000	7,550	5,531
	(*b*) Water-walls and circulators	2,040	3,434	2,700 (approx.)	1,554	126 (bottom)
	(*c*) Super-heater—Convection		4,100	Unknown	1,130	1,076 (pendant)
	Side walls	2,730				2—(4 in. tube)
	Rear wall	528				
	(*d*) Economizer	None	Return tube 2,570	None		2,660
13	Type and capacity—Preheater (or sq. ft. of heating surface)	Tubular—23,360 heats air to 500 deg. F. at full load	Tubular—12,300	Plate—10,900	Tubular—8,660	
14	Heat release in furnace. B.t.u. per cu. ft. per hr.		20,000	16,000	19,000	
	(*a*) Below water screen	None		Negligible		
	(*b*) Total furnace volume	20,000	11,400	Vol. below screen unknown. This is at very low temp.		
15	Type of drum—*c*	Welded high tensile strength steel		Riveted	Riveted	
16	Type of furnace bottom	Dry bottom cooled by floor tubes	Welded	Allen-Sherman-Hoff water-cooled and water ejection	Dry hopper water-cooled	

a C.E. Co. = Combustion Engineering Company; B.-W. & G.-M. = Babcock-Wilcox and Goldie-McCulloch Limited; F.W. = Foster Wheeler Limited.
b Entering economizer, if used.

Steam Generating Installations

Canada		U. S. A.					
Picture Butte	Ontario Paper Co. Ltd.	Dresden	Mad River	Bryce E. Morrow	Rio Grande	Cedar Rapids	Pasadena
Canadian Sugar Factories Ltd.	Ontario Paper Co. Ltd.	New York State Electric & Gas Corp.	Ohio Edison Co.	Consumer Power Co.	El Paso Electric Co	Iowa Electric Light & Power Co.	City of Pasadena
Picture Butte, Alta.	Thorold, Ont.	Dresden, N.Y.	Spingfield, Ohio	Comstock, Mich.	El Paso, Texas	Cedar Rapids, Iowa	Pasadena, California
1936	1936	1937	1937-38	1938	1929 (Aug.)	1937	1932
B.-W. & G.-M. Stirling	F.W. 3 drum—bent tube	F.W.	C.E. Co. 3-drum—bent tube	F.W. 3-drum—bent tube	B.-W. Stirling—Class 24 No. 38	Water tube X drum	B.-W.
250	435	675	800	800-850	450	700	400
545	660	825	850	850	750	777	750
Chain grate	Pulverized coal—unit system	Pulverized fuel burners—Intervane type	Pulverized coal	Pulverized coal	Peabody—Combination gas and wide range oil burning equipment.	Water-cooled stoker	Combination gas and oil burners
2,800	7,000	5,570		21,950	8,775	7,500	7,500
63,630	150,000	110,000	225,000	400,000	184,500	300,000	210,000
250	365	368	274 at full load	278 at full load	300 (entering economizer)	380	385
7,075	12,750	8,750	6,150	7,448	14,249	13,389	15,200
	1,700	2,719	4,325	4,076 (projected)	1,274	7,137	946
Pendant	2,500	Convection	7,200	9,450	. & W.—1928 design inverted type	4,533	3,340
None	None	2,304	14,100	28,512	None	4,608	
None	Tubular—15,000	10,560	Combustion Engineering Co.—plate—22,500	Tubular—54,100	B. & W.—Tubular Class 24 No. 38 19,450	Livingstone 20,500	Ljungstrom regenerative—Heats 259,000 lb. air per hr. from 100-494 deg. F.
		45,000	29,600	24,500			35,000 (max.)
	24,350				30,198	53,000	
Riveted	Fusion welded	Fusion welded	Fusion welded	Fusion welded	Riveted	Fusion welded X—drum	Riveted—inside caulked
	Dry bottom sloped for hand raking	Dry ash	Dry	Dry	Flat—non water-cooled—Insulated surface	Water-cooled stoker	Brick—air cooled

THE ENGINEERING JOURNAL

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

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The London Meeting

The Annual Meeting just concluded in London, Ont., like that held at Quebec in 1927, is an example of the successful gathering which can be organized by an active and enthusiastic branch, even if its membership is not large. Many people believe that a somewhat smaller meeting has a more personal touch than can possibly be the case when registration approaches the thousand mark; individual members are not so hard to find, and thus the hospitality which our branches always extend so freely to visiting members affords more opportunity for the formation and renewal of friendships.

The programme at London this year was of a rather unusual character. At the suggestion of the branch committee, the papers and discussions at the technical sessions centred around two important topics, each of which has marked local interest. The first—highway safety—is a matter of special concern in Ontario, where highway construction is being carried on on so imposing a scale, and also vitally affects the great army of motorists and pedestrians all over the Dominion. The pressing nature of the problem dealt with in the second series of papers—flood control in Southwestern Ontario—was emphasized by the occurrence of quite respectable floods in the Thames and Grand River Valleys only a few days after the conclusion of the discussions at the meeting.

Perhaps the most important matter dealt with at the business sessions of the meeting was the present discussion regarding co-operation between The Institute and several of the Provincial Associations of Professional Engineers, a question on which the future of the engineering profession in Canada depends; a notable address of the Prime Minister of Ontario at The Institute's Annual Dinner was full of anecdotes and engineering information, delivered in his own inimitable style; the entertainment which followed the dinner was appreciated by everybody; at the luncheon addresses we heard about the remarkable results of psychoanalysing Robinson Crusoe, and were informed as to the difficulties surrounding the export of power from Canada; in fact there was no monotony of subject matter, and something was available for everyone's taste.

Thanks to the hard work and excellent organization of the local committee, the success of the meeting was undeniable. With a total registration of nearly three hundred and fifty, including delegates from the Maritimes and from British Columbia, Vice-President Buchanan and the branch members and ladies who formed his committees earned and received many expressions of appreciation of the results of their work and of the thoroughly enjoyable character of the meeting.

Presidential Duties During February

On Saturday evening, February 5th, the President attended the annual banquet of the graduates of L'Ecole Polytechnique at the Cercle Universitaire. Before the banquet he was accorded the honour of participating as an official witness in the ceremony of conferring the Honorary Degree of Doctor of Science upon S. A. Baulne, Professor of Reinforced Concrete at l'Ecole Polytechnique, by Mgr. Olivier Maurault, Rector of the University of Montreal. At the banquet which followed, the President had an opportunity of voicing the gratitude of The Institute for the contribution to its welfare made by graduates of L'Ecole Polytechnique. He called attention to the interesting fact that no engineering college in Canada has in proportion to its graduate strength given The Institute such a high percentage of executive officers, notably, Past-Presidents Ernest Marceau, Arthur St. Laurent, Arthur Surveyer, Albert Decary, Olivier Lefebvre, and G. J. Desbarats; Vice-President A. B. Normandin; Councillors Arthur Duperron, Hector Cimon, Aime Cousineau, Auguste Frigon, Bruno Grandmont and Alex Lariviere and the late Treasurer, J. A. Duchastel de Montrouge.

On Monday, February 7th, the President represented The Institute at the annual meeting in Montreal of the Canadian Forestry Association.

On Thursday, February 17th, at the annual smoker of the Montreal Branch he presented the following prizes: The Past-Presidents' Prize (Honourable Mention) to E. R. Jacobsen., A.M.E.I.C., and the Phelps Johnson Prize to G. Martin, Jr.E.I.C.

On this occasion, on behalf of the Council, he also presented to the recently resigned Assistant Secretary a piece of silver upon which the following inscription was engraved under the crest of The Institute:—

"Presented to John F. Plow, A.M.E.I.C.
February 17, 1938, in recognition of his
services to the E.I.C."

On Friday evening, February 18th, he presided at the regular monthly meeting of Council at which there was an unusually large attendance of outside members of Council.

On Saturday evening, February 19th, he represented The Institute at the Annual Banquet in Montreal of the Royal Architectural Institute of Canada, when the principal speaker, the Lieutenant-Governor of the Province of Quebec, paid an eloquent tribute to the Architectural Profession. On this occasion a member of The Institute, Mr. G. MacL. Pitts, was presented with a diploma indicating that he had been elected a Fellow of the R.A.I.C.

On February 24th, the President attended the luncheon meeting of the Ottawa Branch and presented the Gzowski Medal of The Institute to J. H. Parkin, M.E.I.C., Director, Division of Mechanical Engineering of the National Research Council, for his paper entitled, "North Atlantic Air Service, London-Montreal."

Mr. Challies took advantage of this opportunity to refer appreciatively to the prominent position members of The Institute were taking in advancing the cause of scientific and industrial research in Canada. The expressed policy of those in authority during the period around 1916-1920 when the Research Council was being established, that engineers should be "on tap but not on top," has long since and wisely been abandoned. Today members of The Institute were both "on tap and on top" at the National Research Council, as evidenced by the presence on the Council itself of Past President Julian C. Smith, Councillor Augustin Frigon, Dean A. L. Clark, Dean E. P. Fetherstonhaugh, Dean C. J. Mackenzie and its President, Major General A. L. McNaughton, and also by the fact that several of Gen. McNaughton's principal officers are members of The Institute, including Councillor Dr. Boyle, and the recipient of the Gzowski Medal, Mr. Parkin.

Recent Meetings of Council

Meeting of January 31st

A meeting of the Council of The Institute was held at the Hotel London, London, Ontario, on Monday, January 31st, 1938, at nine-thirty p.m., with President J. B. Challies, M.E.I.C., in the chair, and twenty-four past and present members of Council present.

The formal appointments were made of the Secretary, Treasurer, and the chairmen of the standing committees, together with other committee appointments.

On the recommendation of the Finance Committee, the secretary was directed to write to the secretaries of the various branches, enclosing a copy of the suggested uniform system for financial statements for the branches, as submitted by Mr. James McMillan of Calgary to the Round Table Conference in June 1937, with a request from Council that the branches adopt this system of classifying their accounts for their 1938 records.

Professor Spencer of Saskatoon, Chairman of the Special Committee on Membership and Management, presented an informal report of the situation in Manitoba, Saskatchewan and Alberta, as regards co-operation with the Professional Associations, in all of which provinces proposals somewhat similar to those which are being discussed with Nova Scotia were now under consideration. At the request of Council, Professor Spencer undertook to confer with the interested groups in these provinces on his return to the west. Professor Spencer remarked that in the western provinces there was a desire for some co-ordinating body for the Professional Associations, and he was requested to continue his discussions, explaining that The Institute Council is actively interested in working out arrangements generally similar to those for Nova Scotia.

Professor McKiel presented communications he had just received from Nova Scotia, including a revised draft agreement dated January 27th, 1938, in which a number of changes had been suggested in The Institute draft of the proposed agreement with the Nova Scotia Professional Association. After discussion, it was decided to place the consideration of this draft in the hands of a small committee consisting of the President and Councillors Newell and Busfield, who would confer with The Institute's counsel in regard to the changes suggested by Nova Scotia, the result of their conferences to be submitted to Nova Scotia for comment and possible approval.

The keynote of the discussion at this Council meeting was a strong desire on the part of all councillors for any action that might promote closer relations between The Institute and other professional engineering bodies, particularly the Provincial Professional Associations. Great satisfaction was felt at the prospect of an early conclusion to the negotiations looking to a compact between The Institute and the Nova Scotia Association.

Professor Spencer gave a report of the work of the Committee on Membership and Management, stating that necessary information regarding the organization of other societies had been collected and sent to councillors.

Mr. Busfield presented a verbal report of his Committee on the Publications of The Institute.

The Council rose at eleven forty-five p.m.

* * *

Meeting of February 18th

A meeting of the Council of The Institute was held at Headquarters on Friday, February 18th, 1938, at eight o'clock p.m., with President J. B. Challies, M.E.I.C., in the chair, and fourteen other members of Council present.

The Council noted with great regret the death of Kenneth Buchanan Thornton, and unanimously passed a resolution expressing sincere sympathy with Mrs. Thornton and family.

Discussion took place as to the organization and membership of the Papers Committee, whose functions are so important to the welfare of The Institute and the branches. It was decided that the committee for this year shall consist of vice-presidents in the various zones who will organize zone sub-committees consisting of representatives from each of the branches in their respective zones. It is hoped in this way to carry out more effectively the purpose of the committee in arranging for an adequate supply of papers and speakers, particularly for the smaller branches of The Institute.

In reporting progress on the proposed agreement with the Nova Scotia Professional Association, the President explained that a second draft, as revised by the Nova Scotia co-ordinating committee was now under consideration by The Institute's counsel.

In regard to the proposed new Section 76 of the by-laws, there was complete agreement as to the necessity of taking measures to secure a large and favourable vote, and, after discussion, it was decided that a telegram should be sent from the President to every branch chairman, asking each chairman to urge the corporate members of his branch to vote on this important question.

The report of the Finance Committee was presented, together with a draft budget for the year 1938, and, after discussion, this budget was approved as showing an estimated revenue of \$53,600 and an expenditure of \$52,200. It was noted that a small sum had been provided for much needed improvements in the headquarters building.

The resignations of two Associate Members and twelve Students were accepted. Four members were removed from the membership list. Three members were reinstated.

Consideration was given to the appointment of official delegates from The Institute to the Plenary Meeting of the International Electrotechnical Committee to be held in London in June of this year, and to the International Engineering Congress in Glasgow during the same month.

At the request of the Institution of Civil Engineers and the Institution of Mechanical Engineers recommendations were made as to the second award of the James Watt International Medal.

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

Elections.		*Transfers.*	
Members	2	Associate Member to Member	2
Associate Members	10	Junior to Associate Member	4
Juniors	4	Student to Associate Member	6
Affiliate	1	Student to Junior	9
Students admitted	9		

The Council rose at eleven forty p.m.

John Bow Challies, C.E., M.E.I.C.

A review of the major progressive movements within both the Canadian Society of Civil Engineers and The Engineering Institute of Canada for the past 25 years reveals the fact that our 1938 President was constructively active in them all.

During that difficult transition period in The Institute's history, from 1915 to 1919, when the present organization was evolved from the Canadian Society of Civil Engineers and a new era of broadened outlook and enhanced usefulness for The Institute was inaugurated, the writer, as general secretary, had repeated cause for gratitude to J. B. Challies for the advice and assistance he rendered Headquarters, first as an officer of the Ottawa Branch, and then as a member of Council. He became the first and only chairman of the Ontario Provincial Division which was set up by Council for the sole purpose of leading the movement among the organized engineering bodies of Ontario for a licensing authority, with the result that there came into being the Association of Professional Engineers of the Province of Ontario. On the first Council of the Association he represented the Civil Engineers, in which position he served the Association during its formative period and until 1924 when he moved to Montreal. Elected to the Council of The Institute in 1920, he continued in office for two years, during which period he was chairman of the Special Committee on Policy that recommended important changes in the By-Laws of The Institute, all of which were subsequently endorsed by the membership. Perhaps the outstanding feature of these changes was the establishment of the basic principle that is the very warp and woof of The Institute's strength, namely, the right of every branch, large or small, to have direct and continuous representation upon Council and to select such representation from within its own membership. As a reward for his contribution to the licensing movement in Ontario, and to the clarification of the policies of The Institute, he was elected Vice-President in 1922. A member of the American Society of Civil Engineers and actively interested in promoting friendly relations with sister societies abroad, he became chairman of the Committee on International Co-operation in 1925. During 1935 and 1936 he assumed the treasurership, and in the period 1935-1937 was a member of the Consolidation Committee, when he strongly favoured a programme that would permit close co-operation between The Institute and the various professional associations on the basis of their present corporate status and without involving either the autonomy of The Institute or the independence of the Associations.

JOHN BOW CHALLIES, C.E., M.E.I.C.

A member of the famous 1903 Engineering Class of the University of Toronto, which class has already given The Institute a president and three vice-presidents, Mr. Challies commenced his professional career at Ottawa as an engineer of the Topographical Surveys of Canada. Subsequently he successively occupied the positions of chief hydraulic engineer, Department of the Interior; superintendent of Water Power for Canada; director and chief engineer of Water Power and Reclamation Service; director, Dominion Hydrometric Survey; member, Dominion Power Board; member, Dominion Fuel Board; consulting engineer to the Department of External Affairs. In the latter position, as adviser to four Federal premiers, he was for many years a familiar figure before the International Joint Commission and at Federal-Provincial conferences regarding international waterway matters. As its first director, he was largely responsible for the organization of the Hydrometric Survey of Canada, the Water Resources Papers of which are of great importance to engineers dealing with run-off or river flow problems. He took a leading part as special liaison officer representing the Federal Departments in the institution of the Research Council of Canada. Few contributed more constructively to the Dominion-wide movement among governmental employees for an adequate recognition of the engineer in the public service. He was one of the founders of the Professional Institute of Civil Servants. He represented the Government of Canada at the International Engineering Congress in San Francisco in 1915. The outstandingly successful character of Canadian participation in the World Power Conferences at London in 1924, at Berlin in 1930, and at Washington in 1936, was due in no small measure to Mr. Challies' initiative. While in the Federal Public Service he was a recognized authority on administrative, investigatory and international features of water resources and power matters. Since assuming, in 1924, a professional position with The Shawinigan Water and Power Company, of which Company he is now an Assistant General Manager, he has become equally well known in the electrical utility field.

Always a staunch supporter of any effort to advance the interests of the engineering profession, and with a successful record as engineer, administrator and executive, Mr. Challies assumes the presidency well prepared for its exacting duties. His promotion to the highest office in The Institute is a fitting reward for long and loyal service. Space does not permit reference to the President's extra-professional interests, except that his activities therein indicate a capacity for service that augurs well for a very successful presidency. (FRASER S. KEITH)

Address of the Retiring President

G. J. Desbarats, Hon.M.E.I.C.

Delivered before the Fifty-Second Annual General Meeting of The Engineering Institute of Canada, London, Ont., January 31st, 1938.

The ambitious title of President's Address is rather a misnomer in this case as I have no intention of giving an address, but propose to comment briefly on a few of the happenings in the last Institute year.

The outstanding event of the year was, undoubtedly, the celebration of the Semicentennial of The Institute at Montreal and Ottawa last June. It was a great privilege and a great pleasure to preside at this function, especially for one like myself who had known the Canadian Society of Civil Engineers in its early days when it was struggling for recognition and for its very existence. This great gathering, with a registration of about a thousand, amply repaid the organizers and was an inspiration to the Council and members of The Institute.

It was a pleasure for members of The Institute to welcome the delegates from sister societies and the calibre of these delegates was very flattering to The Institute. The leading Engineering Societies of Great Britain and the United States sent their presidents or vice-presidents to represent them to convey their greetings and present their congratulations to our Institute. These eminent engineers, busy men, took time, travelled long distances to be with us at our Semicentennial. It was a recognition of The Institute as the National Engineering Society of this country, representative of the profession in Canada and a token of the high position our Institute has attained in the engineering world.

The special number of The Engineering Journal issued at the time of the Semicentennial was a most creditable publication, a volume of over two hundred pages, containing the story of The Engineering Institute of Canada and a series of some twenty-seven articles by prominent Canadian engineers describing the growth of different branches of engineering.

During the past summer I visited all the Branches of The Institute from Sault Ste Marie to Victoria and later I visited the Branches in the Maritime Provinces. I also visited some of the Branches in the central portion but I wished particularly to visit the branches at a distance from headquarters which cannot have close relations with the administration of The Institute and very seldom meet The Institute's officers.

Needless to say I was very well received at all these branches. No doubt the warmth of the welcome was largely due to my official position as president but in every branch my stay was made very pleasant and I wish to thank the branches for the many courtesies extended to me.

It is difficult to over-estimate the importance of visits of this kind. They bring the officers and members of the branches in close personal contact with headquarters, they afford opportunities for discussion of Institute and Branch problems, they allow the branches to put forward in an informal manner valuable suggestions which would hardly be put forward in an official way, they provide opportunities for removal of misunderstandings and they promote friendly personal relations which are of great value to The Institute.

I was much impressed throughout my trip by the spirit of optimism which pervaded the branches. Unemployment among the engineers has practically disappeared, the engineers have had their full share of the better business conditions which have followed the depression and are looking forward to improved conditions in the construction trade and in government work.

It was pleasing to see the good relations which existed between the branches of The Institute and the Provincial Associations of Professional Engineers, but while these relations were of the friendliest nature it was apparent that steps should be taken to effect closer co-operation between these bodies so as to avoid duplication of effort and ensure joint action in all problems, local or national, of interest to engineers. This co-operation is particularly needed in the smaller communities where the comparatively heavy overhead falls on a small number of members.

Council has given particular attention to this problem and has worked on it continuously all year. The Plenary Council of June had it under consideration and appointed a Committee on Professional Interests charged especially to explore the relations with the Professional Associations and Council also appointed a special committee to discuss co-operation with the Nova Scotia Association. As a result of this activity conversations have been carried on with several of the Provincial Associations and in the case of Nova Scotia a tentative agreement has been drawn up and is now being discussed by the Association and the branches and I hope an arrangement will be made with the Nova Scotia Association which will be the precursor of similar arrangements in other provinces.

Before Council can enter into such an agreement it must be properly authorized and for this purpose it submitted the addition to the by-laws which was discussed here this afternoon. While this by-law defines the general lines on which the agreement is to be drafted it is sufficiently elastic to allow of meeting the special needs of the different Associations. Proper safeguards are provided to avoid any snap decision of Council. I hope that this by-law will obtain a large vote and will be adopted by a large majority.

I have sketched out in my mind a picture of the relations between a Professional Association and The Institute under a co-operative arrangement similar to the one now projected with the Nova Scotia Association. In a University city the students in Applied Science would be encouraged to join The Institute, the local branch would organize a students' section, would supply speakers to it, when needed would urge the students to contribute to its proceedings and also to attend the meetings of the branch. After graduating the student would become a Junior Member of The Institute and would attend the meetings of the branch, take part in its activities, come in contact and become acquainted with the older members. At the age of 27 this Junior would, if qualified, join the Association and automatically become an Associate Member of The Institute. At the age of 35 he would automatically come up for consideration and if qualified would join the member class of The Institute. It does not seem likely that many engineers under 27 years of age could qualify for membership in the Association or that they would feel the necessity for becoming legally Professional Engineers. I have used the age figures 27 and 35 because they are the age limits used by The Institute and because they seem suitable at the present time, but after experience has been gained other figures might be found better and if so would be adopted. The activities of the two bodies would be divided so that The Institute would handle all educational, technical and social activities, etc. The Associations would busy themselves in the legal sphere with questions of registration, remuneration, etc. At the present time a slight majority of the members of The Institute are also members of the Professional Associations. Under arrangements similar to the above, this majority would grow rapidly and The Institute would be composed of two groups, the larger and growing one composed of members of Professional Associations and a smaller one comprising, besides Students and Juniors, members residing abroad and the very small number who are not compelled by law to belong to the Professional Associations and do not wish to join them. Such an agreement would provide larger membership for both The Institute and the Associations, would ease the financial burden on the members, would avoid duplication of effort, provide practical identity of membership and uniformity of aims and prove a decided advantage to both bodies and to the Engineering Profession of Canada.

For the last few years the question of continuing the Engineering Catalogue has been debated every year. It was generally agreed that the Catalogue was a useful and creditable publication, its set up is attractive and it brings the name of The Institute before the public. Its financial results have, however, been disappointing and it was contended that The Institute should not engage in an enterprise of this kind. After canvassing members of The Institute, Council decided it would be advisable to abandon the Catalogue and has arranged to transfer its interests to Mr. N. E. D. Sheppard who has been connected with the Catalogue since its inception and who will continue its publication. The Institute will be relieved of responsibilities which are foreign to its general aims and will be assured that the publication which it has developed and nursed along and which fulfils a useful purpose will not be discontinued.

During the depression many of the members were unemployed and unable to pay their dues but were anxious to retain their membership in The Institute. To meet this situation, Council acting under by-law No. 37 formed a non-active list of members financially embarrassed who were excused from payment of annual dues while still remaining on the roll of members. In view of the improved conditions Council decided to do away with the non-active list and these members have either reverted to the active list or ceased to be members. Similar action has been taken regarding a number of Students and Juniors who were over the age limits. These members have either transferred to a higher class or been dropped from the roll. The list of members of The Institute is thus in a much healthier state than it was at the beginning of the year and gives a more accurate picture of the active membership of The Institute. The total membership of 4,536 shows an increase of 323 over last year. This is a reasonable increase and I hope it will be duplicated during the coming year.

At the close of my year of office I wish to acknowledge the great honour done me by my fellow members in electing me President of The Institute and to say that I appreciate the opportunity given me of serving The Institute and advancing the interests of the profession. I wish to thank the members of Council and the members of the various Committees of The Institute who have given time and effort to the work of The Institute and given me advice and assistance. I am also indebted to the Secretary whose experience and good counsel have been of great value to me and whose staff have worked faithfully during the year. Owing to the celebration of the Semicentennial the year has been an unusual one. I have found the experience very pleasant and I trust that my efforts will prove fruitful and of some use to The Institute.

Institute Prize Awards in 1937

W. H. Powell, M.E.I.C., awarded the *Past Presidents' Prize* for his paper on "The Need of the Engineer's Participation in Public Affairs," graduated from McGill University in 1909 with the degree of B.Sc., and was subsequently first assistant and articled pupil to Mr. B. J. Saunders, D.L.S. At the beginning of the year 1910 he was with the Maritime Bridge Company, New Glasgow, N.S., as a draughtsman, and in 1910-1911 was assistant on a Dominion

W. H. Powell, M.E.I.C.

E. R. Jacobsen, A.M.E.I.C.

Hydrographical Survey in the neighbourhood of Prince Rupert, B.C. In the following year Mr. Powell was in charge of a subdivision survey in northern Saskatchewan with the Topographical Surveys Branch, Department of the Interior, and from March to August 1912 he was in private practice on miscellaneous surveys. In August 1912 he was appointed city surveyor for the city of Vancouver which position he held for a number of years. In 1928 Mr. Powell became engineer for the Greater Vancouver Water District, and is at the present time engineer for the Greater Vancouver Water District and the Vancouver and Districts Joint Sewerage and Drainage Board, Vancouver, B.C. Mr. Powell was awarded the Gzowski medal for the year 1933-34 for his paper entitled "First Narrows Pressure Tunnel, Vancouver, B.C."

E. R. Jacobsen, A.M.E.I.C., received Honourable Mention for his paper submitted for *the Past Presidents' Prize.*

He was born at Calgoorlie, Australia, graduated from McGill University in civil engineering, 1929, and obtained his degree of M.Eng. from the same university in 1932. During his university course he was for three summers with McClave and McClave, as instrumentman and as field party chief for the State of New Jersey. In 1928 Mr. Jacobsen joined the Dominion Bridge Company Limited, Lachine, as designer, and has been loaned to their Winnipeg office and to the Canadian Bridge Company at Walkerville. He is at present structural designer for the Dominion Bridge Company Limited at Lachine, Que.

J. H. Parkin, M.E.I.C.

J. H. Parkin, m.e.i.c., awarded the *Gzowski Medal* for his paper on "North Atlantic Air Service, London to Montreal," was born in Toronto, Ontario, and graduated from the University of Toronto in 1912. From 1914 he was lecturer in mechanical engineering and then assistant professor of mechanical engineering. In 1926 Mr. Parkin was appointed associate professor of mechanical engineering, which position he held until 1929. In addition to his work at the University of Toronto, he was in 1916-1919 assistant to the engineer in chief, British Acetones, Toronto. In 1917-1929 in charge of aeronautical research and instruction at the University of Toronto, and in 1920-29 a consultant on machine and aeronautical questions. In 1929 he was appointed assistant director of the department of physics and engineering physics in charge of aeronautical research with the National Research Council, Ottawa, Ontario.

T. L. McCall, m.e.i.c., the winner of the *Leonard Medal* for his paper on "Some Coal Mining Practices of the Dominion Steel and Coal Corporation Limited," was born at Largs, Scotland in the year 1885. His mining engineering apprenticeship was begun in the year 1903 with Messrs. John and G. H. Geddes, m.e., Edinburgh, and in 1909 he successfully passed the British Home Office examination for 1st Class Colliery Manager. From 1910-1913 Mr. McCall was Assistant to the Managing Director of Ormiston Coal Company, Limited, Scotland, but in 1913 he went to the Federated Malay States where he was manager of Malayan Collieries, Limited until 1920. In 1921 he returned to Sydney, N.S., where he became assistant mining engineer with the Dominion Steel and Coal Corporation Ltd., advancing in 1929 to the position of chief mining engineer, which he holds at the present time.

J. R. Donald, m.e.i.c., has been awarded the *Plummer Medal* (gold) for his papers on "Fire and Explosion Hazards from Industrial Products" and "Chemical Engineering." He is president of the Donald-Hunt Company, Montreal, having graduated from McGill University in 1913, after which be joined the Nichols Chemical Company, Limited, at Sulphite, Ontario. The next year he was engaged in general consulting with the J. T. Donald and Company Limited. From 1916 until 1918 Mr. Donald was chief inspector of explosives and chemicals for the Ministry of Munitions, Canada, and in 1919 was appointed chemical engineer and chief chemist of the Canadian Packing Company Limited, Toronto, later joining J. T. Donald and Company Limited. When the Donald-Hunt Company Limited, inspecting engineers and metallurgists, was formed in 1934. he became president of that organization.

Edgar Stansfield, m.e.i.c., awarded the *Plummer Medal* (silver) for his paper on "The Burning of Low Rank Alberta Coals," graduated from Victoria University, Manchester, England, and came to Canada in 1906 as chemist with the Dominion Iron and Steel Company. From 1907 until 1910 he was chief chemist in an investigation of Canadian coals for the Dominion Government, and from 1910 until 1920 was chief engineering chemist for the Fuel Testing Division of the Department of Mines at Ottawa. From 1918 until 1921 Mr. Stansfield was also chief chemical engineer for the Lignite Utilization Board of Canada, and since 1921 has been chief chemical engineer for the Research Council of Alberta, and research professor of fuels at the University of Alberta, Edmonton, Alta.

D. C. McCrady, S.E.I.C.
Winner of the John Galbraith Prize.

T. L. McCall, M.E.I.C.

G. Martin, Jr.E.I.C.
Winner of the Phelps Johnson Prize.

The Fifty-Second Annual General Meeting

Convened at Headquarters, Montreal, on January 20th, 1938, and adjourned to the Hotel London, London, Ontario on January 31st, 1938.

The Fifty-Second Annual General Meeting of The Engineering Institute of Canada commenced at Headquarters on Thursday, January twentieth, nineteen hundred and thirty-eight, at eight o'clock p.m., with Vice-President J. A. McCrory, M.E.I.C., in the chair.

The Secretary having read the notice convening the meeting, the minutes of the Fifty-First Annual General Meeting were submitted, and on the motion of George R. MacLeod, M.E.I.C., seconded by J. G. Hall, M.E.I.C., were taken as read and confirmed.

Appointment of Scrutineers

On the motion of F. N. Harling, A.M.E.I.C., seconded by J. B. D'Aeth, M.E.I.C., Messrs. A. Turner Bone, A.M.E.I.C., and J. G. Hall, 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 J. L. Busfield, M.E.I.C., seconded by W. G. Hunt, M.E.I.C., that the meeting do adjourn to reconvene at the Hotel London, London, Ontario, at two thirty p.m., on the thirty-first day of January, nineteen hundred and thirty-eight.

Adjourned General Meeting at the Hotel London, London, Ontario

The adjourned meeting convened at three o'clock p.m., on Monday, January 31st, 1938, with President G. J. Desbarats in the chair.

After welcoming the members present, President Desbarats pointed out that the agenda as drawn up provided for the retiring President's address at five o'clock. He asked the meeting to approve of this method of procedure, which would involve the completion of the routine business regarding reports, etc., by that time.

On the motion of R. L. Dobbin, M.E.I.C., seconded by Geoffrey Stead, M.E.I.C., it was *resolved* that the routine business should terminate at five o'clock, and the retiring President's address be given at that hour.

The Secretary announced the membership of the Nominating Committee appointed to nominate the officers of The Institute for 1939 as follows:

Nominating Committee—1938

Chairman: H. F. Bennett, M.E.I.C.

Branch	*Representative*
Halifax Branch	C. A. D. Fowler, M.E.I.C.
Cape Breton Branch	W. C. Risley, M.E.I.C.
Saint John Branch	V. S. Chesnut, A.M.E.I.C.
Moncton Branch	T. H. Dickson, A.M.E.I.C.
Saguenay Branch	A. I. Cunningham, A.M.E.I.C.
Quebec Branch	L. P. Méthé, A.M.E.I.C.
St. Maurice Valley Branch	A. C. Abbott, A.M.E.I.C.
Montreal Branch	J. G. Hall, M.E.I.C.
Ottawa Branch	E. W. Stedman, M.E.I.C.
Peterborough Branch	W. M. Cruthers, A.M.E.I.C.
Kingston Branch	L. F. Grant, M.E.I.C.
Toronto Branch	G. H. Rogers, A.M.E.I.C.
Hamilton Branch	H. B. Stuart, M.E.I.C.
London Branch	D. S. Scrymgeour, A.M.E.I.C.
Niagara Peninsula Branch	G. H. Wood, A.M.E.I.C.
Border Cities Branch	J. Clark Keith, A.M.E.I.C.
Sault Ste. Marie Branch	A. E. Pickering, M.E.I.C.
Lakehead Branch	E. L. Goodall, A.M.E.I.C.
Winnipeg Branch	F. V. Seibert, M.E.I.C.
Saskatchewan Branch	W. E. Lovell, M.E.I.C.
Lethbridge Branch	J. M. Campbell, A.M.E.I.C.
Edmonton Branch	H. R. Webb, A.M.E.I.C.
Calgary Branch	S. G. Coultis, M.E.I.C.
Vancouver Branch	E. C. Thrupp, M.E.I.C.
Victoria Branch	F. C. Green, M.E.I.C.

Awards of Medals and Prizes

The Secretary announced the awards of the various prizes and medals of The Institute, stating that the formal presentation of these distinctions would take place at the Annual Dinner on the following evening:

The Past-Presidents' Prize to W. H. Powell, M.E.I.C., Vancouver, B.C., for his paper "The Need of the Engineer's Participation in Public Affairs." Honourable mention was awarded to E. R. Jacobsen, A.M.E.I.C., Montreal.

The Gzowski Medal to J. H. Parkin, M.E.I.C., Ottawa, "The North Atlantic Air Service—London to Montreal."

The Plummer Medal (Gold) to J. R. Donald, M.E.I.C., Montreal, "Fire and Explosion Hazards from Industrial Products" and "Chemical Engineering."

The Plummer Medal (Silver) to E. Stansfield, M.E.I.C., Edmonton, Alta., "The Burning of Low Rank Alberta Coals, Combustion and Control."

The Leonard Medal to T. L. McCall, M.E.I.C., Sydney, N.S., "Some Coal Mining Practices of the Dominion Steel and Coal Corporation Limited."

Students' and Juniors' Prizes

John Galbraith Prize (Province of Ontario) to D. C. McCrady, S.E.I.C., Peterborough, Ont., "Sanitary Analysis of Drinking Water."

Phelps Johnson Prize (Quebec—English) to G. Martin, Jr.E.I.C., Montreal, Que., "The Elements of Modern Combustion Engineering."

Report of Council, Treasurer's Report, and the Report of the Finance Committee

The Secretary then read the report of Council for the year 1937. The Treasurer's report was presented by Mr. Busfield and the report of the Finance Committee by Vice-President McCrory.

In connection with the report of the Finance Committee the President drew attention to the importance of continuous effort to increase The Institute's membership. For this purpose the spade work would have to be done by the branches, and he feared that in some cases that point had been overlooked. The duty of The Institute Membership Committee was really to stimulate and co-ordinate the activities of the membership committees set up by the branches. Increase in membership would the best way of solving the financial difficulty referred to in the reports of the Treasurer and the Finance Committee.

Reports of Committees

On the motion of F. Newell, M.E.I.C., seconded by Huet Massue, A.M.E.I.C., it was *resolved* that the reports of the following committees be taken as read:

Committee on Western Water Problems, Papers Committee, Committee on Professional Interests, Committee on Membership and Management, Library and House Committee, Employment Service Bureau.

Clarence M. Pitts, A.M.E.I.C., referred to the report of the Finance Committee, noting that the financial statement did not include the revenue and expenditure of the Semicentennial Fund. The Semicentennial celebrations had been a remarkable success, but he thought the membership should know what the expenses of the meeting were.

The President informed Mr. Pitts that while a list of firms and parties who contributed to the Semicentennial fund had been published in The Journal (July 1937, p. 589), and the thanks of The Institute had been extended to them at that time, the amounts of the individual subscriptions had not been published. The Semicentennial Committee had rendered a full statement of all expenditures and receipts, which had been properly audited, and was on file. Would the meeting like to hear that statement? Perhaps Mr. Busfield would like to speak on this matter.

Mr. Busfield stated that the contributions to the special fund amounted to approximately $5,000 of which the Semicentennial Committee had spent about $3,600 on general committee work, making good the losses on the functions of the meeting, and other committee expenses. Of the balance of $1,400, $1,000 had been handed over by the Semicentennial Committee to The Institute, to help defray the cost of the special Semicentennial number of The Journal, while the remainder had been left in the hands of the committee and had been used to pay the expenses of sending the illuminated addresses from branch to branch. Those addresses were at the moment hanging in the Georgian Room of the hotel for inspection. Mr. Pitts thanked Mr. Busfield for his statement.

Brian R. Perry, M.E.I.C., returning to the report of Council, noted in that report a statement that Council prepared an amendment to the by-laws as an alternative to those proposed by a group of thirty-one corporate members, and that Council's alternative amendment had been accepted by the group of thirty-one. As one of the members appointed by that group to represent the group in discussions with Council, Mr. Perry was of opinion that this statement was not technically correct. The amendments proposed by the group of thirty-one had been put forward in a sincere endeavour to co-operate with Council. In preparing them, anything felt to be contentious in the proposals of the Committee on Consolidation had been eliminated, and the group felt that their amendments would serve the purpose of The Institute better than the alternative put forward by Council. He felt that the proposals which resulted later from discussions between the representatives of the group and the representatives of Council, should be regarded as being the proposals of the thirty-one members, this being necessary in order to comply with the requirements of the By-laws. Mr. Perry desired to support the new Section 76 proposed by Council in every way, but felt that the formalities required by the By-laws should be applied in all cases.

The President agreed as to the practical correctness of Mr. Perry's statement, but remarked that a By-law had been prepared by Council and a draft of it agreed to by the representatives of the group—that draft had been sent to The Institute lawyers, who had suggested a few verbal alterations. Thus Mr. Perry was correct in saying that the wording of the proposed section 76 is not exactly the same as was put forward by his group, nor is it the exact wording put forward by Council. The altered version had been submitted to Mr. Perry and was understood to be satisfactory to him.

Gordon Pitts, A.M.E.I.C., remarked that Mr. Perry was trying to avoid the legality of the proposed By-law being questioned owing to its being put forward as a proposal of Council, instead of as a proposal from the group.

Mr. Perry agreed that it was incorrect to state that the proposals of the Council had been accepted by the group. Actually the proposals of the group were accepted by Council. Might not a single objector upset the By-law which everyone desired to see accepted?

J. B. Challies, M.E.I.C., felt that there had been no real departure from the procedure required by the By-laws. The By-law was the Council's original proposal and was subsequently accepted with fine grace by the three representatives.

Mr. Perry would like to see the statement in the Report of Council corrected so as to state that the proposal was put forward by the group and had been accepted by Council and made a *motion* accordingly. Mr. Gordon Pitts having read Section 75 of the By-laws, governing the procedure for introducing new By-laws, Mr. Busfield was of the opinion that the By-laws had been complied with by the procedure actually followed.

The President was doubtful whether an Annual General Meeting can amend a report of Council. Mr. Challies then *moved* that the meeting agree that the proposal for Section 76 should go out sponsored by Council. His motion was seconded by H. F. Bennett, M.E.I.C. The President thought Mr. Challies' motion was not relevant to the subject before the meeting, which was the Report of Council. Any resolution on the By-law such as that of Mr. Perry or of Mr. Challies could be discussed when the By-law proposal was being considered. This view was agreed to.

The President had no hesitation in saying that the By-law as presented by Council to this meeting was absolutely legal. The meeting could of course put forward any amendment to it, which would also have to go to ballot. If the By-law as proposed by Council and adopted or amended by this meeting goes to the membership for vote, he did not think the result could be challenged.

After further discussion, General C. H. Mitchell, M.E.I.C., *moved* that the report of Council be received, and the motion was *seconded* by P. L. Pratley, M.E.I.C. Mr. Clarence Pitts asked for a definite statement as to whether, a proposal having been presented to Council by a group within the terms of the By-laws, it was correct and legal for the proposal of Council to be the only ballot to go before the membership.

Further discussion took place during which Mr. Perry again urged that if any irregularity had occurred in connection with the proposals for a new By-law it would be possible for a single member to prevent its passage, a most undesirable event. General Mitchell's motion for the reception of the Report of Council was then put to the meeting and *carried.*

On the *motion* of J. L. Busfield, M.E.I.C., *seconded* by R. H. Findlay, M.E.I.C., the Treasurer's report was *received,* and on the *motion* of J. A. McCrory, M.E.I.C., *seconded* by J. A. Vance, A.M.E.I.C., the report of the Finance Committee was *received.*

On the *motion* of Mr. Newell, *seconded* by J. M. R. Fairbairn, M.E.I.C., it was *resolved* that the reports of the following six committees be *received*:

Committee on Western Water Problems, Papers Committee, Committee on Professional Interests, Committee on Membership and Management, Library and House Committee, Employment Service Bureau.

Branch Reports

On the motion of A Duperron, M.E.I.C., seconded by H. F. Bennett, M.E.I.C., it was *resolved* that the reports of the various branches of The Institute be taken as read and *received.*

Other Business

Robert F. Legget, A.M.E.I.C., drew attention to the omission from the printed reports of one from the Committee on Consolidation, whose activities were continued after the Annual General Meeting of 1937 until the result of the ballot had been made known. As secretary of the committee he had sent in a report to Council covering the operations of the committee from the last annual meeting until its discharge, and he would like to ask where the report was, and whether it would be presented to this meeting.

President Desbarats replied that the report had been received by Council; it had dealt with various topics, some connected with the consolidation question and some referring to other matters. It had been signed by the secretary and chairman of the committee, but statements had been received from certain members of the committee to the effect that they had not been consulted in regard to the report, and that they were not in agreement with it. Under these conditions it had seemed inadvisable to Council to bring forward that report.

Gordon Pitts, A.M.E.I.C., desired to point out that the report dealt with nothing that had occurred subsequent to the closing of the Committee on Consolidation, and referred to various matters which had come within the purview of the committee. The report was dated January 17th, 1938; the delay in presenting it had been due to the chairman's illness, and to the time necessary to send it to the various members of the committee for consideration. While consolidation in the form recommended by the committee and accepted by a Plenary Meeting of Council was no longer a live question, he did not think that that would be a sufficient reason for omitting the publication of the committee's report.

After further discussion, Mr. Pitts *moved* that the report be read to the meeting; the motion was *seconded* by Mr. F. Legget.

Having heard the motion, R. H. Findlay, M.E.I.C., begged to *move the previous question*, and his motion was *seconded* by Mr. Bennett.

The President pointed out that the acceptance of Mr. Findlay's motion would have the effect of closing all discussion on the matter before the meeting. On being put to the meeting Mr. Findlay's motion was *carried* by a vote of 28 to 6.

Entrance Fees

The Secretary reported that at the meeting of Council held on December 17th, 1937, it had been resolved that, subject to confirmation by the Annual General Meeting, the entrance fees for the year 1938 should be $10.00 for Members, Associate Members and Affiliates, and $5.00 for Juniors, the transfer fee in each case to be the difference between the entrance fee for the two classes. This arrangement would replace that which had been in force since October 1933, namely, a $5.00 entrance fee for all classes of membership. On the *motion* of Mr. McCrory, *seconded* by Mr. Newell, it was *resolved* that the meeting confirm Council's action.

Amendments to By-Laws

At the request of the President the Secretary read the notice for the introduction of a new By-law Section 76, and for amendments to the existing Sections 44 and 51, which had been mailed to corporate members on December 27th, 1937, and printed in The Engineering Journal for January 1938, pp. 40-41.

Proposed New Section 76

Professor H. W. McKiel, M.E.I.C., stated that as this amendment was vitally important to the scheme of co-operation which he, as a representative of Council, had been working out with the Provincial Association of Nova Scotia, he desired to *move* that it be approved by this Annual General Meeting and be sent out to ballot in the form contained in the printed notice.

After reviewing the history of the discussions which had taken place since the result of the ballot on consolidation had become known, Professor McKiel described the effect of the meetings held by C. A. Fowler, M.E.I.C., and himself with the Association and Institute branch officers in Nova Scotia, and he outlined the main provisions of the resulting draft agreement which had now been sent down to Nova Scotia for discussion there.

Professor McKiel pointed out that with regard to New Brunswick the incoming Council of the New Brunswick Association had been instructed at the Association's Annual Meeting to carry on negotiations with The Institute Council during the coming year, with the purpose of developing a similar scheme of co-operation in New Brunswick. That resolution had been carried unanimously.

In *seconding* Professor McKiel's motion, Mr. Gordon Pitts hoped that the tentative agreement now under consideration in Nova Scotia would be communicated to the meeting.

Professor McKiel stated that the document in question was somewhat long, and in its latest form, a draft dated January 27th, 1938, was in the shape which was suggested as being agreeable to the Association of Professional Engineers of Nova Scotia and the two branches of The Institute in that province.

The President pointed out that as that particular draft had not yet been considered by Council and was only a proposal sent from Nova Scotia for further discussion, it would be better that Council's original draft proposal should be read to the meeting. The President stated that while there was practical accord on the principles of the agreement, its wording was not yet in final shape.

Professor McKiel accordingly read the following draft agreement, dated January 4th, 1938, which had been approved by Council for transmission to Nova Scotia for discussion there:—

Preliminary Draft of Proposed Agreement Between The Engineering Institute of Canada and The Association of Professional Engineers of Nova Scotia

Dated Jan. 4th, 1938

MEMORANDUM OF AGREEMENT entered into this day of 1938, by and between The Engineering Institute of Canada, with head office at Montreal, P.Q., represented by its President and Secretary duly authorized for the purpose of signing this agreement by resolution of its Council dated day of 1938, hereinafter called the "Institute"

and

The Association of Professional Engineers of Nova Scotia, with head office at Halifax, N.S., represented by its President and Registrar, duly authorized for the purpose of signing this agreement by resolution of its Council dated day of 1938, hereinafter called the "Association."

WHEREAS it is desirable in the interest of the Engineering Profession that there be close co-operation between the Institute and the Association; and

WHEREAS such close co-operation will be promoted if, so far as is practicable, there is effected:

1. A common membership in the Province of Nova Scotia of the Institute and the Association,
2. A simplification of existing arrangements for the collection of fees;
3. A reduction in the total fees payable by those who are members of both the Institute and the Association.

NOW THEREFORE the parties hereto agree with each other as follows:

1. All present members of the Association and all joining in the future shall become members of the Institute or if they are already members shall continue their membership so that at all times all members of the Association shall also be members of the Institute.

2. Those members of the Association who on the date of this agreement are 35 years of age or older will be classified as Members (M.E.I.C.). Those members of the Association who on the same date are less than 35 years of age will be classified as Associate Members (A.M.E.I.C.).

3. Members joining the Association subsequent to that date shall be allocated to that class of membership in the Institute for which their age and professional experience qualify them under the By-laws of the Institute. All members of the Association on attaining the age of 27 years shall be classified as Associate Members of the Institute. All members attaining the age of 35 years shall be transferred to the class of Member, provided that their professional experience qualifies them for this class under the By-laws of the Institute.

4. The usual entrance fee and transfer fee of the Institute will not be exigible for members of the Association.

5. The Association agrees to collect one joint annual subscription from each of its members, from which it will remit to the Treasurer of the Institute as soon as possible after the 1st of January, and in any event not later than the 1st of June in each year, a fee at the rate of $6.00 per annum for each Member of the Institute (M.E.I.C.) and $5.00 per annum for each other member of the Institute. These subscriptions shall be in lieu of the annual fees due the Institute from these members pursuant to Section 34 of the Institute By-laws and will include the $2.00 annual subscription to the Journal.

6. The Association agrees to pay as soon as possible after the 1st of January, and in any event not later than the 1st of June in each year, to the Treasurer of the Halifax Branch of the Institute and to the Treasurer of the Cape Breton Branch of the Institute $...... for each member of the Association who is a member of the said branches. This payment shall be in lieu of the revenue hitherto received by the said Branches from the Institute, pursuant to Section 56 of the Institute By-laws.

7. This agreement shall be for a period of ..... years ending on December, 194 , and continued thereafter subject to either party giving notice of its desire to terminate same, such notice to be given not less than six months prior to the end of the calendar year.

Professor McKiel remarked that under the proposed agreement, while The Institute does not bind itself to refuse membership to any qualified engineer in Nova Scotia, so that there would still be some members of The Institute who would not be members of the Association, such persons would have to pay the regular Institute fee, an amount which would be greater than the combined fee for the same class of membership. There would thus be a substantial inducement to Institute members who had not yet joined the Association to do so.

Professor McKiel further pointed out that the income of The Institute under the proposed scheme would actually be slightly greater than the present net income of The Institute from its membership in Nova Scotia.

Professor R. A. Spencer, M.E.I.C., stated that at a joint meeting of the executive committee of the Association of Professional Engineers in Saskatchewan with the Saskatchewan Branch of The Institute, the meeting had gone on record as favouring similar proposals, and had appointed a committee to draw up details to submit to The Institute Council.

Before the question was put, Professor McKiel read his motion as follows:—

> That the new By-law, No. 76, be approved by this Annual General Meeting precisely in its present form, with a recommendation to the Council that the By-law be submitted to vote with the least practicable delay on a ballot separate from any other ballot and with a brief explanatory statement regarding its import.

Both Professor Spencer and Mr. Gordon Pitts rose to second this motion.

Mr. Gordon Pitts remarked that in seconding this motion he had desired to indicate that as far as the Committee on Consolidation was concerned the proposal had their thorough support.

The motion having been put to the meeting was *carried unanimously*, and it was noted, that as no amendments to the new section had been suggested, a pro and con committee would not be needed.

E. P. Muntz, M.E.I.C., remarked that the unanimous approval by the Annual General Meeting of the motion which had just been passed was an important event in the history of The Institute, and he *moved* that the meeting express its congratulations to Professor McKiel and Mr. Fowler for their endeavours on The Institute's behalf. Mr. Bennett, as a past councillor of the New Brunswick Association, and also of the Nova Scotia Association, had much pleasure in seconding the motion, which was *carried* by acclamation.

In expressing his thanks and appreciation, Professor McKiel said that his own reward had been in hearing the amendment approved, and he desired to add that the real power behind the movement in Nova Scotia to whom credit was due was actually Mr. C. A. Fowler.

A. L. Carruthers, M.E.I.C., as a member from the west, expressed admiration of the action which had been taken in Nova Scotia, and desired to say that the Victoria Branch had particularly asked him to express appreciation of the work, effort and thought which had been expended in this matter.

Address of Retiring President

At this point, in accordance with the resolution passed at the beginning of the meeting, President Desbarats delivered his retiring address, commenting on the various events in The Institute during the past year. (This address is printed on pages 147 and 148 of this issue of The Engineering Journal.)

Election of Officers

The Secretary presented the report of the scrutineers appointed to canvass the officers' ballot for 1938, and the officers named therein were declared duly elected as follows:—

President	J. B. Challies, M.E.I.C.
Vice-Presidents:	
Zone B	E. V. Buchanan, M.E.I.C.
Zone C	H. O. Keay, M.E.I.C.
Zone D	R. L. Dunsmore, A.M.E.I.C.
Councillors:	
Cape Breton Branch	A. P. Theuerkauf, M.E.I.C.
Moncton Branch	B. E. Bayne, A.M.E.I.C.
Quebec Branch	A. Lariviere, M.E.I.C.
Montreal Branch	J. L. Busfield, M.E.I.C.
	R. H. Findlay, M.E.I.C.
Ottawa Branch	E. Viens, M.E.I.C.
Peterborough Branch	A. B. Gates, A.M.E.I.C.
Toronto Branch	O. Holden, A.M.E.I.C.
Hamilton Branch	H. A. Lumsden, M.E.I.C.
Niagara Peninsula Branch	W. R. Manock, A.M.E.I.C.
Sault Ste Marie Branch	J. L. Lang, M.E.I.C.
Winnipeg Branch	A. J. Taunton, M.E.I.C.
Calgary Branch	J. Haddin, M.E.I.C.
Lethbridge Branch	J. T. Watson, A.M.E.I.C.
Victoria Branch	I. C. Barltrop, A.M.E.I.C.

President Desbarats congratulated The Institute on the election as President of a man whose distinguished career was known to all. He had great pleasure in welcoming Mr. Challies to the presidency. The newly elected President was then conducted to the chair by Past-President O. O. Lefebvre, M.E.I.C., and Past-President C. H. Mitchell, M.E.I.C.

President Challies, after taking the chair, expressed his appreciation of the honour conferred upon him, referred to the dignity, tact and devotion to duty of Past-President Desbarats, and remarked that in his opinion The Institute was on the threshold of a new era, in which the policy of closer co-operation with engineering bodies, particularly the Provincial Associations, would be put into practice. During his term of office the prestige of The Institute, which had been so strikingly evidenced during the Semi-centennial celebrations in June, would be zealously guarded by him.

On the *motion* of Dr. O. O. Lefebvre, a cordial vote of thanks was accorded by a standing vote to the outgoing President, Mr. Desbarats, and to the retiring officers of The Institute, who had worked so faithfully for The Institute during the past year.

On the *motion* of Past-President Fairbairn, the hearty thanks of The Institute were extended by a standing vote to the London Branch in recognition of their hospitality and activity in connection with the holding of the Fifty-second Annual General Meeting.

On the *motion* of Mr. Muntz, *seconded* by E. R. Smallhorn, A.M.E.I.C., it was unanimously *resolved* that a vote of thanks be tendered to the scrutineers for their services in canvassing the vote on the election of officers, and also that the ballot papers be destroyed.

Proposed Amendments to the By-laws Sections 44 and 51

With regard to these proposals, Dr. O. O. Lefebvre *moved* that the proposed changes in the two existing By-laws, numbered 44 and 51, be received by this Annual General Meeting, and that Council be requested to send same to vote, the ballot to be separate from any other ballot and in a form that will permit a vote for or against each of the two proposals.

Dr. Lefebvre did not wish his action in making this motion to be interpreted as signifying his approval of the amendments referred to, to both of which he was personally opposed. He desired to point out, however, that the amendment to Section 51 is one which at present concerns the Montreal Branch only, and in sending this proposal to ballot, he thought that the attention of the membership should be called to this fact. In his opinion this amendment to Section 51 was a matter on which the members of the Montreal Branch should have the whole say.

Dr. Lefebvre's motion was *seconded* by J. A. Vance, A.M.E.I.C.

Huet Massue, M.E.I.C., remarked that as a member of the Executive committee of the Montreal Branch for a number of years, he had noted that the elected members of that executive committee attended a smaller proportion of the meetings than ex-officio members. These senior members took a great interest in the affairs of the branch, and he thought that it would be a pity to do without that experience.

Mr. Massue's views were supported by Mr. Pratley, who was personally opposed to both the proposed amendments, and did not think that the amendment to Section 51 should be considered until the Montreal Branch had been asked for their opinion.

Mr. Gordon Pitts desired to express some views which were partly his own, and partly those of elected members of the branch executive committee. He would support the change in Section 51 because, with the present arrangement, it was useless for the elected members of the committee to attend if the ex-officio members had already made up their minds. There had been an example of this in connection with the sending out of the questionnaire of the Committee on Consolidation. When this questionnaire came to the Montreal Branch the elected representatives had very little to say, and the ex-officio members, who were not in favour of the proposals of the Committee on Consolidation, practically decided the attitude of the committee. In his view the constitution of the Montreal Branch executive committee should be no different from that of the Toronto or any other branch of The Institute.

The President having inquired whether the ex-officio members of the committee had not in point of fact been elected as councillors by the Montreal Branch members, Mr. Pitts expressed the opinion that four ex-officio members would be enough as far as good advice was concerned and this was the reason for the proposal which was being discussed.

Mr. Findlay pointed out that the only ex-officio members of the Montreal Branch executive committee not elected by the branch members would be the President and possibly two vice-presidents. In fact, one vice-president and the Montreal members of Council are elected by the Montreal Branch.

Mr. Newell drew attention to the provision in the proposed amendment to Section 51 that the ex-officio members, not exceeding four in number, are "to be determined by the order of their official seniority." He inquired as to the interpretation to be given to this phrase; as to whether a president would be senior to a vice-president, and whether a vice-president would be senior to a councillor. He thought it would be undesirable to take away from the committee the ex-officio councillors who could interpret to the branch the wishes and desires of Council and to Council the wishes and desires of the branch. If the change went into effect, Mr. Newell thought that the branch would lose a great deal of help which could be given by its councillors.

Mr. Legget remarked that the proposal to amend Section 51 had arisen from a prolonged discussion at the Round Table Conference held in June, at which there was a general feeling that a reduction in the number of ex-officio members was desirable.

In Mr. Pratley's opinion, the members of the branch executive committee, not on The Institute Council, had every encouragement to attend if they so desired. As one of The Institute officers who had passed through the executive committee of the branch, he had been only too glad to retain connection with it and to be of assistance.

Mr. Brian Perry felt somewhat embarrassed in speaking, because he was the actual chairman of the Montreal Branch. He believed that the question had been brought up at the Round Table Conference by C. K. McLeod, A.M.E.I.C., who had been secretary of the Montreal Branch for many years. In Mr. Perry's opinion the proposal was not merely a question for the Montreal Branch but for The Institute as a whole. The elected members of an executive committee should be held directly responsible to the branch for the success of the branch operations. With the present constitution of the Montreal Branch executive committee these elected members did not have the control. In Mr. Perry's opinion this was undemocratic and un-Canadian. When Mr. Perry had first been elected to the Montreal Branch executive committee he found that the newly elected members, who were on unfamiliar ground, got very little experience in the branch in the guidance of branch affairs, and that, in his opinion, was the reason for the small proportion of attendance of the elected members. He desired to make it clear to the members of The Institute outside of Montreal that in the opinion of a great many members of the Montreal Branch the elected members of the executive committee should not be dominated by the ex-officio members, particularly when any contentious matter comes up for consideration and when the ex-officio members may have come to an agreement among themselves. During the past three years, at any rate, nominations for members of council for the Montreal Branch had in all cases been decided by the ex-officio members.

Past-President Shearwood, M.E.I.C., as one of the ex-officio members of the branch executive committee, could assure the meeting that he had never had any sort of agreement with other ex-officio members and he had been greatly surprised when the question came up. Mr. Shearwood had originally asked the executive committee of the Montreal Branch to discuss the matter and express their views, and in his opinion the question should be put to the Montreal Branch as a whole to find out their views on the subject.

J. H. Hunter, M.E.I.C., speaking as the oldest living chairman of the Montreal Branch, had always welcomed the advice given by the ex-officio members, but could not remember presiding at any meeting where the ex-officio members exceeded the elected members in number. Mr. Hunter was opposed to the amendment as tending to raise doubt as to whether the Montreal Branch is able to manage itself or not.

Mr. Vance was of opinion that the matter should be settled by the opinion of the Montreal Branch members, and inquired whether the amendment had been sponsored or discussed by them, or whether the branch had made any recommendation.

President Challies having replied in the negative to these questions, Mr. Gordon Pitts doubted whether many members outside of Montreal would vote on the ballot. He desired to point out, however, that the By-law originated with, and had been supported by, the executive committee of the Montreal Branch.

Mr. Busfield, as an ex-officer and past-secretary of the Montreal Branch, considered that it had been very advantageous to have the ex-officio members present at executive committee meetings. He desired to suggest that as opposition had been expressed to the proposed amendment to Section 51 it should go forward to ballot as provided by the By-laws, and the chairman should name a pro and con committee.

Past-President Desbarats joined issue with members who contended that this was not a matter for the whole Institute, as the situation now existing in Montreal might at any time arise in other branches, as, for example, in Ottawa, where, if the vice-president for Ontario happened to reside in the Ottawa Branch district, and if the branch membership increased slightly, there would be five ex-officio members. In his opinion there should be no indication given that the vote should be restricted to the Montreal Branch. As a past member of the Managing Committee of the Ottawa Branch he was sure that the advice of the ex-officio members was extremely valuable, owing to their long experience on the Managing Committee.

Mr. Brian Perry, noting Mr. Newell's suggestion as to the ambiguity of Section 51, asked whether Mr. Newell would propose an amendment with regard to the matter of seniority, but Mr. Newell was not prepared to do this.

There being no further discussion on Section 51, it was *agreed* that this proposal should go to ballot in the form submitted, and that the President would name a pro and con committee.

Mr. Gordon Pitts, with regard to the proposal to amend Section 44 by increasing the quorum of Council, remarked that this suggestion had developed from the experience of the Committee on Consolidation. Mr. Pitts had noted that last year, when the form of ballot on the consolidation proposals was under discussion, a legal opinion had been secured as to the effect of resolutions passed by an Annual Meeting, this opinion being to the effect that Council was not necessarily bound by resolutions of an Annual General Meeting. If this opinion was correct it meant that the representatives of four thousand members could make decisions which could be thrown out by five members of Council, over whom the membership of The Institute had no control. Under these circumstances, Mr. Pitts was of opinion that five members was not a sufficiently large quorum for the Council. In his opinion it should be eleven. The proposers of the amendment to Section 41 had noted the difficulty in obtaining the presence of eleven councillors at Council meetings, so that in order that the business should not be held up the amendment provided that five members could continue to carry on the regular business of Council, but any serious questions would have to be decided at a Council meeting at which there would be at least eleven members present.

Fraser S. Keith, M.E.I.C., inquired whether at the present time all important questions of policy were not presented for discussion at a Plenary Meeting of Council, the ordinary meetings of Council dealing very largely with regular routine business. During his period of service as General Secretary he could not recall any occasion when more than eleven members had been present at a Council meeting, and in many cases it had been difficult to secure the attendance of five. He understood that this condition still existed. In Mr. Keith's opinion the passage of the proposed amendment to Section 44 would make it extremely difficult to carry on the business of The Institute.

Dr. R. W. Boyle, M.E.I.C., was glad to have the opportunity of recognizing the hard work, thought and time expended on the affairs of The Institute by a small group of people in Montreal. In his opinion it would be better if this work were shared by a greater number. He had thought at first of a quorum of fifteen, but the group of members proposing the amendment under discussion had whittled this number down to eleven. In Dr. Boyle's opinion the only objection to the proposed amendment was the lack of funds to defray at least in part councillors' travelling expenses to Council meetings. Dr. Boyle would recommend that the funds now expended from time to time on Plenary Meetings of Council should be devoted to the payment of travelling expenses for councillors to regular Council meetings, of which at least fifty per cent should be held outside of Montreal. The matter had, however, now been referred to Professor Spencer's Committee on Membership and Management, and Dr. Boyle thought that that it should be decided by the membership at large only after having had the benefit of Professor Spencer's committee's study and report.

Mr. Massue pointed out that statistics of meetings of Council for the last four years showed that at sixty per cent of the meetings of Council there were less than eleven members present. The attendance of Montreal members at Council meetings was never less than seventy-five per cent, in spite of which it was evidently very difficult to secure an attendance of anything like eleven members. This difficulty was, of course, due to the geographical problem, The Institute's membership being scattered over such a large area.

Past-President Desbarats believed that the practical effect of the proposed amendment would be to hamper very seriously the business of Council. If he understood the wording of the amendment correctly, a meeting of Council at which less than eleven members were present could not take any executive action whatever, even in matters of urgency. The members of Council practically available for Council meetings are those within three hundred miles of Montreal, of whom the Montreal members, including the President and Vice-President, make up eight. Members can also come from Ottawa, Quebec, and Three Rivers. Kingston and Peterborough are not practically available on account of railway connections. This being so, in his opinion, it would not be practical to attempt to work on a quorum of eleven.

President Challies remarked that it is the present practice of Council to refer by letter ballot to the whole Council, all matters of great importance. In his opinion this method of securing a decision from Council as a whole was more practical and workable than the scheme embodied in the proposed amendment to Section 44.

President Challies emphasized his objections to both the proposed amendments, and particularly to any increase in the quorum of Council. In his opinion, the doubling of the quorum would seriously hamper and delay the business of Council at a time when Council should be free to act promptly and positively in furthering the widespread desire of the membership for closer co-operative relations with other engineering bodies, and especially with the Provincial Professional Associations.

It was than *agreed* that the proposals for the amendment of Sections 44 and 51 should go out to ballot in accordance with Dr. Lefebvre's resolution, and that pro and con committees should be appointed by the President.

Mr. Legget desired to draw attention to a matter arising from the report of Council. At the present time a Royal Commission on Dominion-Provincial Relations was sitting, headed by the Hon. Newton W. Rowell. That Commission was receiving briefs of great interest dealing with Dominion-Provincial relationships and other matters of practical concern to Canada. Mr. Legget desired to ask the following question:

"Arising from the report of Council, and in view of:

1. Section (1) of The Institute by-laws, items c, d, and f.
2. The difficulties of professional organization in Canada, due to a legal interpretation of one word in the British North America Act.
3. The opportunity presented by the sittings of the Royal Commission headed by Hon. Newton W. Rowell, for a consideration of this matter, an opportunity which can not recur for many years, it is asked if the Council of The Institute, in co-operation with Provincial Professional Associations and organizations in other professions, has yet taken any steps to bring before the Royal Commission on Dominion-Provincial Relations a submission regarding the difficulties of professional organization in Canada, and, if not, is there yet time for such action to be taken?"

President Challies stated that the point brought up by Mr. Legget would receive consideration by Council, and inquired what was the word to which Mr. Legget referred. Mr. Legget replied "education," and remarked that on more than one occasion troubles have arisen because in the British North America Act the professions are not named.

There being no further business the meeting adjourned at six fifty p.m.

Social Functions

An unusual and exceedingly pleasant introduction to the meetings was provided in the form of a tea on the afternoon of the 30th in the Georgian Room of the Hotel London, at which the President and visiting officers and ladies of The Institute had the opportunity of meeting the

President, Premier and Past-President

officers and members of the London Branch and their wives, preparatory to the business of the meeting. The morning of the following day was devoted to registration, the first function of the meeting proper being a luncheon at which His Worship the Mayor of London expressed the city's welcome to the visitors, his address being followed by one on Robinson Crusoe by Professor J. A. Spenceley of the University of Western Ontario, in which he threw an unusual light on the mentality of Defoe's hero.

The Annual Dinner of The Institute on Tuesday, February 1st, was notable for a witty speech by the Prime Minister of Ontario, in which Mr. Hepburn gave an interesting exposition of the Provincial Government's policies in various fields of natural resources development.

The dinner was followed by an excellent variety entertainment organized by the London Branch.

C. F. Davison, A.M.E.I.C., Windsor, G. A. McCubbin, M.E.I.C., Chatham, and E. M. Krebser, A.M.E.I.C., Walkerville, Ont.

The final luncheon on Wednesday, February 2nd, was addressed by Major F. C. Betts, Member of the House of Commons for London, who gave a concise and unbiassed exposition of the pros and cons of the problem of the export of hydro-electric power.

Throughout the meeting the visiting ladies were well looked after by the ladies of the branch, and were particularly interested in the admirable arrangements at the Byron Sanitorium where they took tea on Monday afternoon. All agreed that the theatre party on Monday, and the luncheon and bridge on Tuesday at the London Hunt and Country Club, were most pleasant episodes in the story of the meeting.

Technical Sessions

A somewhat novel feature of the General Professional Meeting was that the majority of the papers presented were devoted to two major topics, each of special interest to Southwestern Ontario. The sessions on Tuesday were concerned entirely with Highway Safety, and those on Wednesday mainly with Flood Control in the Grand and Thames river basins.

Of the two papers on the former subject, the first was by Mr. C. A. Robbins, District Engineer, Toronto, Ontario Department of Highways, who pointed out that in the final analysis the matter of safety rests with the driver of a motor vehicle, and passed on to consider the elements of design necessary to increase the capacity of roads, make for free movement of traffic, and thus reduce accident hazard.

The second address, by Dr. McClintock, Director of the Harvard University Bureau for Street Traffic Research, dealt with the subject from a somewhat different point of view, outlining the basic elements of 'limited way construction,' a system requiring the complete physical separation of opposed streams of traffic; special design of all entries and exits to and from the highway proper; separation of all intersections, and a design which permits proper segregation of relatively fast and relatively slow vehicles.

An active discussion followed, in which the speakers ranged over almost the whole field of highway design, construction and equipment, and referred to such matters as the necessity for the education of drivers, highway illumination, proper provision for pedestrian traffic, and the elimination of defective motor vehicles.

The four papers dealing with Flood Control each treated a separate phase of the subject. Mr. John Patterson, Controller of the Meteorological Service of Canada, furnished a large amount of data concerning rainfall, snowfall, temperature, and the tracks of pressure minima in Southwestern Ontario, pointing out that from a meteorological point of view the occurrence of damaging floods was dependent not only upon a maximum rainfall, but also upon the ground conditions which affect the rate of run off. These conditions are the results of large scale changes in the atmospheric circulation of the northern hemisphere.

Mr. Norman Marr, the chief hydraulic engineer of the Dominion Water and Power Bureau, Ottawa, gave striking data as to the extraordinary variations in flow which occur in the Thames and Grand rivers, both of which have maximum flood flows of thirty to forty thousand cubic feet per second and minimum discharges of about one thousandth of that amount.

Mr. McCubbin, consulting engineer, of Chatham, dealt with the possible effect of large agricultural drainage schemes upon flood discharge, the results of which he considered to have been practically negligible as regards maximum heights of floods.

Mr. F. P. Adams, A.M.E.I.C., city engineer of Brantford, and secretary of the Grand River Conservation Commission, contributed a paper which analysed the characteristics of the two watersheds, discussed possible control methods, and described the storage and regulating reservoirs contemplated for the Grand river.

Shawinigan, Starch, and Streams Commission. Huet Massue, M.E.I.C., J. H. Hunter, M.E.I.C., and S. F. Rutherford, A.M.E.I.C.

During the discussion which followed it was obvious that the whole question was one of wide concern. Several of the speakers urged the importance of giving close consideration to the problem of increasing the minimum flow as well as decreasing the maximum flow of the rivers in question. It seemed to be the general opinion that the need of the moment was not so much for engineering activity, as for a proper education of the public and the supply of accurate information regarding the financial aspects of the question.

E. P. Muntz, M.E.I.C., President of the Ontario Association of Professional Engineers, and G. T. Seabury, Secretary of the American Society of Civil Engineers.

In the field of mechanical engineering two outstanding papers were presented on the closing day of the meeting. Professor C. A. Robb, M.E.I.C., of the University of Alberta, dealt with the development and performance of Canadian steam-electric power plants, and Messrs McQueen and Molke described the design and construction of a large steel pipe line at Outardes Falls, Quebec. The former paper analysed the thermal performance of certain Canadian steam-electric plants as compared with plants of a similar size in some other countries, and suggested that steam and hydro should be studied as complementary sources of power. The latter paper explained the 'shell theory' on which the pipe line in question had been designed, and gave details of its fabrication and erection.

* * *

Throughout the meeting the local Committee left nothing undone which could add to the comfort and enjoyment of the visiting members; their efforts were greatly helped by the interest and assistance given by the civic authorities, the industrialists of the city, and the officers of the University of Western Ontario.

NOTE: *For the illustrations on these pages we are indebted to the London Free Press.*

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.

Newly Elected Officers of The Institute

E. V. BUCHANAN, M.E.I.C., newly elected vice-president for Ontario, was Chairman of the Committee on Arrangements for the Annual Meeting recently held in London, Ontario. Mr. Buchanan was born at Hamilton, Lanarkshire, Scotland, and received his education at the Royal Technical College, Glasgow. He came to Canada in 1910, and in 1911 became electrical and waterworks engineer for the city of London, Ontario. In 1915 he was appointed general manager of the Public Utilities Commission of London, which position he holds at the present time. Last year Mr. Buchanan was elected chairman of the Canadian Section of the American Water Works Association.

E. V. Buchanan, M.E.I.C.

R. L. Dunsmore, A.M.E.I.C.

H. O. Keay, M.E.I.C.

R. L. DUNSMORE, A.M.E.I.C., newly elected vice-president for the Maritime Provinces, is superintendent of the Halifax refinery of Imperial Oil Limited, at Dartmouth, N.S. Mr. Dunsmore was born at Seaforth, Ontario, and graduated from Queen's University in 1915 with the degree of B.Sc. His early engineering experience was with the Department of Public Works, Canada, at Fort William, Ont. From 1914-1919 he was with the Corps of Canadian Engineers overseas, from which he retired with the rank of major. In 1919 he was appointed assistant city engineer of Sarnia, Ont. Later in the same year he joined the engineering staff of the Imperial Oil Ltd., at Sarnia. In 1922 he was appointed engineer in charge of construction for the Imperial Oil refinery at Calgary, and later assistant superintendent. In 1926 Mr. Dunsmore went to Talara, Peru, S.A., for the International Petroleum Company as general superintendent, and was appointed to his present position in 1930.

HERBERT O. KEAY, M.E.I.C., newly elected vice-president for the province of Quebec, and Manager, Research Laboratories, of the Consolidated Paper Corporation, Three Rivers, Que., was born at Laconia, N.H., U.S.A., and graduated from the Sanborn Seminary, Kingston, N.H., in 1894, and from the Massachusetts Institute of Technology with the degree of B.Sc in mechanical engineering in 1900. From 1900-1901 he took a special apprentice course at the Nicholson File Company, Providence, R.I. In 1901-1902 he was assistant engineer of works, Pennsylvania Steel Company, Steelton, Pa., 1902-1905, chief draughtsman, motive power department, Boston and Maine Railway, Boston, Mass., and from 1905-1906 was mechanical engineer. From 1906-1908 Mr. Keay was assistant professor of mechanical engineering at McGill University, and from 1908-1917 he was professor of transportation. From 1917-1919 he was resident consulting engineer with the Laurentide Company, at Grand Mère, Que., and from 1919-1928 was manager of their research department. From 1928-1932 he was director of research, for the Canada Power and Paper Company, and from 1932 to date Mr. Keay has been manager of the research laboratories of the Consolidated Paper Corporation, Ltd. at Three Rivers, Que.

I. C. BARLTROP, A.M.E.I.C., assistant engineer of the Public Works Department for the Government of British Columbia, is the new councillor for the Victoria Branch. He was born in England, receiving his B.A. from Queen's College, Cambridge, entered the Royal Engineers in 1914, retiring with the rank of captain in 1920. In that year he received an appointment on the staff of the Canada Land and Irrigation Company Limited at Medicine Hat, Alberta. In 1925 he joined the Public Works Department as a draughtsman, receiving his present appointment in 1935.

B. E. BAYNE, M.E.I.C., the newly appointed councillor of the Moncton Branch, is with the Canadian National Railways in Moncton, N.B. He is an electrical engineer and graduated from the Nova Scotia Technical College in 1922. From 1922-23 he was with the New Brunswick Electric Power Commission and in the latter year entered the service of the Canadian National Railways. Since that time he has been on construction and maintenance work with the electrical department and on the maintenance of unit cars.

J. L. BUSFIELD, M.E.I.C., newly elected councillor for the Montreal Branch of The Institute, and managing director of Gardner Engines (Eastern Canada) Limited, Montreal, was born in London, England, and educated at the City of London School and Dulwich College. In 1907 he graduated from the Central Technical College (City and Guilds Institute) and London University. From 1907 until 1912 he was on the resident engineer's staff with the eastern division of the Grand Trunk Railway and in 1912 was appointed chief of party in charge of surveys and later office engineer with the Mount Royal Tunnel and Terminal Company. In 1916 Mr. Busfield joined the staff of Walter J. Francis and Company, and in 1922 became a partner in the firm of Beaubien, Busfield and Company, Montreal. In 1927 he entered the commercial field as president of

Busfield, McLeod Limited, and in 1935 accepted the appointment which he now holds. Mr. Busfield has previously held a number of offices in The Institute including those of councillor and treasurer. He is at the present time chairman of the Committee on Publications.

R. H. Findlay, m.e.i.c., newly elected councillor of the Montreal Branch of The Institute, and mechanical engineer for the Dominion Bridge Company Limited, Lachine, Que., was born in Glasgow, Scotland, and received his technical education at the Royal Technical College, Glasgow. In 1911 he came to Canada and accepted a position with the Dominion Bridge Company, and became chief mechanical draughtsman in 1919. In 1930 he was appointed assistant mechanical engineer, and in the same year was appointed mechanical engineer for the Riverside Iron Works Ltd., Calgary, Alta. Mr. Findlay returned to Montreal in 1931 to resume charge of the mechanical engineering department of the Dominion Bridge Company, at Lachine.

John Haddin, m.e.i.c., consulting engineer of Calgary, Alta., is the new councillor for the Calgary Branch. He was born in Scotland and his first engineering experience was in that country. In 1907 he became an assistant engineer in charge of waterworks and sewers at Banff, Alberta, and Maple Creek, Sask. He was later on the design and construction of sewers and sewage disposal work in British Columbia and Alberta. He became partner in the John Galt Engineering Company in 1910 and remained there until 1921 when he became a partner in the firm of Haddin and Miles with whom he is at present associated.

Otto Holden, a.m.e.i.c., newly elected councillor for the Toronto Branch of The Institute, and chief hydraulic engineer of the Hydro Electric Power Commission of Ontario, was born at Toronto, Ontario, and received his technical education at the University of Toronto, graduating with honours in 1913.

Mr. Holden was for a short time with the Public Utilities Commission of London, Ont., and then joined the engineering staff of the Hydro-Electric Power Commission of Ontario. In 1918 he was placed in charge of the design of hydraulic plants and since that time has been engaged on the developments at Cameron Falls, Ranney Falls, Queenston, Chats Falls and others. Mr. Holden has been assistant hydraulic engineer since 1923, and was appointed to his present position last year. Mr. Holden also served as chairman of the Toronto Branch of The Institute in 1936.

J. L. Lang, m.e.i.c., newly appointed councillor for the Sault Ste. Marie Branch, was born in England, receiving his technical education at the University of Toronto, from which he graduated with the degree of B.A.Sc. in 1907. Mr. Lang is a member of the firm of Lang and Ross with whom he has been associated for many years except for the period from 1916-19 which he spent overseas with the Canadian Expeditionary Forces.

A. Larivière, m.e.i.c., has been appointed councillor of the Quebec Branch. Mr. Larivière, who is a graduate of the Ecole Polytechnique from which he received the degree of B.Sc., is a commissioner on the Quebec Public Service Commission. He joined the Commission in 1916 on the completion of a post graduate course in electrical engineering, was appointed engineer in 1922 and in 1931 was made commissioner.

K. S. Le Baron, a.m.e.i.c., is replacing Bruno Grandmont, a.m.e.i.c., as councillor for the St. Maurice Valley Branch. Mr. Le Baron is a graduate of McGill University of the year 1923. In the same year he accepted a position as assistant engineer in charge of power with the Dryden Paper Company, Dryden, Ont., and in 1925 was appointed chief engineer of the company. In 1928 he became chief engineer of the Nashwaak Pulp and Paper Company and in 1929 plant engineer of the Canadian International Paper Company at Three Rivers, Que., which position he now holds.

H. A. Lumsden, m.e.i.c., county engineer for the County of Wentworth, Ontario, has been appointed councillor for the Hamilton Branch. A graduate of McGill University in 1912 he was for a time resident engineer for the Canadian Pacific Railway at Red Deer West, Alberta, and Maple Creek, Sask., and in 1915 was appointed assistant engineer for the Department of Highways of Ontario, which position he resigned to go overseas. He returned to Canada in 1919 and in 1921 rejoined the engineering staff of the Department Highways of Ontario as district engineer of municipal roads.

W. R. Manock, a.m.e.i.c., newly elected councillor for the Niagara Peninsula Branch of The Institute, and manager for the Horton Steel Works, at Fort Erie North, Ontario, was born at Farmer City, Illinois, U.S.A., and graduated from the university of Illinois in civil engineering. His first engineering work after graduation was as a draughtsman with the Chicago Bridge and Iron Works, becoming chief draughtsman in 1917, and assistant manager of operations in 1923. The following year Mr. Manock was appointed manager of operations with the Horton Steel Works Limited, and at the present time is manager of the company.

A. J. S. Taunton, d.s.o., m.e.i.c., is now councillor for the Winnipeg Branch. He was born in England, received his engineering education at Manitoba University from which he graduated in 1912. His early engineering experience was with the Canadian Northern Railway. From 1914 to 1919 he served overseas with the 27th Batt. of the C.E.F., obtaining the rank of major. From 1920 to 1930 Mr. Taunton was district bridge engineer for the Manitoba Government and from 1930 to 1933 was a member of the board of engineers and engineer in charge of the construction of a number of bridges in Winnipeg. In 1933 he became assistant engineer for the Department of Public Works of Canada and at the present time is managing secretary of the Veteran's Assistance Commission in Winnipeg.

A. P. Theuerkauf, m.e.i.c., has been elected councillor for the Cape Breton Branch of The Institute. He is a consultant in engineering matters for the Dominion Coal and Steel Corporation in Sydney, N.S. Mr. Theuerkauf received his education at the Royal School of Technology at Dusseldorf, Germany. Coming to Canada soon after graduation he joined the Dominion Iron and Steel Company, Sydney, as mechanical draughtsman. In 1909 he became designer for the Dominion Coal Co., Ltd., Glace Bay, and the following year joined the staff of the Canada Foundry Company, Toronto. In 1911 he returned to the Dominion Iron and Steel Company and was appointed chief draftsman and subsequently assistant chief and chief engineer of the company.

Ephrem Viens, m.e.i.c., director of Testing Laboratories, Department of Public Works, Ottawa, has been appointed councillor of the Ottawa Branch of The Institute. He graduated in Arts from McMaster University in 1905, specializing in chemistry and physics. Later he took post graduate work.

He was first employed as a chemist at the International Portland Cement Association in Hull, Quebec, which position he held from 1906 to 1907.

In April 1907 he joined the staff of the Department of Public Works as chemist in the Testing Laboratories and from this position rose to that of director of the laboratories.

Mr. Viens' whole time, since joining the staff of this department, has been taken up in specializing in the testing of materials used by the Department of Public works and a number of other departments of the Federal Government.

E. Viens, M.E.I.C.

J. T. Watson, A.M.E.I.C., city manager of Lethbridge, Alta., has been appointed councillor for the Lethbridge Branch. He was born and educated in Scotland, coming to Canada in 1900. In 1906 he was appointed assistant to the chief engineer of the city of Calgary power and light plant. From 1906 to 1916 he was superintendent of the Western Electric Company's plant at Red Deer, Alberta, and in the latter year was appointed chief engineer of the city of Lethbridge power and light and water plant. In 1928 he received an appointment with the East Kootenay Power Company at Coleman, Alberta. In 1929 he received the appointment which he now holds.

ELECTIONS AND TRANSFERS

At the meeting of Council held on February 18th, 1938, the following elections and transfers were effected:

Members

CHESTNUT, Kenneth Randolph, B.Eng., M.Sc., (Univ. of N.B.), asst. engr., National Harbours Board, Saint John, N.B.

WHITBY, Eugene Mortimer, deputy city engr., Hamilton, Ont.

Associate Members

BINNS, Frank, B.Sc. (Mech.), (Tufts College), M.Sc. (Mech.), (Purdue Univ.), instructor in engrg. drawing, Mount Allison University, Sackville, N.B.

DILLON, Marmaduke Murray, Capt., M.C. and Bar, consltg. structural engr., London, Ont.

LASH, Stanley Dale, B.Sc., M.Sc., (Univ. of London), Ph.D., (Univ. of Birmingham), instructor in civil engrg., University of British Columbia, Vancouver, B.C.

MACLENNAN, William Ewen, (Inverness Academy), asst. res. engr., Lake Sulphite Pulp Co. Ltd., Red Rock, Ont.

MORISSET, Joseph Eudore, (Quebec Tech. School), asst. mill engr., Donnacona Paper Co. Ltd., Donnacona, Que.

RYAN, Hollis Franklin, B.Sc. (Elec.), (N.S. Tech. Coll.), mgr., apparatus divn., Canadian General Electric Co. Ltd., Edmonton, Alta.

SHIELDS, William Fisher, B.A.Sc., (Univ. of Toronto), field engr., Lake Sulphite Pulp Co. Ltd., Nipigon, Ont.

THOMSON, William James Renwick, B.Sc. (C.E.), (Tri-State College), asst. engr., Ontario Dept. of Highways, Ottawa, Ont.

TUFF, John Henry, asst. chief engr., G. H. White & Son, London, England.

WRIGHT, Leslie Austin, B.A.Sc., (Univ. of Toronto), 2349 Grand Blvd., Montreal, Que.

Juniors

GISLASON, Stefan Ingnor, B.Sc. (C.E.), (Univ. of Man.), dftsman., Ontario Dept. of Highways, Kenora, Ont.

HUTTON, Francis Spence, B.A.Sc., (Univ. of Toronto), levelman, C.N.R., Hamilton, Ont.

MacNEIL, Duncan Paul, B.Eng., (N.S. Tech. Coll.), test engr., Dominion Coal Company, Glace Bay, N.S.

WILDE, William Clayton, B.Sc. (Elec.), (Univ. of Alta.), sales engr., Canadian Telephones and Supplies Ltd., Calgary, Alta.

Affiliate

KENT, Cecil Charles, (Univ. of London), mgr., Winnipeg office, Fetherstonhaugh & Company, Winnipeg, Man.

Transferred from the class of Associate Member to that of Member

JOST, Leslie Gordon, B.Sc., (McGill Univ.), chief struct'l. engr., Consolidated Steel Corpn. Ltd., Los Angeles, Calif.

MASSUE, Huet, B.A.Sc., C.E., (Ecole Polytechnique, Montreal), asst. engr., Shawinigan Water and Power Company, Montreal, Que.

Transferred from the class of Junior to Associate Member

BUTLER, Ernest W. R., B.Sc. (Mech.), (McGill Univ.), Western Canada Manager, Bailey Meter Co. Ltd., Winnipeg, Man.

DONNELLY, William David, B.Sc. (Mech.), (Queen's Univ.), mech. dftsman., Ford Motor Company of Canada, Windsor, Ont.

GRINDLEY, Frank Llewellyn, B.Sc. (Civil), (Univ. of Alta.), junior engr., Dept. of Agriculture, Dominion Govt., Medicine Hat, Alta.

PHIPPS, Charles Ferdinand, B.Sc. (Elec.), (McGill Univ.), asst. engr., trans. line design, Shawinigan Water and Power Company, Montreal, Que.

Transferred from the class of Student to that of Associate Member

BARNSLEY, Frank Richard, B.A.Sc., (Univ. of B.C.), mgr., air conditioning divn., Canadian General Electric Co. Ltd., Montreal, Que.

CAMPBELL, James Stouffer, B.Sc., M.Sc., (Queen's Univ.), supervisor, pricing and routing depts., Massey Harris Co. Ltd., Toronto, Ont.

CLARKE, Stephen Herbert, (Faraday House Elec. Engrg. College), elect'l. engr., Sladen Malartic Mines, Montreal, Que.

FERGUSON, Allan Andrew, B.Sc. (Mech.), (McGill Univ.), Reed, Shaw & McNaught Ltd., Montreal, Que.

FONG, William Hinn, B.Sc. (Elec.), (McGill Univ.), relay mtce., Montreal Light, Heat & Power Cons., Montreal, Que.

REES, Howard Sutherland, (Grad. R.M.C.), B.Sc. (Civil), (Queen's Univ.) asst. engr., aeronautical engrg. divn., Dept. of National Defence, Ottawa, Ont.

Transferred from the class of Student to that of Junior

BAKER, John Arthur, B.A.Sc., (Univ. of B.C.), sales engr., Taylor Electric Mfg. Co., London, Ont.

BERRINGER, Ormus Benjiman, B.Sc. (Mech.), B.Eng. (Civil and Elec.), (N.S. Tech. Coll.), paving inspr., Lunenburg, N.S.

BIESENTHAL, Clarence G., B.Sc. (Queen's Univ.), dftsman., Spruce Falls Power & Paper Co. Ltd., Kapuskasing, Ont.

BLACHFORD, Henry Edmund, B.Sc., (McGill Univ.), 133 Hillcrest Ave., Montreal West, Que.

HENDRICK, Max Morton, Flying Officer, R.C.A.F., B.A.Sc., (Univ. of Toronto), Officers' Mess, R.A.F., Cranwell, England.

MILLER, Donald Waters, B.Sc. (Civil), (Univ. of Man.), dftsman., Island Mountain Mines Co. Ltd., Wells, B.C.

PITFIELD, Barclay Wallace, B.Sc. (Civil), (Univ. of Alta.), asst. engr., Northwestern Utilities Ltd., Edmonton, Alta.

SOLES, William England, B.Sc. (Mech.), (Queen's Univ.), control engr., Gaspesia Sulphite Company, Chandler, Que.

WILKINS, Ronald Edward, Lieut., R.C.E., (Grad. R.M.C.), B.Sc. (Civil), (Queen's Univ.), Work Point Barracks, Esquimalt, B.C.

Students Admitted

BEGLEY, William, B.Sc., (Detroit Inst. of Tech.), student course, Canadian General Electric Co. Ltd., Peterborough, Ont.

CAMPBELL, Albert Murray, (Queen's Univ.), 44 Woodworth Ave., St. Thomas, Ont.

CAMPBELL, Kenneth William, (Queen's Univ.), 44 Woodworth Ave., St. Thomas, Ont.

HOPKINS, Peter McMillan, (R.M.C.), Royal Military College, Kingston, Ont.

LANTIER, Dunn Jacques, (R.M.C.), Royal Military College, Kingston, Ont.

MARTIN, Clifford Davison, (N.S. Tech. Coll.), P.O. Box 262, Amherst, N.S.

MERCIER, Jules M., (Ecole Polytechnique, Montreal), 6177 Durocher St., Outremont, Que.

NELSON, William Andrew, B.Sc., (Queen's Univ.), demonstrator mech'l. dept., Queen's University, Kingston, Ont.

TAYLOR, William Irwin, (Univ. of Man.), 218 Waterloo St., Winnipeg, Man.

OBITUARIES

Jules Alexandre Duchastel de Montrouge, M.E.I.C.

Members will learn with great regret of the death on February 20th of Jules Alexandre Duchastel de Montrouge, assistant manager of the Port of Montreal and Member of The Institute of long standing. He was in his sixtieth year and had just been appointed treasurer of The Institute.

Mr. Duchastel was the son of the late Baron Duchastel de Montrouge who served as Consul for France in New York and later in Montreal. Educated in Mont St. Louis College in Montreal, Mr. Duchastel graduated from the Ecole Polytechnique in 1901, working for a time with the Phoenix Bridge and Iron Works, Montreal and in the chief engineer's office of the Canadian Pacific Railway. In 1906 he became engineer for the city of Outremont and later was also appointed city manager. In 1924 he resigned to become manager of the Quebec Forest Industries Association Limited and filled that appointment for twelve years. In 1936 he was appointed assistant manager for the Port of Montreal, the position which he held at the time of his death.

Always prominent as an advocate of improved highways, Mr. Duchastel was a charter member of the Canadian Good Roads Association, being one of the group of road engineers and motor enthusiasts who formed the association in 1914.

J. A. Duchastel de Montrouge, M.E.I.C.

Mr. Duchastel joined the Canadian Society of Civil Engineers as a Student in 1899, became an Associate Member in 1904 and a Member in 1912. During the years 1922, 1923 and 1924 he carried out very ably his duties as councillor of The Institute.

William Alfred McLaren, A.M.E.I.C.

It is with deep regret that we record the passing of William Alfred McLaren, A.M.E.I.C., whose death occurred, following a brief illness, at Charlottetown, P.E.I., on January 5th, 1938.

Mr. McLaren was born at Brudenell, P.E.I., July 31st, 1886, where he received his high school education. In 1905 he joined the engineering staff of the Prince Edward Island Railway. From 1907 to 1915 he was employed on the construction of the National Transcontinental Railway. During the great war he served first as lieutenant in the 104th and 105th Infantry, and latterly, on construction of light and standard gauge railways, as lieutenant in the 7th Canadian Railway Troops. In 1919 he joined the engineering staff of the Canadian National Railways. In 1933 he became engineer on highway construction, and in 1937 was appointed engineer in charge of National Park construction in Prince Edward Island, which position he held until his death.

Mr. McLaren joined The Institute as an Associate Member on February 16th, 1923.

W. A. McLaren, A.M.E.I.C.

Francis C. McMath, M.E.I.C.

The Institute has lost a valued member through the death of Francis C. McMath, D.Eng., M.E.I.C., on February 13th in Detroit. Mr. McMath was born at St. Louis, Missouri, January 29th, 1867. After obtaining the degree of B.E. from Washington University, St. Louis, he became assistant engineer of the Detroit Bridge and Iron Works, advancing to the position of chief engineer in 1899. In this position he designed a considerable number of railroad bridges. In 1900 he resigned to organize the Canadian Bridge Company, of which he was president for 21 years. During this time he served in several other capacities and from 1911 to 1919 he was consulting engineer for the St. Lawrence Bridge Company, Limited, which built the cantilever bridge across the St. Lawrence river near Quebec. He also directed the construction of several other important spans in Canada and the United States.

Mr. McMath joined the Canadian Society of Civil Engineers as a Member, November 29th, 1904.

Alexander Forrester Stewart, M.E.I.C.

We regret to announce the death of Alexander Forrester Stewart, M.E.I.C., a Life Member of The Institute and formerly chief engineer of the Canadian National Railways, Atlantic Division, on October 30th, 1937. Mr. Stewart was born at West Bay, Cape Breton, N.S., on January 8th, 1864, attending Dalhousie University and graduating in 1887. His first engineering experience was on the Canadian Pacific Railway in Maine as chainman. Later he went to British Columbia where he was on surveys and also resident engineer on construction. In 1895 he went to South Africa as contractor's engineer on the South Coast Railway in Natal, becoming district engineer of surveys on railway work in the Transvaal in 1897 and later district engineer on construction for the Orange Free State government railways. He also did railway work in Zululand and Cape Colony. In 1901 he was district engineer of maintenance and reconstruction for the Imperial Military Railways in Transvaal.

Mr. Stewart was in the employ of the Orange Free State Government on railway location work prior to the South African war but left immediately on the outbreak of hostilities. At that time he was located at Harrismith near the Natal border and he crossed the border into British territory on horseback through the mountains, reaching Ladysmith just before the siege began. As a civilian he was obliged to leave Ladysmith immediately, going out on the last train before communications were cut. Upon reaching the coast at Durban he decided to proceed by sea to Cape Town where he eventually arrived offering his services to the military authorities.

After the peace treaty in 1902 the Imperial Military Railways were turned over to the civil authorities for administration under the name of the Central South African Railways, headed by the late Sir Percy Girouard, Hon.M.E.I.C. Mr. Stewart was at that time on leave in Canada and employed as division engineer of surveys on the Halifax and Southwestern Railways but at the request of Sir Percy returned to South Africa where he was assigned to the position of resident engineer at Pretoria with jurisdiction over the entire Delagoa Bay line. During his service with the Imperial and Central South African Railways Mr. Stewart had jurisdiction over the maintenance of way and structures and new works and his responsibilities were weighty as practically all bridges were destroyed during the war. In 1904 he accepted a position as district engineer in Cape Colony, returning to Canada in 1907.

Mr. Stewart became assistant engineer of construction for Mackenzie, Mann and Company of Toronto in 1907 and chief engineer in 1916. In 1916 he was appointed chief engineer of Eastern Lines, Canadian Northern Railway and Canadian National Railways successively at Toronto and in 1920 chief engineer of the Atlantic region of the Canadian National Railways at Moncton, N.B., retiring from this position in 1933. Mr. Stewart joined the Canadian Society of Civil Engineers as a Member in 1897.


A. F. Stewart, M.E.I.C.


K. B. Thornton, M.E.I.C.


E. A. Wheatley, M.E.I.C.

Kenneth Buchanan Thornton, M.E.I.C.

We regret to announce the death of Kenneth Buchanan Thornton, M.E.I.C., general manager of the Montreal Tramways Company, on February 10th, 1938. Mr. Thornton was born in Montreal on June 26th, 1873, but received his education in London, England, where he attended the Central Technical College of the City and Guilds of London Institute. In 1893 he returned to Montreal and began a course in electrical engineering at the Royal Electric Company's works. He remained with this company and the Montreal Light Heat and Power Company until 1905 in their manufacturing, testing and operating departments. From 1905 until 1911 he was connected with J. G. White and Company, New York City, where he successively held the positions of resident engineer and manager of Nassau Light and Power Company, Roslyn, Long Island, assistant manager of the operating department of the J. G. White Company and affiliated companies, Portland, Maine, and advisory engineer to the Canadian Light and Power Company.

In 1911 Mr. Thornton became chief engineer and operating manager of the Canadian Light and Power Company and chief engineer and general manager of the Montreal Public Service Corporation. A few years later he became consulting engineer to the president of the Montreal Tramways Company. This last position he held until he became assistant general manager of the company in 1925 and general manager in 1930. During these years Mr. Thornton had charge of the modernization of all departments of the system, the improvements including the renewal of track, purchase of new cars, revision of the power supply, and the introduction of extensive bus services. He served on the board of directors of the Canadian Electric Railway Association, of which body he was President in 1931.

Mr. Thornton joined the Canadian Society of Civil Engineers as a Student on January 4th, 1894, transferring to the class of Associate Member in 1899. He became a Member of The Engineering Institute of Canada November 23rd, 1920. During the years 1921, 1922 and 1923 he was on the Council of The Institute and served as Vice-President for the years 1925 and 1926.

His death brings to a close the career of a man well known throughout the Dominion, who was distinguished both in engineering and administrative work.

Edward Augustus Wheatley, M.E.I.C.

E. A. Wheatley, M.C., M.E.I.C., registrar and secretary-treasurer of the Association of Professional Engineers of British Columbia, passed away on February 2nd, 1938, in Shaughnessy Military Hospital, Vancouver. He was born in London, England, and was in his 53rd year.

His early engineering training took place in England where he attended the City and Guilds Technical College, London, and was later apprenticed with S. J. Johnson and Company Limited, Engineers, Stratford, England. He was next with Sir Hiram Maxim and the Electric and Maintenance Company and 1909 came to Canada. Here his first work was with the Canadian Pacific Railway in British Columbia. Later he was with the Edmonton Brick Company and from 1911 to 1914 he acted as engineer and superintendent with the Alsip Brick Company, Edmonton, Alta. From 1914 to 1918 he was overseas, latterly with the Royal Engineers, with whom he served with distinction. In 1918 he was seriously wounded and was invalided home with the rank of captain after spending several years in hospitals in England and France.

Following the war, Captain Wheatley returned to British Columbia and in 1921 was appointed registrar and secretary-treasurer of the Association of Professional

Engineers of British Columbia. In this position, with untiring enthusiasm and ability, he rendered invaluable service in the advancement of the Engineering Profession in British Columbia.

He joined The Engineering Institute of Canada as an Associate Member in 1921 and was transferred to Member in 1935.

PERSONALS

D. K. Addie, A.M.E.I.C., who has been with the Dominion Glass Company Limited, Montreal, for the past thirteen years, has accepted the position of supervising engineer of Ball Brothers Company, with headquarters in Muncie, Indiana. Mr. Addie is a graduate of McGill University of the year 1925, obtaining the degree of B.Sc. in Mechanical Engineering.

M. G. Taylor, Jr.E.I.C., is now acting general manager of the Venezuela Power Company Limited, Maracaibo, Venezuela, S.A. Mr. Taylor obtained his degree of B.Sc. from the Nova Scotia Technical College in 1927 and that of M.Sc. from the Massachusetts Institute of Technology in 1931. Mr. Taylor has been connected with the Venezuela Power Company since 1929. In 1931 he advanced to the position of manager of the Barquisimeto Branch of the company and in 1935 was made superintendent at Maracaibo, Venezuela.

Louis Trudel, S.E.I.C., who was formerly with the Provincial Electricity Board, has accepted a position with the Southern Canada Power Company Limited. Mr. Trudel, a graduate of the Ecole Polytechnique in 1936, was awarded the Ernest Marceau Prize in the same year for his paper "Etude Comparative sur Modèles Réduits." He is vice-chairman of the Junior Section of the Montreal Branch of The Institute.

Norman A. Link, A.M.E.I.C., has been transferred from the position of roadmaster, Canadian Pacific Railway, Wilkie, Saskatchewan, to that of assistant superintendent at Macleod, Alberta. Mr. Link has served the Canadian Pacific Railway in various capacities since his entrance into engineering work in 1913, although from 1916 to 1919 he was with the Canadian Expeditionary Force overseas and from 1927 to 1931 was superintendent of Duff, Flint and Company, contractors, in Regina, Sask. In 1931 he was made resident engineer at Winnipeg, in 1932 roadmaster at Nipawin, Sask., the latter position he held until 1936 when he became roadmaster at Wilkie, Sask.

Donald Ross-Ross, M.E.I.C., chief industrial engineer, who is in charge of industrial engineering, purchasing and cost accounting at the various divisions of the Howard Smith Paper Mills Limited and subsidiary companies, has also been acting as consulting industrial engineer and cost accountant to the Empire Cotton Mills Limited. Mr. Ross-Ross has now completed this work. He has been connected with the Howard Smith Paper Mills since 1925, when he entered the Cornwall Division of the Company as combustion engineer. In 1927 he became assistant to the mill manager, in 1928 production engineer and in 1931 chief industrial engineer.

Percy Sandwell, M.E.I.C., consulting engineer of Vancouver has been appointed chief engineer for the new Australian newsprint project to be started this year in the Derwent Valley, Tasmania. Mr. Sandwell has had extensive experience in pulp and paper work on the Pacific Coast where from 1922 to 1926 he acted as chief draughtsman and assistant resident engineer for the Powell River Company Limited. From 1926 to 1936 he was resident engineer and from 1932 to 1934 assistant manager of the same company. Since 1934 he has been in practice in Vancouver as a consulting engineer.

W. F. Angus, M.E.I.C., was elected to the Board of Directors of Montreal Light Heat and Power Consolidated at the annual meeting of shareholders held February 16th, 1938. Mr. Angus, who is replacing J. W. McConnell, resigned, is president of Dominion Bridge Company, president of Dominion Engineering Works, Limited, and vice-president of Canadian Car and Foundry Company, Limited. He is also a director of the following companies: Royal Bank of Canada, Montreal Trust Company, Bell Telephone Company, Northern Electric Company, Foundation Company of Canada, Canadian Locomotive Company, Eastern Canada Steel and Iron Works, Robb Engineering Works and Dominion Hoist and Shovel Company.

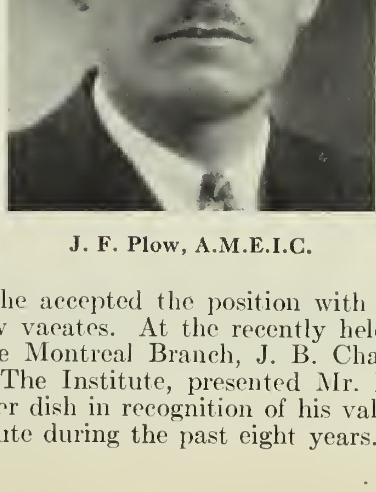
D. E. Blair, M.E.I.C., has been appointed general manager of the Montreal Tramways Company, to succeed the late K. B. Thornton, M.E.I.C., it was recently announced by R. N. Watt, vice-president and managing director.

Mr. Blair, who has been associated with the Montreal Tramways Company for thirty-five years, was born in Montmagny, P.Q., July 1877, and was educated at Quebec High School and McGill University, from which he graduated with a B.Sc. in 1897. He started his career in the transportation industry by entering the service of the Quebec Street Railway Company as electrical engineer. In this position he superintended the electrification of the Quebec, Montmorency and Charlevoix, formerly a steam railway. In 1903 he joined the Montreal Street Railway as assistant general superintendent. A year later he was appointed superintendent of rolling stock and became responsible for the design, construction and maintenance of all street cars used in Montreal. In 1925 he was promoted to the position of general superintendent, in charge of operation and maintenance.

John F. Plow, A.M.E.I.C., formerly assistant secretary of The Engineering Institute of Canada, has accepted a position in Montreal with Charles Warnock and Company, Limited, inspection and testing engineers.

Mr. Plow was educated in Montreal, graduated from the Royal Military College, Kingston, Ontario, in 1921 and afterwards attended McGill University. From 1922 to 1925 he was vice-president of B. Plow and Company Limited, Montreal, manufacturing stationers and printers. In 1925 he entered Price Brothers and Company Limited where from 1927 to 1930 he acted as assistant engineer in the mechanical department of the company's mill at Riverbend, Quebec.

During 1928 and 1929 Mr. Plow acted as secretary-treasurer of the Saguenay Branch of The Institute.



J. F. Plow, A.M.E.I.C.

In 1930 he accepted the position with The Institute which he now vacates. At the recently held semi-annual smoker of the Montreal Branch, J. B. Challies, M.E.I.C., President of The Institute, presented Mr. Plow with an engraved silver dish in recognition of his valuable services to The Institute during the past eight years.

RECENT ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

American Society for Testing Materials: Proceedings of the Fortieth Annual Meeting, Vol. 37, 1937, Pt. 1 Committee Reports, Tentative Standards, Pt. 2 Technical Papers.

Junior Institution of Engineers: Journal and Record of Transactions, 56th Session, 1936-37, Vol. 47.

Royal Scottish Society of Arts: Transactions, Vol. 12, pt. 2, Jan. 1938.

Royal Society of Canada: Mathematical, Physical and Chemical Sciences; Geological Sciences Including Mineralogy; Biological Sciences; third series, Vol. 31, May 1937.

South Wales Institute of Engineers: Proceedings, Vol. 53, No. 5, Feb. 7th, 1938.

Reports, etc.

American Public Works Association: Bulletin No. 6, Municipal Snow Removal and the Treatment of Icy Pavements. Chicago, 1938.

American Society of Testing Materials: Index to A.S.T.M. Standards and Tentative Standards. Jan. 1st, 1938.

Association of Professional Engineers of the Province of New Brunswick: Report of Council to Annual Meeting, Jan. 27th, 1938.

Canada Department of Mines and Resources, Lands, Parks and Forests Branch: Forest Service Circular 49-52—Ocean Shipment of Seasoned Lumber, Vegetable Glues for Plywood and Veneers, A Comparison of the Mechanical and Physical Properties of the Heartwood and Sapwood of Yellow Birch, The Changes in Moisture Content of Yard-Piled Softwood Lumber in Eastern Canada.

Canada Department of Mines and Resources Mines and Geology Branch, Bureau of Mines: Producers of Coke in Canada. Dec. 1937.

Canada Department of Trade and Commerce Dominion Bureau of Statistics, Transportation and Public Utilities Branch: The Highway and Motor Vehicle in Canada 1936. Ottawa, 1938.

Canadian Broadcasting Corporation: Report Nov. 2, 1936-Mar. 31, 1937.

Edison Electric Institute: Boilers, Superheaters, Economizers, Air Heaters, and Piping, 1937. Cable Operation, 1936.

Institution of Civil Engineers: Engineering Abstracts; Section 1 Engineering Construction, Section 2 Mechanical Engineering, Section 4 Mining Engineering, Vol. No. 1, Jan. 1938.

Institution of Structural Engineers: The Use of High Alumina Cement in Structural Engineering. Dec. 1937.

U.S. Department of the Interior Bureau of Mines: Bulletin 406 Contributions to the Data on Theoretical Metallurgy VII, The Thermodynamic Properties of Sulphur and its Inorganic Compounds; Technical Paper 580 West Virginia Coal-Mine Accident Costs and Data, July 1, 1929 to June 30, 1934.

U.S. Department of the Interior Geological Survey: Bulletin 880-C and 892 Kodiak and Adjacent Islands Alaska; Bibliography of North America Geology 1935 and 1936. Water Supply Paper 773 and 816 Contributions to the Hydrology of the United States 1936; Major Texas Floods of 1936.

University of California: Mount St. Helens, a Recent Cascade Volcano, by Jean Verhoogen; The Transportation of Sand in Pipe Lines, by M. P. O'Brien and R. G. Folsom.

BULLETINS*

Chlorination.—The Specialities Engineering and Service Company, Inc., Hoboken, N.J., have issued an 8-page bulletin which describes in detail the system and operation of their "W-B Periodic Process of Chlorination."

Capacitors.—Three 4-page bulletins have been received from the English Electric Company of Canada Limited, St. Catharines, Ont., featuring their capacitors in box, pole and rack type.

Insulating Brick.—The Canadian Johns-Manville Company Limited, Toronto, Ont., have issued a 4-page bulletin demonstrating their new JM-20 insulating brick and its application to twelve different types of furnaces.

Couplings.—A 12-page booklet from Hamilton Gear and Machine Company, Toronto, Ont., describes their flexible couplings for the protection of connected machines from misalignment, thrust and vibration.

Friction Materials.—Canadian Johns-Manville Co. Ltd., Toronto, Ont., have published a 6-page leaflet, Friction Materials for the Iron and Steel Engineer. This contains comprehensive data on brake linings and clutch facings for steel mill equipment.

Scale and Corrosion Control.—D. W. Haering and Co. Inc. 3408 Monroe St., Chicago, Ill., have published a 16-page pamphlet illustrated with graphs, formulae and equations of interest to the chemist and engineer responsible for scale or corrosion control in industrial operations.

Proportioning Systems.—A 24-page booklet received from D. W. Haering and Co. Inc., 3408 Monroe St., Chicago, Ill., describes a simple and accurate line of inexpensive proportioning systems.

*Copies of these bulletins may be obtained by writing to the companies mentioned.

BOOK REVIEWS

Biography of Benjamin Smith Lyman

By Gonpei Kuwada, Sanseido Co., Tokyo, 1937. 104 pp. 7¾ by 5¼ inches, cloth.

Benjamin Smith Lyman was born in Northampton in 1835. He attended Phillips-Exeter Academy and was graduated from Harvard University in 1855. From 1859 until 1861 he studied at the Ecole des Mines, in Paris, and later at the Royal Academy of Mines at Freiberg, Germany.

He was a member of a surveying party at Glace Bay, Nova Scotia, assistant geologist of the State of Iowa and made extensive surveys of the coal districts of Pennsylvania. He was engaged by the British Indian government on the survey of the petroleum fields of the Punjab, 1870, and from 1873-1879 was chief geologist and mining engineer in the employ of the Japanese government. He knew Europe, Asia, British America and his own country. Wherever he went he was a student of the country—its geology and mining, as a matter of course, its language, its literature, its art, its customs, its natural history.

The years he lived in Japan were the most interesting ones of his life and the most fruitful in their results. He made the first survey of the Northern Island of Hokkaido, and then surveyed the petroleum fields of the main island. The English translation of the government reports of these surveys are in the collection at the Forbes Library in seven volumes, 1874-1879, as are also most of the books in his extensive library.

Snow Removal and the Treatment of Icy Pavements

Bulletin No. 6 Compiled by the American Public Works Association, Committee on Street Cleaning. (American Public Works Association, Chicago, 1938.) 11 by 8½ inches. Paper, 54 pages, illus. $1.00

Municipal snow removal service has developed very rapidly during the past ten years not only to make city streets safer for traffic, but also to provide for the full-time use of expensive pavement systems. The safeguarding of city streets against the hazards of icy conditions has progressed exceptionally fast and has gained widespread public approval.

The American Public Works Association has prepared this comprehensive statement of the snow fighting problems and practices in American cities to aid municipal officials and others in securing the maximum efficiency in these important operations. A study of the experiences and practices of 78 cities in the snow belt forms the background for much of the data used.

This bulletin which bears the title "Municipal Snow Removal and the Treatment of Icy Pavements" discusses fully the necessity of having complete arrangements for handling these emergency conditions perfected well in advance of the winter season. The plans, organization, personnel, equipment, and methods of operation are treated in detail to make this bulletin of maximum benefit to public works officials. The conclusions and suggested procedures are those that have been found most effective in the communities that are successfully meeting this problem.

French Naval Architects Proceedings

The Association Technique Maritime et Aéronautique have issued their 41st Bulletin, giving a report of the Association's successful meeting held in June 1937, with the text of the papers and discussions at the meeting.

The volume contains 698 pages of technical material of value to anyone interested in shipping, shipbuilding and aeronautic problems.

It can be purchased from the Secrétariat Général, Association Technique Maritime et Aéronautique, 7 rue de Madrid, Paris, France. The price is 250 francs (postage 16 fr.).

1938 Competition of La Fondation George Montefiore

The Association des Ingénieurs Electriciens sortis de l'Institut Electrotechnique Montefiore announce a prize of 18,000 fr. in their 1938 competition. This prize will be awarded for the best original work presented on the advancement of science and on the progress of the technical applications of electricity in all fields. The papers submitted should bear the title "Papers submitted to the competition of La Fondation George Montefiore, 1938 Session." Entries should be printed or typed and addressed to: M. le secrétaire-archiviste de la Fondation George Montefiore, rue Saint-Gilles, 31, Liège (Belgique).

ERRATA

In printing Professor Smither's article on page 109 of the February Journal, Fig. 2 was slightly displaced in relation to Fig. 1, the vectors not being exactly parallel to the loads.

Please note also that Professor Smither is Associate Professor (not Assistant Professor) of Structural Engineering at the University of Toronto.

In "Canadian Steam-Electric Power Plants" by C. A. Robb, M.E.I.C., in this Journal, page 139, column 4, 4th line from the bottom of the page, for 2,760 substitute 27,600.

BRANCH NEWS

Border Cities Branch

J. F. Bridge, A.M.E.I.C., Secretary-Treasurer.
F. J. Ryder, Jr.E.I.C., Branch News Editor.

At the meeting held Friday, January 17th, 1938, about 30 persons were present to hear the paper presented by Mr. J. W. Houlden, who is in charge of the Ballistic Laboratory of Canadian Industries Limited.

The Fabrication and Testing of Shotgun Shells

A brief historic outline brought out that the bow and arrow was the first weapon that could propel a projectile any distance and still have any degree of accuracy. The discovery of black powder brought with it the ancestors of our present firearms and munitions. With the advent of smokeless powder came a greater degree of accuracy and fewer complaints.

Black powder used in cartridges gave off a heavy smoke, had a heavy recoil, was erosive and corrosive to the steel of the gun barrel and left a residue in the barrel which meant cleaning the gun often. Smokeless powder has none of these bad effects.

Mr. Houlden then explained the complete manufacturing process of an ordinary shell. A shell consists of a brass head, a primer cup which contains the detonating charge, and a paper or cardboard tube which fits into the brass head. The charge of powder, cardboard wads, followed by felt wads, the load of shot and the final wad make up the main parts of the shell. In order to perfect and finish one shell there are 142 complete and distinct operations performed. Throughout all these operations a very rigid inspection is maintained to assure a perfect shell. The finished product is coded so that complete records of each batch may be kept. At least one per cent of all production is tested in the firing laboratories in order to determine patterns, muzzle velocity, striking velocity and pressure in the gun barrel.

A display of a shell in its various conditions of assembly was shown to all which cleared up many of the points not clearly understood in the manufacture of the shell as narrated. A group of slides showing actual production views added further interest to an already very interesting paper.

The meeting was thrown open for questions, and the speaker had to rebuff a barrage of them, which he did to the satisfaction of all concerned.

C. G. R. Armstrong, A.M.E.I.C., moved a hearty vote of thanks to Mr. Houlden, which was enthusiastically endorsed by all.

Calgary Branch

Jas. McMillan, A.M.E.I.C., Secretary-Treasurer.
J. S. Neil, A.M.E.I.C., Chairman, News Committee.

On Tuesday, November 16th, 1937, the Branch was presented with a very instructive paper by J. W. Young, A.M.E.I.C., assistant city chemist, on micro-chemistry and other methods followed by expert witnesses called in to give evidence in the law courts. This unusual lecture was listened to with great interest and provided much food for thought as evidenced by the lively question period which followed Mr. Young's address.

An Hydrographical Survey

The next meeting on December 2nd, 1937, was devoted to subjects presented by two of the more recent members of the Branch—once each year it is the policy of this Branch to invite some of these members to present papers on any subject they wish. G. V. Eckenfelder, S.E.I.C., described the work of a hydrographical survey expedition sent north to chart the Tuktoyaktuk harbour near the eastern arm of the Mackenzie river delta. Tuktoyaktuk is on the Arctic coast and is the nearest deep water harbour available for transshipping ocean borne freight to the Mackenzie river and northern lake transportation system. Mr. Eckenfelder gave a clear exposition of the difficulties encountered such as compass bearings where the proximity of the magnetic pole made the needle sluggish and not to be depended upon. A lucid word picture of the appearance of this great territory in its summer raiment was painted, and was indelibly imprinted on the listeners' memory by means of photographs projected on a screen. Mr. Eckenfelder's lecture made everybody wish, despite the hardships and difficulties encountered, to go on a similar expedition to these open spaces.

Natural Gas Burners

The other paper presented was on "Natural Gas Burners." In this presentation Mr. Neil first described the various flame types used in the burning of gas and the types of burners required to produce each class of flame. This was followed by an outline of the design of a blue-flame burner in which was pointed out the cause of many burner troubles which are popularly ascribed to everything but the actual cause, which is inherent in the design of the burner itself.

Each paper was followed by lively discussion which showed that the interest of the meeting had been thoroughly aroused by the efforts of the "cub" engineers.

An Amateur Tries to Understand Our Weather

A. W. Haddow, B.Sc., A.M.E.I.C., city engineer of Edmonton, held the concentrated interest of members on Monday night of January 17th. Mr. Haddow reviewed the development of methods of gathering data from ancient to modern times. Then using diagrams he explained the views of numerous authorities regarding air circulation; source and effect of the trade winds, monsoons and chinooks. Chinooks, he said, probably give Alberta a greater variety of winter climate than is found anywhere else in the world. Mr. Haddow told some interesting facts concerning the chinook, which he had learned at Edmonton. Fliers, for instance, have found with ground temperatures of 30 to 40 degrees below zero, chinooks had been encountered at 2,500 feet with temperatures of 45 degrees above zero. The velocities of these chinooks at the higher levels reach as high as from 70 to 90 miles per hour with no wind at ground level.

Mr. Haddow's address, coming as it did in the midst of a mid-winter chinook, was followed with more than usual interest, and everyone present thanked him for imparting to them knowledge of our climatic conditions which were formerly veiled in mystery.

Edmonton Branch

M. L. Gale, A.M.E.I.C., Secretary-Treasurer.
F. A. Brownie, Jr.E.I.C., Branch News Editor.

A most interesting paper on "Oil Sand Coring in Trinidad" was presented by Dr. K. A. Clark at the January 20th meeting of the Edmonton Branch of The Institute. Dr. Clark is now Professor of Mining at the University of Alberta. Prior to the present university term Dr. Clark was on 18 months leave of absence. During this time he was engaged by a large British oil company to make investigations in regard to the coring of oil sands in the Trinidad field.

Oil Sand Coring in Trinidad

Dr. Clark's paper concerned itself chiefly with the usefulness of information obtained by coring, in the water-flooding of oil sands. He reviewed briefly the history of water-flooding which may be said to have started in the Bradford, Pennsylvania, oil field. In this field a very prolific water sand occurred at shallow depth. The technique of shutting off water in the early days was not very effective and often a hole became filled with water and ruined. However it was found that this hydrostatic head of water in one hole increased not only the immediate flow in surrounding wells but also the ultimate oil recovery. The idea of water-flooding of oil sands has now become established practice, where practicable, after the field has become fully exploited by ordinary methods.

Preliminary coring and laboratory study of the cores furnish invaluable information as to whether water-flooding would be possible, and if so, economical, and also as to the exact procedure to be followed.

The speaker described briefly the procedure followed in water-flooding and referred to the accuracy with which the results to be expected could be prophesied from a study of the cores.

Dr. Clark also described in a delightfully informal manner a number of his personal experiences in the course of his work in Trinidad and American oil fields.

An interesting discussion followed, which was also participated in by a number of members of the Canadian Institute of Mining and Metallurgy who were present.

Vice-chairman W. E. Cornish, A.M.E.I.C., presided.

Halifax Branch

R. R. Murray, M.E.I.C., Secretary-Treasurer.
A. D. Nickerson, A.M.E.I.C., Branch News Editor.

The combined annual banquet of the Halifax Branch of The Engineering Institute of Canada, and the Association of Professional Engineers of Nova Scotia, was held at the Nova Scotian hotel on January 19th, 1938. Approximately 200 members representing the two organizations gathered for this, their annual joint function. It has been the custom for many years to combine the January meeting of the Halifax Branch with the closing function of the annual meeting of the A.P.E.N.S. in the form of a banquet and get-together.

Toasts were proposed by Chas. Scrymgeour, A.M.E.I.C., and J. R. Kaye, A.M.E.I.C., and were responded to by I. P. Macnab, M.E.I.C., and Col. F. W. W. Doane, M.E.I.C.

D. Leo Dolan, Chief, Canadian Travel Bureau of Ottawa, was the principal speaker of the evening. In a humorous and genial manner, Mr. Dolan spoke of the importance of the tourist industry to Canada, and of ways and means by which that industry could be encouraged and stimulated. Paved roads, the speaker pointed out, were one of the greatest factors in drawing tourists to the Maritime Provinces in the past few years. The extension of this paving programme, together with other favourable factors, would result in a greatly increased tourist travel to the Maritime Provinces in the next few years, the speaker predicted.

Courtesy and naturalness are very necessary in dealing with tourists. Referring particularly to visitors from the United States it was pointed out that they did not expect, nor want, to find the United States flag flying from hotels, tourist resorts and roadside canteens. Neither did they want to eat a majority of canned foods or of foods that were very common in their own country. Tourists are anxious to find a distinctly Canadian or provincial atmosphere, and are glad to obtain distinctly local dishes wherever possible. Mr. Dolan spoke briefly of the work of the Canadian Travel Bureau at Ottawa.

Hon. A. S. MacMillan, Minister of Highways of the Province of Nova Scotia, spoke briefly of the work of the Department of Highways in assisting the tourist industry. Among other activities the Minister referred to a training course being conducted this winter in an effort to assist the managers of the smaller hotels and tourist resorts to meet the needs of the tourist trade. The Minister presented figures to show how the gasoline tax had made the highway paving programme possible, and further to show how an increase in the gasoline tax would make possible the paving of secondary as well as primary highways. These figures were given merely for information to a body of engineers, and not as a statement of government policy.

Mixed entertainment and favours for those present were provided by various local industrial firms. Mr. I. P. Macnab, Chairman of the Halifax Branch E.I.C., acted as chairman of the meeting.

Hamilton Branch

A. R. Hannaford, A.M.E.I.C., Secretary-Treasurer.
W. W. Preston, S.E.I.C., Branch News Editor.

ANNUAL BUSINESS MEETING AND DINNER

The annual meeting of the Branch was held on January 12th, 1938, at the Rock Garden Lodge, Hamilton. Sixty-seven members and guests sat down to a very enjoyable dinner which was followed with fifteen minutes of mysterious hilarity supplied by the "Magical Chatterbox," Sid Lorrain.

The minutes of the evening included the reading of the minutes of the last meeting and the reading of the business and financial statement prepared for presentation to Headquarters for the year 1937, which was duly approved by the meeting.

The following members were elected to form the Nominating committee for the year 1938: A. Love, M.E.I.C., chairman; W. L. McFaul, M.E.I.C., R. K. Palmer, M.E.I.C., W. Hollingworth, M.E.I.C., and E. H. Darling, M.E.I.C.

The Branch Nominating committee had put forward a list of names for the various offices and as no further nominations had been submitted, as required by the by-laws, the following were declared elected:

Chairman..............W. J. W. Reid, M.E.I.C.
Vice-Chairman.........V. S. Thompson, A.M.E.I.C.
Secretary-Treasurer.....A. R. Hannaford, A.M.E.I.C.
Committee.............R. E. Butt, A.M.E.I.C., one year,
A. B. Dove, A.M.E.I.C., one year,
J. R. Dunbar, A.M.E.I.C., two years,
W. A. T. Gilmour, A.M.E.I.C., two years.

L. W. Gill, M.E.I.C., proposed a very hearty vote of thanks to Col. E. G. Mackay, A.M.E.I.C., the retiring chairman, for his splendid work for the Branch during his term of office, and also to the Executive for the work done.

E. P. Muntz, M.E.I.C., spoke briefly of the work of the Branch during the year.

A. O. Wolff, M.E.I.C., chairman of the London Branch, tendered the greetings of his Executive to the Hamilton members.

The guest speaker of the evening, the Rev. Captain Norman Rawson, now followed with an address that will long be remembered by all those who were so fortunate as to be present to hear him.

In a challenging address he deplored the tendency of preachers and engineers to become so enveloped in their own fields that each failed to appreciate the problems of the other. Saying that he did not intend to pull his punches, Mr. Rawson declared that engineers have not been using their brains to the best advantage. He praised engineers for the advance that they have made in material sciences, but, when he considered success in terms of making the world a better place to live in, he considered that the engineer had made a miserable fiasco.

He said the trouble today is not material at all, it is spiritual.

The major problem facing the engineer is not with money, material or markets but with men, and the basic thing keeping us back is fear and distrust. Clever men are afraid to enter public life because of the abuse they receive from the hands of the public and the lack of confidence given to our governing bodies. The speaker thought that we have quite as good men at our helm as we deserve considering the apathy of the electors. He criticized industry for looking on men as tools and stated that fear would not be removed until men could bring children into the world with the assurance that they would have work and security to maintain them. If fear and distrust are to pass we must get back a sense of values, not of wisdom or power but of personality and the final great power of emotion.

He declared the country needs constructive thinking by intelligent people and spoke of the dangers that must be faced if we continued to be indifferent to the study of social economics. He pleaded for real leadership, the kind that confidently overcomes all obstacles; realizing that it required industrial daring and also national and international daring the problems of which he felt the engineer was well qualified and able to solve if they would enter more into the activities of public life and affairs.

The talk was interspersed with considerable repartee between the speaker and His Worship Mayor William Morrison, who, as a guest of the Branch, had spoken earlier in the evening.

Lethbridge Branch

E. A. Lawrence, S.E.I.C., Secretary-Treasurer.
R. F. P. Bowman, A.M.E.I.C., Branch News Editor.

The Lethbridge Branch held its regular dinner meeting in the Marquis hotel, on Saturday evening, January 22nd, 1938. During the dinner music was supplied by George Brown's instrumental quartette, followed by vocal solos by Mr. E. Rannard and community singing.

The guest speaker was Mr. A. K. Bayley, of the Dominion Department of Transport, Aviation Radio Branch, who gave a paper on "Radio Aviation." In his introductory remarks Mr. Bayley outlined the conditions necessary for the successful operation of an air-line and then gave a very lucid exposition of the operation of direction finding equipment and the radio beacon. An interesting discussion followed.

The Lethbridge Branch held a dinner meeting at the Marquis hotel on Saturday, February 5th, 1938. During the dinner instrumental selections were played by George Brown's instrumental quartette, followed by vocal solos by Mr. George Parsons and community singing.

The speakers of the evening were three young engineers who gave short addresses on various topics. The first speaker was Mr. W. E. Ross, of the Calgary Power Company, whose subject was "Generation of Hydro-electric Power." He outlined the importance of rainfall, run-off and seepage conditions, and the study of hydrographic and meteorological data, in determining the available, dependable flow of water for a proposed power project. This was followed by a description of some of the important factors in the operation of a hydro-electric plant, and a detailed explanation of the "losses method," of co-ordinating the various generating units in such a way as to produce a maximum of electricity with a minimum of water power.

The second speaker was E. A. Lawrence, S.E.I.C., of the Department of Natural Resources, C.P.R., whose topic was "The Rise of Early Modern Civil Engineering." Mr. Lawrence, after some remarks about engineering among the ancients, turned to the 17th and 18th centuries when applied mathematics and experimental science combined to produce the engineer as he is known today. He gave a general description of the development of surveying instruments, followed by a historical outline of the growth of various branches of civil engineering. Highways, canals, railways, bridges and tunnels were described, the locations of the various early projects being shown on maps which Mr. Lawrence had prepared for the occasion.

The third speaker was Mr. R. Craig, of Canadian Sugar Factories Ltd., whose topic was "The Electrical Equipment of a Beet Sugar Factory." The speaker gave a very complete description of the equipment of his company at their Picture Butte plant, which is recognized as the most modern plant on the continent. He described the steam plant and the turbo-generator which is the source of supply, and traced the various electrical services throughout the plant. Individual motor drives are almost exclusively used, many of these being interlocked in such a way as to protect the equipment in case of trouble in any one unit. Interesting applications of thermo-couples and potentiometers for the regulation of the processes were described.

A hearty vote of thanks was moved by Mr. G. S. Brown and was carried with applause.

London Branch

D. S. Scrymgeour, A.M.E.I.C., Secretary-Treasurer.
Jno. R. Rostron, A.M.E.I.C., Branch News Editor.

The 52nd Annual General and Professional Meeting of the Engineering Institute of Canada was held this year at the Hotel London in London, Ontario, on January 31st and February 1st and 2nd, consequently no regular monthly meeting of the Branch was held as all members were engaged in making arrangements for this event.

Complete detailed reports of this meeting will be found elsewhere in The Journal.

A total registration of 345, which included 45 ladies, was attained and it is safe to say that the meeting was a success viewed from every angle. This is confirmed by the large number of letters of congratulation and appreciation received from out-of-town visitors by the Chairman of the General Committee and the Branch Chairman.

The Branch is to be congratulated on having one of its prominent members, E. V. Buchanan, M.E.I.C., General Manager of the London Public Utilities Commission, elected at the Business Meeting to the position of Vice-President of The Engineering Institute of Canada.

The London Branch extends its thanks to the, then, President-elect and Mrs. Challies for their kind invitation to members and ladies to afternoon tea on Sunday the 30th January in the Georgian Room of the Hotel London in order to meet distinguished members from Headquarters. This social event was very well attended and many expressions of appreciation and pleasure at the kindness and thoughtfulness of Mr. and Mrs. Challies were heard from those who accepted the invitation. There is no doubt that everyone enjoyed themselves and realized that it made a capital "get together" for the ensuing meeting.

Moncton Branch

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

ISLE OF ORLEANS SUSPENSION BRIDGE.

On January 26th, 1938, a supper meeting of the Branch was held in the Y.M.C.A. E. B. Martin, A.M.E.I.C., the Branch chairman, presided. D. B. Armstrong, A.M.E.I.C., chief designing engineer, Dominion Bridge Co. Ltd., Montreal, delivered a very instructive address on the "Pre-stressing and Erection of the Isle of Orleans Suspension Bridge." With the aid of slides Mr. Armstrong described in detail the many problems connected with the design and erection of this type of structure. The address was followed by a lengthy discussion. A vote of thanks was extended the speaker on motion of F. O. Condon, M.E.I.C., seconded by R. H. Emmerson, A.M.E.I.C.

Ottawa Branch

R. K. Odell, A.M.E.I.C., Secretary-Treasurer.

The first noon luncheon of the 1938 year was held at the Chateau Laurier, Thursday, January 27th, with W. F. M. Bryce, A.M.E.I.C., the newly-elected chairman, presiding. The guest speaker was W. Lindsay Malcolm, Professor of Municipal Engineering at Queen's University. In his address, which was illustrated with lantern slides, he described the newly-constructed Municipal Engineering Laboratory at Queen's University.

THE SANITARY ENGINEERING LABORATORY AT QUEEN'S UNIVERSITY

This laboratory was necessitated by the rapid advances technically in Highway and Sanitary Engineering, according to the speaker, primarily to the Civil Engineering students. He also hoped that the laboratories might be of some assistance to the medical students in their studies in public health and sanitation.

The Highway Engineering Laboratory, with provision therein for soil mechanics, is installed on the ground floor. In this the testing of stone, asphalts, and other materials used in road construction will be made. The various tests for soils, soil consolidation and stabilization will be possible in this new set up.

The Sanitary Engineering Laboratories constitute the major space in this new building. They consist of actually operating water and sewage treatment units. The water treatment units at present consist of three rapid sand filters 3 by 3 by 7 feet deep. All the necessary adjuncts for chemical feeding, control, backwashing, etc., will be provided. It is hoped later this year to add a slow sand filter. Odour and taste control experimental work will be gone on with.

On the sewage side a complete activated sludge plant is installed, with pre-sedimentation, aeration and final settling units being provided. Primary and activated sludge will be digested. The digester room contains 6 units which can be operated in various ways to make the experimental work of wide range. The digested sludge (and other sludges) will be dewatered on sand beds and on vacuum filters.

A trickling filter plant will also be installed in the sewage room, with various kinds of filter materials being provided in the units.

A chemical and bacteriological laboratory for control operations, and student instruction in Sanitary Engineering generally, is provided in the upper floor of the east end of the building. This laboratory has been completely equipped chemically and bacteriologically for this purpose.

TURNER VALLEY—A MAJOR OIL FIELD

At the noon luncheon on February 10th, 1938, G. S. Hume, Ph.D., of the Geological Survey of Canada, spoke on "Turner Valley—a Major Oil Field." Dr. Hume stated that as far as present production is concerned Turner Valley could not yet be classed as one of the major oil fields of the world but with the possibility of 30 to 35 more wells added to present production in the next year, the field had prospects of assuming major importance.

The field is quite exceptional in many ways. Structurally it is one of the most complicated in North America. Along with its three square miles of proven territory, there appears to be distinct possibilities for further development along its west flank and also to the south.

Dr. Hume traced the history of the field with its production of naphtha, crude oil and gas from the time of its discovery down to the present. He outlined the geology and described some of the particular problems that had to be solved. The Dominion Department of Mines and Resources has been making an intensive study of the field with samples taken for examination at every ten feet from the holes as they were being drilled. By such means the structural details of the geology may be worked out so that the information obtained may be applied in the actual development of the area itself or in the possible development of other areas as well.

Dr. Hume described methods of drilling, how the pore spaces in the limestone structure are opened up by the use of a hydrochloric acid solution, thereby allowing an easier flow, how the wells are cased with the bottom of the casing cemented to the oil-bearing rock, and mentioned the rather surprising fact that sometimes in the well-drilling the holes deviate as much as 30 degrees from the vertical. He also quoted figures giving an idea of the amount of production to date from this interesting field.

W. F. M. Bryce, chairman of the Ottawa branch, presided, and there was a particularly large attendance. The address was illustrated with lantern slides.

1937 ANNUAL REPORT OF THE AERONAUTICAL SECTION, OTTAWA BRANCH, ENGINEERING INSTITUTE OF CANADA, WITH WHICH IS INCORPORATED THE OTTAWA BRANCH OF THE ROYAL AERONAUTICAL SOCIETY

The officers for the year were:—

Chairman.—Dr. J. J. Green,
Division of Mechanical Engineering,
National Research Council,
Ottawa.

Secretary.—J. T. Dyment, A.M.E.I.C.,
Aeronautical Engineering Division,
Department of Transport,
Ottawa.

PROCEEDINGS

The following technical papers were given at evening meetings of the Aeronautical Section:

1937

Jan. 13—N. F. Vanderlipp, General Manager, Fairchild Aircraft, Ltd., **Vibration in Aircraft**. Attendance 32.

Jan. 22—J. T. Dyment, A.M.E.I.C., Aeronautical Engineering Division, Department of National Defence, **Stability and Control of Aeroplanes**. Attendance 33.

Mar. 4—Dr. C. Y. Hopkins, Division of Chemistry, National Research Council, **Use of Synthetic Plastics in Aeroplanes**. Attendance 22.

Mar. 18—W. I. Haskett, Patent Attorney, **Patents**. Attendance 10.

Mar. 25—S. Graham, District Inspector, Civil Aviation Division, Department of Transport, **Air Navigation**. Attendance 18.

Apr. 6—Dr. G. S. Farnham, Metallic Minerals Division, Department of Mines, **Fatigue of Metals**. Attendance 20.

April 14—Group Capt. E. W. Stedman, M.E.I.C., K. F. Tupper and Dr. J. J. Green, **Aerodynamic Laboratories of England, Italy and France** with accompanying motion pictures. Attendance over 400.

April 29—M. S. Kuhring, Division of Mechanical Engineering, National Research Council, **Selection and Installation of Aircraft Engines**. Attendance 31.

Nov. 19—Dale Atkinson, Operations Manager, Starratt Airways and Transportation Limited, **Northern Airline Operations**. Attendance 46.

The average attendance of 27 at lectures, excepting the one large meeting, was the same as the preceding year. As before, only ten affiliates attended and contributed their fee of one dollar. The consistent attendants were chiefly members of The Engineering Institute of Canada and/or the Royal Aeronautical Society.

FINANCIAL STATEMENT
From January 1, 1937, to December 31, 1937

Expenditures		
Cash in bank	$ 0 31	
Postcards	33 22	
Postcards owing	4 16	
Stamps	90	
Stamps owing	51	
		$39 10
Receipts		
Cash carried over from 1936	$ 3 70	
Bank balance from 1936	73	
Fees (affiliates)	10 00	
Grant from Ottawa Branch	20 00	
Total		$34 43
Debit Balance		$ 4 67

The financial statement indicates that the total receipts of thirty dollars were the same as the preceding year.

With each meeting costing four dollars and thirty cents, the number of papers should be limited to seven.

Two extra papers were permitted this year due partly to a balance from 1935 and partly by incurring a small temporary debt.

The officers of the Section corresponded with the Royal Aeronautical Society and it is hoped that the receipts of the section will be augmented by a grant from the Society.

A more extensive programme of technical papers would thus be possible.

(Signed) JOHN T. DYMENT, A.M.E.I.C., *Secretary.*

Victoria Branch

Kenneth Reid, Jr.E.I.C., Secretary-Treasurer.

The annual meeting of the Victoria Branch of The Engineering Institute of Canada was held on December 16th, 1937, and was preceded by a dinner, a large number of the resident members being in attendance. The meeting was followed be a period devoted to an examination of the display of illuminated addresses, presented to The Institute on the occasion of its semicentennial anniversary, which were on exhibition for the occasion. Great interest was evidenced by both the members and the many visitors present in the art and beautiful workmanship of the exhibit.

Following this intermission Mr. A. L. Carruthers, bridge engineer for the Province of British Columbia, then gave a short talk on some of the interesting features in the design and construction of the Pattullo bridge over the Fraser river at New Westminster, B.C.

Three films were shown which illustrated quite clearly the magnitude of the work and the methods adopted to carry it out to a successful conclusion.

The members present had read the very excellent paper by Major W. G. Swan, Consulting Engineer for the Government, in the October issue of The Engineering Journal and were therefore fairly familiar with the sub-structure work, with the result that quite an interesting discussion ensued particularly with reference to the size, type, construction and sinking of the main piers; the advantages of the Kane construction in the south approach reinforced concrete trestle; the steel erection by the cantilever method and the sodium lighting of the roadway.

The consensus of opinion seemed to be that a very interesting evening had been enjoyed by everyone.

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.

Notices appearing in the Situations Wanted column will be discontinued after three insertions, and will be re-inserted after a lapse of one month, upon request.

All correspondence should be addressed to

The Employment Service Bureau, The Engineering Institute of Canada

2050 Mansfield Street, Montreal

Situations Vacant

SALES ENGINEER, with mechanical ability and bi-linguist, to act as sales engineer in fire protection field, Montreal and vicinity. Apply to Box No. 1291-V.

SALES ENGINEER, with experience and connections in Montreal district, to sell line of tanks, structural steel and floor grating. Speaking French, preferred. Apply to Box No. 1726-V.

ASSISTANT ENGINEER. A general contractor and builder, A.M.E.I.C., in Quebec province, will require this Spring, a young and capable assistant possessing energy and initiative for estimating and organizing jobs. A graduate engineer with some experience preferred, but character and a desire to make the construction business his life work, essential. Apply to Box No. 1727-V.

ENGINEER, experienced in air conditioning work. Able to survey, estimate, layout and supervise erection. Apply to Box 1734-V.

Situations Wanted

INDUSTRIAL ENGINEER AND SUPT. Age 32, A.M.E.I.C., with combined electrical, mechanical and steel industry experience in several plants. Experience includes design and testing of various types of industrial electrical equipment, supervision of production and cost reduction, heat treating of steel, time study application in several plants, in United States and Canada. At present supt. of modern factory. Apply to Box No. 132-W.

SALES ENGINEER seeks position with a future. A mechanical engineer, JR.E.I.C., with thorough training in England and wide experience for past 8½ years in Canada is seeking a permanent position as sales engineer for manufacturer of industrial equipment, etc. Has had varied experience in sales work, mechanical engineering, heating, ventilating and power plant equipment. Of good appearance, ambitious, intelligent. Excellent references. Apply to Box No. 270-W.

INDUSTRIAL ENGINEERING EXECUTIVE, with wide experience including fourteen years in design, construction, maintenance and operation of pulp and paper mills and power developments. Now employed, desires change of location. Apply to Box No. 320-W.

STEAM POWER PLANT DESIGNER, with wide experience on high pressure steam-electric plant. Available at once. Apply to Box No. 525-W.

Situations Wanted

MECHANICAL ENGINEER, JR.E.I.C., university training, age 28, Married. Four years experience in administration and operation of business. Two years experience construction as instrumentman and field control, and inspection of concrete. Experience assembly line supervision one year. Read, write and speak French. Will go anywhere. Available immediately. Apply to Box No. 551-W.

ELECTRICAL ENGINEER, B.SC., E.E., age 38. Married. Ten years electrical experience; including, one year operation, one year maintenance, and four years on construction of hydro-electric plants and sub-stations. Four years electric maintenance and construction in pulp and paper mill. Also experience on highway construction and Geological Survey. Available at once. Apply to Box No. 636-W.

MECHANICAL ENGINEER, JR.E.I.C., technical graduate, bilingual, age 35, married, experience includes five years with firm of consulting engineers, design of steam boiler plants, mechanical equipment of buildings, heating, ventilating, air conditioning, plumbing, writing specifications, etc. Five years with large company on sales and design of power plant, steam specialties and heating equipment. Available on short notice. Apply to Box No. 850-W.

ELECTRICAL ENGINEER, B.SC. (McGill '28), age 34. Experience includes transmission line and rural distribution construction and design. Some installation of motors and equipment, also house wiring. Available immediately. Apply to Box No. 940-W.

SALES ENGINEER, age 30, graduate in electrical engineering, seeks position with more future. Experience in radio and telephone work and in electrical contracting. At present selling electrical supplies in Western Ontario. Apply to Box No. 1044-W.

CHEMICAL ENGINEER, grad. McGill '34, experienced in meter repairs, control work; and also chemical laboratory experience. Apply to Box No. 1222-W.

CIVIL ENGINEER, B.A.SC. (Toronto '33), S.E.I.C., age 27. Married. Five years experience includes highway surveys, bituminous and concrete paving, steel and reinforced concrete building construction, instrument work, draughting, cost accounting and estimating and some experience as foreman. Available immediately. Apply to Box No. 1265-W.

ELECTRICAL AND RADIO ENGINEER, S.E.I.C., B.SC. (Elec.) '32, M.SC. '34. Experience includes four years part time operator for radio broadcast station, repairs to radio receivers and test equipment, design and construction of amplifiers and inter-office communication systems. Available on short notice. Apply to Box No. 1283-W.

Situations Wanted

CONSTRUCTION SUPERINTENDENT, M.E.I.C. Age 49. Married. Twenty-two years experience as engineer, superintendent and manager in charge of hydro-electric, mechanical production, structural steel erection, also considerable experience in steam plants, combustion, transmission lines, millwright work, complete mine installations, rock work, rock crushers and conveyors. Executive ability. Speaking French fluently. Location immaterial. Apply to Box No. 1482-W.

RESIDENT ENGINEER, familiar with all types of surveys and construction work including, railway, roads, irrigation, drainage, buildings and air ports. Executive ability. Had charge of several large projects. Intimate knowledge of reports and estimates. Available immediately. Any location. Apply to Box No. 1567-W.

ELECTRICAL ENGINEER, B.SC. '27 (McGill), A.M.E.I.C. Age 36. Married. Bilingual. Three years experience in telephone work (installation of manual and automatic exchanges). One year electrical prospecting. Nine years experience with electrical power company. Apply to Box No. 1601-W.

CIVIL ENGINEER, graduate 1927, age 34 years, desires position as town engineer. Eight years municipal experience. Location immaterial. Apply to Box No. 1628-V.

CIVIL ENGINEER, B.SC. in C.E., A.M.E.I.C. Age 32. Married. Three years of pulp and paper mill experience, draughting, instrumentman and maintenance. One year as instrumentman on highway construction. Five years checking and designing reinforced concrete and steel. Apply to Box No. 1658-W.

ELECTRICAL ENGINEER, B.A.SC., U. of T. '24, A.M.E.I.C., single, age 44. Ten years in supervisory operating office and two years in construction division (office and field) of large city electrical utility commission. One year factory supervision and tool design in manufacture of small electrical equipment. Wide experience with internal combustion engines. Experience handling heavy machinery. Private pilot's license for light aircraft. Full details on request. Available on short notice. Apply to Box No. 1693-V.

MECHANICAL ENGINEER, young graduate with six years diversified experience in the pulp and paper industry. JR.E.I.C. Desires position as master mechanic, or, as assistant in large mill. Apply to Box. No. 1694-W.

MECHANICAL AND ELECTRICAL ENGINEER, age 47, graduate University of Toronto, 1911. Machinist's trade. Two years tool design and quantity production in the U.S.A. Twelve years Canadian shop experience design and producing heavy equipment. Twelve years as chief sales engineer and field man for one of the largest Canadian national concerns. Experience in manufacturing and sales of pumps, engines, paper mill equipment, power plant equipment and specialties, electrical machinery etc. Clean record, excellent connection. Apply to Box No. 1699-V.

ELECTRICAL ENGINEER, B.SC., E.E. (Univ. of Man '37). Experience in highway construction as inspector. Available at once. Apply to Box No. 1703-W.

ELECTRICAL ENGINEER, B.SC., A.M.E.I.C., age 44, married. Experience includes draughting, construction and maintenance. The last eight years holding the position of electrical superintendent, of a fair sized industrial plant. Apply to Box No. 1718-W.

The Admiralty Graving Dock at Singapore

On February 14, the Governor of the Straits Settlements, Sir Shenton Thomas, G.C.M.G., formally opened the graving dock which has been under construction for the last eight years at the Singapore naval base. The ceremony, which was attended by ships from all the Eastern stations and by vessels of the United States Navy, as well as by representatives from Australia, New Zealand, the Federated Malay States and Hong Kong, was not, as the public is inclined to suppose, the official inauguration of the naval base as such, but merely of the graving dock. With the dock completed and in working order, however, one of the prime requirements which led to the authorization of the new base is met, and the fleets stationed in Middle and Far Eastern waters will be, in effect, usefully augmented as a result of the increased docking facilities now available, quite apart from any actual increase in the number and size of the warships which political developments may require to be stationed in those waters.

The contract for the new dock, which has been designed in the Civil Engineer-in-Chief's Department of the Admiralty, was placed in the latter part of 1928 with Messrs. Sir John Jackson, Limited, Westminster, S.W.1, as a part of the contract for the complete dockyard. The work of clearing the site commenced in 1929, but the actual construction was considerably delayed as a result of decisions in favour of retrenchment made at the Imperial Conference in the following year. This policy was subsequently reconsidered, following the change of government, in the light of Eastern developments, and the work has since proceeded normally. The dock has a width of 130 ft. at the entrance and a length of 1,000 ft. The depth of water over the sill is 35 ft. at low tide. These proportions render the dock capable of dealing with any ship in the British Navy. The contract for the caisson was sublet to Messrs. Sir William Arrol and Company, Limited, Glasgow, and that for the pumping plant to Messrs. Gwynnes Pumps, Limited, Lincoln. No particulars of the dewatering pumps have been disclosed, but it may be assumed that they will compare in capacity with those of the King George V dock at Southampton, of the same width and about 140 ft. greater length, which can be emptied in four hours.

The estimated total cost of the naval base, when the contract was placed in 1928, was £7,750,000, but various modifications have since been made to the scheme, and the ultimate cost, including machinery, will probably approach £12,000,000. This amount, however, cannot be regarded as excessive in view of the magnitude of the undertaking, which will cover some 2,400 acres, or nearly four square miles, with a water frontage of about 4½ miles. In levelling the site and excavating the dock approximately 8,000,000 cub. yd. of earth have been removed, and the associated dredging has amounted to about 5,000,000 cub. yd. In the construction of the dock and other works, and of some 5,000 ft. of wharf walls, 1,000,000 cub. yd. of concrete have been deposited, together with granite blocks to the total of about 250,000 cub. ft. —*Engineering*.

Preliminary Notice

of Applications for Admission and for Transfer

February 23rd, 1938.

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 1938.

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

CAREY—ROGER PACKARD, of Sackville, N.B., Born at Sackville, N.B., Dec. 10th, 1910; Educ., B.Eng. (Civil), N.S. Tech. Coll., 1935; 1929 (summer), chainman, Topog'l. Survey, Prov. of N.B.; 1930-31 (summers), chainman, Dept. of Highways of N.B.; 1933 (summer), instr'man., Town of Sackville, N.B.; 1935 (summer), plant inspr, Milton Hersey Co. Ltd., controlling operation of paving plants during laying of asphaltic paving at Memramcook and Sackville, N.B.; 1936 to date, instr'man., Dept. of Public Works, Prov. of N.B., Highway Divn., permanent highway constrn., running location, setting grades for earth work, pavement, etc.

References: H. W. McKiel, S. Ball, G. H. Burchill, F. W. W. Doane, W. P. Copp.

ENOUY—WILLIAM GEORGE, of Montreal, Que., Born at Toronto, Ont., Mar. 21st, 1906; Educ., B.A.Sc., Univ. of Toronto, 1927; 1924 (5 mos.), surveying, City of Toronto; May 1927 to date, with H. H. Robertson Co. Ltd., Toronto. as follows; 1927, early training, head office, Pittsburgh, Pa.; 1927-30, junior, engrg. dept., Toronto office; 1930 (4 mos), i/c production Sarnia factory; to end of 1936, progressive steps to charge of engrg. dept., Toronto, incl. supervision of factory operations. During this period served as field supervisor for work involving Robertson products throughout Ontario; 1936-37, sales engr. in Quebec territory, working from Toronto; Nov. 1937 to date, manager, Montreal district sales office.

References: P. E. Poitras, R. Robertson, C. R. Young, W. H. M. Laughlin, D. C. Tennant.

HUTTON—CHARLES HYDE, of Hamilton, Ont., Born at Hamilton, Oct. 21st, 1886; Educ., B.A.Sc., Univ of Toronto, 1907; R.P.E. of Ont.; 1907-31, with the Dominion Power and Transmission Co., Hamilton, Ont. (a holding company of electric light and power and suburban electric railway companies), as follows: 1907-09, repairman—transformers, trouble shooter—distribution, factory elect'l. tests; 1909-12, dftsman. on substation design, rly. survey, field and office work, land descriptions, trans. line location and specifications, for various electric rly. companies; 1912-17, design, estimates, specifications and constrn., steam turbo station, substations, hydraulic extensions, land descriptions, reports, valuations, steel trans. lines, electric rlys.; 1918-26, operating supt., and 1926 to 1931, operating engr. In 1931 the assets of the Dom. Power and Trans. Co. were purchased by the H.E.P.C; of Ontario; 1931 to 1935, employed as operating divnl. supt., for the H.E.P.C.; 1925-28, consltg. steam engr., Power Corporation of Canada; at present, chief engr., Hamilton Hydro-Electric Commission, Hamilton, Ont.

References: W. D. Black, W. G. Hewson, W. Hollingworth, R. L. Latham, W. L. McFaul, W. G. Milne, R. K. Palmer, F. W. Paulin, J. J. Mackay, F. J. Bell, A. E. K. Bunnell, F. R. Ewart, A. D. LePan, C. B. Hamilton, M. C. Hendry, T. H. Hogg, J. J. Traill, C. S. L. Hertzberg.

LAMB—JOHN ALEXANDER, of 922 Temperance St., Saskatoon, Sask., Born at Saskatoon, Sept. 23rd, 1915; Educ., B.Eng. (Civil), Univ. of Sask., 1937; 1931-36, part time chainman and instr'man. on land surveying; 1937, instr'man. on Prairie Farm Rehabilitation; at present, instructing in engrg. laboratory, University of Saskatchewan.

References: C. J. Mackenzie, R. A. Spencer, W. E. Lovell, E. K. Phillips, J. J. White, G. L. Mackenzie.

MUSGRAVE—ARTHUR STANLEY GORDON, of 2376 Central Ave., Oak Bay, B.C., Born at Cork, Ireland, May 14th, 1890; Educ., Bach. Civ. Engrg., Trinity College, Dublin, 1912; R.P.E. of B.C.; B.C.L.S., 1919; 1914-19, Capt., Candn. Engrs., and Royal Engrs.; 1919-35, private practice as B.C. Land Surveyor and Civil Engr., carrying out various large surveys and various road locations and small dam work; 1935 to date, municipal engr. of the Corporation of the District of Oak Bay, B.C.

References: F. C. Green, J. H. Gray, H. L. Swan, W. H. Powell.

McGUGAN—ANGUS, of 6881 Monkland Ave., Montreal, Que., Born at Glasgow, Scotland, Jan. 28th, 1900; Educ., 1914-21 (evening classes), Royal Technical College, Glasgow. Diploma in Mech'l. Engrg.; City and Guilds of London Institute, Diploma in Mech'l. Engrg., 1922; Assoc. Member, Inst. of Engrs. and Shipbldrs. in Scotland; 1916-21, ap'ticeship, mech'l. engrg., Fairfield Shipbldg. and Engrg. Co. Ltd., Govan, Glasgow, pattern making, fitting, erecting, and drawing office; 1921-22, engr. with above company on marine installns., govt. and merchant type vessels—steam reciprocating—Parsons & Brown-Curtis; single and double deduction gear coupled turbines, Fairfield Sulzer and Fairfield Doxford Diesel engines, experimental dept. and shop trials; 1922-23, inspr. on steam and water tests, valves and boiler mountings, Robert Turnbull & Sons, Glasgow; 1923-26, marine engr. officer i/c of main engines on regular watch, C. P. Steamships, Ltd.; 1926 to date, designing engr., Williams & Wilson Ltd., Montreal, Que.

References: D. C. Tennant, R. White, F. S. B. Heward, R. H. Findlay, R. S. Eadie, R. B. Jones, K. S. LeBaron, A. Peden, F. Newell.

PORTER—LAWSON BARDON, of Saint John, N.B., Born at Albert, N.B., Feb. 20th, 1908; Educ., 1926-28, Univ. of N.B.; 1929-30, elect'l. inspr., generators, distributors, Cadillac Motors, Detroit, Mich.; 1930 to date, with the Saint John Harbour Commission (now the National Harbours Board), as follows: instr'man. and inspn., shed constrn. 1930-31; 1931-32, supervision—field layout and quantities, Navy Island development; 1932-33, asst. field engr., coffer dam removal; 1933-34, supervision—field layout and quantities, constrn. of sheds and galleries, track and yard layout and installn. at West Saint John, Navy Island development; engr. in charge of field survey of harbour facilities at West Saint John; 1934-35, engr. i/c field work for constrn. of concrete street paving, West Saint John; 1935, engr. i/c field work, triangulation survey of proposed berths 1, 2, 3 and 4 at West Saint John; 1935 to date, engr. i/c of field surveys, soundings, field layout of works, diving inspn., etc., on reconstrn. of berths 1, 2, 3 and 4, Saint John Harbour.

References: F. C. Jewett, D. G. Ross, T. C. MacNabb, C. C. Kirby, A. Gray, J. Stephens.

RAYMER—DENZILL EDWIN, of 622 St. Joseph St., Lachine, Que., Born at Toronto, Ont., Jan. 7th, 1915; Educ., B.A.Sc., Univ. of Toronto, 1936; 1936-37, detailing, estimating, Toronto Iron Works Ltd.; 1937 to date, detailer, plate and boiler dept., Dominion Bridge Co. Ltd., Montreal, Que.

References: A. S. Wall. R. S. Eadie, F. Newell, L. Jehu, C. R. Young.

RETTIE—JAMES ROBERT, of 428 McGee St., Winnipeg, Man., Born at Winnipeg, July 3rd, 1913; Educ., B.Sc. (Civil), Univ. of Man., 1935; 1935-37, timekpr., storeman and relieving storekpr., C.P.R., Nelson, B.C.; 1937 to date, engr., Anthes Foundry Ltd., Winnipeg, Man.

References: J. N. Finlayson, A. E. Macdonald, G. H. Herriot, W. F. Riddell, H. R. Younger.

RUSSELL—LEONARD JAMES, of Fort Erie, Ont., Born at Fort William, Ont., Apr. 27th, 1912; Educ., B.A.Sc., Univ. of Toronto, 1935; 1935-36, rodman, Trans-Canada Highway; Nov. 1936 to date, dftsman., Horton Steel Works Ltd., Fort Erie North, Ont.

References: W. R. Manock, L. C. McMurtry, C. S. Boyd, C. R. Young, A. W. F. McQueen.

TURNBULL—JOHN G., of Amherstburg, Ont., Born at Dunham, Ont., June 23rd, 1905; Educ., B.Sc., Queen's Univ., 1937; 1927-31, asst. supt., Commercial Motor Bodies, Guelph, Ont.; 1933, body bldg., 1935, engrg. dept., General Motors of Canada, Oshawa, Ont.; 1936, foreman, Ottawa Car Mfg. Co.; 1937 to date, field engr. i/c constrn., Brunner Mond Canada, Amherstburg, Ont.
References: L. T. Rutledge, L. M. Arkley, D. S. Ellis.

WHITEWAY—LORNE BRUCE, of Stellarton, N.S., Born at Murray River, P.E.I., June 8th, 1911; Educ., B.Sc. (Elec.), N.S. Tech. Coll., 1934; 1933 (4 mos), asst. electrn., Acadia Coal Company, Stellarton, N.S.; 1935-37, instr'man., Dept. of Highways, N.S.; at present (temporary), checking inventory for Pictou County Power Board, Stellarton, N.S.
References: I. P. MacNab, W. A. Winfield, K. L. Dawson, E. L. Baillie, H. Fellows.

WYCKOFF—EDWIN GERALD, of Hamilton, Ont., Born at Vittoria, Ont., Oct. 5th, 1907; Educ., B.A.Sc., Univ. of Toronto, 1930; 1927-28, (summers), H.E.P.C. of Ont.; With the Otis-Fensom Elevator Co. Ltd., as follows: 1929, elevator erection, Toronto,1930, elevator erection, Montreal, 1931-33, engrg. student, Hamilton Works; 1933 to date, i/c of various mfg. depts. including motor and generator test dept; electro-plating dept.; factory mtce; and with responsibility under the works manager for all manufacturing procedure and foundry methods, particularly in connection with the manufacture of motors, generators, controllers, and other electrical equipment used in connection with elevators.
References: W. D. Black, W. J. W. Reid, D. W. Callander, A. R. Hannaford, R. W. Angus, H. E. Steventon.

FOR TRANSFER FROM THE CLASS OF ASSOCIATE MEMBER TO THAT OF MEMBER

LeCLAIR—WILLIAM JAMES, of Toronto, Ont., Born at Ottawa, Ont., Aug. 24th, 1891; Educ., 1913-16, Univ. of Toronto; 1914-16, asst. engr., Dept. of Public Works, Ottawa; 1916-17, Lieut., C.E.F., Technical Officer, Can. Forestry Corps. 1917-19, Capt., C.E.F., Technical Officer (France), Canadian Forestry Corps; 1919-28, partner, manager and chief engr., Lawson & LeClair, Dalbeattie, Scotland; Built and operated Victory Works. Remodelled and operated Mount Pleasant and Wilmington paper mills; 1928-30, woods and sawmills engr., Gatineau Divn., Candn. International Paper Co.; 1930-37, chief of lumber seasoning and wood utilization divns. of Forest Products Laboratories, Ottawa, Dominion Forest Service; at present, secretary-manager, White Pine Bureau (clearing house of technical information for the lumber industry, besides supervising manufacture, standardizing grades, and promoting markets for Canadian pine lumber). (*St. 1914, Jr. 1919, A.M. 1928*)
References: J. B. McRae, J. Murphy, C. R. Coutlee, A. Gray, J. L. Lang, D. R. Cameron, C. McL. Pitts, A. K. Hay.

FOR TRANSFER FROM THE CLASS OF JUNIOR

BROWNIE—FRANK AUSTIN, of Edmonton, Alta., Born at Montreal, Que., April 16th, 1908; Educ., B.Sc. (Civil), Univ. of Alta., 1934; 1928-29-30 (summers), rodman, instr'man., Dept. Nat. Resources, C.P.R., Calgary; 1931 (summer), rodman, dftsman., constrn. of Glenmore Water Supply, Calgary; 1934 (May-Nov.), instr'man. i/c surface surveying and shallow hole drilling on seismic surveying, Dominion Gas Service Ltd., Calgary; 1934-35, inspr. of assessments, Dept. of Municipal Affairs, Govt. of Alberta; Nov. 1935 to date, asst. engr., natural gas engrg. office and field, Northwestern Utilities Ltd., Edmonton, Alta. (*St. 1932, Jr. 1935*)
References: J. Garrett, E. Nelson, F. K. Beach, R. S. L. Wilson, H. R. Webb.

CHISHOLM—DONALD ALEXANDER, of Mulgrave, N.S., Born at Eureka, N.S., June 18th, 1906; Educ., B.Sc. (Civil), N.S. Tech. Coll., 1932; 1928 (summer), instr'man., Canada Cement Co.; 1929-30, dftsman., C.N.R.; 1934, asst. engr., and May 1935 to date, res. engr., Nova Scotia Dept. of Highways, Halifax, N.S. (*St. 1930, Jr. 1934*)
References: E. L. Baillie, H. Thorne, S. Ball, F. G. MacPherson, G. C. Reid.

McKAY—ROBERT DONALD, of 72 Duncan St., Halifax, N.S., Born at Yarmouth, N.S., June 13th, 1908; Educ., B.Sc. (Civil), N.S. Tech. Coll., 1933. 1935-36, post-graduate study in sanitary engrg., Graduate School of Engrg., Harvard University; 1930 (summer), student asst., Geol. Survey of Canada; 1930-31, engr'.s helper, Parsons Constrn. Co.; 1931 (summer), instr'man. and paving inspr., Town of Yarmouth; 1934-35, res. engr., and constrn. engr., Dept. of Highways, Nova Scotia; Feb. 1936 to date, sanitary engr., Dept. of Public Health, Nova Scotia, full responsibility and charge of engrg. work of dept. (*St. 1932, Jr. 1935*)
References: S. Ball, Y. C. Barrington, W. P. Copp, F. W. W. Doane, H. W. L. Doane, H. S. Johnston, J. K. McKay, R. R. Murray.

TAYLOR—MORLEY GLADSTONE, of Maracaibo, Venezuela, South America., Born at Parrsboro, N.S., April 22nd, 1904; Educ., B.Sc. (E.E.), N.S. Tech. Coll., 1927. M.Sc., Mass. Inst. Tech., 1931; 1927 (summer), ap'tice, Nova Scotia Light and Power Co., Halifax; With the Venezuela Power Co. Ltd., as follows: 1927-29, head of installn. and meter dept., 1929-30, distribution supt., 1931-35, manager, 1935-37, operating supt., and at present, acting general manager. (*St. 1927, Jr. 1929*)
References: J. R. Kaye, I. P. MacNab, J. B. Hayes, J. H. Reid, J. Cameron, R. W. Tassie.

VICKERSON—GEORGE L., of 10 Winchester Ave., Westmount, Que., Born at Montreal, Sept. 6th, 1904; Educ., B.Sc. (Civil), McGill Univ., 1925; 1926 to date, in charge of contracts for the G. R. Locker Co., Montreal, including design, estimating, superintendence of erection, costing and purchasing (Tile Contractors). (*St. 1926, Jr. 1928*)
References: D. Bremner, B. R. Perry, G. M. Pitts, E. R. Smallhorn, C. V. Christie, R. DeL. French.

FOR TRANSFER FROM THE CLASS OF STUDENT

SANDILANDS—ADAM Jr., of Winnipeg, Man., Born at Winnipeg, May 13th, 1910; Educ., B.Sc. (Elec.), Univ. of Man., 1934; 1929-33 (summers), survey and electr'l. helper, gen. contracting works; 1934, with Gods Lake Gold Mines; 1935-36, ap'tice course, Crampton-Parkinson Co., Chelmsford, England; July 1936 to date, elect'l. and sales engr., Power and Mine Supply Co., Winnipeg, Man. (*St. 1931*)
References: N. M. Hall, A. E. Macdonald, E. P. Fetherstonhaugh, H. L. Briggs, G. H. Herriot, T. C. Main, D. M. Stephens.

SMITH—NORMAN JANSON WINDER, Capt., R.C.E., of Changi, Singapore., Born at Toronto, Ont., Jan. 27th, 1909; Educ., B.Eng., McGill Univ., 1932; 1930-31, duty under D.E.O., M.D. No. 6, Halifax; 1933-35, duty under D.E.O., M.D. No. 2, Toronto; 1935-36, duty under Director of Engineer Services, Ottawa; 1936-37, attached to 23rd Field Co., R.E., Aldershot; 1937 to date, attached to the Royal Engineers, Singapore. (*St. 1931*)
References: G. R. Turner, C. R. S. Stein, J. R. Wainwright.

WILSON—THOMAS WHITESIDE, of 13 Fairview Blvd., Toronto, Ont., Born at Peterborough, Ont., Nov. 7th, 1906; Educ., B.A.Sc., Univ. of Toronto, 1933; 1928-31 (summers), rodman, Dept. Highways Ont., magnetometer survey, underground surveys, Falconbridge Nickel Mines, highway constrn., A E. Jupp Constrn. Co., rodman, under Major C. E. Bush, O.L.S.; 1933-34, i/c excavation for Municipal Excavating Co., on N. Toronto sewage disposal plant, etc.; 1934, i/c work for John English Excavators Ltd.; 1934-36, mtce. dept., T. Eaton Co. Ltd.; 1936-37, i/c safety work, T. Eaton Co. Ltd.; at present, advertising salesman on an engrg. paper, also some editorial work, Hugh C. Maclean Publications Ltd. (*St. 1932*)
References: J. R. Cockburn, W. J. Smither, R. E. Smythe, T. R. Loudon, C. R. Young.

More Light—Free

According to W. J. Orr, Manager of the Lamp Division of the Canadian Westinghouse Company, we obtain to-day five times as much light for our dollar as we did thirty years ago from the first tungsten filament lamps, and ten times as much as from the carbon lamps which they superseded.

This is because more efficient and cheaper lamps are available to-day and the price of electric power has dropped steadily and continuously year by year.

The cost of the light produced by a lamp is determined by three factors. The cost of the lamp and the cost of the current are, obviously, two of these, but the third, the efficiency of the lamp, is actually the most important of the three.

The enormous improvement in the efficiency of electric generating and transmitting equipment, within the past generation, is a familiar story—many of us can remember when electricity for lighting in the average home cost 10.5c per kw.h. To-day, the average householder pays only 3c per kw.h.

Since 1907, the price of the typical Mazda lamp—the 60 watt—has fallen like a plummet from $1.75 to the present price of 20c. The increased efficiency of the lamp, however, which determines how many lamps and fixtures and how much current is required for a given lighting job and therefore affects lighting costs more directly and extensively than the other factors, has risen step by step, year by year, until now the modern 60 watt Mazda lamp is about twice as efficient as it was when first introduced and almost three and one-half times as efficient as the carbon lamp of 1906.

Efficiency in a lamp is expressed in terms of lumens (of light) per watt (of current). This corresponds to the term "miles per gallon" which measures the efficiency of an automobile. Research and engineering have increased the miles per gallon obtained with a modern car, steadily reducing the cost of transportation to the motoring public and this increased efficiency is an important contribution to transportation. The average automobile costs about $1000.00 and, during its life, it consumes about $750.00 worth of gasoline, so that doubling the miles per gallon would cut transportation cost by 21 per cent. The average size Mazda lamp—the 60 watt—costs 20c and, during its life, consumes $1.80 worth of electricity, so that with the lamp, doubling its efficiency would cut the cost of light by 45 per cent! While miles per gallon therefore is an important factor in determining the cost of transportation, lumens per watt or efficiency of an incandescent lamp is many times more important in determining the cost of light.

In 1907, the brand-new tungsten filament lamp was sold by means of the slogan "Three times as much light for the same money," but now, due to the decreased cost of the Mazda lamp and the current to operate it, plus the increased efficiency of the lamp itself, we get ten times as much light per dollar as we did at the turn of the century.

Pegmatites of Manitoba Among Oldest Known Rocks

How old is the earth? Close to two billion years at least, according to A. C. Lane, Emeritus Professor of Geology and Mineralogy, Tufts College, Massachusetts. His determinations were made in the course of his studies of uranium-bearing minerals of certain pegmatite dykes occurring on the Huron and Bear claims in southeastern Manitoba. These dykes are among the oldest known rocks of the earth's crust.

Professor Lane deals with some recent developments in determining the age of minerals in his paper appearing in the February issue of the Bulletin of the Canadian Institute of Mining and Metallurgy. An introductory editorial note explains briefly how the age determinations are made. Uranium, it states, is continually breaking down, or disintegrating in successive steps through radium to a final product which is lead, and the rate at which this change takes place is known. Minerals containing uranium will therefore contain lead also, and the lead-uranium ratio multiplied by a certain factor—approximately 7,600—will give the age of the mineral in millions of years. Thorium also disintegrates at a known rate to give lead as a final product, and the age of the mineral containing thorium can thus be calculated from the lead-thorium ratios. Thus the age of uraninite in a sample of beryl from the Huron claim is calculated to be 1,722 million years, and the age of monozite, also a constituent of the beryl sample, is determined at between 1,917 and 1,952 million years.

—*Canadian Institute of Mining and Metallurgy.*

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Ste. Anne de la Perade Bridge

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Paper presented before a meeting of the Montreal Branch of The Engineering Institute of Canada on March 25th, 1937.

SUMMARY.—The paper deals with the design, fabrication and erection of the new all welded steel highway bridge over the Ste. Anne River, at Ste. Anne de la Perade, Que. The bridge is a six span continuous deck plate girder 644 ft. long, carrying a 24 ft. concrete roadway and two 5 ft. concrete sidewalks, and replaces three old steel pin-connected through truss spans 211 ft. 9 in. long. The new bridge, being situated on the same alignment as the old bridge, necessitated moving the existing spans to maintain traffic, altering the existing piers and abutments, and constructing three new river piers. These are also discussed in the paper, as well as the difficulties encountered due to the exceptional spring floods which occurred during construction.

In September 1935, the councils of the Parish of Ste. Anne de la Perade and of the Village of la Perade, joint owners of the highway bridge over the Ste. Anne river, requested a new design for a highway bridge to replace the existing structure (three 211 ft. 9 in. pin-connected through truss spans), which was then inadequate to carry modern heavy traffic. Their stipulations for the new design were: (*a*) minimum cost, (*b*) if feasible a deck type structure which would enhance the appearance of the neighbourhood, (*c*) grade to remain approximately at the level of the existing floor, (*d*) traffic to be maintained during operations. The location of the bridge is shown in Fig. 1.

Available information of conditions at the site of the proposed structure was very meagre. The following data were obtained from residents of the district. The existing bridge was built some 45 years ago and the piers were supported on pile foundations; the river bed was of fine loose sand, approximately seven feet deep and over clay or gravel. The river ice had rotted in place every spring for the last twenty years.

Two locations were considered for the new bridge. The first location, referred to as alternative A, was situated on the same alignment as the existing bridge. The second location, referred to as alternative B, was located on a new alignment in close proximity to the old. Alternative A had the advantage of being the shorter crossing and having existing piers and abutments which could be used, provided the new load upon them was not greater than their present capacity. The main disadvantage was the necessity of moving the old spans to maintain traffic. In alternative B the old spans could be left undisturbed, but on the other hand the crossing was longer, all new piers and abutments would be required and also expropriations for new approaches would be necessary.

The following schemes were designed and estimated for both alternatives. Concrete simple spans, composite steel and concrete simple spans, through steel truss spans, continuous girder spans riveted or welded. All designs for alternative B were too costly and for alternative A the all welded continuous girder design was adopted as the one most economical and at the same time most thoroughly satisfying the owners' stipulations. (See Fig. 2.)

Bids were invited and the general contract was awarded in 1936, to the lowest bidder, The Dominion Bridge Company Limited, at $107,650. The general contractor in turn sublet the foundation work as well as the bridge deck slab and asphalting to Messrs. Gauthier and Julien, contractors, of Portneuf, Quebec, and the bridge lighting system to the Northern Electric Company Limited, Montreal.

Substructure

The substructure work, necessitated by the accepted design, consisted of altering the existing abutments 0 and 6, shortening the existing piers 2 and 4, and of the constructing of three new piers 1, 3 and 5. To accomplish this, it was necessary to move the existing spans downstream on to timber bents placed directly opposite their piers and abutments, thus leaving the field clear for all foundation work and at the same time maintaining the old spans for highway traffic. (See Fig. 3.)

Temporary Crossing

The bents consisted of fourteen wood piles 35 ft. long and 12 in. diam. driven by drop hammer through holes cut in the ice, and then capped and braced. Slotted gusset

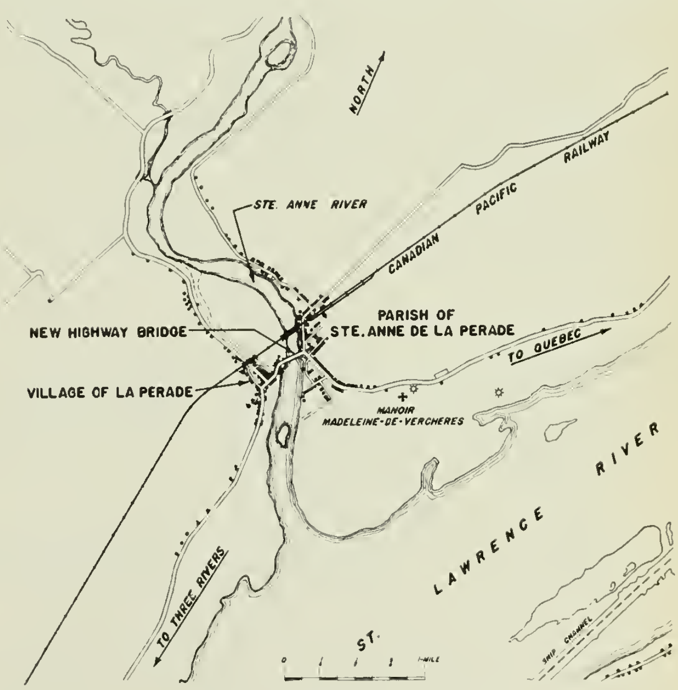

Fig. 1—Location of bridge.

plates, which engaged a 23 ft. jacking beam with cantilevered ends, were connected to the four corners of a span. The span was then jacked up 2 ft. 1 in., permitting runway rails and a truck beam on rollers to be placed under the span shoes. With the span brought down to bear, block and tackle and hand winches were used to move the span

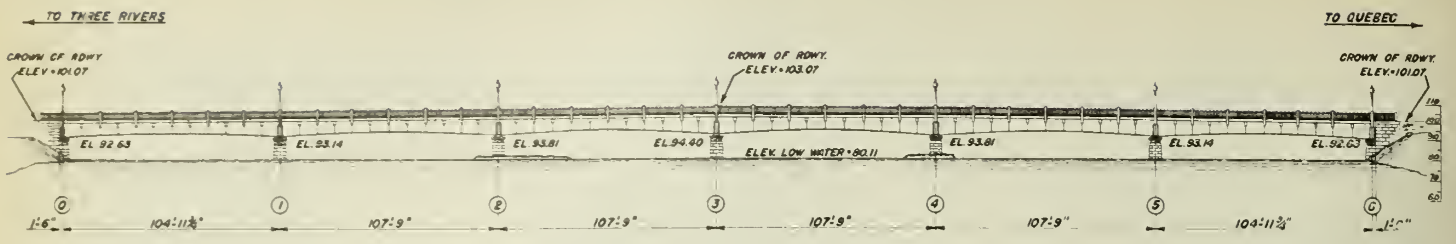

Fig. 2—Elevation of new bridge.

downstream a distance of 32 ft. The span was jacked up to release the truck beam and rollers, and then lowered 5 ft. 1 in. on to the bents. The same method and equipment served for all three spans. The net drop of three feet from the original floor level was made to eliminate unnecessary height and grade of the supporting bents and the timber bent approaches at either end.

Completed in early February 1936, this temporary crossing was destroyed on March 19th, following an unexpected movement of the river ice. Exceptionally high waters (common that spring throughout Eastern Canada and United States), aggravated by an ice jam three miles up the river, together with the fact that the flood gates of St. Albans dam were opened, caused the ice to shove. Floating at about 15 m.p.h. past the bridge site, the ice literally sawed through the timber bents supporting the old spans. The bent at pier No. 4 failed at 7.30 p.m., less than 30 minutes after the ice run started, throwing two spans into the river; at 4.30 a.m. the following morning the bent at pier No. 2 also failed, throwing the last remaining span. Fortunately due to the vigilance and alertness of those in immediate charge, no fatality occurred, and also the foundation sub-contractors, who had ample forewarning of the impending shove, were able to save all equipment they had on the ice.

The crossing was replaced by a trestle of 26 timber bents spaced about 24 ft. centre to centre. Each bent consisted of four 35 ft. piles driven approximately in the line of the current, then capped and braced. They supported three longitudinal rows of steel beams. In turn these steel beams, which were of stock lengths, carried 5 by 10 in. joists at 32 in. centres, which supported the floor plank, curbs and railing of the 16 ft. roadway. (See Fig. 4.)

Erection of the trestle started on March 30th and the new crossing was opened to traffic on Easter Sunday, April 12th, 1936.

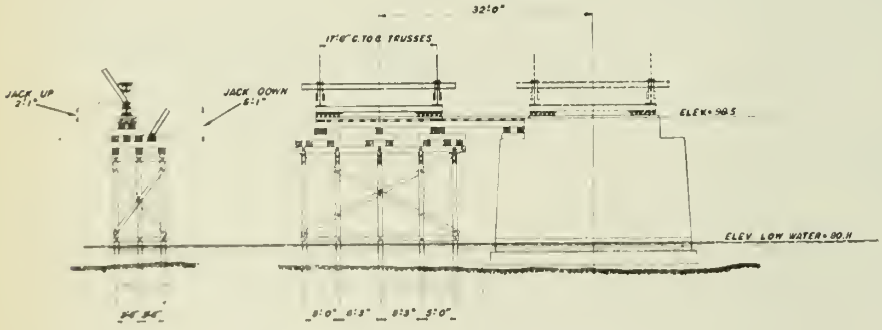

Fig. 3—Method of moving existing spans.

Abutment Alterations

The pier member seats of the old bridge were at elevation 98.5 while the bearings for the new structure are at elevation 92.63. Masonry was therefore removed to form a step in the front part of the abutment, 3 ft. deep, about 10 ft. high and extending across the full width of the abutment. On the base of this step a concrete cap was built to support the new girder bearings at their correct elevation.

Another change was necessitated by the fact that the new roadway is 24 ft. wide with a 5 ft. sidewalk on each side, whereas the old roadway was only 15 ft. 6 in. wide and without sidewalks.

The old abutment was 26 ft. 2 in. in overall width and had two masonry guard pylons protecting the approach to the old bridge. These pylons were removed and the whole top of the abutment covered with a reinforced concrete slab, 9 ft. long and of a section conforming to the outline of the new roadway and sidewalks. This slab is supported on two transverse reinforced concrete beams, cantilevered at each end to secure the required overall width. The rear beam rests on the masonry sidewalls while the front beam is integral with a vertical retaining wall built between the bridge seat and floor slab.

Identical alterations were made on abutment No. 0 and abutment No. 6.

Existing Pier Alterations

No plans or records of pier No. 2 and pier No. 4 were available. From enquiries made locally, it was learned that they had been constructed by the open cofferdam method and were founded on timber piles driven to a good depth by drop hammer. The pier shafts were of solid masonry, built with a superior grade of limestone from quarries at Deschambault, some 12 mi. from the site.

The bridge seat at these piers was changed by the new design from elevation 98.5 to elevation 93.8. The masonry was therefore removed for a depth of about 6 ft. and the remaining shaft then capped in concrete to the proper elevation. Concrete with an ultimate compressive value of 3,000 lb. per sq. in. was used in these caps and temperature reinforcing was placed at the top surface and coping sides.

Every effort was made by the sub-contractor to preserve the masonry removed, so that the stone could be re-used in constructing the shafts of the new piers.

New Piers

The piers were designed for total dead load plus live load plus 30 lb. wind. With a 48 pile layout, these loads yielded a maximum pile pressure of about 20 tons. The design of the new piers was based on that of the existing piers and inasmuch as the latter had withstood river current and ice pressure for over forty years without apparent movement or distress, it was assumed that this design was entirely satisfactory.

The cofferdam consisted of 16 in. at 30.5 lb. per ft. steel sheet piling 30 ft. long driven by drop hammer to about elevation 55.0. Unwatered, the sand was then excavated to elevation 66.5, this excavation being followed closely by three rows of strutted and braced 12 by 12 in. timber wales.

A 2,500 lb. hammer, with a drop of 20 ft., was used to drive the 25 ft. piles. A few of the piles were jetted about 15 ft., but jetting was abandoned as it was found that this caused the piles to drive out of plumb. In most cases penetration for the last ten hammer blows was from 10 to 12 in., and the final penetration about ½ in. An average allowable bearing value of 23 tons for each pile was indicated, using the Engineering News formula $P = \frac{2\,WH}{S + 1.0}$ The piles were sawn off 1 ft. above the excavation level. The average cut-off was about 2 ft., that is to say the total penetration of the piles averages approximately 22 ft.

Forms were erected inside the sheet piling and the concrete base was poured to elevation 79.21, the bottom waling being left in place, and the others removed as pouring progressed. A total of 206 cu. yd. was poured in two days, rubble concrete of one man stones being permitted. Sample test cylinders of this concrete showed an ultimate compressive stress of 2,690 lb. per sq. in. at 28 days, the mix being 1-3-4.

The main body of the pier shaft was built with a Deschambault limestone facing, and a concrete filled core. The procedure was to lay three tiers of masonry and fill the resulting core to within 6 in. of the top stones. This method was repeated until all the masonry was in place. The pier top was then formed and finished in concrete to the correct elevation. The concrete in the shaft core was of 1-3-4 mix, while that in the cap was 1-1½-2½. Test cylinders of the latter showed an ultimate compressive stress of 3,250 lb. per sq. in. at 28 days. There were 25 yd. of concrete in the pier cap, 43 yd. in the hearting and 40 yd. of stone facing. Specifications called for the removal of the steel sheet piling after completion of the pier.

A few difficulties, which may be of interest, were experienced during the construction of these piers.

At the time of the ice shove, pier No. 5 was poured to elevation 79.21, and the cofferdam of pier No. 3 was in place, unwatered, excavated, braced, and all piles driven.

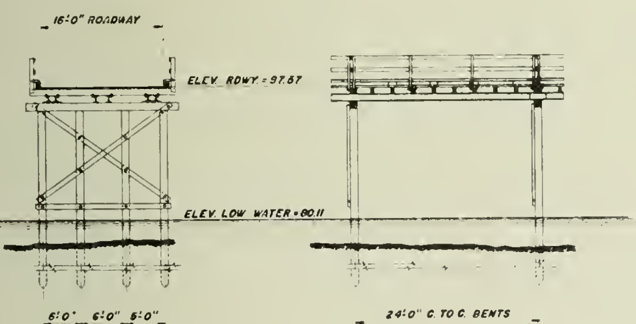

Fig. 4—New temporary crossing.

The ice did little damage to the cofferdam of pier No. 5 but that of pier No. 3 was pushed about 2 ft. out of plumb, and somewhat distorted. Furthermore, high waters up to elevation 88.0 completely flooded both cofferdams.

After the ice had cleared, a survey of the river bottom showed that there was a great deal of scouring all around both cofferdams and at some points to within 3 ft. of the bottom of the sheet piling. Also about 3 ft. of sand had been deposited in the bottom of cofferdam No. 3 by the flood waters.

This cofferdam was first successfully righted by means of block and tackle operated from a derrick scow and from pier No. 4. Due to the heavy scouring there was danger of water breaking through under the sheet piling if the cofferdam was unwatered under this condition. It was suggested by the foundation contractor that the deposited sand be pumped out, and a concrete seal be placed under water. This proposition was thought unsatisfactory as there would always be uncertainty of conditions at the base, and furthermore it appeared quite feasible to backfill around the cofferdams and re-excavate. The pier excavations and further soundings indicated that the sand extended to a depth of at least 30 ft. with very minor traces of clay and it was therefore decided to protect the piers permanently by leaving the sheet piling in place, driving the top to low water elevation after the pier was completed and

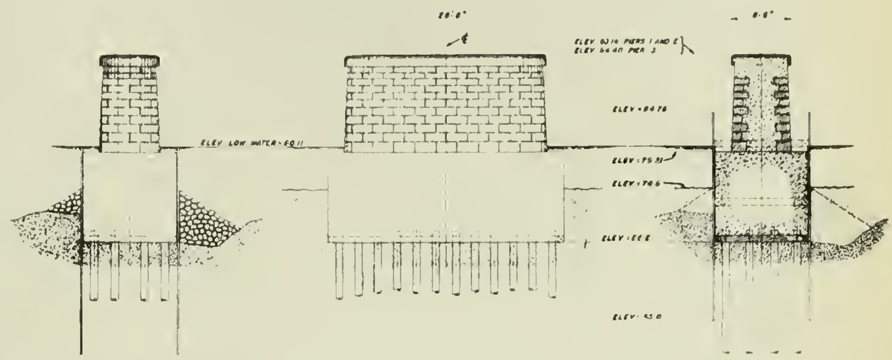

Fig. 5—New piers Nos. 1, 3 and 5.

also by placing rip-rap of one man stones around the cofferdam starting at elevation 71.0 and sloping at a bevel of 1 in 1½ to the river bed. At pier No. 3, brush mats were weighted and sunk alongside the cofferdam and the pockets refilled with stone and sand, topped off by rip-rap, which permitted normal completion of the pier.

At pier No. 1 the sub-contractors had excavated the cofferdam to elevation 66.0 but before the bottom wales were placed the east side pushed in at the bottom, canting some of the piling to a bevel of about 3½ in 12 vertically, and flooding the cofferdam. The remaining sides however, were undisturbed. It was necessary to partly refill the cofferdam, pull out the east side sheet piling and redrive. The pier was then completed without further incident.

Following the collapse of the old bridge, the owners feared that the superstructure design did not allow sufficient clear passage for the ice during spring floods, also that the three new piers would restrict the flow of water and encourage the formation of ice jams, with possible serious consequences to the bridge.

This last argument was largely disproved by the fact that the cofferdams of piers No. 3 and No. 5 were already in place forming an equivalent if not a more objectionable obstruction, and according to the evidence of eye-witnesses no jamming or upending of the ice took place. This might be expected, as the Canadian Pacific Railway bridge piers, located about 350 yd. above the highway bridge, break up any large sheets of ice. The decrease in the waterway due to the three new piers is only about four per cent. Figure 5 shows these piers as completed.

Observations indicated that the ice would have cleared the superstructure as designed by about 3 ft., but it was held to be a wise precaution to raise the bridge as much as possible without making the approach grades excessive. It was finally agreed by the councils to increase the clearance by 27 in., thus making the clearance of the new bridge only 3.5 ft. less than that of the old. This rise accounts for the top part of the pier shafts, below the coping, being built in concrete instead of masonry in order to obtain the desired increase in height at least cost.

Superstructure

Design

The superstructure is designed to C.E.S.A. standard specifications for steel highway bridges, A6-1929, using structural carbon steel.

The permissible unit stresses were as follows:—

Bending on extreme fibres:—	
Tension flange	18,000 lb. per sq. in.
Compression flange	$\left(18{,}000 - 170\frac{l}{b}\right)$ lb. per sq. in.
Shear on gross area of webs	12,000 lb. per sq. in.
Bearing on expansion rollers	600d lb. per lin. in.
Bearing on concrete	600 lb. per sq. in.
Welding, $\frac{5}{16}$ in. fillet	2,500 lb. per lin. in.
Butt welds	12,000 lb. per sq. in.
Vibrated concrete	f'_c = 3,000 lb. per sq. in.
	and f_c = 1,200 lb. per sq. in.
Reinforcing steel	20,000 lb. per sq. in.

Design dead loads were:—

Concrete	3,000 lb.
Asphalt	430 lb.
Steel	970 lb.
Total	4,400 lb. per lin. ft. of bridge

The following live loads were considered:—

Uniform live load:—
- On roadway, 98.6 lb. per sq. ft. to slab, cross beams and girders.
- On sidewalk, 98.6 lb. per sq. ft. to slab and cross beams. 20.0 lb. per sq. ft. to main girders.

Truck live loads:—
- One 20-ton truck, to slab, cross-beams and girders.
- Two 20-ton trucks, abreast, to cross-beams, at 25 per cent increased unit stresses.
- Two 20-ton trucks, abreast, to girders, at ordinary unit stresses.
- Impact, 30 per cent of truck loads.

The bridge cross section is shown in Fig. 6.

The bridge floor, consisting of a 24 ft. concrete roadway and two 5 ft. concrete sidewalks, is supported on cross-beams at 8 ft. 11¾ in. centres. The 7 in. roadway slab is of constant thickness, conforms to the contour of the 2 in. crown, and is protected by a 1½ in. asphalt wearing surface. It is designed for a positive moment between supports and a negative moment at supports. These moments are taken as 75 per cent of the simple span moment due to a 20 ton truck wheel concentration, with 30 per cent impact. The principal reinforcing consists of ⅝ in. round bars at 5 in. centres. This type of longitudinally reinforced slab is particularly advantageous when compared with a slab

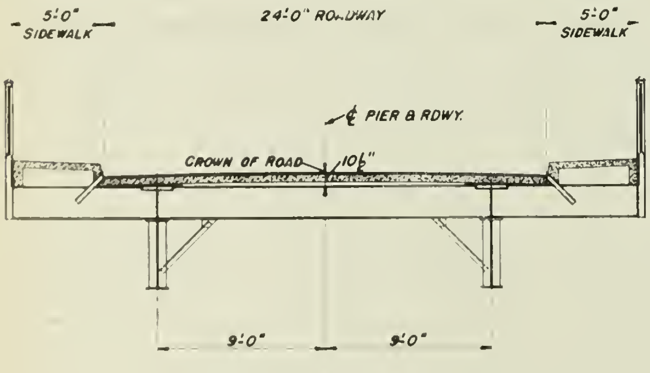

Fig. 6—Bridge cross section.

transversely reinforced, as a greater lateral distribution of concentrated loads is permissible.

The 4 in. sidewalk slab spans from an outside concrete stringer to the roadway curb, and drains towards the roadway with a total slope of ¾ in. The curb and stringer are designed as continuous reinforced concrete beams supported by the cross-beams.

Floor construction joints are located over the centre line of each pier and midway in each span. Galvanized plate drains with 8 by 4 in. outlets are placed along each curb at 53 ft. 6 in. centres.

The cross-beam is a 21 in. I beam at 59 lb. per ft., and was originally designed as a continuous beam supported on top of the main girders. It was accordingly ordered full

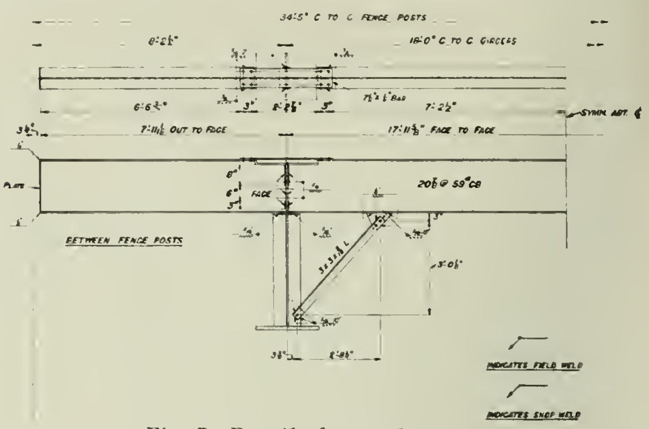

Fig. 7—Detail of cross-beam.

length from the mill. Due to the decision to increase the river clearance of the main girders, the cross-beam was lowered relatively to the main girders, until the top flanges of each were flush, thus gaining 21 in. of clearance. This necessitated cutting the cross-beams at the main girders, and required a welded detail connection which fully developed the shear and cantilever moment at the support. (Fig. 7.) The governing design moment occurs at the centre line between main girders, with two 20-ton trucks abreast. Under this loading the cross-beam is proportioned at 25 per cent increased unit stresses.

The main girder is designed as a beam of constant moment of inertia, continuous over six equal spans and seven unyielding supports. Under these assumptions, moment and shear influence lines for unit loads were determined for each point of investigation, which were the points of support and midpoint and quarter points of each span. From these influence lines, maximum bending moments, shears and reactions were computed. Actually the moment of inertia at the supports is about twice the moment of inertia midway in a span. This deviation from the assumption was studied and found to increase the negative moments over the supports by 12 per cent, and to decrease the positive moment in the first span by 4 per cent and the positive moment in the remaining spans by 15 per cent. The maximum moments were therefore corrected by these factors and the resulting quantities used in proportioning the girder flange material. Computations of the design are shown in Fig. 8 and details in Fig. 9.

The girder depth varies from 7 ft. 0 in. out to out of flange plates at the supports, to 5 ft. 6 in. out to out at the midpoint of each span. The bottom flange forms a parabolic curve of 1 ft. 6 in. rise between supports. The web plate is ⅜ in. thick for the full length of the bridge and the field splices are approximately at the quarter points of each span. The flange area required at any point equals the corrected moment divided by the effective depth and allowable unit stress, less ⅙ the web area. Compression flanges, at points of negative moment, are supported laterally for l/b by kneebraces to the cross-beams. An unusual feature of the flange proportioning is the use of a constant thickness and varying width of flange plate. This arrangement yielded greater economy and permitted simpler fabrication of the girders than the more conventional use of constant width and varying thickness of flange plates. An

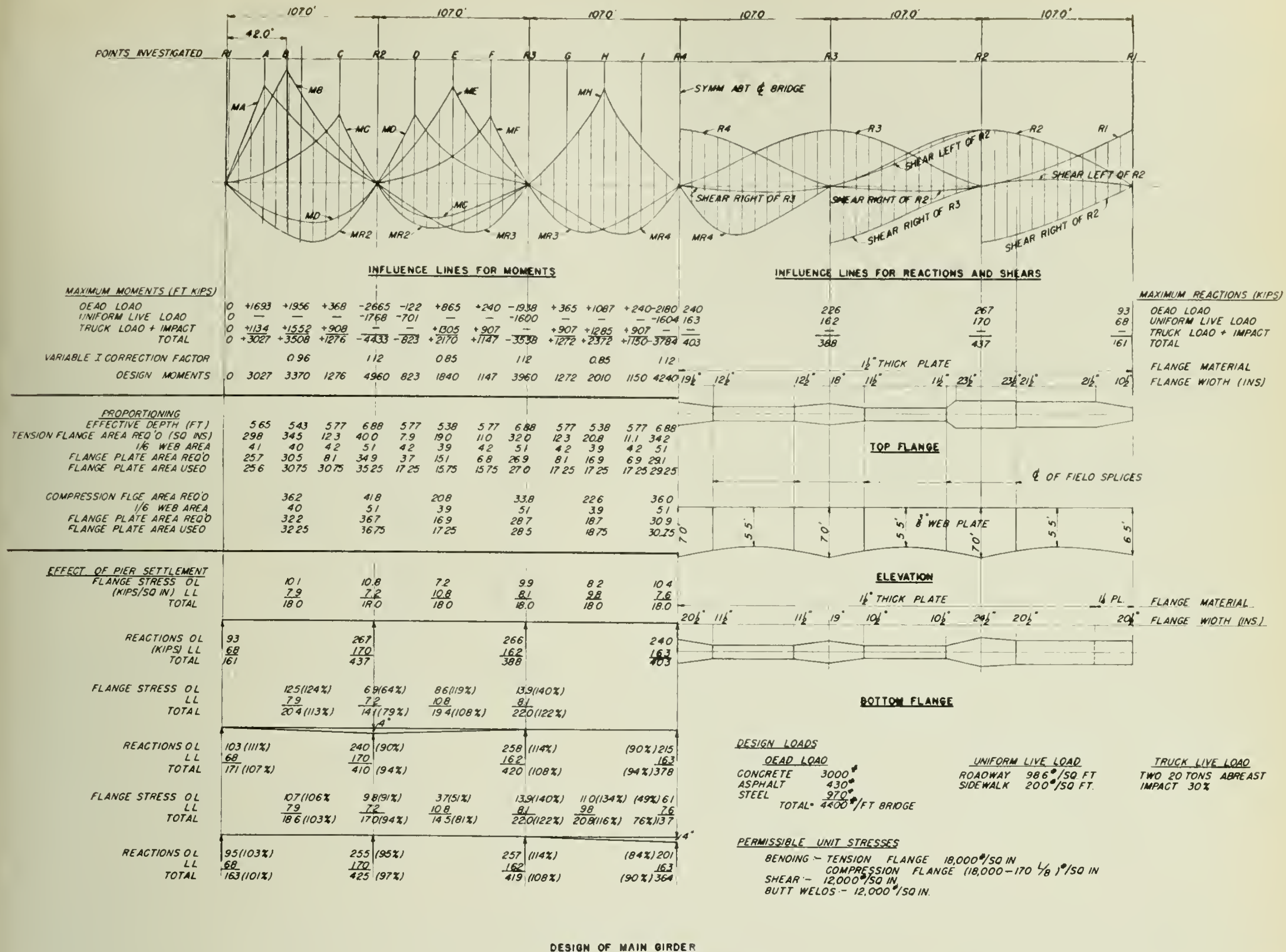

Fig. 8—Main girder design.

investigation of the effect of a pier settlement of 4 in. indicated a maximum increase of fibre stress of 22 per cent under full live load. In order to check any future settlements, if any, permanent brass plug benchmarks were established on all the piers and abutments are tied up with a geodetic benchmark on the church portico.

The jacking girders at each support also act as floor cross-beams and lateral brace frames. Dead load jacking stress at 50 per cent increased unit stresses governed the proportioning of these girders. The concrete floor slab is considered wholly adequate for lateral stiffness. Light temporary diagonal bracing was used during erection only, and removed after the deck was poured.

The main girders are fixed at the centre line of bridge on pier No. 3, and expand towards both ends. All pier members have disc type bearings between the girder and shoe plate. The expansion pier members consist of 8 in. dia. segmental rollers between shoe plate and bed plate. In each expansion pier member, one roller is guided top and bottom by side pintles, while the other rollers are guided from this one by pairs of flats at each end which engage tapped pins. The whole pier member is weatherproofed by bolted plates on all sides and presents a neat and uniform appearance. The fixed pier members consist of solid 7 in. bed slabs.

Fabrication

Shop detail drawings required for welded construction are very simple as compared with those required for similar riveted construction. Two girder sections over 50 ft. long are fully detailed on one drawing at a scale of ½ in. to the foot.

This would not be practicable with riveted girders. Due to the fact that the top flange of the main girder is a parabolic curve for the full length of the bridge and that the bottom flange forms a parabolic curve between each pier member it was necessary to establish convenient working lines for detailing and fabricating. The elevation of the crown of roadway was computed at each pier, a point chosen 2 ft. 9 in. below this elevation, and a straight line joined from point to point. These straight lines then served as working lines in determining the geometry of each fabricated section of girder. Ordinates from the working line to the top and bottom flanges were figured at the location of every cross-beam. All stiffeners between piers are placed at 90 deg. to the working line, only the bearing stiffeners at the pier members being truly vertical.

In general, fabrication divides itself into two principal operations; first, preparation of parts; second, assembly and welding of these parts. A description of the fabrication of one section of main girder will illustrate the procedure adopted throughout the job. This procedure was carefully planned to overcome as much as possible the ever-present shrinkage due to welding. Quarter inch covered welding rod, suitable for downhand fillet welds, was used for all shop welding. A single exception was the use of a free flowing covered rod for shop butt welds of thick flange plates.

All intermediate stiffeners are made from rolled bars which were first sent to the fiddle for straightening and then sheared to exact length plus $\frac{1}{32}$ in. Bearing stiffeners were sheared from plates and straightened before cutting to length.

The variable width flange plates were burned from rectangular plates by radiagraph on a track. The burned edges had to be smooth and without nicks. Where nicks occurred, it was necessary that they be welded and ground smooth. Due to the fact that flame cutting causes the same shrinkage characteristic as welding, a special sequence of burning was required to avoid lateral bowing of the finished flange plate. First, half of one side was burned, then all of the opposite side, and finally the remainder of the first side. This sequence also applies to the burning of web plates. Lower flange plates which occur directly over the pier members have a sharp bend 1 ft. 6 in. either side of the centre line of bearing. These bends were made on the fiddle to a templet. All other curvatures are so gradual they could be obtained by pulling down with clamps or jacking up from the floor when assembling to the web plates. Pairs of guide plates (washers, nuts, etc.) at about 3 ft. centres, were lightly welded and carefully remainder with a free flowing rod. When necessary the weld was peened to avoid excessive distortion. After the weld was complete the small backing bar was chipped off.

When the web of a girder section required one or more shop splices, these were made first, by preparing the abutting edges to form a 70 deg. groove, and welding. During this operation the plates were supported evenly along their length and also temporary stiffeners were tack welded close to the splices to prevent bowing of the plates. The web plate was then ready for marking. The working line was first scribed and then the centre lines of stiffeners were located and marked at 90 deg. to the working line. The spacing between stiffeners was increased $\frac{1}{32}$ in. to take care of subsequent contraction due to welding. On the stiffener lines, the ordinates to the top and bottom flanges were marked, and a smooth curved line made to join them by using a spline. The web was then carefully and accurately burned along these lines by means of a straight line templet and in the sequence referred to when burning the flange plates. Oiled paper templets with rectangular openings were used to indicate the location and length of welds on all stiffeners. When painted upon the surface of the web

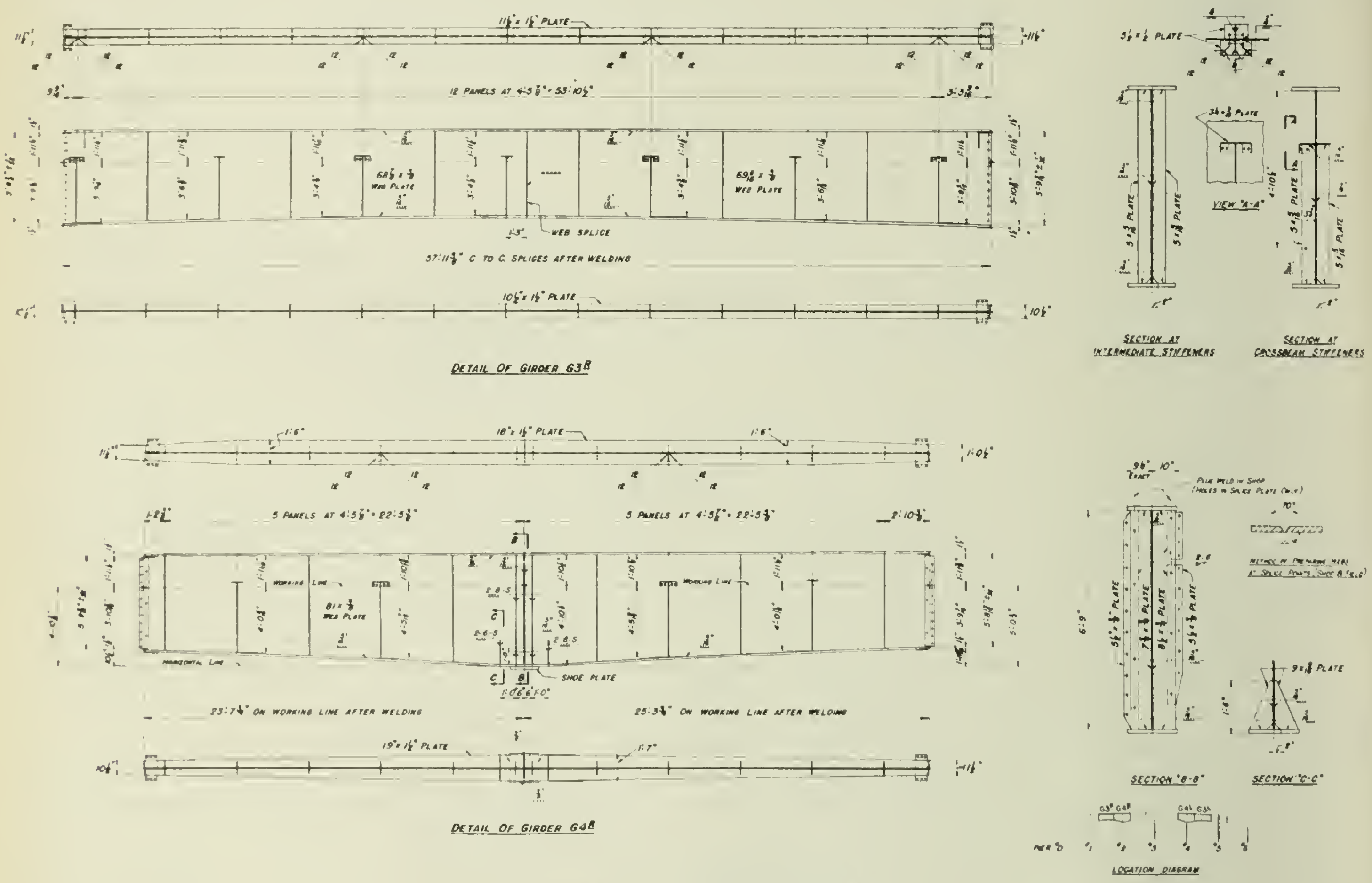

Fig. 9—Detail of typical main girder.

placed either side of the longitudinal centre line of flange plates, forming a centring groove for the web plate during assembly. These guides were removed after all shop welding was completed. Any necessary shop flange splice was welded before burning to shape. The ends were first burned to a 6 deg. bevel and then assembled together over a small backing up strip, leaving a space of ½ in. between top edges of plates. The plates were then dogged down, on either side of the groove, to a heavy block. At the same time the plates were allowed to droop slightly on each side. The first two passes were made with a fillet rod and the plate, the transverse distance between paint marks indicated the thickness of the stiffener, the width of paint mark was a gauge of the size of weld, and the distance between paint marks showed the length and location of each tack weld. There are two tacks opposite one another at each end of a stiffener and staggered tacks between these. The tacks are about 2 in. long and staggered about 6 in. centres. These templet paint marks greatly facilitated the assembly and welding of stiffeners.

All parts being prepared, main assembly of a girder section was commenced by welding the stiffeners to the web plate. The web plate was first placed on two longitudinal supports, allowing the outer edges to droop about ½ in. The stiffeners were then held in place by jigs and welded at one end. Welding then proceeded across the web, thus pulling the stiffeners into place on the web plate. This operation was repeated for all stiffeners and in any order of sequence. Care was taken to keep all end

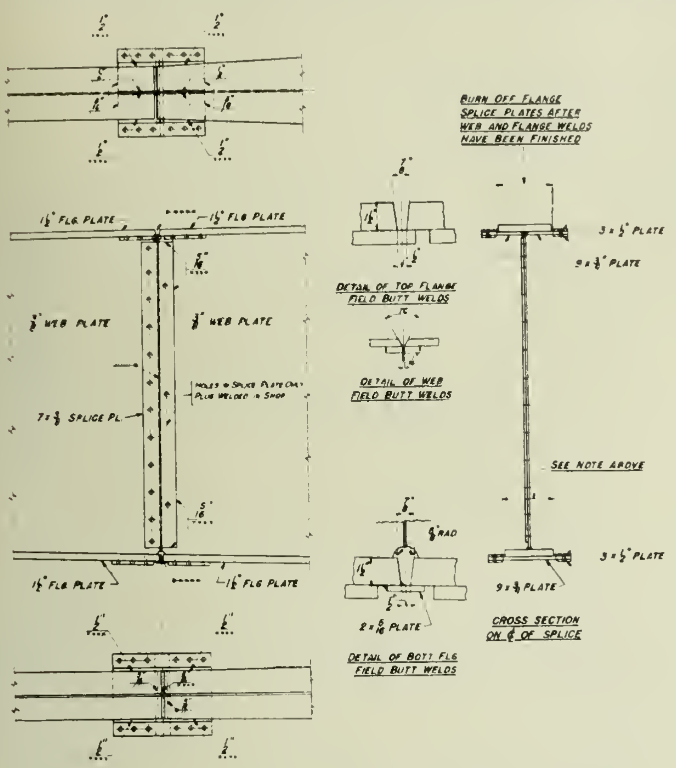

Fig. 10—Typical main girder field-splice.

welds clear of the outer edges of the web plate so as not to interfere with good bearing of the flange plates, and also, any craters had to be filled completely. After all stiffeners had been welded on one side, the web plate was turned over, marked, and the remaining stiffeners welded. All stiffeners were then checked for length and any that were more than $\frac{1}{64}$ in. longer than the web plate were chipped flush.

The flange plates were then assembled to the web plate in the following manner. The top flange plate was laid on rails, with the guide plates turned up, and shimmed to its proper curve. The web plate, with stiffeners, was then picked up vertically and set upon the flange plate between the guide plates. This was followed by lowering the bottom flange plate, with guide plates turned down, upon the web plate. Both flange plates were then pulled tightly against the web plate by long bolt clamps at both ends.

The continuous fillet welding of the web to the flanges required a special procedure to avoid the finished girder section bowing laterally or vertically due to shrinkage. In the following description a panel length means the distance between succeeding stiffeners, that is to say about 4 ft. 6 in. Two men welded at the same time, one man on the near side of the web and the other on the far side of the web. Starting at the centre of the girder section, the man on the near side welded half a panel towards the left, say, while the man on the far side welded half a panel towards the right. The man on the near side then started at the centre again and welded a full panel towards the right, while the man on the far side welded a full panel towards the left. The man on the near side then returned to the left side of the girder centre and starting where he had left off, welded a full panel towards the left. At the same time the man on the far side of the girder made a similar operation towards the right. This alternating method was repeated till about half of the first flange was welded. The girder was then turned over and the same procedure repeated until all of the other flange was welded. The girder was again turned (to its original position) and the remainder of the first flange welded. The girder section was then ready for the preparation of the end field joints.

The main girder field splice, as shown in Fig. 10, is the result of a good deal of thought and study. The splice had three conditions to fulfil. First, it had to be suitable for downhand field welding. Secondly, it had to provide sufficient temporary bolting strength to resist erection stresses. Lastly, it had to be neat in appearance when completed. The assistance obtained from the shop office aided considerably in arriving at this solution.

After the working line of the girder section had been re-established and checked, the girder was set up horizontally on level skids with the working line parallel to a squaring block at each end. Using a surface gauge, the centre lines of the field splices at each end were scribed on the web and all around both flange plates. Care was taken to obtain the exact overall length of the girder section, allowing $\frac{3}{32}$ in. increase of length to counteract the eventual shortening due to field welding. Secondary lines were also scribed 12 in. back from the centre lines of joints These were used for setting all splice plates and to assist in the accurate preparation of the main material for field welding. The edges of the web were prepared for welding by hand burning, leaving enough to finish-chip to a gauge templet. The flange plates were prepared by machine burning to the proper bevel and without chipping. The edges of the flange splice plates, nearest to the secondary

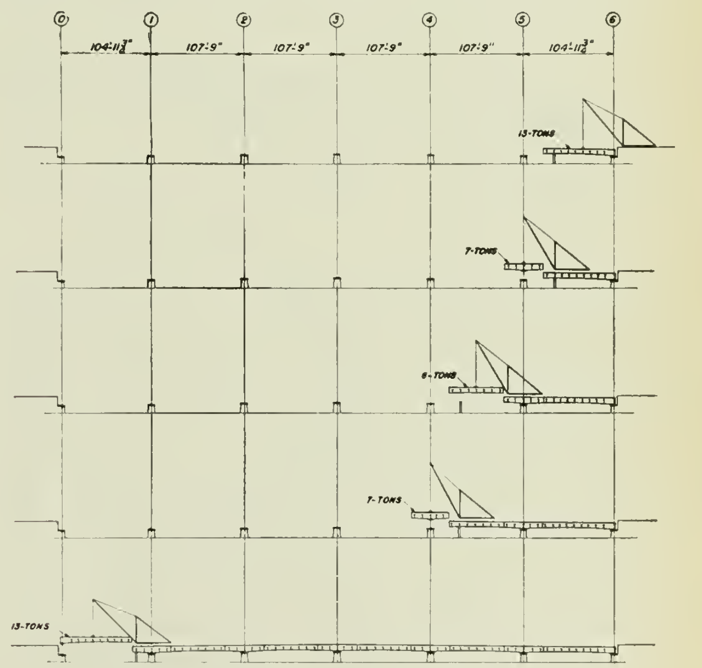

Fig. 11—Erection progress diagram.

scribed line, were milled to facilitate setting. Holes in the web were marked and burned, and then reamed with the same templet used to drill the web splice plates.

The procedure in fabricating the jacking girders was similar to that used for the main girder sections. Fabrication of the cross-beams, brackets, pier members and handrailing was routine and did not require any unusual methods. It may be noted however that the fence bars were not welded but their ends were turned and peened during assembly.

Erection

The erection method is illustrated in the progress diagram Fig. 11. A nominal 12 ton stiff leg derrick set up on a movable platform was used. All material was trucked from the railway siding in the village to the temporary crossing alongside the bridge and directly opposite its ultimate position. The first girder section and all centre sections were placed with the forward ends resting on pile bents. The third stage, placing a six ton centre section, shows the condition of loading which governed the temporary bolting strength of the main girder field splices. Placing the last 13 ton section, however, required a greater moment development. This condition was relieved by placing a bent directly under the derrick footblock. All girder splices, cross-beam connections, temporary bracing, etc., were fully bolted at each stage before the traveller moved on. Due to the difficulties encountered during the construction of pier No. 1, steel erection was somewhat delayed. While this postponement of erection lasted, the traveller was left standing over pier No. 2. Field welding was therefore started, commencing at pier No. 3, and working towards abutment No. 6, before erection was actually completed. By the time field welding was finished at abutment No. 6, the remaining steel had been erected, whereupon field welding started again at Pier No. 3 and was completed towards abutment No. 0.

Two welders, one on each side of the bridge, welded one jacking girder and twelve cross-beams, while at the same time two other welders, one on each girder, welded four main girder field splices. It took about five double shift working days to complete the welding of one span. The welders were handpicked shopmen who had worked on the fabrication. The fact that these welders were men from the shop and had never before been out on erected steel, required the use of special scaffolding to assure their safety and comfort while welding, as well as good workmanship.

The following procedure was adopted in welding a main girder field splice (Fig. 10). The vertical web splice was welded first, using a thick flowing 'all position' covered rod. Starting at about a foot below the top flange, the webs were welded upwards to the top flange. Then starting about two feet below, welding proceeded upwards to where the first weld was started. This method was repeated till the whole web was welded. Web field bolts were then removed and the open holes plug welded. The bottom flange plates were welded next. The first two passes were made with a fillet rod and all remaining passes were made with a free flowing rod. About 12 passes altogether were required to completely weld one flange. An original method was used in making these passes. Considering the plan view of the bottom flange splice and starting on the near edge a few inches to the left of the splice, the first pass was along this near edge, across the flange, and then a few inches along the far edge towards the right. The second pass started on the far edge, a few inches to the left of the splice, then along this edge, across the flange, and then a few inches along the near edge towards the right. Each pass alternated in this manner. This system built up weld metal at the ends of the splice and eliminated any possibility of craters occurring at these points. Welding of the top flange splice followed in exactly the same manner. The temporary flange splice plates were then removed. At the bottom flange they were burned off flush with the flange edges and then chipped off completely, after which the edges of the flange were ground smooth.

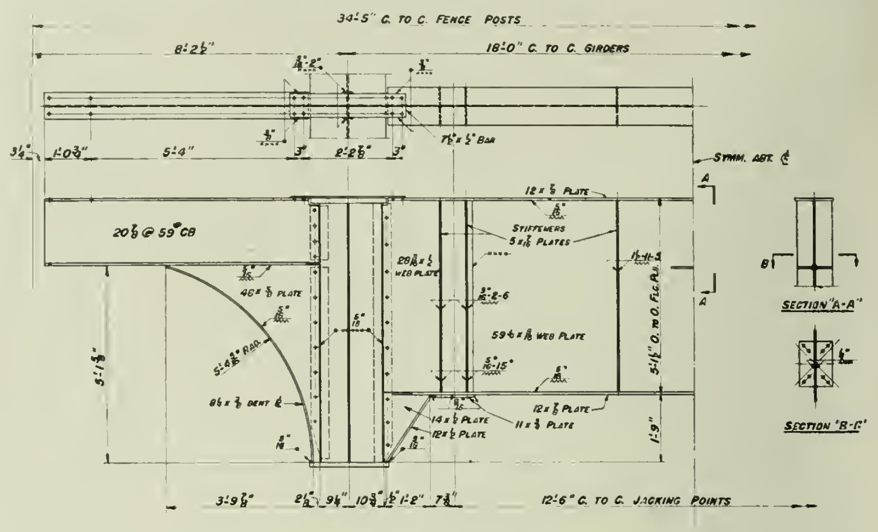

Fig. 12—Detail of typical jacking girder.

Only the small 2 by $\frac{5}{16}$ in. backing plate was left in place. At the top flange they were burned off flush with the flange edges and the parts of the plates underneath the flange were left in place as they did not show after the deck was poured.

Field welding the jacking girders (Fig. 12) consisted principally in welding the webs in the same manner as the main girder webs were welded. For the cross-beams (Fig. 7) the webs were welded first, followed by the welding of the 7½ by ½ in. moment straps and the bottom flange tacks.

Formwork for the concrete floor slab followed immediately after a span was welded. Concreting, form stripping, asphalting and lighting system completed the construction.

Conclusion

The following are a few quantities and facts in connection with the bridge. In the substructure, 145 twenty-five-foot piles were driven, 1,015 cu. yd. of concrete were poured and 2,000 cu. ft. of Deschambault limestone were placed. In the superstructure there are 318 tons of structural steel, of which 183 tons represent the main girders. The covered welding rods used were, ¼ in. Wilson No. 107 for fillet welds, ¼ in. Murex cresta for free flowing welds, and $\frac{5}{32}$ in. Stelco No. 304 for thick flowing welds. A total of 6,460 lb. of welding rod were used in shop fabrication, and 1,780 lb. used in field welding. There are 48 cu. yd. of concrete and 50 tons of reinforcing steel, in the deck slab. 170 sq. yd. of 1½ in. asphalt were required for the roadway surfacing.

The general contract was let on January 16th, 1936. The substructure was completed about July 31st, 1936. Erection of steel started on June 12th, 1936, and was completed on August 6th, 1936. The bridge was officially opened to traffic on October 25th, 1936.

The 18 Foot Diameter Steel Pipe Line at Outardes Falls, Quebec

Design and Construction

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Paper presented at the Annual Meeting of The Institute in London, Ont., February 2nd, 1938.

SUMMARY.—Special supporting and stiffening members are needed if the elastic theory of thin membranes is to be applied to the design of large pipe lines. That application is illustrated by plotting the trajectories of the principal stresses on the pipe surface, noting the effect of the stiffening rings. The manufacture and erection of the pipe line at Outardes Falls are described.

In the design of the Ontario Paper Company's Outardes Falls hydro-electric development, it was necessary to provide some 6,580 ft. of waterway, this being the distance between the intake structure and the power house. The topography of the ground was such as to preclude canal or flume construction for any portion of this waterway. The entire length was therefore designed as a pressure conduit. It consists of the following major elements:

1. Wood-stave pipe, 17 ft. 6 in. internal diameter, 5,888 ft. long.
2. Steel pipe, 18 ft. 0 in. internal diameter, 445 ft. long.
3. Steel penstock, 14 ft. 0 in. internal diameter, 254 ft. long.

The combination of a pressure conduit of this length and size with a normal gross head on the turbines of 222 ft. made it necessary to introduce a surge tank as an integral unit of the waterways system. This was of importance for several reasons, not the least of which was the more than ordinary degree of stability required by the nature of the system load.(1)*

The location of the surge tank was governed by the fact that ledge rock at a suitable elevation was available only 255 ft. on chainage from the longitudinal centre line of the power house. This was of great advantage, since the closer the tank can be placed to the turbines, the more effective is its action.

The grade of the upper 5,900 ft. of the waterway was such that the computed pressures to be resisted permitted the use of wood-stave construction and a contract was let on this basis. This wood-stave pipe has an internal diameter of 17 ft. 6 in. and has been described elsewhere.(1)

Between the lower end of the wood-stave pipe and the upper end of the surge tank tee, the grade dropped approximately 62 ft. in a distance of about 400 ft. The design pressures in this section varied from 113 ft. to 177 ft.

It is this portion of the pipe line which forms the subject matter of this paper.

The profile of the original ground surface at this section, as well as the approximate location of rock, is shown on Fig. 1. Test borings had shown that the rock was covered by an overburden of well drained sand. Bearing tests on the sand were made and from these a unit bearing value was determined for purposes of footing design. The grade selected for the pipe was of necessity a compromise between that required for minimum hydraulic losses and minimum number and size of anchor blocks and that grade which would give the minimum excavation and consequently the least disturbance to the bank immediately upstream from the surge tank.

It was obviously more economical to construct this section of the line as one pipe rather than two parallel pipes. To design and build a pipe as large as this on an earth bank presented unusual and difficult problems. Specifications for several different types of construction were prepared and tenders secured. Of the acceptable designs, the lowest in cost was a steel pipe on spread concrete footings with insulation provided by backfilling up to the horizontal diameter and by building a suitable wood housing over the upper half of the pipe.

Immediately downstream from the surge tank, the pipe line is divided by means of a wye structure into two penstocks, each of which supplies water to one turbine. These penstocks have an internal diameter of 14 ft. and are encased in concrete. Accordingly, there were no unusual features of design in this section of the work.

Principle of Design

In line with modern practice for the design of large steel pipe lines, use was made of the elastic theory of thin membranes, or the so-called "shell" theory, for the 18 ft.

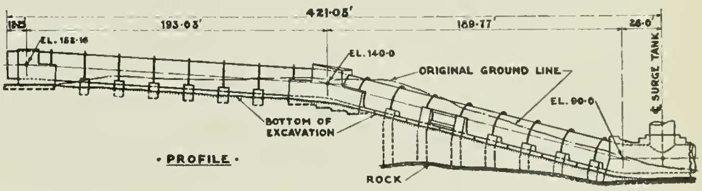


FIG. 1

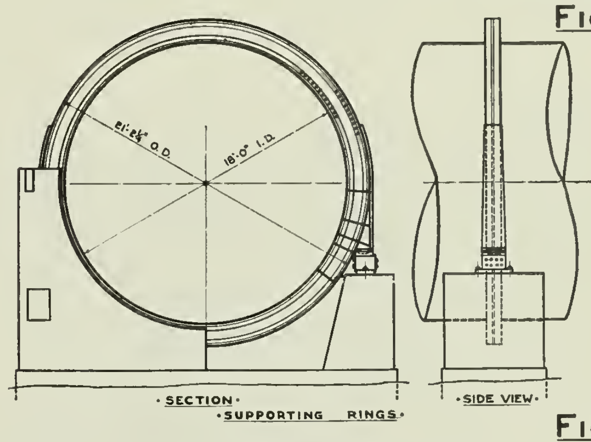


FIG. 2

Fig. 1—Profile of Pipe Line.
Fig. 2—Supporting Ring Girder.

diameter section. Engineers in Europe have designed according to this principle for a number of years, and only comparatively recently has the theory been used for pipe line design by engineers in the United States. As far as the authors are aware, the Outardes Falls pipe is the first to be designed and built in Canada according to this theory. The soundness of the principle has now been demonstrated by a number of structures. Its application

*Numbers in parentheses refer to the items in the list of references given at the end of the paper.

is not limited to pipe lines. The theory may be applied with equal effectiveness to large building roofs, submarine hulls, automobile and aeroplane bodies, large containers, in fact to any structure where thin curved membranes are required.

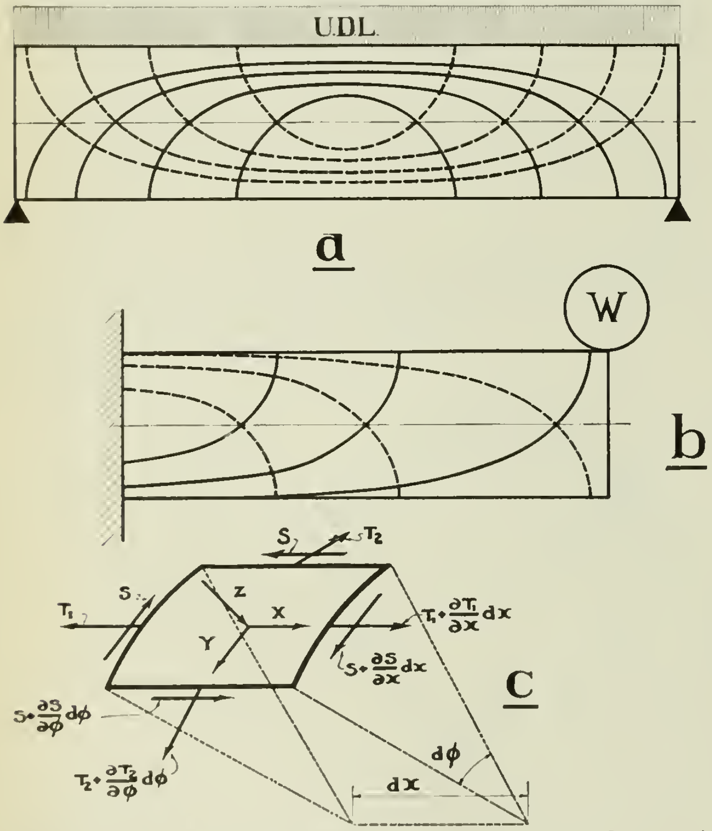
Some of the more recent pipe lines designed according to the shell theory that have come to the authors' notice are:—

Boulder Dam Penstocks[2]	30 ft. and 25 ft. dia.
Shannon River Penstocks	19 ft. 8 in. dia.
Platte Valley Pipe Line	13 ft. 4 in. dia.
Glines Canyon Penstock	11 ft. 6 in. dia.
Glines Canyon Pipe Line	10 ft. 0 in. dia.
Boquet Canyon Pipe Line	7 ft. 10 in. dia.*

In their paper on the Boulder Dam penstocks,[2] C. M. Day and Peter Bier state:

"Analytical work of the Bureau of Reclamation, confirmed by model tests of the Babcock and Wilcox Co., showed that a saddle type of support would have to be substantially continuous before it could support these pipes with reasonable stresses. This would have been costly and therefore stiffeners and supports were developed in line with the general type described by Herman Schorer[3] . . . The necessary formulas were worked out by engineers of the Bureau of Reclamation by applying to the problem the mathematical theory of thin cylindrical shells. The calculated stresses and displacements showed good agreement with those obtained from a model section of experimental pipe. The result was a substantial saving in cost."

In their discussion of Schorer's paper,[3] Templin and Sturm outlined their work of experimentation on and analysis of pipes supported on cradles extending over three



(Portions (a) and (b) reproduced by courtesy of D. Van Nostrand Company, Incorporated.)

Fig. 3. (a) Principal Stress Trajectories, Simple Beam.
(b) Cantilever Beam.
(c) Forces on Elementary Parallelopiped of Pipe Shell.

different arcs of the pipe shell and using different types of stiffeners. They began by investigating an existing 11 ft. diameter pipe which had been designed with the customary ring angle stiffeners and cradle type supports. The members had been proportioned according to a theory which gave satisfactory results on smaller sizes. Nevertheless, field tests of the 11 ft. pipe "showed that when the pipe was almost full of water, high stresses occurred in both the saddles and the stiffening rings at certain critical points, namely, in the shell near the ends of the saddles, in the saddle stiffener rings at the top of the vertical diameter, and at both ends of the horizontal diameter." As a result of mathematical analysis and model experimentation, Templin and Sturm finally arrived at a type of supporting and stiffening member such as is required by the membrane theory.

*Only the trestle portions of this line were designed on the basis of the shell theory.

Fundamentals of the Membrane Theory

Analysis and experience both show that, provided an appropriate type of support is used, the elastic theory of

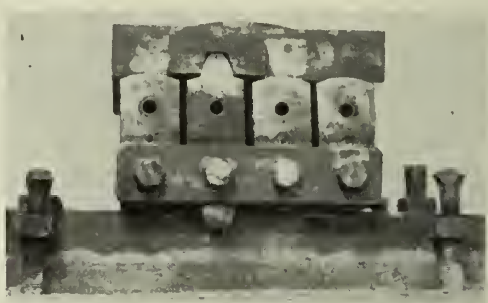


Fig. 4—Rocker Bearing for Supporting Ring Girder.

thin membranes may be used in designing the shell plates of a pipe. The major stresses in these plates are then found to be direct tensile and compressive stresses and shearing stresses. Bending stresses are so small that they do not materially affect the design, except in a narrow zone near the ring stiffeners as will be explained later. Thin shell construction may therefore be used, because of its ability to resist a direct stress system with economy of materials.

For a circular pipe an appropriate support may be provided by any one of many designs. One very simple method consists of a circumferential stiffener applied to the exterior of the pipe. It has the cross section of a simple plate girder and is supported by short steel posts placed near the ends of the horizontal diameter. This is essentially the construction used at Outardes Falls and is illustrated in Fig. 2. Other types are shown in Figs. 8, 9, and 10.

No attempt will be made here to give the mathematical analysis for these pipes. Much of it has been published elsewhere,[3],[4] and one of the authors hopes in a future paper to develop the theory still further.

The stress system in the shell of a pipe supported in such a way as to take full advantage of membrane action is apparently more complicated than that of many engineering structures. This is so only because the form of the structure is such that a more than ordinary degree of accuracy in the analysis yields important results that can be used to advantage in design, the result being that material can be used everywhere with high efficiency and therefore great economy secured. Even in the ordinary simple beam, the actual stress system is more complicated than the usual analysis indicates, but no practical economic significance attaches to a more accurate or precise determination.

One very adequate and comprehensive method of picturing the stress system under discussion is to draw on the developed surface of the pipe a number of the trajectories of the principal stresses. This diagram is then cut out, rolled, and the edges fastened in such a way as to simulate a section of the pipe. A discussion of the stress system in a pipe shell and its illustrations by such a graphical representation of the trajectories of the principal stresses is given in the following section.

ILLUSTRATION OF THEORY BY PRINCIPAL STRESSES

The stresses in a pipe may be analysed by considering the forces acting on a small elementary parallelopiped of the shell. The stresses and forces on such a small element are indicated in Fig. 3. Three general differential equations governing the equilibrium of the forces acting on the element may be written. These are the so-called Bauersfeld equations.[3] Their integration provides means for the calculation of the stresses.

It will be noted that no bending moment forces are shown in Fig. 3. A brief discussion on this point is given below. For a more detailed treatment reference should be made to the discussions of Schorer's paper on the "Design of Large Pipe Lines."[3]

As may be realized from Fig. 3, the Bauersfeld equations give the value of the direct and shearing stresses only in the axial and circumferential directions. A series of diagrams could be prepared showing the variation of these stresses at any number of selected sections and these undoubtedly would help in understanding the stress system of a pipe shell. However, the authors believe that a much better appreciation of shell action can be obtained by plotting the trajectories of the principal stresses. The consideration of shear is thus eliminated and the trajectory diagram gives a picture of the directions of the tensile and compressive stresses over the entire pipe surface.

It will be recalled that at any point in a stressed member two planes may be found, at right angles to each other, on which only normal forces act. Shearing forces on these planes do not exist. The directions of these planes are called the *principal directions*, and the stresses due to the normal forces have been given the name of *principal stresses.*

With this information two systems of curves may be constructed to represent the directions of the principal stresses. Tangents to these curves at any point are in the direction of the principal stresses at that point. Moreover, according to the definition given above, the tangents at the intersection of any curve of one system with any curve of the other system are at right angles to each other. These curves are the *trajectories of the principal stresses.* Except for the case of pure bending, the trajectories are not lines of constant stress intensity. The stress intensity along the trajectories changes progressively in amount and may even for certain conditions reverse its sign; that is, there may be a change fom tensile to compressive stresses, or vice-versa.

To illustrate the above point, on ground that is more familiar to most engineers, the principal stress trajectories for a simply supported beam with a uniformly distributed load and for a cantilever beam with a concentrated load at the outer end are given in Figs. 3 (*a*) and 3 (*b*) respectively.

Before discussing in more detail the stress distribution and deformations in pipes supported by stiffener rings, it may be helpful to consider first the mechanical function required from the pipe shell.

Take, for example, an ordinary fire hose. It lies flat on the ground until the water inflates it. As the water enters, the hose assumes first an oval shape, then as pressure is built up, the oval changes gradually until finally an almost perfect circular shape is obtained. While the hose is supported continuously on the ground, it can be imagined that only hoop tensile forces exist in the walls. If, now, the hose is lifted from the ground, longitudinal stresses must immediately come into existence because of the suspension action. The full hose will also distort at the point of support.

Similarly, in a steel pipe, circumferential tensile forces exist, acting to resist the internal water pressure. In amount, they are dependent only on the pressure and the radius of the pipe. With the pipe supported at intervals, there must also be a set of longitudinal forces, and possibly moment and shearing forces. It is these forces which transmit the live and dead loads to the supports, and their correct analysis constitutes the pivotal element of the entire problem.

In order to consider this problem of finding the stresses resulting from the above mentioned forces, it may be of interest to recall the beam theory commonly in use, and to point out its limitations as applied to large pipes. In most cases, a pipe line is carried on a series of equi-distant supports. There will, therefore, be restraint at the supports, and the following discussion will deal only with beams equally restrained at both ends.

According to the common beam theory, longitudinal forces exist at every section. These are compressive forces on one side of the neutral axis and tensile forces on the other, with a straight line distribution of intensity across the depth. Also, shearing forces exist throughout the section and have a parabolic distribution as shown in Fig. 11. The longitudinal forces elongate or shorten the

Fig. 5—Upstream Section of Steel Pipe Line Before Completion of Girder Wells.

Fig. 6—View from Anchor Block No. 1.

longitudinal fibres while the shearing forces tend to deform any square element of the beam into a rhombic shape. The stresses resulting from these two kinds of forces can be resolved into principal stresses (with the consequent elimination of all shears) and the trajectories obtained, as has previously been described. Ordinarily, shearing stresses are rather hard to visualize, and stress presentation by the method of principal stress trajectories reveals the actual stress distribution in a form easier to understand than by more customary methods.

In the ordinary beam theory, also, loads are considered as being applied in a very theoretical fashion to the beam

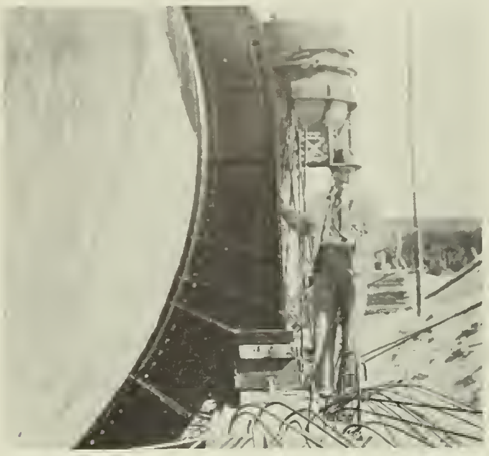


Fig. 7—Foot and Rocker Bearing, Supporting Ring Girder.

as a whole. Since this manner of application cannot be accomplished in practice, the stresses at any section due to the way in which loads are actually applied to the beam are totally ignored.

In addition, the only deformations considered are the deflections due to bending moment.

Approximations of the ordinary beam theory are sufficiently accurate for the majority of beams encountered in engineering practice. This is mainly because of their relatively large ratio of span to depth. For large pipe lines, however, the above statements are not true and a more accurate analysis is required.

On observing the trajectories of a rectangular beam, Fig. 16, it can readily be realized that the beam acts as if it were composed of a series of suspension and arch bridges, transferring the loads in either tension or compression to the supports. Looking at the beam in this fashion, the concept of moments and shears can be dispensed with altogether, the entire beam action being explained solely by a direct stress system. After all, if a sufficiently small element is imagined cut out from a beam in the direction of the principal stresses, it is only either under uniform compression or uniform tension, or a combination of both, in space. The concept of moment comes into consideration only when the element, as the section shown in Fig. 11, becomes so large that it is necessary to assume a varying amount of direct stress over the surface of the element.

However, there are types of structures where a uniform distribution of direct stresses over the whole thickness of the body may be readily assumed; for example, such a structure as an egg-shell, or a dome as indicated in Fig. 12.

Assume now that an evenly distributed surface load is acting on this dome. On the basis of the above discussion, it can be seen that the load elements will be taken to the supporting base by a series of direct stresses curved through the material of the dome membrane. One of these possible stress lines or trajectories is indicated in the figure.

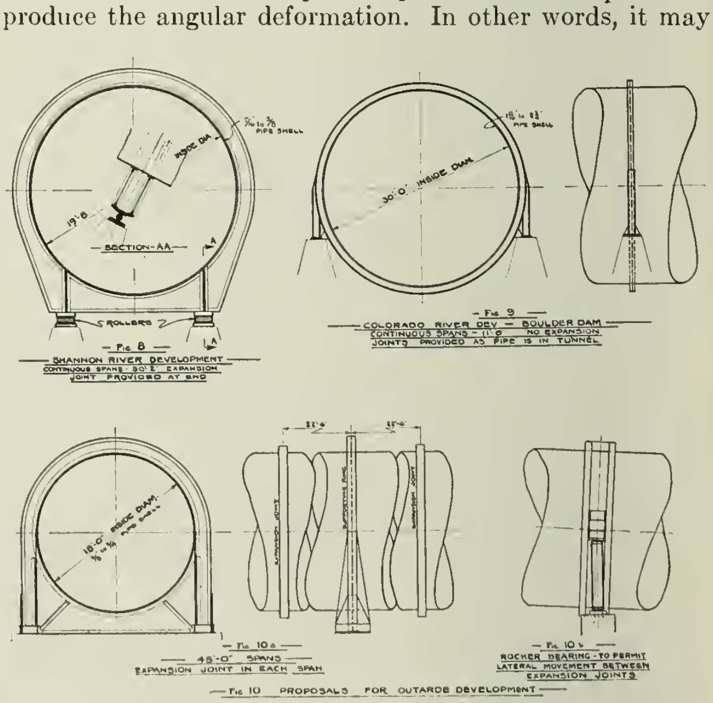
Similarly for Fig. 13, the water loads Z on a small element "A" of the pipe membrane create lines of direct stresses in the membrane which transmit the loads Z to the supports. The shape of these curves is governed by the intensity and distribution of the load elements Z over the pipe membrane, as well as by the elastic nature of the support or any other boundary condition. Thus, if an opening were made in the pipe near the stress line T_a, this curve would be forced to bend around the opening. In order to determine the stress distribution over the surface of the pipe, it is therefore necessary to set up equations which will include not only factors to take care of the loads Z and the shape of the surface, but also any boundary conditions that may exist.

Whenever equations are prepared for a series of stress curves, such as the trajectories T_a and T_b of Fig. 13, they must necessarily be based on a system of co-ordinates. The longitudinal stresses and hoop stresses discussed above (T_1 and T_2 respectively of Figs. 14b and 15) exist only as components, since, in general, the trajectories are neither straight lines nor circles, but other curves. For equilibrium it is therefore necessary to introduce additional forces, that is, the shearing forces.

To explain this concept of shear, consider a small piece of the pipe membrane cut along the trajectories T_a and T_b of Fig. 13. Such a piece is shown in Fig. 14. On the assumption that the forces T_a are compressive and T_b tensile, the section of pipe membrane would deform from a square to a rectangular shape. Any smaller square element "A" cut out along the trajectories T_a and T_b would undergo a similar proportional deformation.

Consider further a square element "B" cut from the same pipe section, but with two edges parallel to the pipe axis and the other two at right angles to these. Such an element can be referred directly to the chosen co-ordinate system. It is evident that the element "B" will not deform in a manner similar to element "A," but will take a rhombic shape, although the forces acting on elements "A" and "B" are identical.

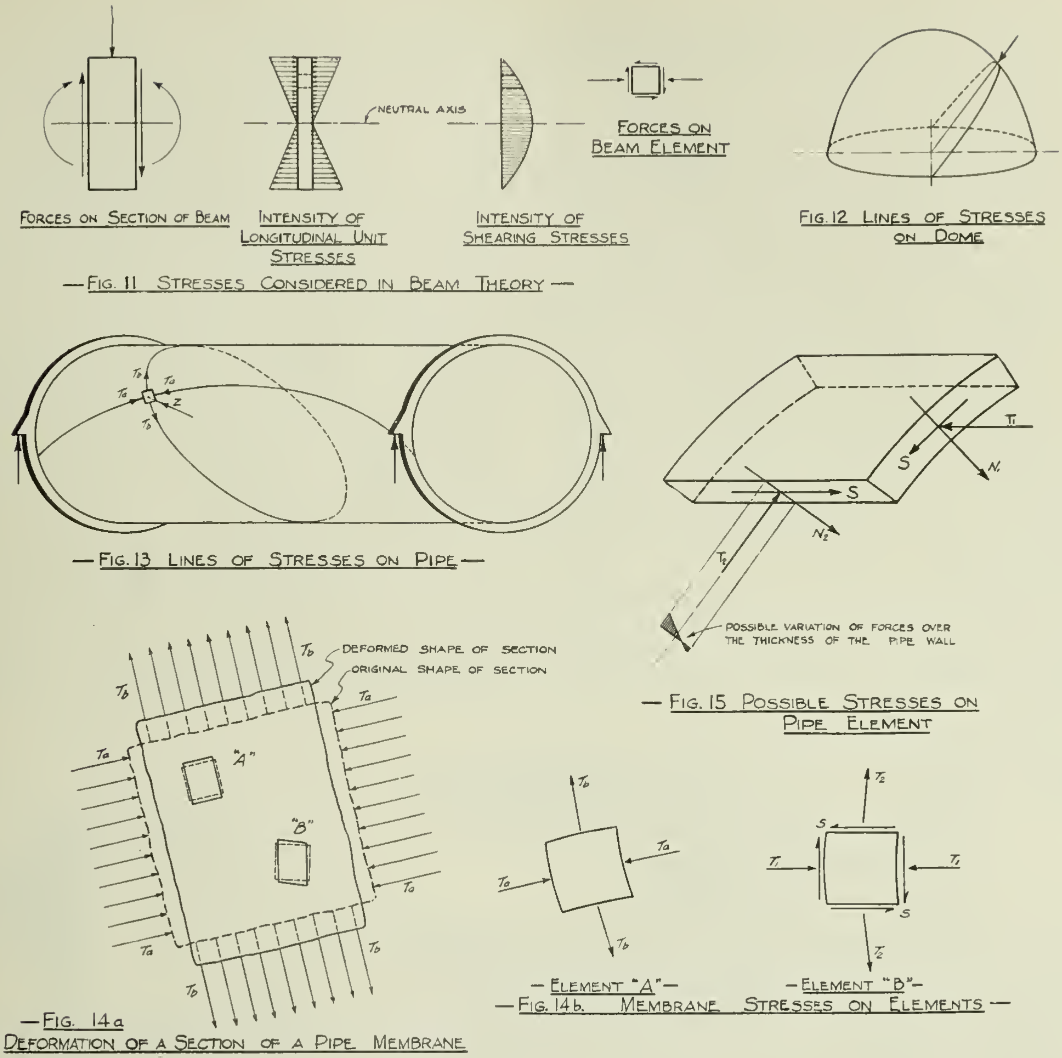
It follows that while element "A" has only forces acting normal to its edges, there must be shearing forces S acting along the edges of the element "B" in addition to the assumed forces T_1 and T_2. These are required to produce the angular deformation. In other words, it may



Figs. 8, 9, 10a, 10b.—Supporting Ring Girders.

be considered that the force T_a on element "A" is resolved into forces T_1 and S on element "B," and that the force T_b on element "A" is resolved into forces T_2 and S on element "B."

It must be noted that the concept of shearing forces was introduced only because a certain system of co-ordinates was selected. Shear may be eliminated if principal



Figs, 11, 12, 13, 14a, 14b, 15.

stresses only are considered. This is the chief advantage of plotting the trajectories of the principal stresses.

Having demonstrated that a set of trajectories may be drawn according to a possible distribution of stresses in the pipe membrane, it is in order to inquire if the initial assumption that was made is correct, that is, whether *all* the forces are direct forces in the plane of the pipe shell or whether there are not some stress components normal to the pipe surface.

Observation of pipe line deformations and of pipe line failures leads to the belief that there is some bending normal to the pipe surface. If an element is cut from the pipe wall, such as is shown in Fig. 15, then the following stress components could act on each of its edges:

(*a*) A component, *T*, in the plane of the plate.
(*b*) A component, *N*, normal to the plate surface.
(*c*) A component, *S*, along the edge.

Also, all of these components could have a varying intensity over the thickness of the plate.

It has been assumed that the pipe consists of a comparatively thin membrane and a series of stiffening rings. Any stress components lying outside of this membrane as well as any variation in the forces over the thickness of the membrane would cause deformation therein. Conversely, the pipe membrane would have considerable resistance to any components, *T*, provided they were located in the central plane of the element.

According to the principle of least work, any stress components resulting from a series of forces will be such as to cause the strain energy to be a minimum. Therefore, if any small element of the pipe shell can be kept in equilibrium by the use mainly of components *S* and *T*, which produce very small deformations, it follows that the components *N*, normal to the element, which produce relatively large deformations, must be small.

Following this reasoning, the problem is to find some means of supporting the pipe in such a way that equilibrium of the structure is obtained without the help of any forces normal to the pipe membrane. This cannot be done with cradle type supports, because the upper part of the pipe would be required to transfer the reaction from the water pressure to the support and this cannot be done along the surface only, without inducing components *N* and consequently bending in the shell.

On the other hand, ring girder supports will permit this transfer to be made with but very little bending in the membrane, as will be seen in the following discussion.

The trajectories of the principal stresses have been worked out for a pipe having an internal diameter of 17 ft. 6 in. and provided with stiffening rings and supports at 60 ft. intervals. An isometric representation of these is included in this paper for purposes of illustration.* Figure

*These were prepared some time ago to illustrate another paper and are the only ones at present available in suitable form for publication.

17 (*a*) shows the trajectories of the principal stresses for the condition of pipe just full. The broken lines represent tensile stresses and the full lines compressive stresses. Stress intensity is indicated by the width of the lines.

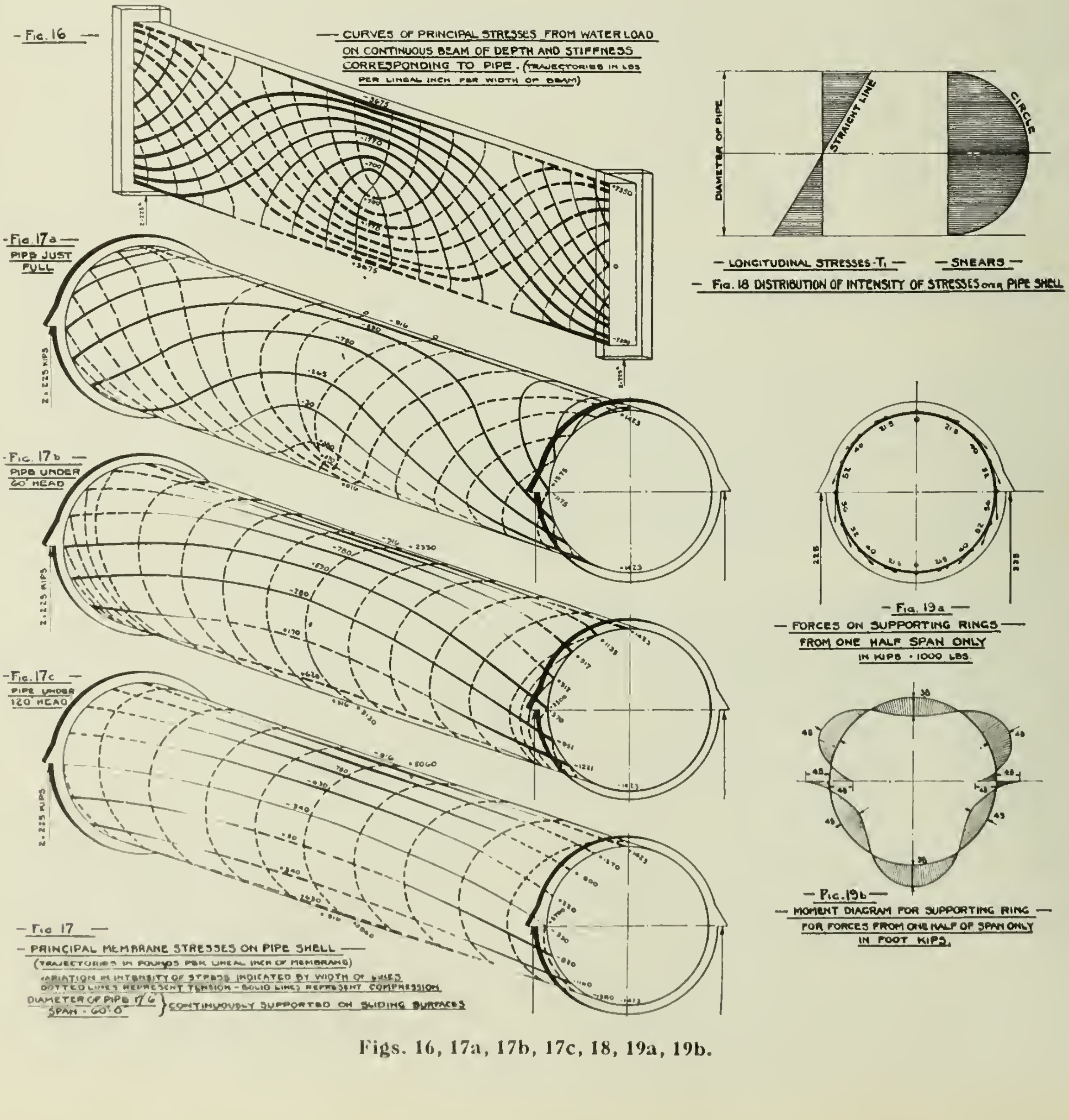
To illustrate these conditions, the pipe could be imagined as composed of a waterproof membrane, suspended by ropes (the broken lines) to the stiffening rings and stiffened by wires shaped to the solid lines representing the compressive stresses. All these imaginary ropes and wires would have to be completely within the membrane in order to give the true equivalent of the state of stress.

The forces acting on the stiffener rings are the resultant components of the principal stresses in the connecting pipe membrane. Since the principal stresses act *in* the shell of the pipe, these resultant components are tangential to the pipe shell at the junction of shell and stiffener ring, as can be observed from the diagram of stress trajectories, Fig. 17. Incidentally, these forces are the same for all pressure heads. Imagine now that the stiffening rings did not extend around the entire circumference of the pipe, but stopped short part way up, as in the case of the conventional cradle support. With this condition there would be no stiff member to take the reaction from the imaginary ropes and wires and the membrane would certainly bulge in this area. In other words, bending moments tending to deform the pipe will always occur with cradle supports. With circumferential ring supports these moments can be almost entirely eliminated from the pipe shell.

In Fig. 16 there are shown the trajectories of the principal stresses for a beam fully restrained at both ends, and having the same span, stiffness, and loading as the pipe of Fig. 17. Looking at the pattern of the trajectories, it can easily be seen that such a beam is composed of a simple central span supported by cantilever arms at both ends. There are also two distinct sets of trajectories, perfectly symmetrical about the neutral axis, one set representing the compressive stresses and the other the tensile stresses.

Similarly, it is possible to compute the stress pattern for a hollow cylindrical beam. But as mentioned above, the distribution of the live load over the surface of such a beam is of great importance, particularly if the walls of the cylinder are thin and if the ratio of beam depth to span is large. The ordinary beam theory neglects this point altogether, since it is of little importance with the usual shallow beams.

In addition, internal water pressure increases in intensity from top to bottom and the resulting ring stress will vary in like manner. Combining the hoop stresses with the beam stresses, there results the patterns of Figs. 17 (*a*) to (*c*). It is seen that with the pipe just full, the stress condition is similar to that of a rectangular beam. As the internal pressure increases, one set of the trajectories



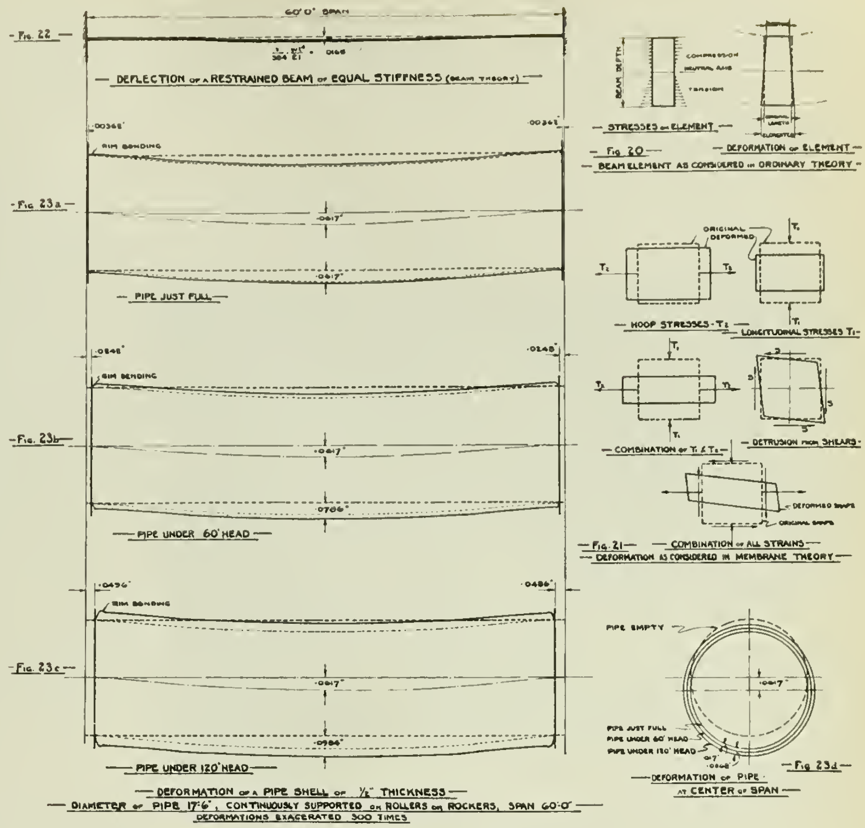
Figs. 16, 17a, 17b, 17c, 18, 19a, 19b.

develops into hoop stresses and becomes more and more pronounced as such both in shape and in magnitude. The other set of trajectories straightens out longitudinally with increasing pressures. Variations in intensity and in sign along the length of the beam may also be noted. The curvature of these trajectories increases with the distance between stiffening rings, but decreases with increase of internal pressure.

The Stiffening Ring

It will be noted that the trajectories at the pipe supports are not parallel to the horizontal axis of the beam, but are inclined thereto at slight angles which vary in amount across the section. This, of course, is due to the action of the shearing forces. Since equal restraint has been assumed at the supports throughout this discussion, the patterns of the trajectories on either side of the support are therefore identical but of opposite configuration. The horizontal components of the trajectories will be of equal intensity but opposite in direction and consequently in equilibrium. The tangential components in the plane of the stiffening ring produce shearing forces acting on the inner periphery of the ring. These, in turn, cause bending moments in the latter member.

The intensity of the shearing forces at any point is directly proportional to the sine of the angle locating that point. Plotting intensities (but not directions) at a point in a horizontal direction, a diagram similar to the right hand illustration of Fig. 18 results.



Figs. 20, 21, 22, 23a, 23b, 23c, 23d.

The bending moment diagram for the stiffening ring will depend upon the type of support adopted. For the support illustrated in Fig. 2, the approximate form of the bending moment diagram is given by Fig. 19 (*b*).

Rim Bending

Because of the amount of metal concentrated in the supporting ring, the latter will not expand under pressure as much as the shell. In other words, when the pipe is under pressure there is a slight constriction at each ring, accompanied by bending of the shell. This has been given the name of *rim bending* and the stresses caused thereby must be added to the longitudinal beam stresses. Fortunately, its effect is confined within a short distance on either side of the rings.

Stresses Due to Temperature

For a steel pipe, the intensity of the stresses caused by changes in temperature must be given serious consideration. In Canada it is usually necessary to insulate steel pipes to prevent ice formation on the inside of the shell during the winter. Adequate insulation will keep the temperature of steel pipes very close to the temperature of the water. The maximum range in water temperatures from summer to winter is comparatively small, but account must always be taken of the changes in temperature that may occur in the steel during periods when the line is unwatered for inspection, etc. It cannot be assumed that these periods will coincide with days when the air temperature is within the annual range of water temperatures. The pipe must therefore be designed for a range of temperature higher than its normal annual variation.

The temperature at which closure is made during construction will evidently be a determining factor in this connection. If closure could be made at or about the mean of the maximum range in temperature, this would be the correct procedure, but construction schedules may not always permit it.

With no provision for expansion and contraction and with the pipe ends fixed by anchor blocks, a longitudinal direct stress of at least 10,000 lb. per sq. in. must be contemplated for the range of temperatures normally occurring in Canada. The addition of stresses of this order of magnitude to the maximum longitudinal stresses would force the designer to use heavier shells, if standard working stresses are to be maintained.

Deformations

The ordinary beam theory is not sufficiently accurate for use in computing the deformations of a pipe shell. It is based solely on the change in length of the horizontal fibres under the action of bending, as indicated in Fig. 20. When applied to a pipe shell, the calculated displacements would be too small. Shearing stresses as well as hoop stresses contribute largely to the deformation of the pipe membrane. This is shown in Fig. 21.

Furthermore, it is necessary to consider the flow of material normal to the line of force application, i.e., Poisson's ratio must be applied.

The mathematical operation necessary for finding the deformation of a pipe shell is somewhat similar to solving a jig-saw puzzle. The shell is first cut into squares. These are then deformed according to the calculated membrane stresses and an endeavour is made to fit them together again. If they fit, it is said that the conditions for compatibility have been fulfilled and the calculations are correct. If they do not fit together, which may be caused by restraining conditions at the support, then either a mistake was made in the assumption for the membrane stresses or some other force must be assumed, such as a bending moment force, and the operation repeated.

Figure 23 shows the calculated deformations of the shell of the same pipe as in Fig. 17. Figure 22 gives the deflections of the equivalent restrained beam according to the ordinary formula.

It is to be noted that under all pressures (within the elastic limit of the pipe material) the central meridian deflects the same vertical distance. This movement is mainly due to the longitudinal and shearing forces in the pipe membrane. Hoop stresses will contribute an outward radial movement of the pipe shell due to the enlargement of the diameter.

Fig. 24—Downstream Section of Steel Pipe Line. Note concrete struts and copper expansion joint strips.

The stiffening rings, being much less deformable than the membrane, will materially decrease the radial movement in their vicinity, and the so-called rim bending deformation appears.

Another interesting feature is the tendency of the pipe to shorten under water pressure. This may be an important feature of design where no allowance for longitudinal movement of the pipe is made.

In examining the exaggerated shapes of Fig. 23, the meaning of the words "membrane" and "shell" as applied to the theory is very evident. Soap bubbles or rubber balloons blown from two straws at either end would behave in exactly the same way. Such thin films cannot resist bending moments and their shape is therefore a direct indication not only of their state of stress, but also of the deformations to be expected in shell structures. They supply additional confirmation of the essential correctness of the membrane theory, which states that under certain continuous conditions of load and with suitable supports, equilibrium can be attained without the occurrence of stress components normal to the surface of the shell. With knowledge of this theory it is possible to design extremely economical structures.

Description of the Outardes Falls Pipe Line

The general outline of the 18 ft. diameter pipe is given in Fig. 1. Plate thicknesses vary from ½ in. at the upstream end to ¾ in. at the downstream end and each ring is made of three plates. A short section of plate at each ring stiffener is ⅛ in. heavier than the corresponding plates on either side, in order to take care of rim bending stresses.

Each stiffening ring is fabricated in the form of a circular plate girder with a ⅜ in. by 18 in. web plate and two angles for each flange. A heavy bracket type foot is formed at each side. It is built of welded plate members. This transmits the loads from the pipe through the rocker bearings to the footings.

Computations showed that if no provision were made for free expansion of the pipe, the addition of thermal compressive stresses to the beam compressive stresses would result in stresses higher than those ordinarily used. A hollow cylinder is well adapted to resist axial compressive forces. But, in addition to direct axial loads, there would also be transverse bending of the pipe as a whole, as well as rim bending. These forces might have an important influence on the elastic stability of the pipe. No large scale experiments were known to the authors that would constitute verification or otherwise to any theory that might be developed. It was therefore considered advisable to make adequate provision for free longitudinal expansion.

Two slip-type expansion joints, therefore, have been provided, one on each side of the central anchor. As far as the downstream section of the pipe is concerned, this was the obvious location, since the axial dead weight component could be more easily taken care of by the lower anchor located on ledge rock. The slope of the upper section was small and the axial dead weight component therefore small also but nevertheless appreciable. The central anchor is located near the brow of the hill and it was decided to relieve this of as much of the thrust as possible. For the construction programme it was desirable to start erection of the pipe at both ends and work towards the centre. From the viewpoint of both design and construction, it was therefore better to reverse the more customary procedure and locate this expansion joint at the downstream end of the section.

To allow for free movement of each stiffening ring on its base, a train of four rockers is provided on either side at each support. These are similar in design to those frequently used on the free end of bridge spans. To prevent any creep of the rocker train on its sloping base, a bar formed with a 14 deg. involute tooth at top and bottom is fastened to one rocker of each train. It engages with a corresponding member on each of the rocker bearing plates. The upper plate moves with the stiffening ring and the lower plate is bolted to the concrete of the footing.

Fig. 25—Downstream Section of Steel Pipe Line. Girder wells have been completed and frost housing supporting beams are in place.

This bearing is shown in Fig. 4. The upper of the two side tie plates has been removed in order to show the construction adequately. The engaging member for the lower tooth had not been welded to the base plate at the time the picture was taken.

Since the pipe was to be backfilled up to the horizontal diameter, it was necessary to provide means to allow free movement of the ring stiffeners. This was accomplished by extending walls up from the concrete footings the necessary height to form a well. A watertight connection between these concrete walls and the pipe shell was made by a specially designed copper expansion strip which would allow both axial and radial movement of the shell. One edge of this strip was embedded in the concrete side wall of the well and the other fastened to the pipe by a cir-

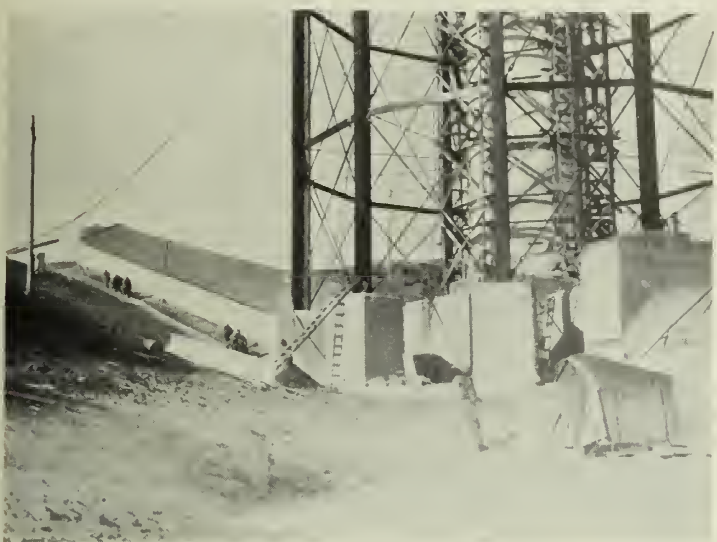


Fig. 26—Completed Frost Housing.

cumferential steel strap drawn tight by suitable lugs and bolts. The outer space between the shell, copper expansion strip, and concrete wall was filled with loosely packed rock wool to prevent the backfill entering and impeding the action of the joint.

Each ring girder and the shell ring attached to it were assembled in the manufacturer's shop and shipped to the job as a unit. The flange angles of the girder were riveted to the web plates. All other joints were made by electric arc welding. The three ring plates of the shell section were assembled on a spider and the longitudinal joints made by down hand welding. The ring stiffener was made in sections and tack welded to the pipe ring, after which the joints on the stiffener were made. Welding of the fillet joint between the shell plates and the toes of the girder flange angles was then completed.

To secure good contact between the shell and the girder angles, a portable bull press was used at each tack weld, the pressure being maintained while the tack metal was being deposited.

The ring stiffeners were placed on board the Ontario Paper Company's boats at the manufacturer's wharf in Montreal, transshipped at Baie Comeau to scows, which latter made the remaining 40 mile passage to the wharf at Outardes Falls. On arrival at the site of the work, they were placed on the previously prepared footings and rocker assembly, lined up, and blocked in position until the shell plates were welded to them.

The task of handling and placing the 7½ ton ring girders to exact position on rocker bearings with a sloping grade was not an easy one. Correct alignment of the upper and lower sections of the pipe was essential to secure proper functioning of the expansion joints. This work was carefully done and the measure of its success was demonstrated by the excellent fit secured at the central elbow, where closure was made.

As far as can be observed, both joints are now working in a perfectly satisfactory manner.

All shell plate joints were of the usual 60-deg., included angle, single vee, butt type, and were made by the electric arc welding process. Covered rod was used throughout the work, including all tack welds incorporated into the finished joint. The specifications required that welding be done only in the flat and vertical positions, except where definite permission was granted for overhead work.

The three plates for each shell ring were therefore assembled on a spider in the field and the longitudinal seams made in the flat position. The circumferential edges were prepared so that the upper two-thirds of these joints could be welded from the outside of the pipe and the lower one-third from the inside of the pipe. Backing-up strips were used which were later removed. The exposed root of the weld was carefully examined by the welding inspector and any defects or lack of reasonable smoothness were rectified.

For work of the type described herein it was of the utmost importance that high quality welding be secured. The quality of a welded joint is measured jointly by the specific process used and by the ability of the welding operator to apply that process, and in setting up a procedure for the investigation and inspection of welded work, these two phases in welded joint production must be clearly distinguished. The former of these comprises all the design variables, viz.:

1. Characteristics of the parent metal.
2. Characteristics of the deposited metal.
3. Characteristics of the welding current.
4. Shape of the welding groove.
5. Method of preparing welding groove.
6. Number of passes or beads.

As such, these design factors, in combination, must be carefully investigated to determine whether the joint will give the desired ductility, soundness, strength and impact resistance.

Given a specific welding process, all welding operators must be able to produce sound welds by that process, i.e., the weld metal must be properly fused, there must be no cracks, and slag inclusions and porosity must not exceed a specified maximum amount. These latter are the only requirements over which the operator has control. Testing of welding operators therefore was directed only towards these ends.

An experienced welding inspector was attached to the staff of the resident engineer at Outardes Falls for the period covering the welding of the pipe line and penstocks. The qualification tests for the various welding processes recommended by the manufacturer for his work were made in the latter's shops by the inspector before he proceeded to Outardes Falls.

Fig. 27—Side View of Ring Girder and Rocker Bearing.

The first batch of welding operators were also tested by the inspector in the shop. However, all operators were again given a qualification test immediately on arrival at the job. This was done to test their ability to pass the required standards under field conditions. Furthermore, all operators were made to re-qualify about every ten days to two weeks at the discretion of the inspector.

In addition to the inspection of all welding work as done, the periodical tests of the operators enabled the inspector to keep close check on the performance of all men, so that, in co-operation with the manufacturer's superintendent, operators were assigned to the various classes of work best suited to individual abilities.

This scheme worked very well. A high rate of production was secured and only a very small footage of seams was required to be chipped out and re-welded.

The various qualification tests were made in accordance with the "Tentative Rules for the Qualification of Welding Processes and Testing of Welding Operators," revision of June 1937, as published by the American Welding Society.

In addition to the requirements of these rules, a Charpy impact test was required for each welding process and for the testing of operators. The minimum impact value allowed was 30 ft.-lb.

All tests of shop welds, including the Charpy impact test, were extremely satisfactory.

Seven coupons were taken in the field from the pipe seams in various places and one from one of the ring girders. A one-inch strip was cut from the centre of each coupon and sent to the Ontario Research Foundation, Toronto, for machining and making the Charpy test. Etch tests were made in the field on the remaining two pieces of each coupon.

Two of these Charpy Test specimens broke at 30 ft.-lb. and two at 43 ft.-lb. with the remaining four between these two limits. The average of the eight specimens was just slightly under 37 ft.-lb. All of the etch tests met the specified requirements for penetration and fusion and maximum size of gas pockets and slag inclusions, with but one exception. This latter coupon was taken from a circumferential seam near the end of the horizontal diameter. The etch test showed one gas pocket in excess of $\frac{1}{16}$ in. diameter. A portion of the welded seam on either side of the coupon was chipped out and carefully examined by the welding inspector. No additional defects could be found and the seam was accordingly re-welded and passed as satisfactory.

This particular item of control did more than any other to keep the operators on their toes with respect to quality welds. A record was kept of the seams welded by each operator, and the coupons, of course, were selected at random so that no operator knew just when or where a determinative test of his work might be made.

The excellent quality of the work secured is evidenced by the record of the test specimens, and by the fact that no leakage whatsoever was observed after the pipe was filled and placed under pressure.

Protective Coatings

As stated sbove, the pipe was backfilled up to the horizontal diameter and the exposed portion enclosed with a wood housing. Before this work was done the upper half circumference was given two coats of coal tar paint, and that portion against which backfill was to be placed was given two coats of high quality coal tar enamel, with an intervening course of open mesh asbestos fabric.

These latter materials were selected on the basis of their record as long-lived protective agents for steel, and in the particular case of the enamel, its ability to resist soil stress and also its ability not to crack or spall at low temperatures.

No coating of any kind was placed on the interior of the pipe.

The pipe line was filled with water in September 1937, the elapsed time between this event and the letting of the contract being not quite nine months.

The contractors for the fabrication and erection of both the pipe line and penstocks were the Canadian Allis-Chalmers Limited of Toronto with the Canadian Vickers Limited, Montreal, acting as sub-contractors for the 18-ft. diameter section described in this paper and for the surge tank tee.

All shop inspection, including the inspection of shop welding, was made for the Ontario Paper Company by Charles Warnock and Company, Limited, Montreal.

The general contractors for the power development were the Foundation Company of Canada, Limited, who accordingly handled all regional transportation, earth work, concrete work, etc., associated with the pipe line.

The authors wish to make grateful acknowledgment to Mr. R. C. McMordie, A.M.E.I.C., for his work in making the necessary calculations and in drawing the diagrams of the principal stress trajectories and to Mr. H. S. Lundy and Mr. W. M. Stewart for their work in preparing the various figures.

As mentioned at the beginning of this paper, the pipe line described herein forms an important element of the Ontario Paper Company's Outardes Falls power development. The site of the work is on the north shore of the Gulf of St. Lawrence. For the entire power development Dr. H. G. Acres, M.E.I.C., Niagara Falls, Ontario, acted as consultant, associated with Mr. J. T. Jaeger, Chief Engineer of the Ontario Paper Company.

REFERENCES

(1) The Conception and Design of the Outardes Falls Power Development, H. G. Acres, Engineering Journal, October 1937.

(2) Penstocks for Boulder Dam, C. M. Day and Peter Bier, Mechanical Engineering, August 1934.

(3) Design of Large Pipe Lines, Herman Schorer, Trans. American Society of Civil Engineers, 1933.

(4) Line Load Action on Thin Cylindrical Shells, Herman Schorer, Trans. American Society of Civil Engineers, 1936.

Some Difficulties of Maintaining Electrical Service

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Paper presented before the Montreal Branch of The Engineering Institute of Canada, November 11th, 1937.

In this paper an endeavour will be made to touch briefly the many causes of interruptions as experienced by our company in the province of Quebec, treating them from a hydro-electric point of view. Assuming that the equipment installed is capable of operating satisfactorily under both normal operating conditions and also under temporary overload conditions, conditions will be considered which are abnormal and under which service must be maintained, to the consumer.

Fig. 1—Ice piled up on road breaking pole.

A power system can be divided into three main sections:—

(1) Generation
(2) Transmission
(3) Distribution

GENERATION

Under generation one can consider the place where the energy is available and where water power is converted into electrical energy. Water power is really potential energy because of precipitation and evaporation of water resulting in the flow of water through streams and rivers in a downstream direction from the run-off areas above sea level to the sea. It is the fall of water from a higher level to a lower level which creates water power.

TRANSMISSION

Transmission can be considered the connecting link between the generating station and the centre where the power is to be distributed. Transmission usually involves (*a*) the necessary step-up transforming equipment, and (*b*) the equipment necessary to conduct energy from the power house to the consuming centre.

DISTRIBUTION

Under distribution can be classed the equipment necessary to take the electrical energy from the high tension switching terminals of the transmission system and to deliver it to the consumer. It consists of two parts:—

(*a*) Step-down transforming equipment.
(*b*) Distribution lines.

Adequate electrical service consists of three main functions and is the maintaining of (1st) continuity of electrical supply, (2nd) voltage regulation within certain limits, and (3rd) constant frequency.

The chief reasons for interruptions or failure of service are as follows:—

(*1*) *Failure of the supplying company's equipment to carry its load.*
(*2*) *Overloading equipment.*
(*3*) *Mistakes in operation.*
(*4*) *Failure of customer's equipment.*
(*5*) *Mistakes made by customers' operators, chiefly due to the pulling of disconnecting switches under load.*
(*6*) *Floods or low cycle periods of river flow.*

Rivers obtain their water from run-off areas which in turn obtain it from melting snow and rainfall. The run-off area determines the character of the river. The two main causes of curtailment of power in a hydro-electric power house are (1st) change in operating head, and (2nd) change in the volume of flow of the river. All rivers experience seasonal flow variation cycles and some have well defined weekly and even daily flow cycles, due to the operation of power plants located upstream.

Power system loads also experience seasonal and daily cycles of power demand. If the power available at low water periods coincides with the high demand power period and the demand required in power is greater than that available from the water then curtailment of power will result. Where storage pondage is available attempts are made to store water during periods of low load demand and to use it during periods of heavy load demand.

At the period of ice break up in the spring when the flow is increased, the possibility of jams caused by ice, trees and other floating debris is of considerable concern to the operating engineer. If the jam occurs below the power house it frequently raises the tailrace level reducing the operating head. If it occurs above the power house it backs up the water above the jam causing a temporary shortage of water below the jam with the resulting reduction

Fig. 2—Ice piled up on dam in front of power house.

in head at the power house. Formation of jams usually means the raising of the water level above the jam.

When the whole flow of the river has to be passed through sluice gates and the flood period is accompanied by the break-up of ice, a dangerous and worrying time is experienced by the operating staff. The passing of ice three or four feet thick, and in large sheets, through the sluice gates and the maintaining of the required power supply from the power house at the same time, is an operation which requires great care and exceedingly good judgment. It must be remembered that when ice jams occur and they are to be broken up, there must be an open water channel downstream of the jam to allow the broken ice to pass downstream; otherwise the jam will re-form immediately downstream. The possibility of floods, particularly in the spring, is greatly increased in rivers which flow from the south towards the north owing to the fact that the high water period occurs during the thaw in the south before the ice cover on the river in the north has broken up and moved out to the lake or sea.

(7) *Ice jams and variable river flows.*

The power development is the scene of many bitter and persistent battles against ice and frazil. Frazil is water which has been agitated usually by passing over rapids and which water is below 32 deg. F. It usually settles itself into a jelly-like substance consisting of fine particles,

Fig. 3—Limb of tree broken off by snow and wind, short-circuiting overhead conductors.

and packs below ice coverings. It mixes well with snow to make a sticky substance which forms a persistent packing below ice coverings. Wind in cold weather agitates the water and blows spray into the air where it immediately freezes and falls back into the water as frazil. It settles on gates, racks, turbine blades, etc. Under certain conditions it has been found to extend, in lakes, to approximately 70 ft. below the ice covering where the total depth is 90 ft., and in certain rivers it has been found to occupy 63 per cent of the total available space below the ice covering. It requires, under certain conditions, constant dynamiting and a passageway must be opened between the power house and some predetermined point in the forebay to allow the water to arrive at the power house rather than have it deviate by some other means to the main channel of a river. Tugs and dynamite are frequently used to force these passageways through the accumulations of ice and frazil.

When the forebay extends for a considerable distance from the power house upstream and where the flow does not exceed 2¼ ft. per sec. which, in this province, will permit the formation of an ice covering, then the possibility of frazil troubles at the power house in the winter are largely eliminated.

(8) *Sleet storms and snow storms.*

Sleet storms with the accompanying incrustation of ice on overhead conductors, insulators and supports, cause considerable damage to both transmission lines and overhead distribution systems. The glaze formation of ice usually forms to one side above and below the conductor. When formation of sleet is accompanied with rain, pear shaped formations of ice take place at intervals along the wire as well as the ordinary ice incrustation formation. Usually sleet forms in this province accompanied by an easterly wind at approximately 32 deg. F. The ice formation usually adheres to the conductors at temperatures up to approximately 35 deg. F. Not only is the additional weight to the supporting structures, etc., objectionable, but as the result of the ice formation on the overhead conductors an unnatural vibration sometimes referred to as "galloping" or "dancing" takes place. This unnatural vibration occurs at certain wind velocities, in this province at approximately 15 miles per hour, and when the ice starts to fall from the conductors. Ice incrustations have been found on conductors weighing two pounds per foot on No. 3/0 diameter 7/16 inch copperweld ground wire, and on another occasion ice weighing approximately four pounds per foot was found on aluminum transmission line conductors. Unnatural vibration must be distinguished from the natural vibration which takes place on a normal transmission line. The difference between these two forms of vibration is, however, that the natural vibration can be dampened out to a point where same can be considered not dangerous to the lines by the application of Stockbridge dampers, armoured rods, etc. Many experiments have been made and a great deal of data collected but up to the present there is no equipment on the market, that the writer knows about, that can be purchased which will dampen out the unnatural vibration called "dancing." The problem of thawing ice, by electric heating, from conductors is one which is being given considerable study and good results have been reported.

Snow storms are very objectionable particularly to overhead distribution systems when they occur before the leaves have fallen from the trees and when they are accompanied by wind storms.

(9) *Wind storms.*

Wind storms if of sufficient velocity often carry foreign materials into the overhead lines frequently accompanied by the resultant short circuit and the tripping out of the

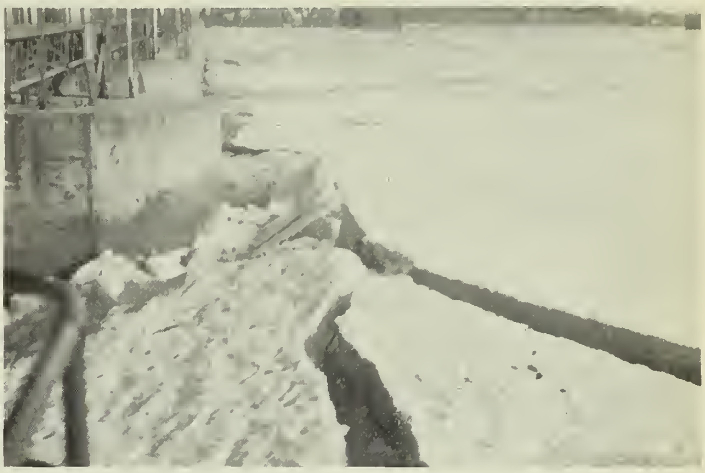
Fig. 4—Formation of ice on string of insulators.

circuit. Frequently the short circuit, as well as the additional weight of the foreign material, breaks the conductors.

(10) *Electrical storms.*

Electrical storms cause damage to (1st) equipment supplying the lines with power, and (2nd) to the overhead circuits themselves.

According to recent observations made by the General Electric Company in studying lightning, they have proved that lightning is frequently a succession of strokes rather than one direct stroke. Lightning may either strike from the clouds towards the ground or it may leave the ground and travel towards the clouds, or two strokes—one may leave the ground and the other may leave the clouds and meet each other. The following two examples will illustrate the peculiar paths which are taken by lightning in its effort to find a good ground. In one case lightning struck a 90 ft. pine tree, travelling down the tree, ploughed up a furrow in the ground until it reached a pole carrying telephone wires, travelled up the pole splintering the wood behind it and finally found its ground after passing through the telephone wires. Another example which occurred is as follows: A few months ago lightning discharged through an apple tree, travelled through 37 ft. of earth, went through two metal beds, through the body of a boy, travelling from one foot to his chest, through a radio aerial to a secondary power circuit and finally came to ground through a telephone circuit. The boy was killed, several electric lighting circuits were put out of commission and the telephone system was damaged. Storms cause frequent trip-outs of circuits separating power houses



Figs. 5 and 6—Ice going through sluice gates.

Fig. 7—Ice-breaking tug attempting to smash ice jam in river.

Fig. 8—Using dynamite to remove ice from river.

Fig. 9—Overhead telephone lines brought down by sleet.

Fig. 10—Limbs of trees weighed down by snow short-circuiting overhead conductors.

from the load centre and customers from the load centre. Considerable study has been given to the minimizing of damage from electrical storms such as the use of good grounds and ground wires, counterpoise, lightning arresters, surge absorbers, discharge gaps, etc. Excellent operating results are reported to be obtained with this equipment as far as the operating record is concerned.

(11) *Interruptions from outside sources.*

Interruptions from outside sources such as (*a*) cutting trees, causing them to fall across overhead lines, (*b*) stealing of conductors which are alive or dead, (*c*) breaking of poles by vehicles, and (*d*) damaging of insulators and equipment by persons shooting at them.

Overhead conductors up to voltages of 12,000 volts have actually been stolen when alive. Attempts have been made to steal 12,000 volt P.I.L.C. cables alive. Short circuits frequently follow the attempts to steal live lines with the resultant burning of the thief.

To supply adequate electric service, not only must the correct equipment be installed to supply normal loads but adequate provision must be made to carry abnormal loads in emergencies, caused by conditions such as have been mentioned above.

The staff of a power company supplying power has a heavy burden to bear. Not only must they operate in such a manner as to supply service under all conditions but they must keep their equipment in first-class condition and replace obsolete equipment before it gives trouble. The system must also be a financial success. Under the present conditions of rising prices for material and labour, increased taxation, and the tendency to lower rates, it is not an easy matter to fulfil the requirements of giving adequate service.

The author would like to extend his thanks to the Canadian General Electric Company and to the Shawinigan Water and Power Company for the use of photographs and information which have materially assisted in the preparation of this paper.

DISCUSSION ON

Engineering Efficiency into the Highways

Address by Miller McClintock, Ph.D.,[1] presented before the General Professional Meeting of The Engineering Institute of Canada, at London, Ontario, on February 1st, 1938, and published in The Engineering Journal, March 1938.

F. P. Adams, A.M.E.I.C.,[2] inquired how the side roads approach a 'limited way.' The author replied that special entrance lanes are placed at reasonable distances apart for the approach from the side and exit from 'limited way' highways.

W. M. Veitch, A.M.E.I.C.,[3] asked what had been done concerning the abuse of curb parking. The author remarked that the only place where he had recommended the complete elimination of curb parking is in the Loop area of about one and one half square miles in Chicago. Double parking is evidence of oversaturation. Parking meters have been used with success, but they should only be used where parking is intended, and a revenue is expected for this service. An intensive survey of the Loop district in Chicago was made and this definitely decided that curb parking was not in the interests of the merchants located in that area. The surveys were made by the operators of the various large stores. Sales slips were prepared to show the various classifications of parking and movement of traffic to and from the area. When purchases were made purchasers were asked as to whether they had arrived by street railway, bus or private car; whether thay had parked their cars at the curb, placed them in a garage or used a public parking space. It was interesting in this connection to learn definitely that only 1.5 per cent of the business came from curb parkers. Following this survey, the elimination of parking in the Loop district was recommended.

C. G. Moon, A.M.E.I.C.,[4] observed that centre line marking and border markings on highways were desirable in order to eliminate the very tired feeling that a driver gets after eight to ten hours' driving on unmarked roads; a definite centre line would be a great help. Grass borders are an improvement over the usual gravel borders which cannot be seen. A painted curb is a considerable aid. Painting the roads in suitable colours would increase heat absorption with a favourable result in the removal of ice.

A. L. Carruthers, M.E.I.C.,[5] inquired as to 'limited ways' paralleling local roads and the use of by-passes. The author expressed the thought that arterial highways would be by-passed around cities. A study has been made of the business originating from traffic using direct highways. It has been quite definitely determined that the extent of this business is limited to those very local stores such as hot dog stands, gas stations and so forth, which cannot be considered as a permanent local industry. It is apparent that main highways should not pass through thickly populated districts. They must pass by them, allowing entrance and exit by the usual by-pass methods. It is a shame that the highway traffic must fight its way through congested streets.

R. F. Legget, A.M.E.I.C.,[6] asked if pedestrians had priority over a car and whether it is economical to permit single-passenger cars to congest city traffic; further, could bus transportation be used in an effort to eliminate the parking evil. Mr. Legget also inquired if motorists financed these magnificent superhighways.

To this the author replied that the general public does not choose to go by means of mass carriers. For this reason it may be difficult to eliminate the single-passenger car. Motorists have been found willing to pay their own way, and this condition is found everywhere. Funds for the financing of these superhighways are available from motor transportation. In his opinion, the pedestrian must have the right-of-way; following that, the bus or tram carrying a large number of passengers. In business areas, pedestrians must always be able to move to and from business houses, and must therefore be given preference in movement.

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[2] City Engineer, Brantford, Ontario.
[3] City Engineer, London, Ontario.
[4] St. Catharines, Ontario.
[5] Bridge Engineer, Department of Public Works, British Columbia.
[6] Lecturer in Civil Engineering, Queen's University, Kingston, Ontario

DISCUSSION ON

Engineering the Highways for Safety

Paper by C. A. Robbins,[1] presented before the General Professional Meeting of The Engineering Institute of Canada, at London, Ont., on February 1st, 1938, and published in The Engineering Journal, March, 1938.

R. W. McColough[2]

The writer agrees with the author that irrespective of the length to which the engineer may go in designing the highway from a safety viewpoint the final factor of safety rests with the driver of the motor vehicle, and while engineers who are constructing highways are faced with many difficult problems, those who have the responsibility for motor vehicle control are perhaps faced with problems more difficult to solve.

The writer cannot agree with Mr. Robbins that the design of highways is a new science, but the design of highways for carrying high speed motor vehicles is new. While we may talk of motor vehicle control, speed limits and other highway safety measures, at the same time, in designing highways today in order to visualize what may be required of them in the future it is only necessary to look at what has taken place during the past few years—great increase in volume of traffic, in the weight of motor vehicles, and in the speed. The engineer having decided what type of highway is required having regard to the traffic requirements during the expected life of the roadway is still faced with a serious problem. Unfortunately, the roadway which is to be constructed to carry the traffic of the future must be built with funds available today and therefore he is faced with the problem of showing his government the necessity for such expenditures and the government in turn is faced with finding the funds available from today's traffic to take care of traffic which may develop in the future.

Given ample funds highway engineers can design highways almost entirely eliminating hazard as far as the highway itself is concerned. An example of this is the west side elevated highway in the City of New York which has no intersections, no opposing traffic and no pedestrian traffic. Such highways, of course, are far beyond the pocket of any of the provinces in Canada. The more densely populated provinces of Ontario and Quebec, of course, must lead the way in highway developments in the Dominion. Their resources are much beyond those of the province of Nova Scotia. Nevertheless, with the limited resources of such provinces as this, one must take cognizance of the requirements of the future, and highway construction in this province is being constructed from this viewpoint. Consideration is being given to alignment, curves are being super-elevated on much the same formula as Ontario, traffic lines are being marked on our highways. On two lane highways approaching sections where the vision is obscured the line marking is moved two feet towards the right hand side of the pavement on each approach to the crest of the hill, this so that the cars meeting at the crest will be carried four feet apart by the line marking. Signs prohibiting passing on the upgrade are placed on such sections.

Undoubtedly the four lane divided or dual highway will take care of a greater volume of traffic in safety than a four lane undivided highway, and in my opinion the dual type will be used largely in the future. As stated by the author, it is desirable that there be a separation of at least 30 ft. but even when this space is not available a divided highway is preferable to the undivided.

Accommodation for pedestrians is necessary both from the viewpoint of their safety and from the viewpoint of the carrying capacity of the highway. Pedestrians walking on a highway will slow up traffic to a marked degree, thus causing congestion of motor vehicle traffic.

With reference to the lighting of highways, the writer has driven at night over a number of sections of highway which were lighted. Frankly, up to the present time no great advantage to the motorist has been noted unless the roadway is patrolled and all operators of motor vehicles compelled to operate on the lower beam of their headlights; as divided highways largely do away with the difficulty of headlight glare moneys spent for highway lighting might give more benefit to the public if expended in another direction. The writer, of course, realizes that highway lighting is only in its experimental stages and one should not be too quick in passing judgment.

The placing of safety and direction signs is a part of the highway engineers' duties. These signs cannot be placed haphazardly, if they are they will tend to danger rather than to safety on the highway. Direction signs should be placed in advance of the point on the highway where the motorist must change direction. Signs placed at the intersection have a marked tendency to cause the motorist to stop at what is perhaps a dangerous intersection. Curve and other safety signs should be made with reflectors which will show up at night. Signs without reflectors are not always visible at night and this is the time when they are most required.

In this province advertising signs on the highways are practically prohibited. They are not only unsightly but are very often erected at a point which may cause a menace on the highway due to the diversion of the motorist's attention.

R. E. Jones[3]

While main highways have a considerable volume of traffic during hours of darkness, it is much lower than during the daytime. With the case of pleasure drivers this is to a large extent due to the reluctance of many to drive over darkened roads, particularly when wet. There is the greatly increased accident hazard both to the motorist and to the pedestrian.

Highways are now being lighted in such a manner that distant vision approaching the range of vision in the daytime is obtained. The passing of glaring headlamps is no longer troublesome as while they ordinarily appear very bright it is only relative on account of the dark area surrounding them.

For the economical lighting of highways proper design of the system is important.

As the intensity of light sometimes used in business districts is neither desirable nor necessary on the highway, advantage is taken of the silhouette effect. A driver is not interested in the colour or other details of an object but he does want to be able to see its outline clearly. This is the effect given by the light from distant points being reflected off the pavement towards the driver. For this reason it is very desirable to have pavements light in colour.

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[1] District Engineer, Department of Highways, Ontario.

[2] Chief Engineer, Department of Highways, Nova Scotia.

[3] Assistant Engineer, Hydro-Electric Power Commission of Ontario.

The luminaire must be of a type which will project the light along the road instead of wasting a large part in the adjacent fields.

On account of the reflection required from the roadway the unit must overhang the pavement at least a short distance.

The light must be at sufficient height above the road to avoid direct glare but not so high that costly high supporting structures will be required and maintenance will be difficult.

At present there are two distinct types of luminaire suitable for highway lighting.

The incandescent type has the ordinary lamp enclosed in glassware which with the aid of a reflector above controls the direction of the light.

The sodium lamp emits a soft yellow light and is placed in an aluminum fixture which is so designed that no directing glassware is required.

Probably the most important point that should be emphasized is the necessity of using enough light. Records show that often a poorly lit road is more dangerous than a dark one.

A. C. Abbott, a.m.e.i.c.[4]

The Shawinigan Water and Power Company installed a half mile experimental installation of 10,000 lumen sodium lamps in 1934 on the Montreal-Quebec highway just west of Three Rivers.

The general features of this installation are given in a short paper written by the writer and published in The Engineering Journal of October 1934.

This original installation of sodium lamps was purely experimental on the part of the Shawinigan Company, and was left in service for approximately two years. It was then dismantled with the thought of reinstalling it, with additional lighting, on a more travelled highway north of Montreal. This reinstallation was not carried out for certain reasons but the question is now again being studied.

As regards the type of lighting which might be installed, the sodium lamp is still favoured as against incandescent, as the best form of lighting for the purpose, due to the character of the light and fine definition of objects on the roadway. As against this, however, the sodium is considerably more expensive than an equivalent installation of incandescent and, if a considerable section of highway is to be illuminated, the type of lighting made use of will probably be decided upon a cost basis, which is very definitely unfavourable to sodium.

J. P. Bickell[5]

The writer agrees with Mr. Robbins' analysis of the problem which places the major responsibility for accidents on the driver; he cannot, however, accept his unqualified reference to the incompetence of drivers unless a failure to exercise full foresight and concentration can be so classified.

The average driver who has passed a test and secured a driver's license is entirely competent to drive at average speeds under average conditions. However, he may and does fail to adjust himself to unusual conditions. Not that he fails to allow for darkness or rain or ice or snow or general conditions but that when an emergency arises or something occurs to distract him momentarily, he is very often unable to make the necessary decisions with adequate speed and accuracy.

With respect to railway crossing accidents, there is little evidence of increasing hazards at these points. There has been some increase, as there has been in all accidents, but the danger at these points is not as great as is popularly supposed. Railway crossing accidents amount to only about one or two per cent of the annual total of all accidents. They are, however, extremely serious in consequences and are spectacular and as a result receive publicity far beyond that given other accidents.

Separation of traffic at railway crossings is important but not in my estimation nearly as important as separation of traffic at congested highway intersections and the separation of two-way traffic on main roads by the construction of dual highways. The development of dual roads and clover leaf intersections is, from the standpoint of safety, the major achievement of highway engineering in recent years.

The most interesting statement in Mr. Robbins' paper is that lighting of our main highways is not far distant. A good many years ago, the writer expressed the belief that such lighting would be used eventually. Certain it is that if there is incompetence among drivers, it is most evident after dark. "Overdriving" headlights is probably the most common fault of motorists and while a relatively small percentage of all driving is done during darkness, statistics show that 40 per cent of all injuries occur during darkness, while in 1935 and 1936 fatalities were less numerous in daylight than at night.

The tremendous importance of darkness as an accident factor is most clearly demonstrated by these figures.

In conclusion the writer would refer to through highways and signs. There are altogether too many of both. Certainly the employment of through highway designations for the purpose of stopping traffic at dangerous intersections is a prostitution of the term, which was intended not to delay traffic on cross streets but to expedite movement on the through highway. Drivers encountering stop sign after stop sign at the entrances to highways carrying little or no traffic soon become contemptuous of such signs.

When signs are erected for trivial reasons, they not only make our instructions appear foolish but they give drivers the impression that they can be disregarded with impunity with the result that important signs may be passed without being given sufficient attention.

Another feature of this situation is the distraction of drivers. In the first paragraph of these remarks it was stated that lack of concentration was the most obvious indication of incompetence among drivers. Driving at modern speeds is a task requiring the unceasing concentration of driver and every sign or other object which causes him to divert his attention from the road for even an instant is a hazard. Therefore, no sign should be erected on a highway unless the hazard it foretells is greater than the possible danger in the diversion of the driver's attention. Then if the sign is warranted by such measurements, it should be capable of instantaneous interpretation so that the distraction may be of the shortest possible duration.

W. M. Veitch, a.m.e.i.c.[6]

The paper which has just been read on highway safety engineering impresses us again with the wonderful progress which has been made in highway engineering during recent years. The most notable example of this progress, in this part of the country at least, may be taken as the centre road between Hamilton and Toronto.

The author mentioned in his paper that the three-way highway was not desirable. However, the three-lane highway between London and Lambeth is a great improvement over the narrow pavement which existed previously. Doubtless, a four-lane highway is better, but both the financial aspect and the rapid increase in automobile traffic will

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[5] Registrar of Motor Vehicles, Motor Vehicles Branch, Department of Highways, Ontario.

[6] City Engineer, London, Ont.

make it necessary to convert present roadways into three-lane highways with the ultimate view, of course, of converting them, later, into six-lane, dual traffic roads.

The question of the pedestrian is one which city roadway engineers must keep constantly in mind. In London, in roadway design, street lighting and traffic regulations the pedestrian is always the first consideration. In traffic regulations, the mother with a baby carriage is considered as the limiting factor. School children traffic is a problem which is under consideration at the present time. Just at the moment a study is being made on the safety of children, having in mind the installation of flashing school signs operating by time clocks at school hours. The writer is not in favour of too much care being taken of school children; their safety must depend to a great extent on their own traffic consciousness and also on the safety education which they may obtain from their teachers.

The writer agrees with the author that the erection of signs is much overdone. This is especially true in cities and we are rapidly reaching the point where too many prohibitive signs, at least, are defeating the object for which they were designed. Some years ago, it was recommended that "stop signs" should only be placed at intersections where secondary streets enter through streets. Some fifty "stop" signs were removed and replaced with "slow" cautionary signs. This change has proved very successful.

Has the Department of Highways ever considered the zoning of areas with regard to speed? There are certain sections of road where the need for a speed limit seems unnecessary, and, again on other sections even the present limit makes driving dangerous. The question of highway curve signs has always been a mystery. While driving on the highways, more especially at night, one can never be sure what the nature of the curvature is from the sign. In many cases, a very slight curve is encountered. One gets indifferent. Is it possible that the degree of curvature might be shown by figures on the sign or by the curvature of the warning arrow?

The question of automobile horns is one which should be discussed. In a city at least the use of any noise-making devices on automobiles will be prohibited in the near future. The only present use for an automobile horn is to warn the cyclist or other motorist that he is not obeying the rules of the road. This surely is a matter for the police rather than for the motorist himself. Another objectionable use of the automobile horn seems to be for the purpose of scaring pedestrians, who, after all, should have the right-of-way at street intersections.

Another question which crops up almost continually is the question of Provincial Government aid in the construction and maintenance of highway roads and traffic regulation through the cities. We are constructing and maintaining miles of highway through cities for the use of tourist and truck traffic, which does not contribute any money for the use of these highways; all taxes on automobiles, trucks or gasoline, cannot be used, at the present time at least, either for maintenance or regulation of highway routes in the cities. In the last few years, we have constructed three bridges on highway-traffic routes in this city. Each one of these bridges has been constructed strong enough to ensure the safety of the heaviest bus or truck operating on the provincial highways. In each case, the City Council has approached the Government to pay at least a share of this extra burden on the municipality but each time their request has been refused.

A. K. Hay, A.M.E.I.C.[7]

The whole question of designing safe highways is closely allied with the yearly improvement in the design of the motor vehicle which permits it to travel at ever increasing speeds. This in turn brings one to a discussion of obsolescence in the highway structure. The author has pointed out a number of features which are now considered to be minimum requirements if a main trunk highway is to be made suitable for present day traffic. But if his paper had been given even four or five years ago one would have heard quite different requirements set forth as to what, for example, should constitute a proper grade and alignment. And no doubt four or five years from now the requirements will be even more exacting and more costly. The countryside is full of stretches of roadway which have become out of date in a comparatively short term of years not because the structure of the road has worn out but because they were not designed to meet present day traffic speeds.

It becomes proper then to ask if there will not soon be some limitation set in this costly race between road design and road usage. It is unreasonable to expect the automotive designer to set any limit on improvements in the vehicle but what might well be done is to set some speed in miles per hour as being the logical maximum at which the ordinary driver may be expected to operate his car with safety to himself and to others using the road. Some exhaustive set of tests on a large number of drivers could be made, measuring their reflexes or reactions under different sets of conditions and from this a figure could be determined as to the maximum safe speed for which the highway should be designed. Then we could go ahead and make our designs with some assurance that the roads would not be obsolete long before they were worn out.

Coming now to the question of what to do with the pedestrian on the highway it seems obvious that public opinion will soon be reflected in legislative action towards giving this "forgotten man" some better measure of protection. It appears reasonable that authorities who control the road should be given the power to construct or to force the construction of footpaths in semi-urban areas and that the cost of these should be borne in part by the local district and in part by the users of the highway who create the danger.

The organization with which the writer is connected has for some years past been building such paths in suburban territory in co-operation with the local municipal councils. As a result we have found very definitely that it is almost useless to construct alongside a paved roadway a path which has for its wearing surface cinders, crushed stone or gravel. Many pedestrians will not use it but will continue to walk on the road, more particularly at night and in wet weather. To give any degree of satisfaction the wearing surface of the pathway must be at least as attractive as that of the adjoining pavement. In practice this is not difficult of attainment as there are a number of moderate priced surfaces which answer the purpose quite well without going to the expense of a permanent city sidewalk laid to a right grade. The writer has found that a bituminous surface, either hot or cold-mixed, laid on a crushed stone, gravel or cinder base may be built for about 12 cents per sq. ft. under our particular set of conditions.

The writer was greatly interested in the author's remarks about the elimination of headwalls in culverts, and would like to hear as to whether or not his Department's experience with this practice has been uniformly satisfactory. Undoubtedly there is a saving in time and money in most culvert installation if one can get away from the extra form work, foundation problems etc., which are entailed in building a headwall. Insofar as the down-stream end is concerned there might not be much room for argument. But what about the upstream end? Is there not a real danger that during the season of spring floods water will percolate along the outside of the barrel

[7] Ottawa Suburban Roads Commission, Ottawa, Ont.

of the structure and cause a washout or at least some erosion and settlement in the roadway embankment above the culvert?

Hugh A. Lumsden, M.E.I.C.[8]

Few engineers are better qualified to speak on the subject of highways and their safety than the author. His long and wide experience has been the background enabling him to present such an instructive and interesting paper.

A hundred and two years ago John Loudon McAdam, a Scotch engineer, passed away. He it was who commenced an era of improved roads. He is said to have enunciated the theory that "roads should be built to suit the traffic and not traffic to suit the roads." This is as true today as ever, and the practices now being followed by the Department of Highways of Ontario, in order to meet traffic conditions, have been well outlined in the foregoing paper. It must be remembered, however, that only on a limited mileage can we hope to bring about many of the conditions spoken of, such as those attendant to a dual highway including alignment grade, clover leaf intersections, under passes, lighting, etc. Over a tremendous mileage in every province, including Ontario, we will continue to improve the roads at a much slower rate, not from choice but from financial necessity. Nevertheless the example set in the construction of the dual highways and by the inclusion therein of so many of the features mentioned by Mr. Robbins will be an inspiration which will be followed wherever practical.

In a recent annual report I suggested that in the estimates for the coming year not only in my own county but in every county, township and municipality, there should be set aside a definite sum for the express purpose of promoting safety. It may be for eliminating ditches, for erecting guard or guide rails, for putting up reflector signs, for building pathways or for any purpose which will render the roads more safe both for motorist and pedestrian.

The fundamental trouble which accounts for most accidents the last speaker has truly said "is not to be found in the design of the road or car, but in the incompetence of the drivers."

What then can be done to make drivers more competent? In making such suggestions it is feared I depart somewhat from the paper but if the highways are to be engineered for safety surely we must in some manner bring about greater responsibility on the part of those who use them.

1. *Education*—Teach in the schools the rules of the road so that both potential drivers and pedestrians may know what to expect.

   More frequent examination of all drivers for fitness and competence in driving.

   More frequent inspection of all vehicles using the roads.

2. *Regulation*—More traffic officers over all highways not necessarily for the purpose of prosecuting or persecuting but of regulating traffic on all roads.

   The elimination of "crocks." This may cause some disappointment to the boys who have rigged up a car of 1914 vintage, but it is absurd that many cars are allowed on the roads at all. For instance, four wheel brakes should be compulsory.

Again I wish to compliment Mr. Robbins, not only on his splendid paper but on the fact that in the district about Toronto over which he has charge, he is incorporating every device possible to assure safety.

[8] County Engineer, County of Wentworth, Ontario.

The Author

The author stated that a complete new road was being built from Toronto to Niagara Falls, thence to Fort Erie. The road between Burlington and Fort Erie is on a new location following the lake and river. Grades and curves have been practically eliminated with no level crossings. It is considered that the tourist traffic brought in about $300,000,000 to Ontario and Quebec in 1937.

J. A. Vance, A.M.E.I.C., inquired if there were not too many signs on the road, especially at curves. The department considered all curves dangerous and for this reason, the author said, signs are placed at all curves. A new plan is being considered, that of placing a maximum speed limit at curves graded 50 miles, 40 miles, 30 miles, etc.

W. C. Miller, M.E.I.C., brought up the question of ice retention on a road where bituminous paving and concrete paving are placed in parallel lines. The author agreed with Mr. Miller's remarks, saying that some hazard in the braking of cars was due to the fact that the black bituminous road, because of its heat absorption, permits the melting of ice at a more rapid rate than on concrete. Lighting of roads, especially where there are two types of paving, is a difficult problem.

Dr. Miller McClintock inquired if the trees in the centre boulevard strip were not an interference to night driving, due to the flickering of the lights among the trees. The author admitted that there had been some complaint about this.

F. P. Adams, A.M.E.I.C., asked if it were the intention of the Ontario Highways Department to plant trees along the roads. The author replied that the Department has two landscape artists working on proposals for highway beautification.

Replying to E. M. Krebser, A.M.E.I.C., the author stated that all the Canadian Provinces had joined in sign uniformity but they do not use uniform colours.

J. M. Fairbairn, A.M.E.I.C., brought forward the information that in the United States, at clover leaf crossings, they widen the highway at the point of leaving so that a car can be off the main highway as a separate lane for several hundred yards in which to pick up speed thus avoiding interference with traffic.

J. R. Rostron, A.M.E.I.C., asked whether there have been any experiments with dome lighting in the road pavement. The author made the reply that winter maintenance makes dome lighting in the pavement impossible. A suggestion has been made that each lane should be wider than 20 feet in order to give a greater freedom of movement. It is the author's opinion that if this were done there might be a risk of three cars attempting to pass where two only were intended. In the United States, where there are six-lane roads, the inner or centre pavements have been built ten feet wide, the second eleven feet wide and the outer pavements twelve feet wide. The author believes this was done in Massachusetts. In California the roads have been made eleven feet wide on the outer lane and twelve feet in the inner. Two eleven-foot lanes have also been used in other States on dual highways.

In reply to questions by F. H. Midgley, M.E.I.C., and D. S. Scrymgeour, A.M.E.I.C., concerning stop signs and lights at railway crossings the author described the methods used by the Province of Ontario. A 20-mile limit on all railway crossings is used. Busses must stop. Wig-wags have been installed with a combined automatic gate on the approaching lanes only. These have been used in the United States. A single wig-wag sometimes is obstructed by freight trains and accidents have happened. Some experimenting has been done with beams of red light across railway crossings. This has proved fairly successful.

Institute Committees for 1938

FINANCE

J. A. McCrory, *Chairman*
de Gaspe Beaubien
A. Duperron
F. Newell
J. L. Busfield

LIBRARY AND HOUSE

J. B. D'Aeth, *Chairman*
H. Massue
A. J. C. Paine
B. R. Perry
E. A. Ryan

LEGISLATION

A. Lariviere, *Chairman*
J. R. Freeman
S. Young

PAPERS

J. A. Vance, *Chairman*
H. S. Carpenter
R. L. Dunsmore
H. O. Keay
J. A. McCrory

PUBLICATION

J. L. Busfield, *Chairman*
R. W. Boyle
A. Duperron
R. H. Findlay
F. S. B. Heward

PAST-PRESIDENTS' PRIZE

J. T. Johnston, *Chairman*
G. A. Lindsay
O. O. Lefebvre
S. S. Scovil
J. J. Traill

GZOWSKI MEDAL

H. Cimon, *Chairman*
A. O. Dufresne
C. V. Johnson
L. B. Kingston
J. O. Martineau

LEONARD MEDAL

S. C. Mifflen, *Chairman*
G. V. Douglas
G. E. Cole
J. McLeish

DUGGAN MEDAL AND PRIZE

A. H. Harkness, *Chairman*
J. R. Grant
P. L. Pratley

PLUMMER MEDAL

A. Stansfield, *Chairman*

STUDENTS' AND JUNIORS' PRIZES

Zone A (Western Provinces)

H. N. Ruttan Prize

H. S. Carpenter, *Chairman*
I. C. Barltrop
R. M. Dingwall

Zone B (Province of Ontario)

John Galbraith Prize

E. V. Buchanan, *Chairman*
R. W. Boyle
O. Holden

Zone C (Province of Quebec)

Phelps Johnson Prize

(English) J. A. McCrory, *Chairman*
J. B. D'Aeth
R. H. Findlay

Ernest Marceau Prize (Province of Quebec

(French) H. O. Keay, *Chairman*
A. Duperron
K. S. LeBaron

Zone D (Maritime Provinces)

Martin Murphy Prize

R. L. Dunsmore, *Chairman*
B. E. Bayne
H. S. Johnston

BOARDS OF EXAMINERS AND EDUCATION

C. J. Mackenzie, *Chairman*
I. M. Fraser
A. P. Linton
W. E. Lovell
P. C. Perry
E. K. Phillips

INTERNATIONAL RELATIONS

J. M. R. Fairbairn, *Chairman*
E. A. Allcut
R. W. Angus
P. L. Pratley
John Murphy
F. P. Shearwood

WESTERN WATER PROBLEMS

G. A. Gaherty, *Chairman*
C. H. Atwood
Charles Camsell
L. C. Charlesworth
T. H. Hogg
O. O. Lefebvre
C. J. Mackenzie
S. G. Porter

DETERIORATION OF CONCRETE STRUCTURES

R. B. Young, *Chairman*
E. Viens, *Vice-Chairman*
G. P. F. Boese
C. L. Cate
A. G. Fleming
W. G. Gliddon
O. O. Lefebvre
J. A. McCrory
C. J. Mackenzie
J. H. McKinney
R. M. Smith

MEMBERSHIP AND MANAGEMENT

R. A. Spencer, *Chairman*
V. C. Blackett
P. H. Buchan
R. L. Dobbin
D. A. R. McCannel
R. R. Murray
B. R. Perry
P. M. Sauder
A. J. Taunton
J. A. Vance

PROFESSIONAL INTERESTS

F. Newell, *Chairman*
O. O. Lefebvre
H. W. McKiel

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."

Volume XXI April, 1938 No. 4

The New General Secretary

Leslie Austin Wright, B.A.Sc., A.M.E.I.C., has been appointed by the Council as General Secretary of The Engineering Institute of Canada, the appointment having been made on the recommendation of a special committee of Past-Presidents. The new Secretary takes office at the beginning of April.

Council's action has been rendered necessary by the fact that after serving The Institute since the spring of 1925, the Secretary has felt obliged to ask to be relieved of his official duties. After carefully considering all the known candidates eligible for the position, the committee unanimously selected Mr. Wright, and their choice, having been considered and approved by the Finance Committee, with the concurrence of the present incumbent, and having been submitted by ballot to all members of the 1937 and 1938 Councils and to the Past-Presidents, was duly confirmed at the Council meeting on March 18th.

The new General Secretary was born and educated in Toronto, graduating from the University of Toronto in 1910 in Mechanical Engineering. During his university course Mr. Wright distinguished himself in athletics, particularly on the track and in basketball; he was editor-in-chief of the tri-weekly newspaper, The Varsity, and after graduation gained further experience in journalistic work with the Mail and Empire.

Later, his professional career began with four years in the bridge department of the City Engineer's office and a year with McGregor-McIntyre on structural work. Four years of railway construction and maintenance followed with the C.P.R. engineering department, largely on grade separation; then a period of general engineering with P. Lyall & Sons and the Foundation Company of Canada; an interlude as sales engineer with the Fletcher Manufacturing Company, and a term of eleven years of structural work with Kent-McClain Limited.

Mr. Wright has been a frequent contributor to engineering and architectural magazines, mainly on constructional topics, and has lectured at McGill University in an extra-curricular course of the Faculty of Engineering. He is an Associate Member of The Institute, a Member of the Corporation of Professional Engineers of Quebec, and is now President of the Montreal Branch of the University of Toronto Alumni Association.

With such a varied experience of men and affairs, it is felt that Mr. Wright is well equipped for the many-sided activities which fall to the lot of an Institute Secretary. The younger members will appreciate his familiarity with the problems of the undergraduate and the young engineer. His experience in organization and procedure will be helpful in dealing with questions affecting the general membership and branch affairs.

In all of these matters he can confidently rely on the willing co-operation of The Institute's members and officers.

The Editorial Chair

Observant readers of The Engineering Journal will notice on this page the name of a new editor. With that officer's kind permission, the retiring editor takes this opportunity of offering the most cordial welcome to his successor in the editorial chair. The tools of the editor's trade, including the official paste pot and scissors, the capacious waste paper basket and the blue pencil, have all been handed over with due solemnity; it is hoped that they will now be wielded with an increased measure of that sympathy for authors, and consideration for readers, which the retiring editor has tried to exercise in the past.

The incoming editor needs no introduction to Institute members; to other readers, the sketch of his career which appears above will give assurance that the fortunes of The Journal are now in good hands.

The retiring editor would bespeak for his successor and the branch editors collaborating with him, the active co-operation of the membership in making The Engineering Journal fully representative of the activities of The Institute.

Honour to Whom Honour is Due

This is not the occasion to pronounce any eulogy upon the splendid service rendered The Institute by the gentleman who, on April 1st, will, at his own request, be relieved of the exacting duties of the general secretaryship.

For thirteen years Richard John Durley has with distinction, dignity and widespread approval, occupied one of the most important positions in the gift of his brother engineers. That his services were faithfully and acceptably rendered is attested by the communications which have come to the sitting President from the Past-Presidents, and from members of both the 1937 and 1938 Councils, who during recent weeks have been consulted by letter ballot regarding the critical condition of the Headquarters executive following the resignation of the Assistant Secretary, the departure of the Publications Manager of The Journal, and the urgent request, on the advice of his physicians, of the General Secretary himself for early release from his official duties.

The general membership should know that Mr. Durley's going is greatly regretted by all the Past-Presidents and by Council, and by none more sincerely than the 1938 President.

Fortunately for The Institute, during the initiatory period at least of the new incumbent, Mr. Durley's advice and assistance will be available as he has accepted the invitation of the Council to carry on as Secretary Emeritus.

Mr. Durley's many warm friends throughout organized engineering everywhere, and particularly among the twenty-five branches of The Institute, will hope that release from regular office hours and relief from the heavy responsibilities he has carried, especially in recent years, will bring him that leisure and change to which his professional work and his personal worth so well entitle him.

J. B. C.

R. J. Durley, M.E.I.C.
Secretary Emeritus

De Gaspe Beaubien, M.E.I.C.
Treasurer

L. Austin Wright, A.M.E.I.C.
General Secretary

Meeting of Council

A meeting of the Council of The Institute was held at Headquarters on Friday, March 18th, 1938, at eight o'clock p.m., with President J. B. Challies, M.E.I.C., in the chair, and twelve other members of Council present.

The Council noted with regret the death of Jules A. Duchastel, the recently appointed Treasurer, and unanimously passed the following resolution, which the Secretary was directed to forward to Madame Duchastel:—

> "The Council of The Engineering Institute of Canada, having heard with deep regret of the death of Jules Alexandre Duchastel de Montrouge, so recently appointed Treasurer of The Institute, desires to record the loss sustained by The Institute, the engineering profession in Canada, and the public to whose service Mr. Duchastel devoted so much effort.
>
> The Council also begs to extend to Mme. Duchastel and members of the family the most sincere condolence with them in their bereavement."

It was unanimously resolved that de Gaspe Beaubien, M.E.I.C., be appointed Treasurer of The Institute.

The President reported as to the action taken regarding the changes in the executive staff at Headquarters rendered necessary by the recent resignation of the assistant secretary, Mr. Plow, the departure of the publications manager, Mr. Sheppard, and the retirement of Mr. Durley from the general secretaryship. As a result of careful consideration by a special committee of past-presidents convened to consider the situation it had been unanimously decided to recommend L. Austin Wright, A.M.E.I.C., for the position of general secretary. This selection, having been duly considered and approved by the Finance Committee, was submitted by letter ballot to all members of the Councils of 1937 and of 1938 and to the past-presidents, and received their approval. As a result of this vote the position of general secretary had been offered to and accepted by Mr. Wright.

After discussion it was unanimously resolved to appoint Mr. Wright as general secretary of The Institute, the appointment to take effect on April 1st.

Mr. Busfield, chairman of the committee appointed to report upon the publications of The Institute, presented a preliminary progress report outlining the changes in The Engineering Journal which the committee were prepared to recommend as a result of the replies to the questionnaire which had been sent out to the general membership. Mr. Busfield proposed that the committee's present report should be circulated to members of Council for their study, and that later a further questionnaire should be submitted to the membership. The report was received and the committee was authorized to proceed in accordance with these suggestions.

Certain changes in the membership of The Institute's Committee on Professional Interests and the Committee on Membership and Management were noted and approved.

Regarding the proposed agreement with the Nova Scotia Professional Association, the President reported that a revised draft had been approved by The Institute's legal advisers and had been sent to Nova Scotia for consideration by the joint committee there. As a result, certain changes had been suggested in one of the sections. In accordance with the President's report Council approved of the new section which had been forwarded from Nova Scotia, this agreement, with the new section, being now in the form which meets the views of the Council of The Institute and of the joint committee in Nova Scotia. It was pointed out that to become effective it was still necessary to take a ballot of members of Council and also of corporate members of The Institute within the province of Nova Scotia. The President and Secretary were directed to proceed accordingly, in the hope that all necessary formalities would be completed before the next meeting of Council on April 22nd.

Mr. Newell, as chairman of the Committee on Professional Interests, reported on the recent information which he had obtained from Professor Spencer respecting the progress of the negotiations in Saskatchewan.

Consideration was given to the possibility of holding a special meeting of Council in Halifax during the President's visit to the Maritimes, at which time it is hoped that the signature of the agreement between The Institute and the Professional Association will take place. It was decided that it would be very desirable to hold such a Council meeting.

The report of the Finance Committee was considered, and it was noted with approval that expenditures and receipts were running close to the budgeted amounts. The resignations of six Associate Members and three Students were accepted; one reinstatement was effected, and a number of special cases were dealt with.

The report of the scrutineers of the ballot for the proposed new Section 76 of the By-laws was presented and accepted. It indicated an overwhelming majority in favour of the new Section 76, and accordingly the new By-law was declared to have carried. The General Secretary was instructed to advise the secretaries of all the Provincial Associations of this significant endorsation by the corporate membership of The Institute of the principle of closer co-operation with the Provincial Associations.

The President drew attention to Subsection (*b*) of section 75 of the By-laws providing for the rewording and rearranging of the by-laws on the initiative of Council. It was unanimously resolved that Mr. Durley be asked to undertake the preparation of revised versions of such by-laws as appear to require clarification or simplification, and make suggestions to Council as to these, and as to their re-arrangement.

At the suggestion of Mr. Viens it was unanimously resolved to appoint H. L. Seymour, M.E.I.C., to represent The Institute with a watching brief at a meeting which it is proposed to hold in Ottawa with a view of urging the House of Commons to extend existing Housing Legislation so that it will more adequately provide for low rent housing projects. Mr. Seymour was asked to report to the Council regarding the proceedings at this meeting.

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

Elections		*Transfers*	
Member	1	Associate Member to Member	2
Associate Members	5	Junior to Associate Member	2
Junior	1	Student to Associate Member	5
Affiliate	1	Student to Junior	16
Students admitted	20		

The Council rose at eleven twenty-five p.m.

Result of the Ballot for the Introduction of a New Section (76) of the By-laws

This proposal, put forward by Council for the purpose of empowering Council to enter into certain agreements with the Provincial Associations of Professional Engineers, was sent out to ballot on February 15th, and has now been approved by the membership of The Institute.

The report of the scrutineers appointed by Council to canvass this ballot was submitted and accepted at the Council meeting on March 18th. In it the scrutineers certify the following results:

Ballots received	1,581
Ballots rejected	65
Ballots accepted	1,516
Votes in favour	1,482
Vote against	34

According to the by-laws two-thirds of the accepted ballots are required for a favourable vote, or 1,011.

* * *

Accordingly the new By-law takes effect immediately; it reads as follows:

"*Section 76.* The council may co-operate with any association or corporation of professional engineers constituted by an Act of any Province of the Dominion of Canada (hereinafter referred to as "the Association") in furtherance of the mutual interests of the members of the Institute and of the Association. To this end, the council may, notwithstanding the foregoing By-laws, enter into an agreement with the Association regarding—

(*a*) The admission and classification as members of the Institute (in accordance with the foregoing By-laws insofar as the council in its discretion deems advisable) of applicants for membership in the Institute who are members of the Association;

(*b*) The amount, if any, and method of collection of entrance fees payable by applicants for membership in the Institute who are members of the Association;

(*c*) The amount and method of collection of annual fees payable by members of the Institute who are also members of the Association;

(*d*) Provision for the termination of the said agreement;

(*e*) Any other provisions necessary for the carrying out of the said agreement.

To become effective, the said agreement, after publication in the Journal of the Institute, must be sanctioned by—

(1) An affirmative vote of two-thirds of the letter-ballots cast by the members of council; and

(2) An affirmative vote of a majority of all valid letter-ballots cast by the corporate members of the Institute resident within the Province of the Association."

Proposed Agreement Between The Institute and The Association of Professional Engineers of Nova Scotia

The proposed agreement printed below is in the form recommended by accredited representatives of the Council of The Institute and of the Association of Professional Engineers of Nova Scotia.

It is now published in The Journal pursuant to the new By-law No. 76, which is now in effect, having been approved on March 18th, 1938, by the corporate members of The Institute.

The executive committees of the Halifax and Cape Breton Branches of The Institute have approved of this agreement.

MEMORANDUM OF AGREEMENT made in duplicate at the City of Montreal, in the Province of Quebec, this day of 1938,

BY AND BETWEEN

THE ENGINEERING INSTITUTE OF CANADA having its Head Office at the City of Montreal, in the Province of Quebec, hereinacting by its President and Secretary, duly authorized for the purpose hereof by a resolution of its Council passed at a Meeting duly called and held on the day of 1938, hereinafter called "the Institute,"

Party of the First Part

and

THE ASSOCIATION OF PROFESSIONAL ENGINEERS OF NOVA SCOTIA having its Head Office at the City of Halifax, in the Province of Nova Scotia, hereinacting by its President and Registrar, duly authorized for the purpose hereof by a resolution of its Council passed at a Meeting duly called and held on the day of 1938, hereinafter called "the Association,"

Party of the Second Part.

WHEREAS it is desirable in the interest of the Engineering Profession that there be close co-operation between the Institute and the Association; and

WHEREAS such close co-operation will be promoted if, so far as is practicable, there is effected:

(*a*) A common membership in the Province of Nova Scotia of the Institute and the Association;

(*b*) A simplification of existing arrangements for the collection of fees;

(*c*) A reduction in the total fees payable by those who are members of both the Institute and the Association;

NOW, THEREFORE, the parties hereto agree with each other as follows:

1. All persons who are, on the date of this Agreement or who may be hereafter during the term of this Agreement, registered as Professional Engineers under the provisions of Chapter 186 of the Statutes of the Province of Nova Scotia for the year 1920, and subsequent amendments thereto, and who are not on the date of this Agreement, nor on the date of such future registration, as the case may be, Corporate Members of the Institute, shall under the provisions of this Agreement automatically become Corporate Members of the Institute on and after said date, subject to the terms and conditions of this Agreement, as hereinafter set forth.

2. Registered members of the Association who at the date of this Agreement have reached the age of thirty-five years shall be accorded the status of "Member" (M.E.I.C.) in the Institute and those under thirty-five years of age shall be accorded the status of "Associate Member" (A.M.E.I.C.) in the Institute, and after reaching the age of thirty-five years shall be automatically transferred to the status of "Member."

3. Any person registered as a Professional Engineer in the Association subsequently to the date of this Agreement and who is not a Corporate Member of the Institute at the date of said registration shall be accorded the class of membership in the Institute warranted by the age, experience and professional qualifications of such person according to the By-laws of the Institute and the decision of the Council of the Institute. Any person over thirty-five years of age classed as "Associate Member" (A.M.E.I.C.) may, if dissatisfied with such classification, apply to the Council of the Institute for the status of a Member (M.E.I.C.) and shall be entitled to have his classification and qualifications for same reviewed by the Council of the Institute.

4. Registered members of the Association shall not be required to pay the entrance or transfer fees of the Institute.

5. In lieu of the ordinary membership fees of the Institute the Association shall pay to the Treasurer of the Institute the sum of six dollars ($6.00) per annum for each member of the Association having the Institute classification of "Member" (M.E.I.C.) and the sum of five dollars ($5.00) per annum for each other member of the Association. These fees shall entitle the members of the Association to all the privileges of the Institute membership and shall include the annual subscription to the Institute Journal.

These fees shall be due and payable to the Institute by the Association annually in advance on the First day of January of each year.

The provisions of this Section 5 of this Agreement shall not be effective until the First day of January, 1939.

6. It is agreed that the Branches of the Institute in Nova Scotia shall continue actively to function as such during the term of this Agreement, and to enable such functioning there shall be set up and continued from year to year during the term hereof a Committee of five members to be known as the Joint Finance Committee; two of said members shall be appointed annually by the Council of the Institute; two members shall be appointed annually by the Council of the Association and the fifth member, who shall be a Corporate Member of the Institute and a Registered Professional Engineer, shall be appointed annually by the four members aforesaid and the said fifth member shall be Chairman of the Committee. In case the four members aforesaid fail to appoint the fifth member, the said fifth member shall be appointed by the President of the Engineering Institute of Canada. The said Committee shall decide annually the sums of money to be paid by the Association to the Branches of the Institute for their operation. The Committee is further empowered to determine the time and manner of such payments and the Association shall make payment to the Branches in accordance with the Committee's decision.

7. The term of this Agreement shall be the period commencing on the date hereof and ending on the 31st day of December, 1942, on which date this Agreement shall terminate provided either party has given to the other a notice of termination at least six months prior to the 31st day of December, 1942, and if no such notice is given this Agreement shall continue after the 31st day of December, 1942, from year to year but may be terminated at the end of any calendar year by either party giving notice in writing to the other of such termination at least six months prior to the end of any calendar year.

8. The terms and provisions of this Agreement may be amended by mutual agreement, in writing, between the parties hereto, duly executed by them.

9. This agreement and the terms and provisions thereof shall not be applicable to the Institute members who are not registered with the Association.

IN WITNESS WHEREOF these presents have been duly executed on behalf of the parties hereto on the date and at the place first above written.

IN THE PRESENCE OF: THE ENGINEERING INSTITUTE OF CANADA

.... *President*

.... *Secretary*

THE ASSOCIATION OF PROFESSIONAL ENGINEERS OF NOVA SCOTIA

.... *President*

.... *Registrar*

Prize of $25.00

The Publication Committee offers a prize of $25.00 for the best design submitted by any member of The Institute, for a new cover for The Engineering Journal. Provision should be made in the design for an illustration, and the design should be sufficiently flexible to provide for a horizontal or vertical illustration, or perhaps even over the whole page.

This competition will close on June 1st, 1938. Designs should be submitted to the Chairman of the E.I.C. Publication Committee, 2050 Mansfield Street, Montreal, from whom further particulars can be obtained by prospective competitors.

OBITUARIES

Major Frederick Demille Burpee, Affil.E.I.C.

Members of The Institute will learn with regret of the death of Major Frederick Demille Burpee, Affil.E.I.C., in Ottawa on February 25th, after a lengthy illness. Major Burpee was born in Ottawa on April 25th, 1876, and at the age of 17 entered the Ottawa Electric Railway Company. His promotion in this company raised him to the position of vice-president and general manager in 1924 and this position he held until his death. Major Burpee was director of several companies, including the Capital Trust Corporation, and held a foremost position in the industrial and public life of Ottawa. During the Great War, he was engaged on the British front constructing standard and narrow gauge railways.

Major Burpee joined The Institute as an Affiliate in 1922.

Richard LaFontaine Haycock, M.E.I.C.

Richard LaFontaine Haycock, M.E.I.C., general engineer with J. R. Booth Limited, died on February 1st, 1938, at his home in Ottawa, after a brief illness. Mr. Haycock was born in Ottawa on December 22nd, 1874, where he attended Lisgar Collegiate Institute, later proceeding to McGill University, from which he graduated in 1897 with the degree of B.Sc. in Mechanical Engineering.

After graduation Mr. Haycock worked for short periods with the Canadian Atlantic Railway at Ottawa and the Canadian Pacific Railway in Winnipeg. Later he was employed with the Lackawanna Steel Company, Buffalo, and with the International Marine Signal Company, Ottawa, for which company he spent some time installing buoys in the harbour of Rio de Janeiro.

From 1910 to 1914 Mr. Haycock was associated with the late Mr. Noulan Cauchon as partner in the firm of Cauchon and Haycock. During this period he was retained as consulting engineer on many governmental and private projects in various parts of Canada. In 1914 Mr. Haycock was appointed by the Ottawa City Council as acting waterways and sewage engineer. In 1916 Mr. Haycock became superintendent of transportation with the Algoma Steel Corporation, Sault Ste. Marie, Ontario. In 1918 he joined the General Supply Company as a mechanical engineer. Later he entered private practice and to 1932 was connected with the Fraser-Brace Engineering Company.

For the past six years Mr. Haycock has been general engineer with J. R. Booth Limited and was in charge of all pulp wood handling machinery throughout the plant.

Mr. Haycock joined The Institute in 1916 as an Associate Member, becoming a Member in 1919.

David Wentworth Robb, M.E.I.C.

Members of The Institute will learn with regret of the death of David Wentworth Robb, a Life Member of The Institute and a prominent Nova Scotia industrialist. Mr. Robb was born on May 9th, 1856, in Amherst, Nova Scotia. After his early education in the Amherst schools, he was apprenticed from 1874 to 1877 in the foundry and machine shops of Alex Robb, Amherst. In 1877 he became superintendent in this company and acted in this capacity until 1879 when he became senior acting partner of the firm of A. Robb and Sons. In 1890 Mr. Robb came to fill the position of president of the firm Robb Engineering Company Limited. This company, founded by Mr. Robb's father, is now a subsidiary of Dominion Bridge Company, under the name of the Robb Engineering Works.

Mr. Robb was a former Mayor of Amherst and at one time president of the Amherst Board of Trade. In 1931 he was Maritime representative on the Dominion Government Commission which made an adverse report on the construction of a canal across the Chignecto isthmus connecting New Brunswick and Nova Scotia.

Mr. Robb joined the Canadian Society of Civil Engineers as a Member in 1894, and in March 1936 was made a Life Member of The Engineering Institute of Canada.

Charles Stephen, A.M.E.I.C.

The death of Lieutenant-Commander Charles Stephen, R.N. (Ret.), A.M.E.I.C., technical adviser of the R.C.M. Police, which occurred in Ottawa on March 14th, 1938, will be much regretted by members of The Institute. Commander Stephen was born in Liverpool, England, on August 9th, 1880. After attending Liverpool Technical College and Liverpool University he began his engineering training with Messrs. Wannup and Davies, engineers, Liverpool, remaining with them for 12 months. The next three years he spent erecting and repairing engines for the Cunard Engine Works and the following three and one-half years gaining engineering experience at sea and in Brazil for the Booth Steamship Company. Further experience in marine engineering was obtained as junior engineer on the S.S. *Planet Neptune* and later, on various ships of the White Star Line, and with Messrs. Harland and Wolff in Belfast, supervising construction on the S.S. *Olympic*.

Commander Stephen came to Canada and in 1911 was appointed superintendent engineer at Macdonald College, Ste. Anne de Bellevue, P.Q. When War broke out he reported for service in the Royal Navy, serving later as Engineer Lieutenant-Commander on H.M.S. *Glorious*. On his return to Canada in 1919, he was made resident engineer and chief engineer and superintendent at Macdonald College, resigning that position in 1930 when he was appointed to a newly created office of the Federal government, known as chief engineer and technical adviser, Department of Inland Revenue. This position Commander Stephen filled most ably until 1932 when he accepted the position which he held at the time of his death. In the capacity of technical adviser to the Royal Canadian Mounted Police, his wide experience in marine engineering proved of great assistance to the marine section of that famous organization.

Lieut.-Commander Stephen became an Associate Member of The Institute in 1916.

John Alexander Low Waddell, D.Sc., LL.D., M.E.I.C.

Dr. J. A. L. Waddell, a Life Member of The Institute, died on March 3rd, 1938, in New York. Dr. Waddell was born in Port Hope, Ontario, on January 15th, 1854, and there attended the public schools and from 1865-70 Trinity College School. In 1875 he graduated from Rensselaer Polytechnic Institute at Troy, N.Y., and after filling various positions went to Japan where he taught in the Imperial University at Tokio from 1882 to 1886. On his return to the United States he established an office in Kansas City, Mo., where his headquarters remained until 1920 when he came to New York.

Dr. Waddell enjoyed an international reputation as an expert in bridge design, having to his credit in Canada and the United States hundreds of bridges of all kinds. He also designed and constructed many important bridge structures in Mexico, Japan, New Zealand, Russia and Cuba.

Dr. Waddell was decorated by the Chinese, Italian, Japanese and Russian Governments for services he had rendered in those countries. Besides these honours he was the recipient of numerous others in Canada and the United States. He was awarded the first Clausen Gold Medal by the American Association of Engineers in 1931, for "having in the preceding half century done the most to advance the interests of the engineering profession in the United States."

Dr. Waddell joined the Canadian Society of Civil Engineers in 1903 as a Member, becoming a Life Member in 1935, of The Engineering Institute of Canada.

PERSONALS

De Gaspe Beaubien, M.E.I.C., the newly appointed treasurer of The Engineering Institute of Canada, consulting engineer of De Gaspe Beaubien and Company, is a member of the Electrical Commission of Montreal, director of Beaubien Limitée, President of David et Frère, Limitée, and chairman of the Montreal Housing Commission. Mr. Beaubien was born in Outremont on May 18th, 1881, the son of the Honourable Louis Beaubien of Montreal. Upon his graduation from McGill University in 1906 with the degree of B.Sc., Mr. Beaubien became demonstrator at that University. In 1908 he entered the Westinghouse Electric and Manufacturing Company, at East Pittsburgh, having obtained experience with the Montreal Light, Heat and Power as early as 1903. From 1908 until 1922 he was in practice as consulting engineer in his own name, then from 1922 until 1929 under the name of Beaubien, Busfield and Company.

Mr. Beaubien joined The Institute (then the Canadian Society of Civil Engineers) as a Student in 1903, becoming an Associate Member five years later, and being elected a Member in 1921.

R. C. C. Brown, S.E.I.C., has accepted a position as Junior Aeronautical Engineer in the Department of National Defence at Ottawa. Mr. Brown graduated from Queen's University, Kingston, Ont., in 1933 with the degree of B.Sc., and prior to his change of position was with the Fairchild Aircraft Company, Longueuil, Que.

Capt. John A. Creasor, M.C., A.M.E.I.C., formerly construction superintendent, Canada Cement Company, Belleville, Ont., is now with the Canadian Refractories Limited, at Kilmar, Que. Capt. Creasor graduated from McGill University in 1914 with the degree of B.Sc. and then served with the allied forces overseas.

F. Stewart Gumley, A.M.E.I.C., has been appointed manager of the structural department of Burn and Company Limited, Howrah Ironworks, Howrah, India. This company is now constructing a cantilever bridge over the Hooghly river. The main span of the bridge is 1,500 ft. with a cantilever span of 564 ft. Mr. Gumley was formerly designing engineer with Martin and Company at Calcutta, India, in charge of design and construction of bridges, buildings and engineering structures in structural steel. Prior to this he was works manager with J. and J. Lawrence Limited, in Edinburgh, Scotland, and at one time with the Western Bridge Company Limited, Vancouver, B.C.

F. E. Winter, A.M.E.I.C., formerly technical assistant of the Canadian Electrical Association, is now with the Montreal Engineering Company. Mr. Winter graduated from McGill University with the degree of B.Sc. in 1926.

John Kazakoff, S.E.I.C., has recently received an appointment with the Bolivian Power Company, La Paz, Bolivia. Since graduating from McGill University in 1935 with the degree of B.Eng., Mr. Kazakoff has been with the Canadian Ingersoll Rand Company Limited, Sherbrooke, Que.

Paul F. Sise, M.E.I.C.

Paul F. Sise, M.E.I.C., president of the Northern Electric Company Limited, Montreal, was elected director of the Shawinigan Water and Power Company, March 16th. In addition to being president of the Northern Electric Company Limited, Mr. Sise is director of the Royal Bank of Canada, of the Bell Telephone Company of Canada, Montreal Trust Company, Lake of the Woods Milling Company, Dominion Engineering, Industrial Acceptance Corporation, Amalgamated Electric Corporation, Belding-Corticelli, Limited, and Sherwin-Williams Company of Canada, Limited. After graduating from McGill University in 1901 with the degree of B.Sc., he was connected with the Westinghouse Company in Pittsburgh, New York and Montreal until 1904, when he entered the Northern Electric and Manufacturing Company as secretary-treasurer. In 1910 he was appointed managing director of the company. When the Northern Electric and Manufacturing Company was amalgamated with the Imperial Wire and Cable Company in 1914, he became vice-president and general manager of the new organization. He was appointed to his present position in 1919.

W. G. Mitchell, M.E.I.C., has recently established a consulting office at 680 Sherbrooke Street West, Montreal.

Mr. Mitchell graduated from McGill University in Mining Engineering in 1913 and spent a year in post-graduate research on ore dressing problems, qualifying for the degree of M.Sc. in 1914. He was for a short period associated with the Dominion Government Forest Products Laboratories of Canada from date of their establishment in Montreal and later (1916-1918) spent two years in varied engineering work in Russia, Siberia and Manchuria.

In 1919-1920 he made an extensive survey of technical and economic conditions of the pulp and paper industry throughout Europe for Canadian interests and on returning to Canada in 1921 joined the staff of Price Brothers and Co. Ltd. as assistant to the president, shortly thereafter assuming charge of the Company's pulp and paper mills and power plant operations in the Lake St. John District. During the period 1922-1930 he was closely associated with a large programme of expansion carried out by the Price Company, quadrupling its newsprint manufacturing capacity. He withdrew from the organization of Price Brothers and Co. Ltd. in 1932 and has subsequently been engaged in private practice in the southern United States and, since 1934, in Canada, acting for a time as technical adviser to the Canadian Pulp and Paper Association on matters relating to research and development policy.

Mr. Mitchell joined The Engineering Institute as Member in May, 1920, acted for two years as Chairman of the Saguenay Branch from the date of its inauguration, and later (1927-1930) served for four years as Vice-President of The Institute for Zone C (Quebec).

Mr. Mitchell's activities in recent years have been concerned largely with the economic and technical aspects of industrial development in relation to investment and management and it is to this field that his practice will be principally devoted.

H. L. Swan, M.E.I.C., has relinquished the appointment of district engineer, Department of Public Works, Province of British Columbia, and has been appointed administrator of the highway traffic branch of the Provincial Public Works Department. His new duties include the regulation and control of truck and bus traffic in the province, particularly in connection with the licensing of vehicles for various purposes as distinguished from the police regulation of traffic from a safety or ordinary motor vehicle licence point of view. It is gratifying to note the appointment of an engineer to this administrative post. Mr. Swan will serve as chairman of the Advisory Board which deals with highway traffic in this manner. The change in policy of the Provincial Government has been made necessary by the increasing importance of the work.

Fraser F. Fulton, A.M.E.I.C., has been appointed general sales manager of the Special Products Division of the Northern Electric Company Limited, Montreal. Since 1928 when he graduated from McGill University with the degree of B.Sc. in Electrical Engineering, Mr. Fulton has been with the sales department of the Northern Electric Company.

Gordon McL. Pitts, A.M.E.I.C.

Gordon McL. Pitts, B.Sc., B.Arch., M.Sc., F.R.A.I.C., A.M.E.I.C., was elected a Fellow of the Royal Architectural Institute of Canada during its Annual Meeting in Montreal in February. Mr. Pitts is a member of the firm of Maxwell and Pitts, architects, Montreal, and was the very active chairman of the Committee on Consolidation of The Institute.

Frank Tempest, A.M.E.I.C., has returned from South America where he was connected with the Tropical Oil Company as refinery engineer at Barranco, Bermeja, Colombia. He is now with Imperial Oil Limited, Calgary. Prior to going to South America in 1931 he held the position of construction engineer and plant foreman with the Royalite Oil Company at Okotoks, Alta.

ELECTIONS AND TRANSFERS

At the meeting of Council held on March 18th, 1938, the following elections and transfers were effected:

Member

GRANT, William Roy, B.Sc. (Civil), (McGill Univ.), president, Barnett-McQueen Co. Ltd., Fort William, Ont.

Associate Members

CARTER, Thomas Allen, B.Sc. (Elec.), (Queen's Univ.), elect'l. engr., Saguenay Power Co. Ltd., Arvida, Que.

LEEBOSH, Ilja, Mech. Engr., (Polytech. Inst., Coethen, Germany), engr., Canadian Bridge Co. Ltd., Walkerville, Ont.

McKINNEY, John E., divn. plant engr., Bell Telephone Company of Canada, Toronto, Ont.

McMANAMNA, Theodore Louis, B.Sc. (C.E.), (Univ. of Kansas), vice-president and mgr., International Water Supply Ltd., Fort Erie North, Ont.

TATE, George Harold, B.A.Sc., (Univ. of Toronto), power engr., Canadian Kodak Co. Ltd., Toronto, Ont.

Junior

SKERRY, Francis Stephen, B.Eng. (Elec.), (N.S. Tech. Coll.), 172 Windsor St., Halifax, N.S.

Affiliate

ALLWRIGHT, Ernest Gilbert, (Montreal Tech. Inst.), engr., Aluminum Company of Canada Ltd., Arvida, Que.

Transferred from the class of Associate Member to that of Member

FARROW, Richard Charles, district engr., Water Rights Branch, Prov. of B.C., Victoria, B.C.

KETTERSON, Andrew Robert, Major, D.S.O., (Royal Tech. Coll., Glasgow), engr. of bridges, C.P.R., Montreal, Que.

Transferred from the class of Junior to that of Associate Member

McDONALD, Donald J., B.Sc., (Queen's Univ.), foreign wire relations engr., Eastern area, Bell Telephone Company of Canada, Montreal, Que.

PATTERSON, Ian Stewart, B.Sc. (E.E.), (N.S. Tech. Coll.), industrial control specialist, Can. Gen. Elec. Co. Ltd., Montreal, Que.

Transferred from the class of Student to that of Associate Member

BENNETT, Robert Douglas, B.Eng., M.Sc., Ph.D., (McGill Univ.), head of organic dept., J. T. Donald & Co. Ltd., Montreal, Que.

BURRI, Henry William, B.Eng. (Mech.), McGill Univ., proposition engr., Mathews Conveyer Co. Ltd., Port Hope, Ont.

COLLISON, Lloyd S., B.A.Sc., (Univ. of Toronto), filtration plant operation, City of Hamilton, Ont.

DILL, Edwin Willson, B.A.Sc., (Univ. of Toronto), designing dftsman., The Carborundum Company, Niagara Falls, N.Y.

LYON, Grant MacKenzie, B.Sc. (C.E.), (Univ. of Man.), engr., Red Lake Gold Shore Mines Ltd., Red Lake, Ont.

TRUDEL, Louis, B.A.Sc., C.E., (Ecole Polytechnique, Montreal), Southern Canada Power Co. Ltd., Montreal, Que.

Transferred from the class of Student to that of Junior

BENJAFIELD, Philip Grant, B.Sc., (Queen's Univ.), instr'man., International Nickel Company, Copper Cliff, Ont.

BONNELL, Alexander R., B.Sc. (C.E.), (Univ. of N.B.), instrumentman, highway divn., N.B. Dept. of Public Works, Fredericton, N.B.

CRAIG, William Royce, B.Sc. (E.E.), (Univ. of Alta.), engr., Canadian Sugar Factories, Picture Butte, Alta.

CUNNINGHAM, Donald David MacC., B.Sc. (E.E.), (Univ. of N.B.), test engr., N.B. Electric Power Commission, Newcastle Creek, N.B.

DONOHOE, Gordon Miller, B.Sc., (Univ. of N.B.), 102 Guildford St., Saint John West, N.B.

HAYES, Herman Rutherford, B.Sc. (Civil), (Univ. of Alta.), industrial engr., Burns & Co. Ltd., Edmonton, Alta.

HURDLE, Harold Lancelot, B.Sc., (Univ. of Alta.), ap'tice. engr., Calgary Power Co. Ltd., Calgary, Alta.

JARVIS, Gerald Walter, B.Sc., (Queen's Univ.), dftsman., McColl-Frontenac Oil Co. Ltd., Montreal, Que.

LAWSON, George Whytall, B.A.Sc., (Univ. of Toronto), designer and dftsman., Dufferin Paving and Crushed Stone Ltd., Toronto, Ont.

PHILLIPS, Frederick Rene, B.Eng. (Civil), (McGill Univ.), asst. to J. S. Hewson, A.M.E.I.C., engr. and contractor, Montreal, Que.

SCHNYDER, Max, B.Eng. (Mech.), (McGill Univ.), dftsman., for John Stadler, M.E.I.C., Montreal, Que.

SHARP, William Gray, B.Sc. (E.E.), (Univ. of Alta.), installn. and service engr., Sharp's Theatre Supplies, Calgary, Alta.

SMITH, Owen Leonard, (N.S. Tech. Coll.), Canadian Comstock Company, Arvida, Que.

STIERNOTTE, Alfred, B.Sc. (Chem.), (Univ. of Alta.), lab. asst., Royalite Oil Co. Ltd., Turner Valley, Alta.

TAYLOR, Frederick Wm., B.A.Sc., (Univ. of Toronto), asst. to E. A. Cross, M.E.I.C., Consltg. Engr., Toronto, Ont.

THOMAS, James Macleod, B.Sc. (E.E. and C.E.), (Univ. of N.B.), res. engr., highway divn., N.B. Dept. of Public Works, Fredericton, N.B.

Students Admitted

BELLE-ISLE, Jacques G., (Ecole Polytechnique, Montreal), 3872 Berri St., Montreal, Que.

BROWN, Lindsay H., (R.M.C.), Britannia Heights, Ont.

CARRIERE, Murray Francis, B.A.Sc., (Univ. of Toronto), 299 Evelyn Ave., Toronto, Ont.

COUTURE, George Albert Elwood, (R.M.C.), 170 St. Louis Road, Quebec, Que.

DUPUY, Harry E. G., (McGill Univ.), 4051 Grey Ave., Montreal, Que.

ELLIOTT, Clarence W., (Univ. of Alta.), Edmonton, Alta.

FORSTER, Alfred Manning, (N.S. Tech. Coll.), 88 Walnut St., Halifax, N.S.

GODARD, Hugh Phillips, M.A.Sc., (Univ. of B.C.), c/o Dept. of Cellulose Chemistry, McGill University, Montreal, Que.

HEATH, Frederick Johnston, (Univ. of Alta.), 10122–124th St., Edmonton, Alta.

HOLE, Jack H., (Univ. of Alta.), 9421–108a Avenue, Edmonton, Alta.

JOHNSON, Frederick Paul, (Univ. of Alta.), 9924–87th Ave., Edmonton, Alta.

KOBYLNYK, Demetrius Frederick, (Univ. of Alta.), 11046–88th Ave., Edmonton, Alta.

MACKENZIE, Robert Kenneth, (R.M.C.), Kingston, Ont.

McCALLUM, Francis, (Univ. of Sask.), 801 Colony St., Saskatoon, Sask.

SENKLER, Edmund John, B.A.Sc., (Univ. of B.C.), 3637 University St., Montreal, Que.

SLATER, Stewart, (Grad. R.M.C.), 358 Brock St., Kingston, Ont.

STEVENSON, Herbert Irving, (Univ. of Man.), 73 Ethelbert St., Winnipeg, Man.

SUTHERLAND, Donald Henry, (Univ. of N.B.), Borden, P.E.I.

SYLVESTER, Jack Douglas, (Univ. of Alta.), 7935–111th St., Edmonton, Alta.

WARD, Kenneth Roy, (R.M.C.), 476 Victoria St., Kingston, Ont.

ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

American Institute of Consulting Engineers: Constitution and By-Laws and List of Members, March 1st, 1938. Proceedings of the Annual Meeting, January 17th, 1938.

Institution of Mechanical Engineers: Proceedings, Vol. 136, June-November 1937.

Mysore Engineers Association: Minutes of Proceedings of Twenty-Ninth Annual Session. Vol. XV, Nos. 3 and 4, June to December 1937.

Society of Engineers: Transactions, 1937.

Reports, etc.

American Society for Testing Materials: Symposium on Consistency, presented at Fortieth Annual Meeting, June 29th, 1937.

Canada Department of Labour: Twelfth Report on Organization in Industry, Commerce and the Professions in Canada in 1937.

Canada Department of Trade and Commerce Bureau of Statistics, Transportation and Public Utilities Branch: Statistics of Steam Railways of Canada, 1936. Ottawa, 1938.

Canadian Government Purchasing Standards Committee: Tentative Specifications: Low Titre Chip and Powdered Soap for Laundry Purposes; Schedule of Methods of Testing Textiles; Burned Fireclay Brick for Stationary Boiler Service. February 1938.

Electrochemical Society: Preprint 73-5 to 73-19, Anode and Cathode Weight Losses in Galvanic Corrosion; A Table of Electrochemical Equivalents; Transient Voltages at the Beginning of Discharge of a Storage Cell and their Relation to the Actual and Transfer Resistance of the Positive Plate; Motor-Electrolytic Potential; The Structure and Hardness of Electrolytic Chromium; A Study of Reaction Products and Mechanism in the Electrolytic Reduction of Ethyl Iodine; The Electrical Charges of Aqueous Colloidal Systems; The Causes of Porosity in Electrodeposited Coatings, Especially of Nickel on Steel; Alkaline Plating Baths Containing Organic Amines; The Chemistry of Bleaching Chemical Wood Pulps; Comparisons of Electro-Osmosis, Electrophoresis, and Streaming Potential and Their Theoretical Significance; Alkaline Plating Baths Containing the Ethanolamines; The Electrodeposition of Manganese from Aqueous Solutions; Chemical Modifications of Cellulose; The Application of Osmosis to the Recovery of Caustic Soda Solutions Containing Hemicellulose in the Rayon Industry.

Institution of Civil Engineers: Engineering Abstracts, Section 1, Engineering Construction; Section 2, Mechanical Engineering; Section 3, Mining Engineering. Vol. 1, No. 2, February 1938.
New York, Port of: Seventeenth Annual Report, December, 1937.
Ontario Hydro-Electric Power Commission: List of Electrical Equipment Approved by the Commission. 4th ed. August 1937.
Purdue University: Automatic Gas Fired, Storage Type Water Heaters, J. M. Krappe. (Engineering Experiment Station, Lafayette, Ind., Engineering Bulletin, Vol. XXI, No. 5.)
Quebec Bureau of Mines: Annual Report for the year 1935, Pt. D. Quebec, 1936.
Underwriters' Laboratories, Inc.: Report on Steel Pipe Lines for Underground Water Service (Special Investigation 888, July 22nd, 1936).
U.S. Department of Commerce: Report of the Twenty-Seventh National Conference on Weights and Measures. (Miscellaneous Publication M 159.)
U.S. Department of the Interior Bureau of Mines: Properties of Typical Crude Oils from Fields of the Eastern Hemisphere; Contributions to the Data on Theoretical Metallurgy, VIII The Thermodynamic Properties of Metal Carbides and Nitrides; Quarry Accidents in the United States during the year 1935. (Bulletins 401, 407, 408.)
U.S. Treasury Department Public Health Service: Experimental Studies of Water Purification. Washington, 1938.
University of Illinois: Solution of Electrical Networks by Successive Approximations, Laurence L. Smith. (Engineering Experiment Station, Bulletin Vol. XXXV, No. 27.)
University of Washington: Moment Equations, a Method of Analysis for Continuous Beams and Rigid Frames. (Engineering Experiment Station, Bulletin No. 92.)

BOOK REVIEW

Theory of Statically Indeterminate Structures

By W. M. Fife and J. B. Wilbur. McGraw-Hill, New York, 1937. 248 pp., 6 by 9 inches, $3.50.

Reviewed by S. R. Banks, A.M.E.I.C.*

"Only a knowledge of the basic principles of stress analysis can serve as a safe basis for departure from methods more rigorously correct . . . If approximate methods are to be introduced, they must be carefully studied in order to ascertain that they may be safely and properly applied to a given problem." These words of the authors, which might well be considered as their apology for the presentation of this work, constitute perhaps a timely admonition to the present-day engineer, to whom empirical and short-cut methods make an appeal that increases inevitably with the pace of modern times.

With the courage of this conviction, the authors (who are Associate Professors of Civil Engineering at Massachusetts Institute of Technology) have confined themselves to the theoretical treatment of ideal structures, developing the standard methods of analysis from the fundamental elastic laws. These latter are enunciated and explained in the first of the five chapters into which the book is cleanly and logically divided. Under the heading of "Deflections," presentation is made of some half-a-dozen ways of computing distortions of structures, and the Williot-Mohr graphical approach to the subject is dealt with lucidly. Two chapters, entitled respectively "Stress Analysis" and "Influence Lines," are devoted in their entirety to statically indeterminate structures, and in these are to be found applications of the various traditional analytical expedients. It is of interest to note, however, that the Hardy Cross method of distribution of end-moments is given an equally prominent place: and an example of its validity is provided by comparison numerically with the method of slope-deflection equations. The final chapter treats in several ways of the well-worn problem of secondary stresses in the simple truss.

Throughout the volume, definitions and explanations appear to be made with care and precision, a generous discussion, for instance, of the characteristics of determinate and indeterminate structures forming part of the discourse on "basic concepts." Attention is always drawn to the probable significance of errors arising from any particular assumption, and the limitations of the different systems of analysis are indicated. It is a feature of the book that the theory is illustrated at all stages by fully-worked numerical examples: and a series of some fifty problems is provided at the end for the reader's exercise.

The book, not unnaturally, in view of its subject and authorship, bears the academic impress, and will evidently find its greatest sphere of usefulness as a text for students specializing in structural work; though at the same time it will by no means be out-of-place in the reference library of the designing engineer.

*Assistant Engineer, Monsarrat and Pratley, Consulting Engineers, Montreal.

Air Conditioning Brings Problems to Water Men

One of the new problems confronting those concerned with city water supply is the enormous demand for water in some cities resulting from air conditioning of theatres, stores and factories. In many cities such equipment now consumes millions of gallons of water daily, often taxing the capacity of the water system. If air conditioning expands as rapidly as some expect, many cities will be forced to enlarge their plants and reach out for new sources of supply.

The Camera and Airplane in Canada

Extracts from address before the Ottawa Branch of The Institute on March 10th, 1938, by A. C. T. Sheppard, B.A.Sc., D.L.S., Bureau of Geology and Topography, Department of Mines and Resources, Ottawa, Ont.

The application of the camera and airplane to mapping in this country and the problems associated with it are distinctly those of a pioneer country. In the United States, for instance, the major problem is that of preparing detailed maps of settled country; in Canada the biggest problem is that of preparing maps showing the topography of areas hitherto unmapped and largely unsettled.

The results obtained so far in Canada have been impressive, according to Mr. Sheppard. Before 1922 approximately 240,000 sq. mi. were mapped in a more or less adequate manner, whereas now 720,000 sq. mi. are mapped, a large share of which has been by the use of air methods. The work may be divided into two parts: the flying and photographic operations, and the reduction of photographic information to map form. While there is a close relationship between the two operations, so far as government work is concerned the former lies within the province of the Royal Canadian Air Force and the latter with the technical mapping services of the Department of Mines and Resources, and the Department of National Defence. An Interdepartmental Committee on Air Surveys and Base Maps keeps the work co-ordinated and an Associate Committee on Survey Research of the National Research Council looks after research problems.

After consideration of the various types of planes available on the market, the R.C.A.F. has given preference for their photographic operations to the Northrop Delta to which can be fitted wheels, floats or skis, depending upon the nature of the area in which operations are to be carried out. For northern work in summer, floats are used on account of the multitude of water areas that provide convenient landing places.

At the conclusion of the War, the old free nose flying boats were used in Canada for photography. They had a limited range of photographic flight at an altitude of 5,000 ft., not exceeding 225 mi., which was a serious handicap to effective mapping. The change to cabin aircraft, equipped with floats, more than doubled the duration of flight and greatly improved the performance. The altitude for oblique photography was increased to 8,000 ft., and the spacing between parallel flight lines from six to eight miles. Camera mounting was also changed from the cockpit, pointing in the direction of the route, to a position inside the cabin pointing in general along the track of the aircraft.

Lines of flight are laid out in an east and west direction. For vertical photography the flying is usually at 10,000 ft., and is so arranged that one strip of photographs will overlap another without intervening gaps. The spacing for these is usually from 1¼ to 1½ mi. apart so as to give an overlap of 40 per cent if the flights are flown as projected. North and south cross flights to help "tie in" the east and west flights are made at the easterly and westerly limits of the map sheet and at suitable intervals in between. When the area is particularly hazardous the flying height for vertical photography may be increased to 12,000 or even 15,000 ft. Cameras, camera mounts, auxiliary equipment, camera film and paper used were briefly touched upon by the speaker as well as office instrumental equipment and methods of plotting.

All photographic negatives are kept by the Royal Canadian Air Force. The Department of Mines and Resources maintains an Air Photographic Library in which prints of all negatives are filed. These prints are available for use by Federal and Provincial services as well as by private organizations and individuals. By means of the index and filing system which has been adopted, complete information is readily available regarding any operation, flight, or individual photograph. The library now contains 725,000 individual index prints, an increase of 35,000 during the past year. The extent of the library's activities may be judged by the turnover of 100,000 prints sold, loaned or used in the library during the year. Of this number 40,000 were used for purely mapping purposes.

In summing up the value of some of the services rendered by air photography to Canada Mr. Sheppard stated that much interesting work is being carried out with respect to the identification of geological features and formations, and for studying physiographic problems. The Forestry Service is also developing a technique for identifying tree types and for estimating their height and from this, surprisingly accurate estimates of stands of timber are being made. Already over 100,000 sq. mi. of forests have been classified in this way, at a much lower cost than ground surveys.

The Hydrographic Service is making valuable use of air photographs in charting shore lines and in locating submerged features. The Department of Agriculture is deriving material assistance from air photography in problems connected with the drought area. Even in the field of legal surveying, the surveyor in re-establishing lost corners is able to get much evidence which when assembled is very valuable in helping to untangle many a legal mix-up.

It is hoped that eventually the whole country will be covered with maps at least of a reconnaissance nature and meanwhile rapid progress is being made with the detailed mapping in fields of economic importance.

BRANCH NEWS

Border Cities Branch

J. F. Bridge, A.M.E.I.C., Secretary-Treasurer.
F. J. Ryder, Jr.E.I.C., Branch News Editor.

The regular monthly dinner and meeting was held in the Mural Room of the Prince Edward hotel, on February 28th. Approximately forty members were present to hear the paper presented by Mr. Charles Hopper, resident engineer of C. A. Parsons and Company Limited, Newcastle-on-Tyne, England.

Prior to the presentation of the paper our branch councillor, H. J. A. Chambers, A.M.E.I.C., gave a report of the general meeting that was recently held at London, Ontario.

Boyd Candlish, A.M.E.I.C., introduced the speaker, Mr. Hopper, whose subject was "Some Improvements in Modern Turbine Practice."

Some Improvements in Modern Turbine Practice

The last half century has been an 'engineer's era' insofar as most developments have been along scientific lines. The steam turbine was first developed by Sir Charles Parsons in 1884 as a land engine. The older types of turbines were single cylinders operating under low pressure steam and were commonly called 'steam-eaters.' In order to advance the thermal efficiency of the turbines, engineers have introduced higher temperatures and pressures which call for many changes in the old type of turbine. This has developed two new types, namely, the 'tandem' with two cylinders and single exhaust and the 'single cylinder duplex' having two sets of low pressure blades.

The increase in temperature and pressure has called for the improvements in materials used particularly in the shafts. The introduction of the high pressure oil pumps for lubrication was designed to lift the shaft from its bearings, leaving the shaft floating in oil, thus overcoming the starting friction and reducing the starting torque in the shaft. Pressures in such pumps run from 1,500 to 2,000 lb. per sq. in.

The electrical heating of bolts now assures the engineer of fairly uniform stress to a pre-determined amount in each bolt. The nut is first tightened by hand, then the bolt is electrically heated and the nut further tightened. The contraction of the bolt while cooling gives the necessary pressure for clamping the casing. The reverse is true when it is necessary to remove the casing.

Low carbon, stainless steel has been found to be the best material for blading. Further, the method of rolling the steel always in one direction, improves its use for blading and does away with surface defects so commonly found previously.

The best thermal efficiency obtained in a modern steam turbine with reheated exhaust is between 29 and 36 per cent.

At present a machine is being designed to operate on 2,300 lb. pressure.

After the usual barrage of questions and answers, T. H. Jenkins, A.M.E.I.C., moved a hearty vote of thanks to Mr. Hopper to which all unanimously agreed. E. M. Krebser, A.M.E.I.C., extended the appreciation of the branch to the speaker and also welcomed our visitors.

Edmonton Branch

M. L. Gale, A.M.E.I.C., Secretary-Treasurer.
F. A. Brownie, Jr.E.I.C., Branch News Editor.

The guest speaker at the February dinner meeting of the Edmonton Branch, held on the 25th at the Macdonald hotel, was Mr. W. Dixon Craig, K.C. His subject was "Expert Evidence."

Expert Evidence

That this, in some respects controversial, subject was of great interest to local engineers was indicated by the large attendance of members. Mr. Craig opened the subject by outlining the fundamental principles of our method of settling disputes in the courts. Once the question before the court is defined, the next step is to set up and interpret the facts of the case. This interpreting of the facts is the duty of the jury, if there is one, or in other cases, of the judge acting in place of a jury. The third step, the application of the law, is the duty of the judge.

The primary function of witnesses is to place the facts before the courts. Originally there was no exception to this rule—witnesses dealt in facts only, not opinions. Gradually however, and especially in cases involving scientific matters, there has grown up the practice of admitting "opinion" evidence submitted by "experts." This is only justified when such witnesses have such special knowledge or skill that they can assist the jury by interpreting for it facts which would otherwise be meaningless to the ordinary individuals comprising the jury. Naturally since the general rules of evidence are being relaxed to admit such evidence, the "experts" are required to show that they are qualified to express sound opinions on the field of knowledge in question.

Mr. Craig then presented a brief outline of the history of technical evidence, citing a number of interesting cases to illustrate the gradual growth of its acceptance in the courts. He then went on to show how necessary such evidence is and yet how open to criticism it is in a number of respects.

For the courts to attempt to study scientific questions by the inductive method, going back to the beginning and developing for itself a complete body of theory in a certain field of knowledge, would be impossible. Even if possible in other respects the time required would be prohibitive. For this reason the court must rely on the testimony of scientific men, subject to cross-examination.

On the other hand, the method in general use of obtaining such evidence is open to grave criticism. Expert witnesses, being human, and being paid agents of one side of the case, are not unbiased. Their evidence is chosen, not for fairness to both sides but for the benefit of one side or the other. Since their evidence is based on opinion they cannot be indicted for perjury. And finally, with experts definitely attached to one side or the other and subject to cross-examination, the result is often very confusing—the jury is set to decide "where doctors disagree."

Notwithstanding these criticisms, Mr. Craig expressed the highest regard for the probity of the engineering profession.

The speaker closed by indicating his own opinions as to the solution of these difficulties mentioned above. The discussion which followed, concerned itself mainly with this point and indicated how interesting the members had found Mr. Craig's address.

Branch chairman J. D. Baker, M.E.I.C., presided.

Halifax Branch

R. R. Murray, M.E.I.C., Secretary-Treasurer.
A. D. Nickerson, A.M.E.I.C., Branch News Editor.

About forty members gathered at the Halifax hotel on February 24th, 1938, to hear Professor H. W. McKiel, of Sackville, N.B., give a report on the annual meeting of The Institute, held at London, Ont.

Professor McKiel, M.E.I.C., referred particularly to the attitude of the annual meeting with respect to the proposed scheme of co-operation between the E.I.C. and the Association of Professional Engineers of Nova Scotia. He pointed out that the annual meeting was very enthusuastic about the Nova Scotia scheme. Referring to the ballot now being taken by The Institute on amendments to the by-laws, the speaker suggested that all members should vote in favour of the proposed amendments in order that The Institute may be empowered to enter into co-operation agreements with the Professional Association in various provinces.

Professor McKiel's remarks were brief and to the point, and were enthusiastically received by the meeting. At the conclusion of his address, he answered various questions asked by the members present.

C. A. Fowler, M.E.I.C., moved a resolution of thanks to Messrs. G. J. Desbarats, Past-President, and J. B. Challies, President of The Institute, for their co-operation with the Nova Scotia Committee in preparing plans for a closer union between The Institute and the A.P.E.N.S.

C. H. Wright, M.E.I.C., suggested that a notice be sent to all members of the Halifax Branch asking them to vote in favour of the proposed amendments to the by-laws and pointing out that this favourable vote is necessary to enable The Institute to enter into the proposed co-operation agreement with the A.P.E.N.S. This suggestion was approved by the meeting.

The Secretary announced that at the March meeting of the Branch a paper will be presented by W. S. Wilson, A.M.E.I.C., chief engineer of the Dominion Steel and Coal Co., on the new power plant recently installed by that company in Sydney.

Hamilton Branch

A. R. Hannaford, A.M.E.I.C., Secretary-Treasurer.
W. W. Preston, S.E.I.C., Branch News Editor.

At the monthly meeting of the Hamilton Branch on February 16th, 1938, in McMaster University, Dr. R. K. Stratford, Chief Research Chemist for Imperial Oil Company, Limited discussed "The Practical Significance of Laboratory Tests on Lubricating Oils." He described the tests employed and compared the results obtained from actual tests on oils from different sources and oils which had been put to different service in combustion engines. Dr. Stratford was introduced by A. B. Dove, A.M.E.I.C., chairman of the local Papers Committee.

Testing Lubricating Oils

Petroleum products such as lubricating oils are difficult to standardize, the speaker stated, because they are organic and vary widely in composition. At present most of the standard tests are physical tests based on empirical considerations, but much research is being conducted in an attempt to find a more scientific yet practical method of classification. Dr. Stratford outlined the current tests with the aid of lantern views of the equipment used. The properties thus determined are A.P.I. gravity, flash point (the temperature at which the sample first ignites momentarily in the presence of a small jet of fire), fire point (the temperature at which it burns), viscosity at 100 deg. F., viscosity at 210 deg. F., viscosity index (relationship of viscosities at two set temperatures), pour point, carbon residue, and colour. The properties of lubricating oils are so varied that specifications establish certain ranges of permissible properties rather than definite characteristics. The properties of oils from different sources, Dr. Stratford showed by means of results of analyses, are markedly different. He claimed that the chief merits of the standard tests were to determine the source of an oil and to see if it were up to standard.

Lubricating oils can also be evaluated by oxidation tests, stated the speaker. The ability of an oil to resist oxidation determines its value.

Because the accepted methods of analyzing oils are empirical, continued Dr. Stratford, it is difficult to know when to discard an oil. He presented the results of analyses on oils before and after they had been put to varying amounts of severe service. The properties compared were, A.P.I. gravity, flash point, viscosity at 210 deg. F., pour point, colour, neutrality number (degree of acidity), sludge, water, dilution and ash. Abnormality in one of these properties often affects other properties. For this reason Dr. Stratford urged that a complete analysis be made of used oils. Only in so doing can the true trouble be discovered and the proper time for discarding be learned.

Dr. Stratford told his hearers that the terms film strength, heat resisting, oiliness, faster penetration, and corrosive, commonly used by combustion engine makers, had no great significance.

Also, he prophesied that motorists will gradually change from their present practice of using heavy oils in favour of low viscosity oils. He warned that a light oil should be watched closely and tested periodically. The rate at which it is consumed, he said, will probably govern its adoption.

Following a well supported discussion E. T. Sterne, of Brantford, proposed a vote of thanks to Dr. Stratford. W. J. W. Reid, A.M.E.I.C., was chairman, and the attendance was seventy-five. Refreshments in an adjoining room climaxed the meeting.

Addressing the Hamilton Branch at McMaster University on March 16th, 1938, Mr. A. K. Jordon, sales engineer with Aluminum Company of Canada, stated that we use aluminum products unwittingly many times a day. Our breakfast, he continued, is cooked in aluminum pots, and we pour our coffee from an aluminum percolator. His topic was—

The Use of Aluminum in Industry

The speaker first reviewed the history, production and properties of aluminum. This element was discovered in 1825 but had no importance for sixty years. Canada's aluminum industry began in 1901 at Shawinigan Falls, and now produces 50,000 tons of the metal a year. One third of the earth's crust contains aluminum but the ore used in Canada, high-grade bauxite, is obtained from open mines in British Guiana. It is smelted at Arvida, Quebec, by an electrolytic process involving the use of "cryolite" from Greenland. The familiar properties of aluminum are its light weight and high conductivity of heat and electricity. Commercially pure aluminum has a tensile strength of 14,000 p.s.i. "Common alloys" such as 1 per cent manganese or 5 per cent silicon have greater strength and lower elongation. "Strong alloys," one of which has 4 per cent copper and 48,000 p.s.i. tensile strength, have properties similar to common steel.

Before the introduction of "strong alloys" in 1910 the uses of aluminum were limited to cooking utensils and novelties, stated Mr. Jordon. Nowadays its chief consumer is the transportation industry whose aim is to reduce the weight of bicycles, automobiles, trucks, busses, railway cars, aeroplanes, zeppelins and boats. The second most important market is in the field of electrical conductors. The manufacture of cooking utensils, machinery like washing machines, and electrical appliances such as radio parts is also important. The iron and steel industry uses aluminum for deoxidizing. In the construction field it is used on store fronts, and in making mining skips and cages, booms for excavation equipment and floor systems for bridges. The chemical industry has aluminum containers for certain chemicals. Ground aluminum is a common base for paint. Food, particularly candy, is wrapped in aluminum foil. Caps for bottles, and tubes for pastes are also made from aluminum. Recently powdered aluminum has been added to the air in mines to combat silicosis. "No matter where you go," declared Mr. Jordon, "you come in contact with aluminum products."

To show the scope of the aluminum industry in Canada the speaker showed a number of lantern views and pointed out that there are twenty plants which employ 4,000 people and represent an annual payroll of $5,000,000. Domestic consumption is small but exports appreciable. Canada ranks third to United States and Germany in world production. The production of aluminum in the last twenty years has increased 800 per cent, many times more than any other metal.

J. W. J. Reid, M.E.I.C., was chairman of the meeting. A. B. Dove, A.M.E.I.C., introduced the speaker, and A. Love, M.E.I.C., proposed a hearty vote of thanks following a discussion in which most of the thirty-three present took part. Refreshments climaxed the evening.

Lakehead Branch

H. Os, A.M.E.I.C., Secretary-Treasurer.

Visit to Lake Sulphite Mill

On the invitation of A. T. Hurter, A.M.E.I.C., engineer in charge of Lake Sulphite Mill construction, 22 members and guests motored to Red Rock on November 22nd.

The visitors divided into groups and each party was conducted on a tour of inspection by a member of the engineering staff. A dinner was served in the staff dining room.

A vote of thanks was moved by J. M. Fleming, A.M.E.I.C., and seconded by R. J. Askin, A.M.E.I.C. W. H. Hurd, Secretary of the Lake Sulphite Company, responded to the address.

A dinner and dance meeting was held on Wednesday, January 26th, 1938, at the Shuniah Club, Port Arthur, Ont.

Members and guests with their ladies were seated at 7.30 p.m., after singing of "O Canada." The dinner was followed by community singing. The chairman, G. R. Duncan, A.M.E.I.C., expressed pleasure at having the ladies present. J. R. Mathiesen Jr.E.I.C., proposed a toast for long life and happiness to the ladies. Mrs. G. H. O'Leary replied to this toast. Representatives of sister professions brought the best wishes of their respective professions.

The Branch also took this apportunity to honour one of their members, J. M. Antonisen, M.E.I.C., on the occasion of his having been elected to Life Membership in The Institute. R. J. Askin, M.E.I.C., in a brief résumé, outlined Mr. Antonisen's achievements through a long and eventful engineering career in Canada and other countries. The speaker more particularly complimented Mr. Antonisen on the splendid services he had, through many years, given as city engineer of Port Arthur. Miss Antonisen was presented with a bouquet of flowers for Mrs. Antonisen who was unable to attend. Mr. Antonisen replied thanking his fellow members for the singular honour bestowed upon him.

This concluded the programme of the meeting and dancing and bridge was enjoyed by the members and their ladies.

The regular monthly dinner meeting was held February 16th, at the Prince Arthur hotel. E. Lorne Goodall, A.M.E.I.C., vice-chairman, presided in the absence of the chairman, G. R. Duncan, A.M.E.I.C.

A talking picture of "Heat and its Control" prepared by Johns-Manville Corporation was shown by Mr. A. G. Sinclair, representative of the Company. This picture is the first sound movie ever to be made on the subject and depicted the story of heat from the time man worshipped the sun to present-day methods of development and manufacture of heat conservation materials. Special sets, accurate in detail, were used to show James Watt's invention of the steam engine and other historical milestones in man's efforts to attain mastery over heat. Actual laboratory demonstrations, animated drawings and shadowgraphs were used to visualize the nature of heat and other efforts toward the scientific conservation of heat, the activity in a modern heat research laboratory, and how modern materials for conserving heat are developed, manufactured and utilized.

A vote of thanks was tendered to Mr. Sinclair and the Johns-Manville Corporation by S. E. Flook, M.E.I.C., and seconded by J. M. Fleming, A.M.E.I.C.

London Branch

D. S. Scrymgeour, A.M.E.I.C., Secretary-Treasurer.
Jno. R. Rostron, A.M.E.I.C., Branch News Editor.

The regular monthly meeting was held on February 23rd, 1938, in the Council Chamber, County Building, London, and the speaker of the evening was Mr. W. A. Osbourne, Vice-President of Babcock-Wilcox and Goldie McCulloch Ltd., Galt. His subject was "Babcock Integral Furnace Boilers."

A number of members of the Canadian Association of Stationary Engineers were present as guests and they with our own members accounted for a large attendance, 53 being present.

The chairman, A. O. Wolff, M.E.I.C., welcomed the guests and after a few appropriate remarks he called upon H. L. Hayman, A.M.E.I.C., to introduce the speaker.

Mr. Osbourne's talk was illustrated by a large number of excellent slides. This particular unit, the Integral Furnace Boiler, is so called because everything required for the generation of steam is contained in the one unit, even the furnace. Pulverized coal is used as fuel and full details of the pulverizers were shown—the crushing element being steel balls. A very ingenious device is employed for automatically regulating and controlling the supply of coal dust and air at the burner. The arrangement of tubes was shown and also the path of the heat. The tubes have studs welded to them and these again have a thick coating between them and around the tubes of a hard mastic compound. Models and sections of the various parts were exhibited. Mr. Osbourne said that others were also making progress but he was confident that his firm was producing a steam boiler outfit in which they had every confidence.

Many questions were asked and answered and a lively interest in the subject shown.

A vote of thanks to the speaker was proposed by D. M. Bright, A.M.E.I.C., heating engineer, London, seconded by Major W. E. Andrewes, A.M.E.I.C., and unanimously carried.

The appreciation of the members of the Canadian Association of Stationary Engineers, who were present, was voiced by one of their number.

Owing to the holding of the General Meeting of the E.I.C. in London last January, the annual dinner meeting and election of officers of the Branch, which is usually held in that month, was cancelled. However a meeting of members was called for the election of officers for 1938 prior to this meeting and this resulted as follows:

Chairman	A. O. Wolff, M.E.I.C.
Vice-Chairman	H. F. Bennett, M.E.I.C.
Committee	Major W. E. Andrewes, A.M.E.I.C.
	D. M. Bright, A.M.E.I.C.
	W. C. Miller, M.E.I.C.
	V. A. McKillop, A.M.E.I.C.
	J. R. Rostron, A.M.E.I.C.
Ex-Officio	E. V. Buchanan, M.E.I.C.
	J. A. Vance, A.M.E.I.C.
Secretary-Treasurer	D. S. Scrymgeour, A.M.E.I.C.
Auditors	R. W. Garrett, A.M.E.I.C.
	F. C. Ball, A.M.E.I.C.

Montreal Branch

E. R. Smallhorn, A.M.E.I.C., Secretary-Treasurer.

BRIDGING A CENTURY

A sound film entitled "Bridging a Century" was shown by the Branch on January 27th. This described the fabricating of the cables of the Golden Gate Bridge. It was presented through the courtesy of the Roebling Company. Their representative, Mr. A. R. Kirsch, was present. Prior to the meeting a courtesy dinner was held at the Windsor hotel.

Chairman: P. L. Pratley, M.E.I.C.

THE WILLANS LAW IN THE ANALYSIS OF STEAM PLANT PERFORMANCE

On February 3rd, 1938, J. T. Farmer, M.E.I.C., of the Montreal Engineering Company, presented a paper on the above subject. Mr. P. W. Willans, designer of the well-known high speed engine, in the course of his investigations of steam engine performance, enunciated a principle which has proved to be very general in its application.

In the case of a steam turbine, a Willans Law connects the rate of total steam consumption to the proportion of rated load carried.

For a steam boiler this law connects the fuel consumption rate with the rate of steam production, and so on.

Chairman: R. E. MacAfee, M.E.I.C.

JOINT MEETING WITH THE INSTITUTE OF RADIO ENGINEERS

On February 9th, W. P. Dobson, M.E.I.C., Chief Testing Engineer of the Hydro-Electric Power Commission of Ontario, gave a talk on "Hydro and the Interpretation of Radio Rulings." Mr. Dobson dealt with: 1, Methods used to enforce code rulings; 2, Relations of the Hydro Laboratories to C.E.S.A. and Provincial Authorities; 3, Interpretation of the code; 4. Specifications and their need.

WELDED STEEL PIPE

C. R. Whittemore, A.M.E.I.C. of the Dominion Bridge Company, on February 10th presented a paper in which he discussed the economical construction of welded pipe which is largely influenced by the use of semi-automatic and automatic welding processes, the advantages of concrete lined pipes, the manufacture of the pipe from sheet steel, and the protection of the outside of the pipe.

JUNIOR SECTION

"Concrete in the Field" was the subject of an address given before the Junior Section on February 14th, 1938, by E. McKinstry of the Dominion Concrete Company at Kemptville, Ont. Mr. McKinstry received his engineering training at Ohio State University which he left in 1925. On his return to Canada, he was employed by John McRae, consulting engineer in Ottawa. He has also acted as architects' superintendent on jobs and further as a designer of concrete and reinforced concrete structures. Mr. McKinstry was well qualified to speak on the subject he chose which had particular reference to the making of concrete pipe. An exhibit of some of the older engineering books in The Institute Library were on display in the lecture hall.

ANNUAL SMOKER

A most successful smoker was held on February 17th at the Windsor hotel. About 400 hundred members and guests were present and enjoyed an excellent entertainment. President Challies presented the Past-Presidents' Prize and the Phelps Johnson Prize during the evening. C. C. Lindsay, A.M.E.I.C., chairman of the Reception Committee of The Institute, which was responsible for the smoker, was given a hearty vote of thanks for his efforts in organizing such an enjoyable gathering.

WAVES, WORDS AND WIRES

On February 24th Dr. J. O. Perrine of the American Telephone and Telegraph Company addressed the Montreal Branch on the subject of "Waves, Words and Wires." He discussed and demonstrated long distance telephone circuits and radio programme network circuits. The demonstration showed the required characteristics and also the undesirable ones, which must be kept under control, such as electrical echo, singing, overloading of amplifiers, and noise. A high fidelity microphone and loud-speaker, along with other apparatus were set up for this meeting. Bell system circuits from Montreal to Toronto and from Montreal to New York were used.

Prior to the meeting a courtesy dinner was held at the Windsor hotel. Prof. C. V. Christie, M.E.I.C., was chairman. Members of the Institute of Radio Engineers were invited to the lecture and dinner.

ELECTRO-GALVANIZING

Mr. A. Weisselberg, M.A.S.M.E., a consulting engineer of New York City, gave a most interesting lecture on March 3rd, 1938, before the Montreal Branch. Mr. Weisselberg is a graduate of Vienna University and well qualified to speak on the subject he chose. In his talk on the development of electro-galvanizing, he particularly referred to wire and described and illustrated modern equipment and methods. The L.P.G., or German process, for galvanizing wire was described and the author commented on the quality of products obtained by this process. The lecture was illustrated by means of slides.

Prior to the meeting a courtesy dinner was served at the Windsor hotel.

Chairman: E. C. Kirkpatrick, M.E.I.C.

HEAT AND ITS CONTROL

A talking motion picture entitled "Heat and Its Control" was presented before the Montreal Branch on March 10th, 1938. This picture, produced by the Canadian Johns-Manville Company Limited, told the story of heat from the dawn of history, through the development of the steam engine, the discovery of the true nature of heat, and finally the development of insulation materials. The setting up of air currents in air spaces, and convection currents around heated pipes, etc., were shown by shadowgraphs. This picture was of interest to those concerned with problems of heat conservation. One of the engineers of the Canadian Johns-Manville Company Limited was on hand to answer questions and join in the discussion.

Chairman: J. G. Hall, M.E.I.C.

JUNIOR SECTION

On March 14th, 1938, the Junior Section of the Montreal Branch heard a paper by Victor I. McCallum on "Modern Treatment of Asbestos Ores." Mr. McCallum is a student in third year mining at McGill University and has spent considerable time at the asbestos mines at Thetford Mines, Que. In his paper he described the various methods of treating ores as employed here in Canada, how the machinery is used and the reasons for each step in the process.

Chairman: Guy Bélanger, S.E.I.C.

HOUSING SURVEYS FOR MONTREAL

The lecture on March 17th, 1938, "Housing Surveys for Montreal" by Réal Bélanger, C.E., was of great interest to those concerned with social problems and with town planning. These surveys were made under the control of the Department of Planning and Research of the Metropolitan Commission, with the help of the Health Department of the City of Montreal. The living conditions of low income families and slum conditions of this city were the main points of study.

Mr. Bélanger graduated from the Ecole Polytechnique in 1925. He was employed by the City of Montreal in the Technical Service and Sewer Commission, and is now with the Metropolitan Commission in the Department of Planning and Research.

Invitations to attend the lecture were issued to members of various public bodies and to the Architects Association of the Province of Quebec.

Chairman: Aimé Cousineau, A.M.E.I.C.

Niagara Peninsula Branch

G. E. Griffiths, A.M.E.I.C., Secretary-Treasurer.
J. G. Welsh, S.E.I.C., Branch News Editor.

The Niagara Peninsula Branch of The Institute held a general meeting in the Welland Club, Welland, Ontario, on Thursday, March 10th, 1938.

Approximately seventy members and friends sat down to a very enjoyable dinner served by the club staff. Following dinner the chairman, L. C. McMurtry, A.M.E.I.C., suggested that the five immediate past-presidents of the branch form a nominating committee for the executive for the coming year, as has been the custom in the past.

The chairman then introduced R. L. Hearn, M.E.I.C., chief engineer for the Dominion Construction Company, who showed their moving pictures with sound description of the Abitibi Power Construction. The picture very clearly described and showed the construction of the project through most of its various stages and in places where photographing of the work was too difficult the construction procedure was cleverly shown with diagrammatic sketches and cross-sections.

Following the showing of the picture W. R. Manock, A.M.E.I.C., moved a hearty vote of thanks with which everyone unanimously agreed.

After adjournment of the meeting those present were privileged to look over several cross-sectional construction drawings of the project, brought by Mr. Hearn.

Ottawa Branch

R. K. Odell, A.M.E.I.C., Secretary-Treasurer.

At the noon luncheon at the Chateau Laurier on February 24th, 1938, C. A. Bowman, A.M.E.I.C., editor of the Ottawa Citizen, spoke upon the subject of "Pax Nipponica."

J. B. Challies, M.E.I.C., of Montreal, newly-elected President of The Institute, was also present and made the presentation personally to J. H. Parkin, M.E.I.C., of the National Research Council, Ottawa, of the Gzowski Medal which had been awarded to him recently by The Institute.

PAX NIPPONICA

"When Great Britain has come to terms with Germany and Italy," Mr. Bowman said during the course of his address, "it should be easier to send a strong British fleet to the Far East, but Japan cannot afford to await the arrival of new British naval power. Japan is in the most desperate situation of any great industrial country. There has to be Japanese expansion into the Chinese and Pacific markets as the only apparent way to avoid revolution at home."

The responsibility for Japan's threat to world peace, in Mr. Bowman's view, is largely due to the influence of western nations. He traced the present conflict of forces in the Far East from the arrival of British traders in China a century ago, followed by the opening up of

Japan in 1860 under the pressure of American, British and other investors in foreign markets. Japan turned to a modern constitution, patterned after western policies in 1867—the year of Canadian confederation. Between 1870 and 1930 the population of Japan doubled: the present Japanese population is more than 68,000,000, crowded on a group of islands about three times the area of Newfoundland.

Japan's great industrial expansion came during the war years, after 1914. Encouraged by the Allies, largely to allow British shipping to be used for other purposes, Japanese export trade expanded by 78 per cent into other Asiatic countries, by 427 per cent into North America and by 385 per cent into Africa. The Japanese are determined to hold on to the captured markets; they believe the very existence of the nation is dependent upon exporting more to markets abroad. This dependence upon foreign trade, said Mr. Bowman, is one result of Japan being persuaded to copy Western national policies.

In the same war period of expansion between 1914 and 1918, Japanese industrial power increased 34 per cent. Some details of increased output quoted by the speaker were: electric power 206 per cent, spindles in cotton industry 44 per cent, yarn output 55 per cent, pig iron 143 per cent and steel products 116 per cent. Workers were attracted from agriculture into the factories so that the industrial population increased by 63 per cent.

The Japanese were faced with restrictions on trade in so many western countries, and even more restrictions on migration, they had decided to rely on military force to expand along an imperial path on the continent of Asia. They spoke of the Chinese market as Japan's lifeline; but China offered no outlet to Japan for surplus population. Nor could the Japanese expand into Siberia, even by conquering Soviet Russia. They were essentially dwellers in the warmer climates; many experienced observers in the Far East were of the opinion that Pax Nipponica would eventually include a Japanese empire to embrace some of the desirable island groups further south. "But perhaps the new British fleet may have been built for the Pacific arena," said Mr. Bowman, "and Hong Kong may have been developed into a naval base equal to Singapore, before the Philippines, the Dutch East Indies, Australia and New Zealand are brought within the orbit of Pax Nipponica."

One alternative would be to find a civilized way to carry on trade and industry without financial imperialism and commercial war, but the speaker could see no sign of any such Utopian solution on either the western or the eastern horizon.

William Bryce, A.M.E.I.C., chairman of the local branch, presided, and a number of Montreal and other out-of-town members were also present.

At the noon luncheon at the Chateau Laurier, Ottawa, on March 10th, A. C. T. Sheppard, B.A.Sc., D.L.S., of the Bureau of Geology and Topography of the Dominion Department of Mines and Resources, gave an address on "What Canada is Doing With the Aid of Camera and Airplane." W. F. M. Bryce, A.M.E.I.C., chairman of the Branch, presided.

A résumé of Mr. Sheppard's address appears on page 207 of this Journal.

Peterborough Branch

W. T. Fanjoy, A.M.E.I.C., Secretary-Treasurer.
J. L. McKeever, Jr.E.I.C., Branch News Editor.

At the regular meeting of the Peterborough Branch held on January 21st, 1938, the speaker was Mr. F. D. Bowman of the Carborundum Co., Niagara Falls, N.Y., who spoke on the subject "The Manufacture of Carborundum Abrasive and Refractory Material."

Mr. Bowman briefly outlined the story of carborundum, from its development in 1891 by Dr. Acheson, and traced it through progressive stages to its present prominent place in industry.

The film which the speaker presented, entitled "Jewels of Industry," was a historical record of carborundum from its discovery by Dr. Acheson in 1891. Its first uses were for polishing jewels, grinding valves, dentist's drills and small wheels. After development of Niagara Falls and consequent large supply of electrical energy, manufacture of carborundum was begun on a large scale.

Carborundum is made from coke, sand, sawdust and salt, heated electrically to about 4,000 deg. F. For a 70,000 lb. mix, about 2,000 hp. hours of energy are required, after 36 hours outer layers are broken off and crystals obtained. These crystals are crushed, graded into size, bonded and moulded in ceramic clays, and vitrified. Final operations consist of inserting hubs and truing and dressing stones.

Carborundum wheels are used for low tensile materials, and "Alaxite" is used for high tensile material. The majority of alaxite wheels are made in the Canadian plant of this company.

The final part of this film showed the wide range of applications of this product, including automotive cylinder grinding, body grinders, tool room grinders, cutting and polishing marble, wood products, etc.

Mr. Bowman's talk was most interesting and was much appreciated by the Branch.

Attendance 55.

Saskatchewan Branch

J. J. White, M.E.I.C., Secretary-Treasurer.

Continuing the series of joint meetings for the benefit of the profession in Saskatchewan, the local branch of The Engineering Institute of Canada met on January 21st, 1938, at the Kitchener hotel, Regina, with members of the Association of Professional Engineers of Saskatchewan and the local branch of the American Institute of Electrical Engineers.

The chairman of the meeting was Stewart Young, M.E.I.C., chairman of the Saskatchewan Branch of The Engineering Institute of Canada.

The meeting was preceded by a dinner at 6.30 p.m., at which seventy engineers were present.

Following the dinner F. E. Estlin introduced Mr. M. C. Lowe of the Canadian General Electric, Winnipeg, Manitoba, as the speaker of the evening, his subject being "The Mining Industry in Manitoba and Western Ontario." This industry, Mr. Lowe pointed out, is second in importance and its development has involved that of other industries closely allied. The cost of transportation to the mines by rail, water and air was discussed and considerable attention given to the question of power supply to the mines.

Following the address and a general discussion a hearty vote of thanks was moved by Messrs. McGavin and Lewis.

Vancouver Branch

T. V. Berry, A.M.E.I.C., Secretary-Treasurer.

Through the courtesy of the United States Bureau of Reclamation the Vancouver Branch were fortunate on January 20th, 1938, in entertaining Major S. E. Hutton, Assistant Director of Information, U.S. Bureau of Reclamation, who lectured before the Branch on the Grand Coulee Dam in the York room of the Hotel Georgia.

Grand Coulee Dam

About one hundred and fifty members and others listened to Major Hutton unravel a saga of human skill, courage and organization against physical conditions that sometimes appeared overwhelming.

Major Hutton's lecture was illustrated by over one hundred slides. He described the excavation of the site and the disposal of the surplus by means of a complicated system of endless belts. The various steps in the control of the Columbia river by cofferdams for the purpose of excavating the foundation to bedrock and the concreting of the foundations were described by Major Hutton in an interesting manner replete with technical detail and information.

To one who had not visited the Grand Coulee project in the State of Washington the lecture and the pictures impressed with the vastness of the structures. To date, more concrete has been placed in the foundations of the dam than in the whole of the Boulder dam.

The speaker concluded the lecture with a description of the excavation, segregation and transportation of the aggregates for the concrete to the spoil piles preparatory to mixing in the two central concrete mixer plants situated one on each side of the river.

The thanks of the meeting were conveyed to the speaker by Dr. E. A. Cleveland, M.E.I.C. The congratulations of the Branch to T. H. White, M.E.I.C., Life Member and oldest member of The Institute, whose ninetieth birthday occurred on January 27th, was proposed by James Robertson, M.E.I.C., and heartily responded to by the meeting.

Winnipeg Branch

J. Hoogstraten, A.M.E.I.C., Secretary-Treasurer.

The annual meeting of the Winnipeg Branch of The Engineering Institute of Canada was held in Theatre B, University of Manitoba, on February 3rd, 1938, at 8.15 p.m.

Moving pictures of the latest developments in modern transportation facilities, mining, and oil production on the McKenzie river and in the North West Territories were shown through the courtesy of Mr. R. McKinnon of the Imperial Oil Company.

Mr. Fred V. Seibert, Superintendent of Natural Resources, Canadian National Railways, gave an interesting review of transportation problems in the North encountered by surveyors of a decade ago.

Professeur A. E. Macdonald, retiring chairman of the Branch, in his address reviewed the events and proceedings of the past year before turning over the chair to W. D. Hurst, newly elected chairman for the year 1938.

The following officers were declared elected for the year 1938:—

Chairman of the Branch	W. D. Hurst, A.M.E.I.C.
Vice-Chairman	L. M. Hovey, A.M.E.I.C.
Secretary-Treasurer	J. Hoogstraten, A.M.E.I.C.
Executive Committee	G. C. Davis, A.M.E.I.C.
	V. H. Patriarche, A.M.E.I.C.
	J. T. Rose, A.M.E.I.C.
Chairman Programme Committee	W. F. Riddell, M.E.I.C.
Chairman Membership Committee	C. V. Antenbring, A.M.E.I.C.

Messrs. C. H. Attwood and J. A. MacGillivray each have one more year to serve on the Executive committee, and Messrs. A. E. Macdonald and H. L. Briggs continue as immediate past chairman and immediate past secretary-treasurer respectively.

Modern Methods of Sludge Treatment

On February 17th, 1938, Mr. Albert A. Genter of Baltimore, Maryland, spoke on "Modern Methods of Sludge Treatment."

Mr. Genter opened his address by likening the processes of the sewage disposal plant to the processes of the self-purification of a stream.

In the sewage treatment plant, large particles and grit are removed by the use of screens and grit chambers, followed by the removal of a large part of the suspended solids by sedimentation.

In the activated sludge process, the sewage flows into the aeration tank where it is mixed with about 30 per cent of activated sludge, and where air is blown through it. This addition of oxygen results in bacterial action which produces flocculation and facilitates further sedimentation.

The treatment of sludge consists of the addition of coagulating compounds followed by pressing or vacuum filtering. In another process, the sludge is digested before passing to the vacuum filters. In this process, the raw sludge is maintained at a temperature favourable to the growth of anaerobic bacteria, which act on the sludge to the extent of reducing its volume approximately fifty per cent.

The sludge from the digester may be subjected to the elutriation process which consists in thoroughly mixing water with the sludge for a few minutes and allowing the solids to settle. This elutriation reduces the percentage of certain soluble ammoniacal decomposition products in the sludge. Since these products enter into composition with ferric chloride and other similar coagulants, their removal by elutriation reduces the quantity of coagulant necessary prior to vacuum filtering.

W. D. Hurst, A.M.E.I.C., J. T. Rose, A.M.E.I.C., and H. G. Hunter, M.E.I.C., participated in the discussion which followed. A vote of thanks to Mr. Genter was moved by H. G. Hunter of Montreal.

Polar Exploration

On March 3rd, a meeting of the Branch was addressed by Captain Innes-Taylor on the subject "Polar Exploration."

The Antarctic continent contains 5,000,000 sq. mi., ninety per cent of which is covered with ice and snow, ranging in depth from a few feet to 12,000 ft. The polar region is a plateau 10,800 ft. above sea level, which can only be reached by climbing mountain passes.

Ross was the first to penetrate the pack ice and reach land. The first Scott expedition found tree fossils, out-croppings of coal, and two active volcanoes. Using Eskimo methods, Amundsen reached the pole in 1911, while the second Scott expedition, using man haulage, reached it thirty days later. The distance which must be travelled across ice and mountains is 850 mi. each way.

The first Byrd expedition, in 1929, reached its base in Little America in an old mine sweeper and a wooden sealer built in 1882. Byrd flew a triangular course over and around the pole on November 29th, 1929.

The second Byrd expedition likewise was transported in two ships, one of which was a whaler built in 1878. They took four planes, 7 tractors, 157 huskies, and 55 men, of whom 16 were scientists. They discovered that the Ross ice shelf, reaching 500 mi. from the continental margin, is anchored in place by islands as high as 1,200 ft. above sea level, yet submerged under 600 ft. of ice. Gold and copper ores were discovered, and also an estimated 200,000 sq. mi. of lignite and anthracite coal deposits. There are no living creatures in the interior, but on the edge of the ice shelf are large numbers of penguins, seals, and whales.

A vote of thanks was moved by Major A. J. Taunton, 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.

Notices appearing in the Situations Wanted column will be discontinued after three insertions, and will be re-inserted after a lapse of one month, upon request.

All correspondence should be addressed to

The Employment Service Bureau, The Engineering Institute of Canada

2050 Mansfield Street, Montreal

Situations Vacant

MINING AND METALLURGICAL ENGINEER, experienced in manganese mining and manufacture of ferro-manganese. Must be familiar with markets, operation and development of a property in Eastern Canada. Available on short notice. Give technical education and brief summary of practical experience, and if possible Toronto references. Apply to Box No. 1710-V.

SALES ENGINEER required for western agents with well established connection. Applicant must have electrical experience with reasonable mechanical engineering knowledge to efficiently handle sales of motors, transformers, switchgear, pumps, hoists, chain drives, etc. State age, experience, salary required. Box No. 1743-V.

Civil Service Vacancies

DRAUGHTSMEN (Four Vacancies)

Comp. 27541. Three vacancies in the above class are required to be filled in the general engineering division of the Department of Transport, Ottawa, Ontario, and one vacancy in the chief engineer's branch, Department of Public Works, Ottawa, Ontario.

Note: *Temporary appointments only may be made at present.*

Salary.—In the event of permanent appointment the initial salary of $1,500 per annum will be increased upon recommendation for meritorious service and increased usefulness at the rate of $60 per annum until a maximum of $1,800 has been reached.

Duties.—Under supervision, to draw maps and plans; to plot survey notes; to perform other related work as required.

Qualifications Required.—High school graduation; at least three years of experience in a drafting office, including map drafting, or three years of drafting experience in an engineering office; ability to prepare completed drawings from sketches, survey notes and engineers' instructions; ability to make simple engineering computations; proficiency in lettering and printing and in the making of neat and accurate maps and plans; good knowledge of the work of an engineering office. For one position in the Department of Transport, credit will be given for experience in the design of freight sheds, involving details of electrical wiring. For the present vacancies preference will be given to qualified applicants who are not more than approximately thirty-five years of age on the last day for the receipt of applications.

Application forms properly filled in must be filed with the Secretary, Civil Service Commission, Ottawa, Ontario, **not later than April 16, 1938.**

Applications forms are obtainable at all city post offices, the post offices in the larger towns, the Offices of the Employment Service of Canada, The Engineering Institute of Canada or from the Secretary, Civil Service Commission, Ottawa, Ontario.

Situations Wanted

PAPER MILL ENGINEER: B.A., B.A.Sc. Married. Age 34. A.M.E.I.C. Ten years experience in paper mill costs, maintenance, design and construction. Now employed as cost engineer in Southern States. Hard worker with excellent references. Available immediately. Apply to Box No. 150-W.

ELECTRICAL ENGINEER, B.Sc. '28. Two years student apprenticeship at Can. Westinghouse Co., including test and electrical machine design. Also about two years experience in operating dept. of large electrical power organization. Available on short notice. Apply to Box No. 660-W.

ELECTRICAL AND CIVIL ENGINEER, B.Sc. Elec. '29, B.Sc. Civil '33. Jr.E.I.C. Age 32. Experience includes four months with Can. Gen. Elec. Co., approximately three years in engineering office of large electrical manufacturing company in Montreal, the last six months of which were spent as commercial engineer, also experience in surveying and highway work. Year and a half employed in electrical repair. Best of references. Apply to Box No. 693-W.

CIVIL ENGINEER, B.A.Sc. (Toronto '27), age 34, married. Five years railway and construction work as building inspector and instrumentman. Level engineer and on construction of a long timber flume for a pulp and paper mill. Field engineer for a sulphite company, in charge of the following mill buildings, acid, digester, blow pit, barker room, chip storage and acid towers. Available immediately. Apply to Box No. 714-W.

Situations Wanted

SALES ENGINEER, age 30, graduate in electrical engineering, seeks position with more future. Experience in radio and telephone work and in electrical contracting. At present selling electrical supplies in Western Ontario. Apply to Box No. 1044-W.

ELECTRICAL ENGINEER, B.Sc. '29, age 30. Single. Eight and a half years experience on maintenance, on construction, floorman and operator on hydro-electric system. Desires construction, service, sales or research work. Any location. Excellent references. Apply to Box No. 1062-W.

CHEMICAL ENGINEER, grad. McGill '34, experienced in meter repairs, control work; and also chemical laboratory experience. Apply to Box No. 1222-W.

CIVIL ENGINEER, B.A.Sc. (Toronto '33), S.E.I.C., age 27. Married. Five years experience includes highway surveys, bituminous and concrete paving, steel and reinforced concrete building construction, instrument work, draughting, cost accounting and estimating and some experience as foreman. Available immediately. Apply to Box No. 1265-W.

ENGINEER SUPERINTENDENT, A.M.E.I.C., R.P.E., Que. and Alta. Age 47. Twenty years experience as engineer and superintendent in charge of hydro-electric, industrial, railroad, and irrigation construction. Specialized in rock excavation and suction dredging. Intimate knowledge of costs, estimating and organizing. Available immediately. Apply to Box No. 1411-W.

CIVIL ENGINEER, graduate 1927, age 34 years, desires position as town engineer. Eight years municipal experience. Location immaterial. Apply to Box No. 1628-W.

CIVIL AND ELECTRICAL ENGINEER, Jr.E.I.C. (Univ of Man.). Married. Age 25. Good draughtsman. Four months draughting, one year instrumentman on highway location and construction, inspection and miscellaneous surveying and estimating. Six months as field engineer on pulp and paper mill construction. Prefer electrical or structural design. Available at once. Apply to Box No. 1633-W.

CIVIL ENGINEER, B.A.Sc. '33, O.L.S. Age 27. Married. One year and a half in charge of power plant construction. Four summers on land surveys and one summer on mine survey work. Also experience in draughting, electrical wiring, and highway engineering. Apply to Box No. 1757-W.

ELECTRICAL ENGINEER, N.S. Tech. Coll. Single. Age 25. Experience in sales, electrical installation, and construction work. Available immediately. Will go anywhere. Apply to Box No. 1758-W.

CHEMICAL ENGINEER, graduate, Toronto '31. Seven years experience in paper mill, meter maintenance, control work and chemical laboratory. Speaking French and English. Location immaterial. Available at once. Apply to Box No. 1768-W.

Preliminary Notice

of Applications for Admission and for Transfer

March 23rd, 1938.

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 1938.

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

CHARLES—ROBERT SIMPSON, Jr., 181 Elmwood Ave., London, Ont., Born at Salem, Ill., U.S.A., Sept. 17th, 1909; Educ., B.A., Amherst College, Amherst, Mass., 1929. Home study. 1 year training in water treatment plant design; 1924-25 (6 mos.), dftsman., 1926-27-28 (9 mos.), supervision of pump installn., Layne New York Co., Inc.; 1929-31, res. engr. on constrn. of 10 M.G.D. supplementary well water supply for the city of New York, for Layne New York Co.; 1931-32, asst. field engr. on constrn. of well water supplies totalling 60 M.G.D. in France, for the city of Paris and others; 1932-33, field engr. i/c constrn. of a well water supply for the city of Tangier, Morocco, for the International Water Co.; 1933-35, field engr. i/c constrn. of 30 M.G.D. well water supply for the cities of Saigon and Cholon, French Indo-China, incl. 13 water treatment plants having a total capacity of 17 M.G.D., for same company; 1935-36, research engr. on design and constrn. of water treatment plants, for W. I. Klein, consltg. engr.; Sept. 1936 to date, field engr. i/c of water supply and water treatment plant design and constrn. in Canada for International Water Supply Ltd., London, Ont.

References: E. V. Buchanan, V. A. McKillop, W. M. Veitch, D. S. Scrymgeour, H. A. McKay, S. G. Johre, M. Pequegnat.

HARSHAW—FRANCIS NORMAN, of Ste. 2, McKim Block, Saskatoon, Sask., Born at Medicine Hat, Alta., April 20th, 1911; Educ., B.Sc. (Civil), Univ. of Sask., 1933; 1928-32 (summers), rodman, chainman and inspr. of public works programme in Saskatoon; 1935 (July-Nov.), head of sub-party in Geol. Survey of So. Alta.; at present, transmitter operator, CFQC, Saskatoon, Sask.

Reference: C. J. Mackenzie, R. A. Spencer, A. R. Greig, W. E. Lovell, G. M. Williams.

HEYWOOD—DON W., of 6720 Sherbrooke St. West, Montreal, Que., Born at Council Bluffs, Iowa, U.S.A., Dec. 8th, 1902; Educ., 1923-24, Univ. of Alta. 1928-29, Milwaukee School of Engineering; 1926-27, operation and mtce. of hydro-electric stations, and 1927-28, constrn. work, Calgary Power Co. Ltd.; 1929-30, supt. of constrn. of substations, high and low voltage switchboards, electric elevators, 1931-32, supt. of service and repair shop (elect'l.), with Electrical Engineers Ltd., Calgary (now wound up); 1932-37, organization of limited liability company, assuming the office of secretary. (Work similar to that of previous company) Electric-Crafts Ltd., Calgary, Alta.; Oct. 1937 to date, design and supervision of electrical installns., McDougall & Friedman, Consltg. Engrs., Montreal, Que.

References: G. K. McDougall, F. J. Friedman, J. D. Fry, G. S. Clark, A. D. Ross, R. S. Trowsdale, J. McMillan.

HODGSON—ERNEST ATKINSON, of Ottawa, Ont., Born at Utica, N.Y., Oct. 15th, 1886; Educ., Univ. of Toronto, B.A. 1912, M.A. 1913. Post-graduate study at Univ. of Chicago and St. Louis Univ. Ph.D. in Geophysics, St. Louis, 1932; 1914-18, seismologist, and 1918 to date, chief, Division of Seismology, Dominion Observatory, Ottawa, Ont. (Dominion Seismologist).

References: R. M. Stewart, O. O. Lefebvre, J. C. Smith, H. J. Ward, R. W. Boyle.

HORNBACK—MICHAEL EDWIN, of 2535 Montclair Ave., Montreal, Que., Born at Chillicothe, Miss., U.S.A., Aug. 2nd, 1889; Educ., B.S. in C.E., Univ. of Miss., 1912. R.P.E. of Que.; 1909-10 and summers 1911-12, rodman and instr'man., U.S. Engineer Office, Boston and Rock Island, Ill.; 1912-14, designer and dftsman., reinf. concrete rly. structures, Chicago, Milwaukee and St. Paul Rly.; 1914-15, designer and dftsman. of reinf. concrete industrial bldgs., Condron Company, Struct'l. Engrs., Chicago; 1915 (May-Sept.), designer of grain elevator structures, James Stewart & Co., Contractors, Chicago; With the John S. Metcalf Co., Chicago, as follows: 1915 (Jan.-May), designer of grain elevator structures; 1915-16, asst. to the engr. i/c of design and supervn. of constrn. of Calumet Terminal grain elevator; 1916 (Apr.-July), chief dftsman. on design of Wichita Terminal grain elevator; With the John S. Metcalf Co. Ltd., Montreal, 1916-17, designer of grain elevator structures, and from 1917 to 1937, as engr. in charge of designing and making of drawings of mech'l. equipment and timber, reinforced concrete and steel structures for many engineering works, including grain elevator systems at Halifax, N.S., and West Saint John, N.B., extensive additions to grain elevator system at Quebec, grain car unloading plant, Sorel, marine tower for Dominion Flour Mills Ltd., Montreal Harbour Commn. cold storage warehouse and power house bldgs., grain elevators at Montreal, and many other projects.

References: L. Coke-Hill, T. W. Harvie, W. B. McLean, G. R. Dalkin, A. G. Tapley.

HUTCHEON—NEIL BARRON, of Saskatoon, Sask., Born at Rosetown, Sask., March 13th, 1911; Educ., B.Sc. (Mech.), 1933, M.Sc., 1935, Univ. of Sask.; 2 years research work, Univ. of London, Univ. College, London, England (Ph.D. pending), 1935-37; 1931-33, student instructor in physics, during undergraduate course, Univ. of Sask.; 1933-34, instructor in mech. engr., 1934-35 (half time during Master's course); 1930 and 1934 (summers), rodman, Sask. Dept. of Highways; 1935-37, research work in mech. engrg., Univ. of London; July 1937 to date, asst. professor in mech. engrg., Univ. of Saskatchewan, Saskatoon, Sask.

References: C. J. Mackenzie, R. A. Spencer, W. E. Lovell, I. M. Fraser, G. M. Williams.

KRENDEL—CONRAD JOHN, of Winnipeg, Man., Born in Russia, May 6th, 1911; Educ., at present completing final year in civil engrg., Univ. of Manitoba; 1935-36, dftsman., 1936-37, instr'man., location and constrn. surveys, bridge constrn., and 1937 (May-Sept.), res. engr., Dept. of Northern Development, Ontario.

References: J. Hoogstraten, A. E. Macdonald, G. H. Herriot, W. M. Scott, D. M. Stephens.

MacGILL—ELIZABETH MURIEL GREGORY, of Montreal, Que., Born at Vancouver, B.C., March 27th, 1905; Educ., B.A.Sc. (E.E.), Univ. of Toronto, 1927. M.S.E., Univ. of Mich., 1929. 2 years graduate study leading toward Doctorate at Mass. Inst. Tech., 1934; 1927-29, junior engr., Van Austen Co., Pontiac, Mich.; 1935 to date, asst. engr., Fairchild Aircraft Ltd., Longueuil, Que.

References: J. H. Parkin, A. Ferrier, R. W. Angus, E. A. Allcut, C. H. Mitchell, C. R. Young.

MALBY—THOMAS GEORGE, of Arvida, Que., Born at Winnipeg, Man., July 10th, 1911; Educ., B.Sc. (C.E.), Univ. of Man., 1935; 1930-31-32 (summers), rodman, inspr. of lines, City of Winnipeg Hydro-Electric; 1935 (Aug.-Nov.), bituminous concrete inspr., Manitoba Good Roads Dept.; 1936-37, mapper, aerial surveys, Bureau of Geol. and Topography, Ottawa; Sept. 1937 to date, engr., Saguenay Power Co. Ltd., Arvida, Que.

References: G. H. Herriot, J. W. Sanger, C. Miller, S. H. deJong, E. M. Dennis.

MITCHELL—DAVID ALEXANDER, of La Tuque, Que., Born at McTaggart, Sask., Jan. 27th, 1912; Educ., B.A.Sc., Univ. of Toronto. 1937; 1937 to date, electr'l. engr., Brown Corporation, La Tuque, Que.

References: C. H. Mitchell, E. A. Allcut, T. R. Loudon, R. E. Smythe, C. R. Young.

PIERCY—WALTER JAMES, of 12 Elm St. South, Timmins, Ont., Born at McAdam Jct., N.B., Sept. 6th, 1913; Educ., B.Sc. (E.E.), Univ. of N.B., 1934; 1934-36, broadcast repeater attendant; 1936-37, broadcast studio control operator and transmitter operator; 1937 to date, underground electrician, on trolley and battery operated electric locomotives, McIntyre Gold Mines, Timmins, Ont.
References: A. F. Baird, J. Stephens, E. O. Turner, W. J. Pickrell.

THRUPP—FREDERICK EDWARD MILAN, of Hamilton, Ont., Born at Belgrade, Serbia, Jan. 24th, 1884 (British subject by birth); Educ., Dipl. Ing., Technical Univ. of Darmstadt, Germany, 1907. Member, Inst. E.E., Assoc. Member, Inst. M.E.; 1908-09, Siemens-Schuckert, Rome; 1909-10, Siemens Bros., Dynamo Works Ltd., London; 1910-12, i/c of Madras branch of same company; 1912-13, engr. to Sicilian Chemical Co. and Sulphur Mines; 1914, supervising engr., Ministry of Interior, Egyptian Govt.; Lieut. R.E. (Signal Service) during the War; 1922-24, commercial mgr., Pozzuoli works, Italian Armstrong Co.; 1926-35, managing director, Italian Babcock and Wilcox Co.; at present, manager for Canada and Newfoundland. The Buell Combustion Co. Ltd., of London, England.
References: F. P. Shearwood, A. P. B. Shearwood, W. L. McFaul, W. J. W. Reid, H. A. Lumsden, A. R. Hannaford, E. G. MacKay.

FOR TRANSFER FROM THE CLASS OF ASSOCIATE MEMBER TO THAT OF MEMBER

ELDERKIN—KARL OSLER, of 646 Roslyn Ave., Westmount, Que., Born at Weymouth, N.S., Oct. 27th, 1895; Educ., B.Sc. (Mech.), McGill Univ., 1920; 1916-17, and 1920-21, dftsman., designing jigs and tools, N.S. Steel and Coal Co., New Glasgow, N.S.; 1921, foreman, erecting turbines, D. G. Loomis & Co.; 1922-23, dftsman., St. Lawrence Paper Co.; 1923-25, dftsman. and chief dftsman., Price Bros. & Co. Ltd., Kenogami, Que.; 1925-28, asst. to the chief engr., Abitibi Power and Paper Co. Ltd., Iroquois Falls, Ont.; 1928-29, chief engr., Mersey Paper Co., Liverpool, N.S.; 1929-31, chief engr., 1931-33, asst. mgr. and chief engr., 1933-35, mgr. i/c of all engrg. and operations in Nfld., and 1935-36, gen. manager, International Power and Paper Co. of Nfld. Ltd.; 1937 to date, engr., with John Stadler, M.E.I.C., consltg. engr., Montreal, i/c of purchase and layout of mill equipment. (*St. 1920, Jr. 1920, A.M. 1929.*)
References: R. L. Weldon, C. H. L. Jones, J. Stadler, H. J. Buncke, A. A. MacDiarmid, F. O. White, T. S. Morrisey, F. L. Mitchell.

KINGSTON—THOMAS M. S., of Chatham, Ont., Born at Penetanguishene, Ont., Oct. 11th, 1900; Educ., B.A.Sc., Univ. of Toronto, 1924; R.P.E. of Ont.; 1920-22 (summers), Toronto Harbour Commission; 1925-26, office engr., E. P. Muntz Inc., Buffalo; 1926, asst. to divn. engr., Lehigh Valley R.R., Buffalo; 1926-27, field engr. and office engr., Portland Cement Co., Buffalo; 1927 to date, with the city of Chatham, Ontario, as follows: 1927-28, asst. city engr., 1929-34, city engr. and supt. of water commission; 1934 to date, city engr., city mgr., supt. of waterworks, Sec'y. of Police Commission, Sec'y. of Board of Health. (*St. 1921, Jr. 1927, A.M. 1931.*)
References: G. A. McCubbin, T. R. Loudon, W. A McLean, F. P. Adams, W. C. Miller, C. K. S. McDonnell.

FOR TRANSFER FROM THE CLASS OF JUNIOR

GEORGE—JOSEPH DAVID, of 1331 Henry St., North Battleford, Sask., Born at Urmia, Persia, Mar. 4th, 1908; Educ., B.Sc. (Civil), Univ. of Sask., 1933; 1931, engr. on survey work, City of North Battleford; 1935-37, rodman, then junior engr. on Borden Bridge, Dept. of Public Works of Canada; 1937 (3 mos.), res. engr. on asphalt pavement, Dept. of Highways of Sask.; 1937 to date, junior engr., on constrn. of Dam under P.F.R.A., Dept. of Agriculture of Canada. (*J r.1937.*)
References: J. J. White, R. A. Spencer, H. R. Mackenzie, B. Russell, C. J. Mackenzie, F. G. Goodspeed.

HORTON—EVERILL BLACKWELL, of Riverbend, Que., Born at Toronto, Ont., Nov. 27th, 1906; Educ., B.A.Sc., Univ. of Toronto, 1931; 1929, labourer, Kirkland Lake Gold Mine; 1929, motor car assembly, Durant Motors, aircraft rigging, Ontario Air Service; 1932, research, Electrical Construction Co.; 1933-34, asst. engr., Trans-Canada Airways; 1935, asst. master mechanic, Sturgeon River Gold Mining Co.; 1936-37, machinist, Link-Belt Ltd., Toronto; April 1937 to date, designing engr. and dftsman., Price Bros. & Co. Ltd., Riverbend, Que. Struct'l. design, plant and bldg. mtce., machine design. (*Jr. 1936.*)
References: S. J. Fisher, G. F. Layne, F. L. Lawton, G. H. Kirby, N. F. McCaghey, N. D. Paine.

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References: F. J. Leduc, A. Frigon, A. Surveyer, H. Massue, A. Cousineau, A. Duperron, T. J. Lafreniere, J. G. Chenevert.

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References: J. B. Challies, A. C. D. Blanchard, R. G. Swan, R. N. Coke, J. H. McLaren.

FOR TRANSFER FROM THE CLASS OF STUDENT

BENJAFIELD—JOHN F., of 123 York St., St. Thomas, Ont., Born at London, Ont., July 20th, 1908; Educ., B.Sc., Queen's Univ., 1933; R.P.E. of Ont.; 1929-30, rodman, C.N.R., London; 1933-35, dftsman., Ont. Dept. of Highways; 1935-36, instr'man., City of St. Thomas; 1936-37, instr'man., C.N.R., London; Feb. 1937 to date, field engr., Foundation Company of Canada, at Cornwall, Ont. (*St. 1933.*)
References: J. Ferguson, W. C. Miller, R. E. Chadwick, W. P. Wilgar, W. L. Malcolm.

JOHNSON—JAMES RICHARD, of Montreal, Que., Born at Kamloops, B.C., Oct. 20th, 1910; Educ., B.Eng. (Mech.), McGill Univ., 1934; 1934-35, repair dept., and 1935-36, i/c of repairs and mtce., wood mill and groundwood depts., Laurentide Divn., 1936-37, design of new equipment for wood mill, Consolidated Paper Corporation; Feb. 1937 to date, asst. chief engr., Dominion Rubber Co., Montreal, Que. (*St. 1933.*)
References: R. Ford, T. M. Moran, C. R. Lindsey, W. B. Scott, H. G. Timmis.

JORDAN—JACK McLEAN, of 205 Wychwood Ave., Toronto, Ont., Born at Fenelon Falls, Ont., Oct. 10th, 1910; Educ., B.A.Sc. (Civil), Univ. of Toronto, 1934; Summer 1932, and 1934-35, rodman, acting as instr'man. and dftsman., Ont. Dept. of Highways; 1935-36, sub-foreman, project No. 50, Dept. of National Defence; 1936-37 with Curran & Briggs Ltd., Toronto, i/c of branch office on large paving contract in Ontario; cost accounting; purchase of materials and supplies, etc., April 1937 to Feb. 1938, same as above with additional experience dfting. and estimating. (*St. 1934.*)
References: C. H. Mitchell, C. R. Young, W. J. Smither, R. E. Smythe, W. L. Saunders, J. J. Sears, H. T. Routly, L. E. Jones.

McMANUS—LESLIE HAROLD, of Edmonton, Alta., Born at Lomond, Alta., Aug. 1st, 1911; Educ., B.Sc. (Civil), Univ. of Alta., 1934; 1936-37 (summers), instr'man. and junior engr., Main Highways, Prov. of Alta.; 1936 to date, instructor in civil engrg., University of Alberta, Edmonton, Alta. (*St. 1936.*)
References: R. S. L. Wilson, H. R. Webb, C. A. Robb, W. E. Cornish, J. W. S. Chappelle.

McMATH—ANDREW ALLAN BROWN, of 218 Ontario St., Sherbrooke, Que., Born at St. Lambert, Que., Feb. 26th, 1911; Educ., B.Eng., McGill Univ., 1934; 1933 (summer), fitter, Fairchild Aircraft Ltd., Longueuil; 1934-35, dftsman., Sherbrooke Machineries Ltd.; 1935-36, demonstrator, McGill University; 1936-37, dftsman, compressor dept., and August 1937 to date, i/c of pulp and paper engrg. dept., Canadian Ingersoll Rand Ltd., Sherbrooke, Que. (*St. 1934.*)
References: S. R. Newton, G. M. Dick, E. T. Harbert, C. M. McKergow, E. Brown.

High-Alumina Cements

Pending the issue of a British Standard Specification dealing with the subject of high-alumina cements, the Institution of Structiral Engineers has drawn up and issued a report on the use of such cements in structural engineering. As is also the case with Portland cement, the chemical reactions occurring after setting are not yet fully elucidated, and the recommendations now set forth must be accepted as being rather of an empirical than final character, and although on the safe side they must also be considered in some respects as not altogether supported by practical experience. The conclusions of the report may be summarized as follows:—

High-alumina cement when tested by setting time should invariably be gauged with 22 per cent of water. The setting time may vary widely without the other characteristics of the cement being affected, an initial setting time of between 3 hours and 6 hours is quite normal, while the final set usually takes place within 1½ hours of the initial set. If this initial set is more than 6½ hours, or the final set more than 1½ hours after the initial set, the cement should not be used.

The testing of high-alumina cement for strength is a delicate operation and should be entrusted to professional testers, skilled in the testing of this type of cement. A suitable test would be a compression test on cubes of about 3 in. made by gauging three parts of standard sand with one part of cement and 12½ per cent of water by weight of the cement. Metal moulds should be employed, the bottom edges being smeared with grease to make them water-tight. After filling, the mould should be kept moist for 24 hours. Cubes intended for breaking at a greater age than 24 hours should be removed from the moulds and placed in water. Made in this way, cubes should give a strength of at least 5,000 lb. per sq. in. at the age of 24 hours and 7,000 lb. per sq. in. at the age of 7 days. The strength of such cubes will be found to approximate closely to the strength of a good 4:2:1 washed ballast concrete of the same age and made with the same cement. Cement which, when tested as above, gives a strength of less than 4,000 lb. at the age of 24 hours should not be used, irrespective of the strength which it may give at 7 days.

Most of the aggregates suitable for Portland cement concrete are suitable for high-alumina cement concrete. There are, however, certain exceptions and high-alumina cement is less tolerant of fine dust than is Portland cement in this respect. On the other hand, high-alumina cement is a harder material than Portland cement and the fraction of the fine aggregate between the No. 25 sieve and the 52 sieve is very useful for giving improved workability. Owing to the harshness of high-alumina cement the mixing should be more thorough than is common in mixing Portland cement concrete.

The amount of water theoretically necessary to complete hydration is 40 per cent by weight of the cement. For any mix the ideal amount of water (including that in the aggregate) is 6 gallons per cwt. of cement. Sufficient inert aggregate should be used so that the mix will carry this 40 per cent of water by weight of the cement. It is rarely necessary to use mixtures richer than about 5:1, with an aggregate of ¾ in. maximum size. A richer mix may not produce a stronger concrete, as it is possible that the amount of aggregate will not carry sufficient water for complete hydration.

The damp curing of high-alumina cement concrete is of more importance than in the case of Portland cement concrete and neglect of this precaution will probably be fatal to the production of good concrete. High atmospheric temperatures of the order of 80 deg. F. to 120 deg. F. have an adverse effect upon the strength of high-alumina cement concrete.—*Engineering.*

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THE ENGINEERING JOURNAL

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The Combustion of Pulverized Coal

Henry Kreisinger,

Engineer in Charge of Research and Development, Combustion Engineering Company, Inc., New York.

Paper presented before a joint meeting of the Border Cities Branch of The Engineering Institute of Canada and the Detroit Section of the American Society of Mechanical Engineers, November 16th, 1937.

SUMMARY.—The basic principles of pulverized coal burning in modern furnaces are set forth, as developed from detail studies of the processes of combustion of powdered fuel. The author considers the effects of the nature and quantity of the primary and secondary air supply, the fineness and character of the fuel particles, the characteristics of the ash, the turbulence of the gas streams in the furnace and the furnace temperature.

He describes experimental work on the burning periods of fuel particles at various temperatures and discusses the advantages and difficulties of powdered fuel combustion.

This paper deals with the combustion of pulverized coal with special reference to water-cooled furnaces. It discusses the effect of various factors on ignition and follows the process of combustion through the furnace. The factors considered are the amount of primary air, admission of secondary air, fineness of coal, the percentage of moisture and volatile matter in coal, characteristics of ash, mixing, oxygen concentration and the furnace temperature.

The two most outstanding features in the progress of steam generating equipment within the last 15 or 20 years are the application of pulverized fuel and the development of the water-cooled furnace.

Advantages of Water-Cooled Furnaces

Water-cooled furnaces made possible very large steam generating units, and high rates of combustion. They also practically eliminated furnace maintenance. Water-cooled furnaces can be made large because they are built of tough steel instead of fragile refractories. Expansion and contraction can be easily taken care of because the temperature of the water-cooled walls varies over a much smaller range than the temperature of refractory furnace walls. The temperature of the metal in water-cooled furnaces varies over a range of about 500 deg. F.; the temperature of refractory walls varies over a range of 2,000 deg. F.

High rates of combustion can be used because the sweeping of the burning mixture over furnace walls does not damage the water-cooled steel walls. High rates of combustion require intensive mixing in the furnace in order that nearly complete combustion may be obtained, and intensive mixing in the furnace is always accompanied by sweeping of the flame over the furnace walls. In some designs water-cooled walls are used to change the direction of the flow of burning mixture, and this change of direction produces mixing. Without the intensive mixing in the furnace at high rates of combustion many of the larger particles of coal would pass out of the furnace only partly burned and the flue dust would run high in combustible.

Water-cooled furnaces absorb large quantities of heat, thereby lowering the temperature of the furnace gases and of the ash carried by the gases so that these ash particles do not stick to the boiler tubes and the superheater elements. Such sticking of the ash to the boiler tubes and superheater would clog the gas passages and would make high rates of combustion impractical. At present the limit to high rates of combustion is the slagging of boiler tubes and superheater.

Drawbacks of Water-Cooled Furnaces

There is a general impression that it is difficult to light a fire in a water-cooled furnace, that the fires are unstable at low ratings and that the absorption of heat by the water-cooled furnace walls retards combustion. However, these drawbacks are more imaginary than real; refractory furnaces are just as cold as water-cooled furnaces when fires are started, and the stability of fire at any rating is largely a matter of burner design, air adjustment and a steady fuel supply to the furnace. For easy lighting and stable fires at low ratings the burners should be so designed that only part of the air needed for the complete combustion is supplied with the coal. This makes a rich mixture which ignites readily. Because of this small weight of air the mixture is heated quickly to ignition temperature. When we start a cold automobile engine we choke the air to obtain a rich mixture which ignites readily. In a boiler furnace the additional air needed for complete combustion should be supplied beyond the zone of ignition.

Beyond the temperature required for quick ignition of the fuel nothing is gained by going to higher temperature. In fact there are experimental indications that high temperatures retard the combustion. In some industrial processes we use high temperatures to break down compounds into elementary substances.

Why Pulverized Coal is Favoured

The main reason why pulverized coal firing is favoured over other methods of burning coal is the feature that pulverized coal burns like gas, and therefore, the fires are easily lighted and controlled. Almost any kind of coal can be reduced to powder and burned like gas. A change of coals upsets the operation of pulverized coal plant to a much smaller degree than a stoker fired plant. Pulverized coal furnaces can be readily adapted to burn other fuels that burn like gas.

What is Pulverized Coal?

Pulverized coal is a mixture of small particles of coal varying in sizes from about one millionth part of an inch to about one fiftieth part of an inch, which is a very large range in sizes. If we would magnify a small sample of pulverized coal a thousand times, the smallest particles would be the size of small grains of sand and the largest ones would look like boulders about two feet in diameter; there would be a great many grains of sand to each boulder. Between these two extremes there would be all the sizes imaginable. We would also find many of the smallest size particles clinging together in clusters and others adhering to the surfaces of the large size particles.

Coal is reduced to pulverized form so that it can be kept in suspension in moving air and supplied to the furnace in a stream as a mixture of air and coal. The air gives the mixture its fluidity so that it can be handled and burned like gas.

Another reason for reducing the coal to powder is to make it possible to bring the air closer to the surface of the coal particles so that the oxygen can come readily in contact with it. At a furnace temperature of 2,000 deg. F. a piece of coal one inch in diameter requires for its complete combustion a volume of air contained in a sphere one yard in diameter. If the piece of coal were in the centre of this sphere of air, the average distance of the oxygen molecules within this sphere from the piece of coal would be about 13 in. A particle of coal 0.006 of an inch in diameter, which is the largest size passing through 100 mesh screen, requires a volume of air contained in a sphere 0.22 of an inch in diameter. With the particle of coal located in the centre of this sphere, the average distance of the oxygen molecules within this sphere from the coal particle is less than 0.09 of an inch.

Determination of Fineness

The fineness of pulverized coal is determined by running a sample through a set of screens and obtaining the percentages going through each screen. The usual sizes of screens used for such determination are 200, 100, 50 or 40 mesh screens. Thus, the fineness of pulverized coal may be described as 70 per cent through 200 mesh, 90 per cent through 100 mesh and 98 per cent through 50 mesh screen. The percentage on 50 mesh screen should be small, because this oversize coal usually does not stay in the furnace long enough to be burned to ash. Much of this large size coal is deposited in the soot hoppers or is carried out of the stack only partly burned. It is more important that the percentage on 50 mesh screen be low than to have a high percentage to go through 200 mesh screen. The largest particles going through 200 mesh screen are about .003 of an inch in diameter. The number of these large particles is comparatively small. There are a great many small size particles approaching one millionth part of an inch. These very small particles are mere dust and stay in suspension a long time even in quiet air. Although the total weight of these very small particles is small their number is very large. When pulverized coal is brought into a furnace these very fine particles ignite readily and burn quickly. These particles help to a large extent to start the ignition.

Combustion of Pulverized Coal

It is impossible to make accurate observation of a particle of coal burning in a boiler furnace. Most of the particles are small and hard to see in a burning mixture; they also move fast and burn quickly.

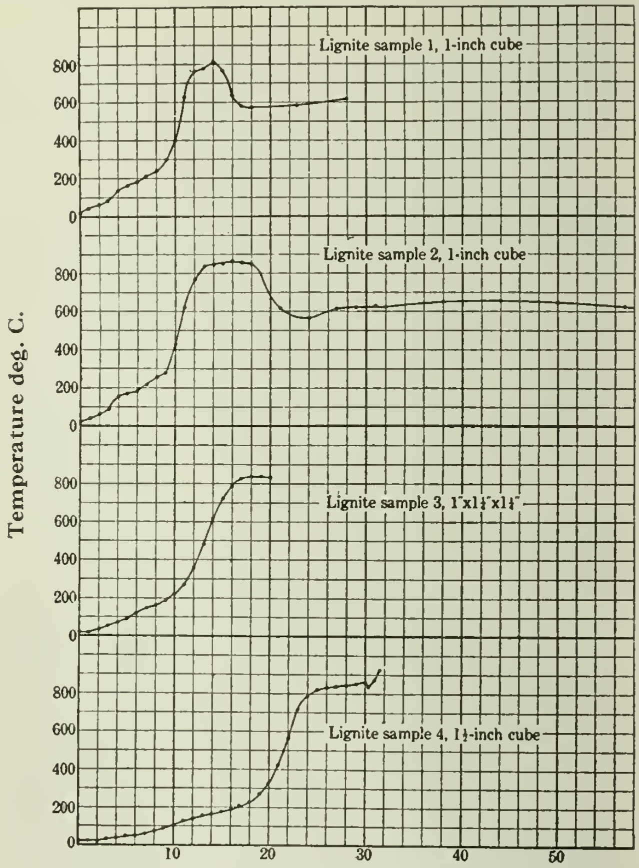
In some cases, however, when the percentage of the oversize coal is high, the very large particles can be seen beyond the tips of the luminous flame as large flaming dots about a quarter of an inch in diameter. This apparent large size of the particles is due to the envelope of flame indicating that the volatile matter is still coming off and burning. After all the volatile matter has been distilled and burned these burning particles appear as bright specks much smaller than the flaming dots.

The length of time coal particles take to go through the process of combustion depends on (1) the size of the particles, (2) the moisture content, and (3) the volatile matter content. The very small particles burn instantaneously. The largest particles take one or two seconds or even more time and many of them never burn completely. Coal with high moisture takes more time because the moisture must be driven off first before the temperature can rise high enough to distil and burn the volatile matter. While the volatile matter is being distilled off, no oxygen can penetrate to the surface of the particle because it is caught by the volatile matter and is combined with it.

Combustion of Cubes of Lignite

The various stages of the process of combustion can be observed in detail with a larger piece of coal. If we take a small cube of coal, put a thermocouple in the centre of it and place the cube in a laboratory muffle furnace, heated to about 850 deg. C., we can observe the rise of temperature inside the cube and study the stages of combustion in detail. Figure 1* shows the rise of temperature at the centre of four such cubes of lignite when they were placed in a muffle furnace. During the first minute the heat received by the cube was used mostly to evaporate moisture. This stage was lengthened by the high moisture content. During the second minute smoky gas could be seen coming out of the surfaces of the cube and at the end of the second minute flame appeared and enveloped the cube. The distillation and burning of the volatile matter continued and at the end of four minutes the edges of the cube became cherry red and small pieces were chipping off. Cracking continued but a large part of the cube stayed together for about fifteen minutes. The temperature at the centre of the cube rose very slowly during the first ten minutes while the moisture and volatile matter were driven off, and then rose rapidly. In the case of a 1½ in. cube the evaporation of the moisture and the distillation of volatile matter took almost twenty minutes.

The remnants of the first two cubes were taken out of the furnace at the end of fifteen minutes and placed on



Time, minutes counted from the instant cube was placed in furnace.

Fig. 1—Temperature Rise in the Centres of Small Cubes of Lignite.

Placed in a muffle furnace heated to a temperature of 850 deg. C. The temperature in the centre of the cubes rises slowly while moisture and volatile matter is driven off.

*Taken from "Combustion Experiments with North Dakota Lignite," U.S. Bureau of Mines Technical Paper 207 (1919).

an asbestos sheet. The temperature in the interior of the cubes dropped to about 600 deg. C. at which point it remained constant for some time. The surfaces of the cube were covered with ash but through the cracks in this ash layer dull red was visible. Evidently enough air penetrated through the layer of ash to the unburned carbon to support a slow combustion which maintained the temperature at about 600 deg. C. Although the ash prevented to a large degree contact of oxygen with the combustible under the ash layer, it also prevented rapid dissipation of heat.

This experiment shows that the heat absorbed by the cube during the first few minutes is used to drive off the moisture and the volatile matter. The temperature of the fixed carbon does not rise appreciably until the volatile matter has been distilled off. The evaporation of the moisture and the distillation of volatile matter takes place first in the outer layers of the cube and gradually penetrates to the centre. The edges and corners are more exposed to the heat and therefore absorb heat faster and lose the moisture and volatile matter in a shorter time. They are brought to glowing temperature before the body of the cube, and the fixed carbon in them would start to burn if the envelope of burning volatile matter had permitted oxygen to come in contact with it. When most of the volatile matter has been distilled off and oxygen can come in contact with the fixed carbon, the latter starts to burn. The fixed carbon burns and leaves the cube in the form of CO_2 but the ash stays behind, gradually forming a protective layer of ash over the remaining fixed carbon. The oxygen that does penetrate the layer of ash and comes in contact with the fixed carbon combines with it to form CO_2 or other carbon compound. This CO_2 thus formed under the layer of ash has the same difficulty penetrating the layer of ash on its way out as the oxygen had on its way in. Thus, the CO_2 is delayed under the ash layer and is in the way of more oxygen making contact with the fixed carbon.

In the burning of pulverized coal the various stages are much shorter, but their relative length and sequence is the same. The length of the stages is greater with the large particles than with the small ones. The ash residue is also a greater hindrance to oxygen making contact with the remaining carbon because there is more of it in the larger particles.

What is Combustion?

The combustion process in a boiler furnace takes place in two steps; first, the coming of the combustible in contact with the oxygen, and second, the chemical combination after the two have come in contact. Obviously the chemical combination can not occur any faster than the contact-making. This is true whether the combustible is in a gaseous or solid state. Above the ignition temperature the chemical combination is instantaneous. Therefore, the rapidity of combustion depends on the rapidity of oxygen coming in contact with the combustible. The rate of contact-making determines the rate of combustion. This is a fundamental principle of combustion in boiler furnaces.

Speed of Chemical Combination

At lower temperatures the speed of the chemical combination is about doubled for every 10 deg. C. temperature rise. It is not known how far up the temperature scale the doubling continues, but assuming that it holds between 100 deg. C. and 700 deg. C., the latter point being approximately the ignition temperature of coal, the speed of chemical combination would be doubled sixty times. The speed is known to be appreciable at 100 deg. C. because if coal is heated to this temperature and loss of heat is prevented, the coal will soon catch on fire. On the above assumption, if the speed at 100 deg. C. is equal to R, the speed at 700 deg. C. would be $R \times 2^{60}$. Thus, supposing that at 100 deg. C. the speed of chemical combination is one molecule per quarter of a century, then at 700 deg. C. there would be one million oxygen molecules combining in one one-thousandth part of a second. It is certain however that this doubling of the speed does not go up to 700 deg. C., but it is also reasonably certain that

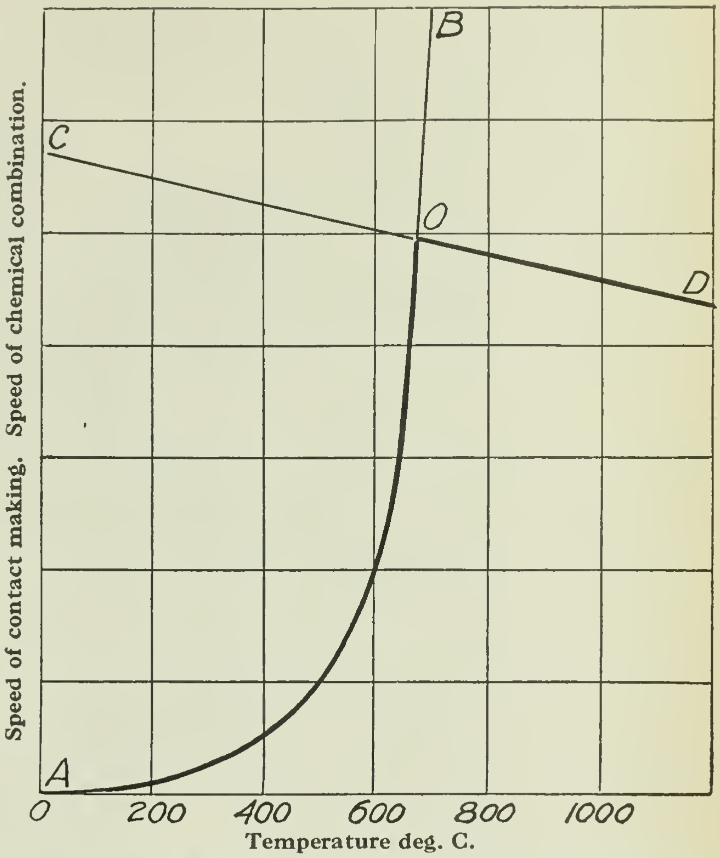


Fig. 2—Relation Between Temperature and Rate of Combustion.

Curve *AOB* represents the variation of speed of chemical combination with temperature. Curve *CD* represents the speed of contact-making. At the left of the intersection point *O* only some of the molecules of oxygen that make contact combine with the combustible; at the right of point *O* all oxygen molecules that make contact combine with the combustible. The speed of combustion is represented by the lines *AOD*.

the speed continues to increase (although at a decreasing rate) up to a temperature of 700 deg. C., and beyond that point to a considerably higher temperature. Eventually a temperature is reached beyond which there is not only no further increase in the speed, but where dissociation comes into play and increases with further rise in temperature until the compounds dissociate as fast as they are formed. However, it is safe to assume that at the temperatures attainable in a boiler furnace the speed of chemical combination is very high, and for all practical purposes is instantaneous at and above the temperature of ignition. Hence the rapidity of combustion depends entirely on the rapidity with which contacts are made.

The relation between the rate of combustion and temperature is shown graphically in Fig. 2, in which the horizontal scale is the temperature, and the vertical scale the rate of chemical combination and also the rate of contact making. The rate of chemical combination is very low at atmospheric temperature but increases rapidly as the temperature rises. It is represented by the curve *AOB*. The rate of contact making is represented by the line *CD* crossing the curve *AOB* at *O*. At the low temperature many molecules of oxygen make contact with the coal particle but only comparatively few combine with the combustible. At these low temperatures the speed of combustion is equal to the speed of chemical combination. As the temperature rises, an increasingly greater proportion of the molecules that make contact combines with the combustible until the point O is reached where all the molecules that make contact with the combustible combine with it. This point may be called the ignition temperature. Above this temperature the speed of combination is as high as the speed of contact making, and the speed or the rapidity of combustion depends entirely on the speed at which contacts are made. The oxygen and combustible must make contact before they can combine. The speed of combustion follows the line AOD. If we wish to increase the speed or rapidity of combustion we must raise the line CD, particularly the part OD. This is done mainly by increased mixing.

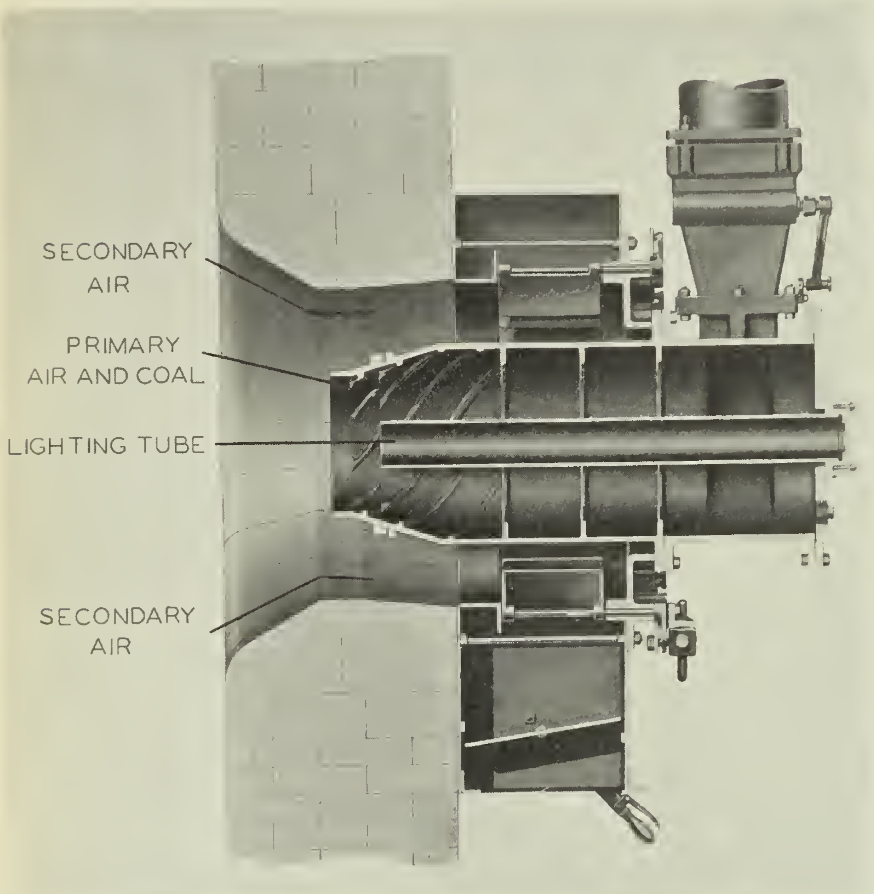


Fig. 3—Burner for Horizontal Firing.

Primary air and coal moves with a rotary motion through the coal nozzle. Secondary air moves with similar rotary motion outside of the coal nozzle and hugs the refractory throat of the burner. The mixture of primary air and coal ignites before the secondary air intermingles with it.

Designing Pulverized Coal Furnaces

The problem for the designer of pulverized coal furnaces is to provide conditions favourable to ignition temperature close to the burner, and rapid contact-making in the burning mixture. Conditions favourable to quick ignition close to the burners are a small amount of air with the coal, fine pulverization, and turbulence. When fires are started in a direct firing system the mill is operated at low milling rate with reduced air flow through the mill. Such operation results in fine pulverization. Rapid contact making is produced by intensive mixing of the burning mixture, and fine pulverization. Intensive mixing takes the burning particles of coal from one place where most of the oxygen has been used up to another place where there is still free oxygen available for combustion. Fine pulverization brings the combustible close to the oxygen.

Bringing Ignition Close to the Burners

Bringing the ignition close to the burner is easier with coals high in volatile matter than with low volatile matter coals. It is difficult with anthracite coal. The quantity of air to be supplied with the coal as primary air should be just about enough to burn the volatile matter. With high volatile matter coal the primary air can be 35 per cent of the total air needed for combustion, with anthracite coal less than 10 per cent. In other words, the amount of primary air expressed in percentage of total air is about equal to the percentage of volatile matter in the coal. This approximate rule is much easier to follow in a storage system than in direct firing in which the quantity of air supplied with the coal can not be reduced below the minimum at which the mill can be operated satisfactorily.

Control of Primary and Secondary Air

In vertical firing the coal is fired vertically downward and the burning mixture makes an upward turn near the bottom of the furnace. Primary air brings the coal in through the coal nozzle. A small amount of air is supplied through the burner around the coal nozzle. Secondary air is supplied progressively through air ports in the front wall after the coal mixture has ignited. This method of firing is well adapted for burning coals with very low volatile matter content, such as anthracite.

In horizontal firing the coal is usually fired through round horizontal nozzles in the centre of the burner as shown in Fig. 3. The mixture of coal and primary air flows through the nozzle with a rotative motion which tends to concentrate the coal in a rich mixture near the walls of the nozzle. The rotative motion also causes the mixture to bush out when it leaves the nozzle and produce turbulence. The secondary air is supplied around the coal nozzle. It enters the burner through a set of vanes in a number of streams so directed to give the flow a rotative motion. This rotation keeps the air close to the throat of the burner and away from the mixture of coal and primary air. The underlying principle is to get the mixture thoroughly ignited before it is diluted by the intermingling of the secondary air. This type of burner is rather sensitive to the volatile matter content in the coal, and is not suited for burning coals very low in volatile matter such as anthracite. With coals high in volatile matter the flame has a tendency to be drawn into the burner and damage it by heat; the throat should be made small. With coals low in volatile matter the ignition starts too far from the burner and is unstable; the throat should be large.

In corner firing there are one or more burners (as shown in Fig. 4) in each corner of the furnace. The streams of coal and primary air are directed towards the centre of the furnace tangent to a small circle. The secondary air is supplied partly around the coal nozzles and partly through secondary air ports either above or below the coal nozzles. The air around the coal nozzles is regulated to keep the ignition close to the burners without backing into them. Most of the mixing occurs in the furnace where the streams of coal and air meet. This method of firing is suitable for coals low in volatile matter.

Starting and Holding Ignition

The mixture of coal entering the furnace is heated by the flame of the already burning mixture near the burner. The heating of the coal distils the volatile matter which makes a readily ignitable mixture with the primary air. When this mixture is ignited it burns with a hot luminous flame which radiates heat to the incoming mixture of coal and air. The hotter this flame the more heat is radiated by it to the incoming mixture, and the quicker the volatile matter will be distilled and the gaseous mixture brought up to ignition temperature.

To hold the ignition close to the burner the incoming mixture or part of it is brought in with a turbulence. That is, part of the stream of the mixture is made to branch off on each side of the main stream nearly at right angles to the general direction of flow, thus producing eddies or turbulence, greatly reducing the velocity of that part of the mixture in the direction from the burners into the furnace. Thus, the velocity of the mixture in the coal nozzle before the branching off of parts of the stream may be 100 ft. per sec. In the parts that are branched off two thirds of this velocity may be spent in eddies or turbulence, leaving only one third of the velocity in the original direction away from the burner. The slowing down in this direction causes the stream to bush out and expose a wider front to the radiant heat. The result is that this turbulent part of the stream becomes heated to ignition temperature before it moves an appreciable distance from the burner. The temperature of the flame after ignition has started is necessarily much higher than the ignition point because the mixture must be brought to this temperature to start the ignition, and when combustion is started the heat generated by it greatly elevates the temperature of the burning mixture, causing it to expand and producing additional bushing out of the stream.

Figure 5 shows three methods of producing turbulence at the burner. The tips of the coal nozzles are modified to produce eddies and bushing out of the stream of the coal mixture. In *A* two strips are placed in the tip of the nozzle; in *B* the tip of the nozzle is serrated; in *C* the tip of the coal nozzle is riffled. These methods are applicable to vertical firing and tangential or corner firing.

Enlarging the cross section of the coal nozzle and thereby reducing the velocity of the entire stream of the mixture will not accomplish the desired results, because the energy for mixing is lacking. Furthermore, the reduction of the velocity of mixture in the delivery pipe and the burner nozzle is likely to cause the larger particles of coal to drop out of suspension and result in drifting.

Concentration of Oxygen in a Boiler Furnace

When air is supplied to the furnace, it contains nearly 21 per cent of oxygen. As the process of combustion goes on the oxygen is reduced at first very rapidly and then more slowly to about 2 per cent at the point where the gases leave the furnace. Simultaneously, CO_2 is formed, taking the place of free oxygen. The very small particles burn first because they have a small amount of combustible in them and because most of the oxygen needed for their combustion is near to them. The large particles of the coal burn only partially while the free oxygen is at high concentration. Their combustion must be completed after the concentration of free oxygen in the furnace gases has been greatly reduced. It becomes increasingly more difficult for the unburned part of the large particles of coal to make contact with the free oxygen, because these oxygen molecules are far apart and the inert gases, nitrogen and CO_2, are in the way of their free movement. If we had to depend on natural diffusion the rate of contact making of the oxygen with combustible would be slow. To speed up the rate of contact making intensive mixing is needed. The coal particles must be moved from places where all the oxygen has been used up, to others where there are still some free oxygen molecules.

Mixing requires energy which is usually supplied in the form of high velocity air streams. Such air streams are directed to produce turbulence. Usually these air jets are made to impinge against one another, or give the burning mixture a rotative motion nearly at right angles to the general flow of the gases through the furnace. In this rotative motion the furnace walls play an active part, because they force the burning mixture to make turns. Only water-cooled walls can be used for this purpose; refractory walls would be damaged. In many commercial boiler furnaces practically all of the secondary air is supplied through the burners or near them. There is intensive mixing near the burners, but by the time the burning mixture has moved a comparatively short distance from the burners the energy brought in by the air is all spent, and the gases then flow through the remaining part of the furnace in parallel streams with very little intermingling between them. All the factors for producing rapid combustion, fine coal, turbulence, and high oxygen concentration are in action near the burners. The fine coal particles are burned completely near the burners; the large particles must complete their combustion in the last part of the furnace where the concentration of oxygen is low and where there is only a limited turbulence.

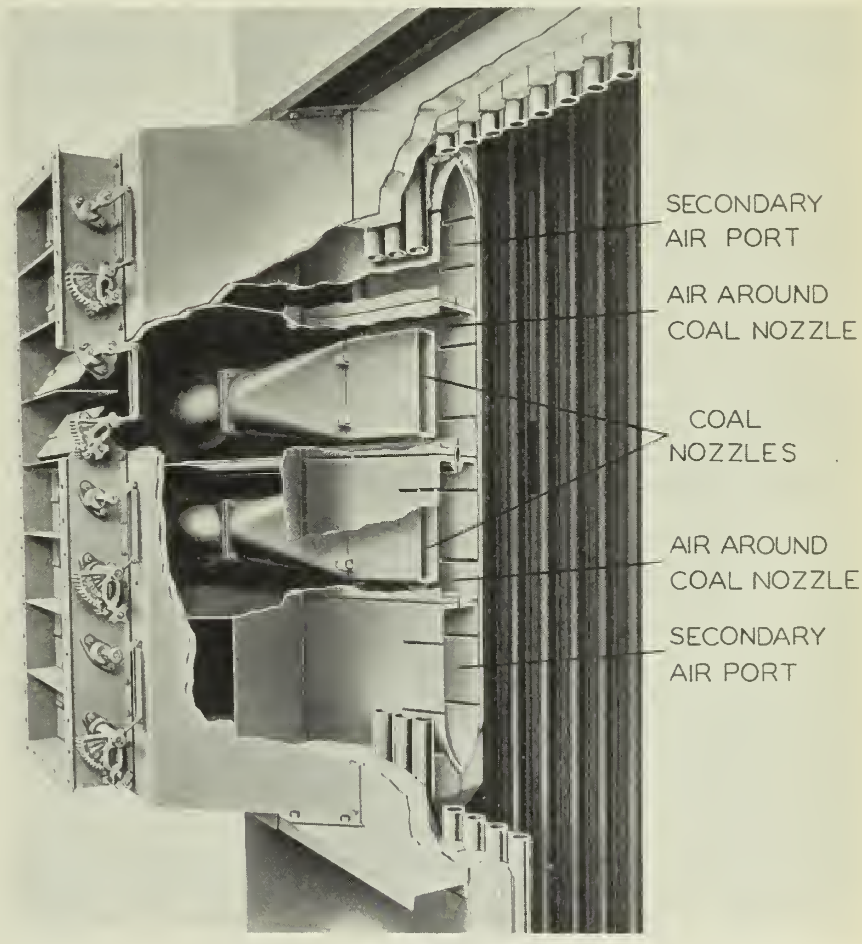


Fig. 4—Burners for Corner Firing.

Primary air and coal flows through the coal nozzles. Secondary air flows through the air ports above and below the coal nozzles and intermingles with the coal mixture coming from the nozzles after ignition has started. When flame is too close to the burner some secondary air is admitted around the nozzles.

In Fig. 6, curve *A* shows graphically the concentration of oxygen along the path of the burning mixture through the furnace. The drop in oxygen concentration is proportional to the rapidity of combustion. At the burners just when the ignition starts the concentration is nearly 21 per cent. The mixture consists of all the coal and the primary air which is about 40 per cent of the air needed

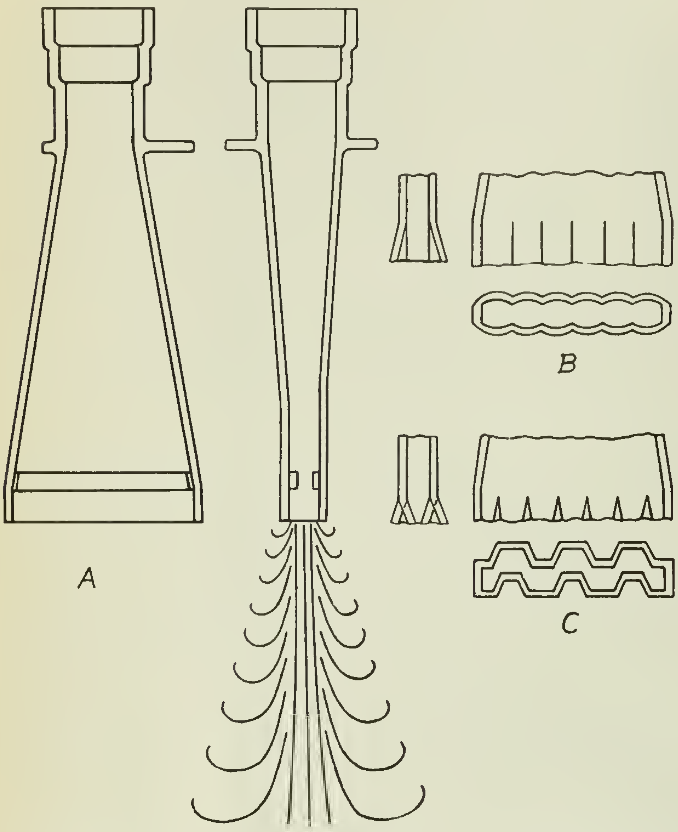


Fig. 5—Methods of Producing Turbulence at the Tip of the Coal Nozzle.

In *A* turbulence is obtained by inserting two strips in the tip of the nozzle. In *B* the tip of the nozzle is serrated. In *C* the tip has the shape of a riffle divider.

for complete combustion. Just beyond the point of ignition the secondary air is supplied either through the secondary air ports of the burners or through separate air ports near the burners. This secondary air consists of the remaining 60 per cent of air needed for combustion plus about 15 per cent excess air. The slow drop in the concentration of the oxygen up to this point is due to the addition of the secondary air. The concentration of oxygen then drops very rapidly due to the high initial concentration, intensive mixing produced by the addition of secondary air, and large percentage of superfine particles in the coal. As the energy brought in with secondary air is spent in mixing, and as the very fine coal particles are burned up, the concentration of oxygen becomes low and drops more slowly until in the last part of the path of the burning mixture the drop of oxygen concentration is very slow. It is during this last part of the path that the large particles of coal must complete their combustion. Some of these large particles do not complete their combustion and are deposited in the soot hoppers or pass out with the gases. They form most of the combustible found in the flue dust.

Supplying Secondary Air at More Than One Point

A better air supply design would be to supply the secondary air in three stages; about 55 per cent through or near the burners after the ignition has been well started, 10 per cent at about one fourth of the path of the burning mixture from the burner, and another 10 per cent about half way in the furnace. The two last additions of the air should be supplied at as high velocity as possible in order to bring in a large amount of energy for mixing. The concentration of oxygen under this condition of air supply would be somewhat like that shown by the dotted curve *B*. The lower oxygen shown at the end of the furnace indicates more complete combustion of the large particles caused by the additional mixing.

Observation of Burning Particles in Furnace

The burning of what is left of the large particles of coal at the end of the furnace can be seen by looking against the darker surface of the furnace walls or boiler tubes. These burning particles appear as bright hot specks in the passes of the boiler, and sometimes they come out through an observation door and complete their combustion outside the furnace. They are hard to see against the background of bright hot refractory furnace walls so that it is easy to reach the conclusion that there are not any, and that the combustion is complete. However, a closer observation shows their presence.

Excessively High Temperature Not Needed for Quick Combustion

Water-cooled furnaces absorb heat and thereby lower furnace temperature. It is a common impression that this reduction in furnace temperature retards combustion. The basis for this impression is the common observation that rapid combustion is accompanied by high temperature. We are apt to reason that the high temperature produces quick combustion and that we must have high furnace temperature to obtain rapid combustion. However, the fact is that the rapid combustion causes the high temperature, and that the rapid combustion is caused by intensive mixing, fine pulverization, or some other factors.

But there is a good experimental evidence that high temperatures beyond the ignition point actually retard combustion. Table I* gives the results of experiments made at the U.S. Bureau of Mines. These experiments were made to determine the burning periods of carefully sized fuel particles at furnace temperatures varying from about 670 to 1,000 deg. C. (1,238 to 1,832 deg. F.). The table shows that the burning periods are considerably longer at 1,000 deg. C. than they are at 750 deg. C. That is, raising the furnace temperature from 750 to 1,000 deg. C. increased the length of time necessary for burning about 65 per cent.

Table I

Temperatures and Indicated Burning Periods of Certain Sizes of Fuels

Furnace temp. deg. C.	−45 +50 Coal milliseconds	−45 +50 Semicoke milliseconds	Coal, same weight particle as −45 +50 Semicoke milliseconds
750	282	275	214
800	317	308	240
850	367	342	276
900	386	374	308
950	436	410	336
1,000	406	455	368

The experiments were made in a small furnace shown in Fig. 7. The furnace was about 3 ft. high and hexagonal in cross section, the sides of the hexagon being 1 in. wide. The sides of the furnace were made of nichrome ribbons and were heated by passing electric current through them. There were slots about ½ in. wide in two opposite corners

*Tables I and II and Figs. 7, 8 and 9 are taken from Co-operative Bulletin 50, U.S. Bureau of Mines, Mining and Metallurgical Investigations (1931).

TABLE II
WEIGHT OF FUEL PARTICLES

Fuel	Mesh	Number of particles weighed	Weights per 100 particles
			Mg.
Coal	−45 +50	1,000	2.8
Semicoke	−45 +50	1,000	1.4
Charcoal	−45 +50	1,000	1.8
Coal	−50 +60	500	1.9
Coal	−80 +90	1,000	0.73
Beehive coke	−45 +50	1,000	3.1

of the hexagon, covered by mica and forming windows for observation. The outside of the furnace was protected by insulation against rapid cooling. During any one set of experiments the temperature was kept nearly constant. Carefully sized fuel particles were dropped in and the period of their combustion was recorded through the mica windows on a photographic film which was attached to a revolving drum. The burning particles showed tracks on the film, and with the speed of the rotation of the film known the period of combustion could be determined within 5 milliseconds.

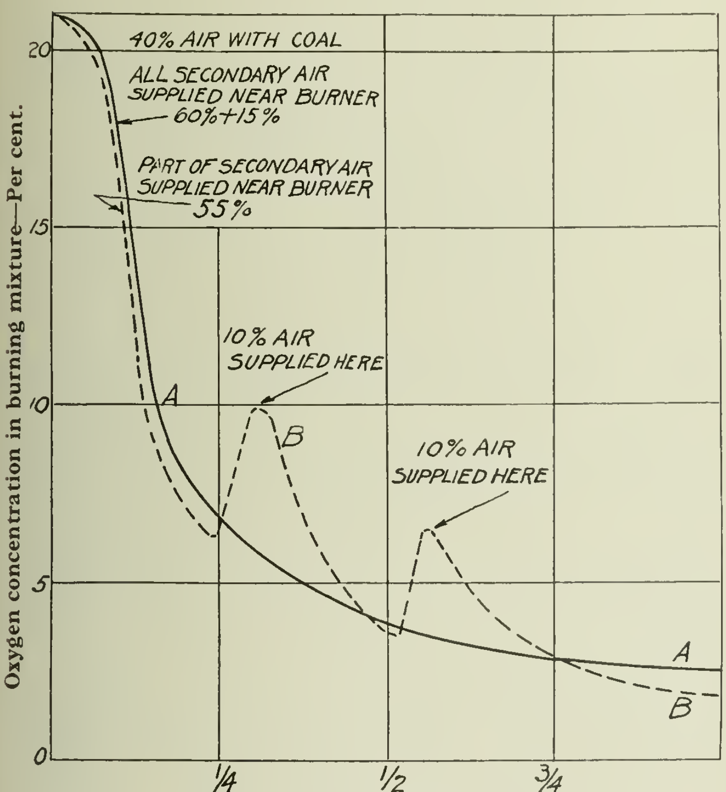


Fig. 6—Curves Showing Oxygen Concentration in Furnace Gases.

Curve *A* shows the oxygen concentration when all of the secondary air is supplied near the burner. Curve *B* shows the concentration when the secondary air is supplied at three points along the path of the burning mixture to maintain turbulence. Total air is 15 per cent excess in both cases.

Most of the tests were made with bituminous coal and semicoke of the following analysis:

	Coal	Semicoke
Moisture	1.4	2.1
Volatile matter	32.5	13.8
Fixed carbon	56.3	71.6
Ash	9.8	12.5
Sulphur	1.0	1.1
B.t.u. per lb.	13,260	12,760

Figure 8 shows the tracks of burning particles of bituminous coal burned at a furnace temperature of 1,000 deg. C. Note the initial short thick portion of the track which represent the combustion of the volatile matter which burned with flame. After the volatile matter has burned the combustion of the fixed carbon showed a narrow track indicating combustion without luminous flame.

Similar photographs of burning charcoal particles showed the absence of the thick initial portion of the track; there being practically no volatile matter to burn, there was no flame.

Figure 9 gives a graphical summary of the results of the experiments. Note the definite and pronounced lengthening of the periods of combustion with temperatures.

The results of these experiments somewhat surprised the experimenters because the results were contrary to the common conception. The experimenters are sure that the combustion was complete at all temperatures, and that the results are trustworthy. They are not able to explain the retardation of combustion by higher temperatures.

Why should higher furnace temperatures retard or speed up combustion of pulverized fuel?

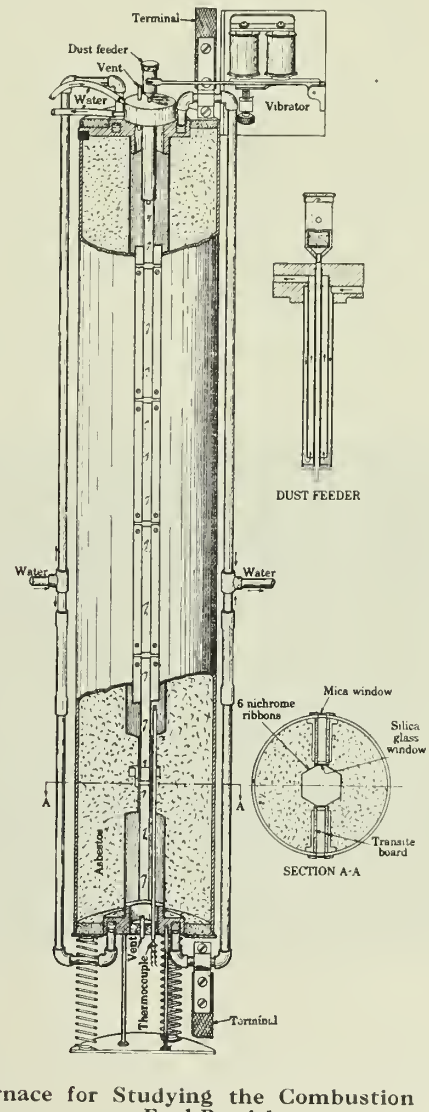


Fig. 7—Furnace for Studying the Combustion of Individual Fuel Particles.

It has been stated in this paper that the rate at which oxygen makes contact with the combustible determines the rate of combustion. If we can find how rising temperature affects the rate of contact making, we can find the answer to the above question. The oxygen is a part of the gaseous mixture in the furnace. The combustible is the solid carbon in the particle of pulverized fuel. The furnace temperature is the temperature of the gaseous mixture in the furnace. The temperature of the burning particle of fuel is higher than the temperature of the surrounding gaseous mixture because the heat generated by its combustion raises its temperature above that of the surrounding gases. There is a sharp temperature gradient from the burning particle to the surrounding gases. The following factors come into play with rising furnace temperature:—

(*a*) The molecular speed increases as the square root of absolute temperature. This greater molecular speed causes the oxygen molecules to hit harder when they make contact with the carbon particles, and thereby may increase the velocity of chemical combination. However, inasmuch as the rate of chemical combination is already very high and the rate of combustion depends entirely on the rate of contact-making, the harder hitting does not affect the rate of combustion.

The molecular speed affects directly the rate of contact-making, therefore, the rate of contact-making should increase as the square root of the absolute temperature.

(*b*) The density of the furnace gases decreases as the absolute temperature rises. There are fewer oxygen molecules in a given volume of furnace gases, and the rate of contact-making should decrease in proportion to the density. This decrease should be inversely proportional to the absolute temperature.

(*c*) The viscosity of gases increases with temperature. That is, as the temperature rises the resistance to movement of the particle of coal through the gases increases. It requires greater force to move the particle of coal out of one place where all the free oxygen has been consumed to another place where free oxygen is available; or, the same force causes a slower and shorter movement. The higher viscosity

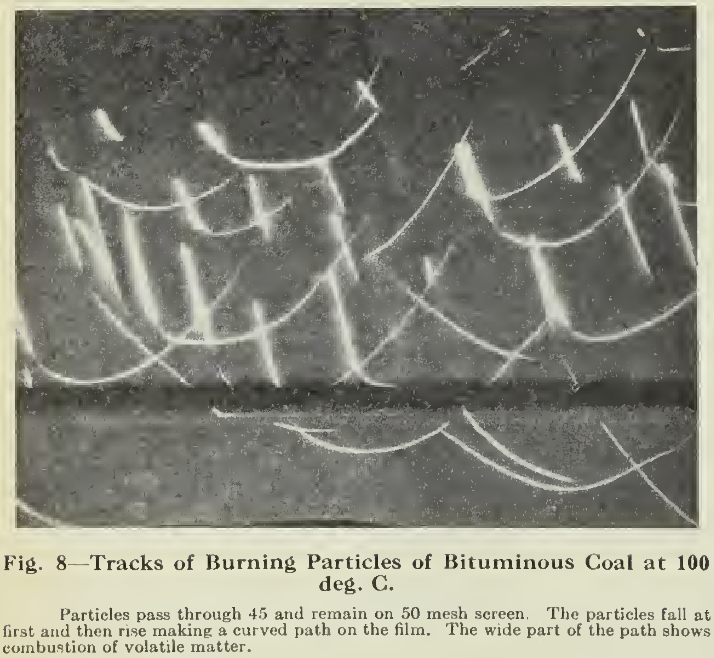


Fig. 8—Tracks of Burning Particles of Bituminous Coal at 100 deg. C.

Particles pass through 45 and remain on 50 mesh screen. The particles fall at first and then rise making a curved path on the film. The wide part of the path shows combustion of volatile matter.

causes the moving coal particles to drag with them the CO_2 formed by the combustion, thus reducing the access of free oxygen to the surface of the particles.

The combined effect of the higher molecular speed and lower density of furnace gases caused by the rise of furnace temperature from 700 to 1,000 deg. C. may decrease the rate of contact making in the ratio of 1.14 to 1, and at the same time the viscosity increases 20 per cent thus probably decreasing the rate of contact making in the ratio of 1.20 to 1. The combination of these factors would decrease the rate of contact making in the ratio of 1.37 to 1. In other words, the lengthening of the burning period would be about 37 per cent. The observed lengthening of the combustion period was 65 to 70 per cent.

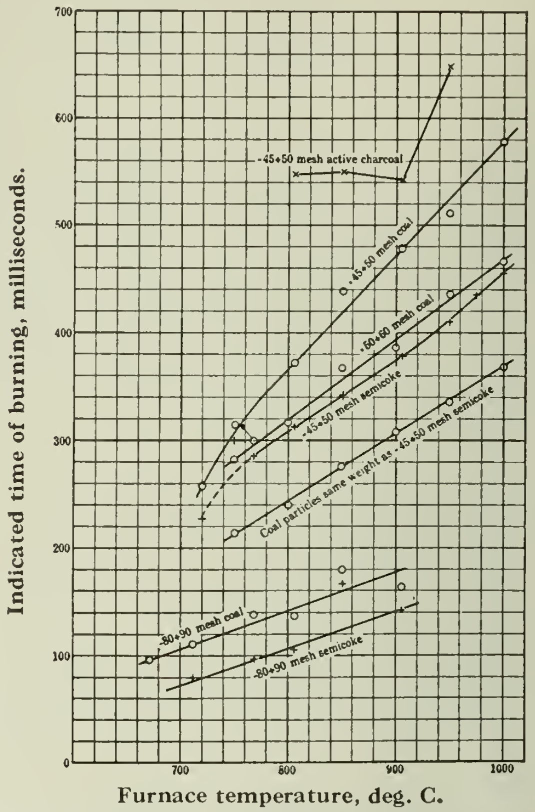


Fig. 9—Time Required for Burning Powdered Fuels of Three Sizes at Various Furnace Temperatures.

The combustion in the experimental furnace was quicker than it is in a boiler furnace, because the oxygen concentration in the experimental furnace was kept constant at 21 per cent. In a boiler furnace the concentration varies from 21 to about 2 per cent. The average concentration in which the large particles burn probably does not exceed 6 per cent. The rate of contact-making and, therefore, the rate of combustion is proportional to the concentration.

There may be a tendency to belittle the value of the results of the experiments because they were made in a small laboratory furnace. However, laboratory methods are the best means to acquire exact knowledge. In studying a process like combustion which depends on so many factors, only one factor at a time should be varied, keeping the other factors constant. The laboratory apparatus is designed to make this possible.

The experimenters did this, and thus were able to determine the effect of furnace temperature, size of fuel particles, and the kind of fuel on the rapidity of combustion.

In an attempt to make a similar study with a boiler furnace it is impossible to control the various factors with any degree of accuracy. The result is that one factor may be credited with the benefit caused by others. The results of the laboratory experiments cited in this paper may help us to turn our inquiry more directly to the real causes of our present troubles.

Most of the difficulties with pulverized coal combustion occur at low ratings and it is easy to put the blame on cold furnaces. The true cause may be too much air with the coal, supplying secondary air too close to the burner and thus interfering with ignition, and supplying both the primary air and secondary air at very low velocity, too low for any effective mixing. The coal delivery pipes, the coal nozzles, the secondary air ports are designed for the full capacity of the unit. The cross section areas of these parts are made to give sufficiently high velocity for good mixing and good combustion at full rating. The low ratings are left to take care of themselves. It should be borne in mind that the velocity of the coal mixture, and of the secondary air entering the furnace is a measure of the amount of energy supplied to the furnace for mixing. At half rating the velocity is about one half, and the energy is one fourth, of what they are at the full rating; at one quarter rating the energy is about one sixteenth of the energy at full rating. Lower flow is obtained by partly closing the dampers in the air ducts which dissipates the energy at the damper; the cross section areas of the coal nozzles and air ports remain unchanged. The worst factor at low rating is the use of more air with the coal than is required for good ignition. The velocity in the coal delivery pipe cannot be reduced below a certain minimum, otherwise there would be coal deposition and drifting in the pipe, which would result in intermittent coal supply to the furnace and even plugging of the pipes. In direct firing there must be a certain amount of air flow through the mill which is seldom the right amount for quick ignition. All these factors affect the combustion and their effect can not be nullified by a refractory furnace.

The association of rapid combustion and high temperature is so familiar that we do not stop to inquire which is the cause and which is the effect. The reluctance to question accepted and apparently obvious conceptions is an old trait of man. He has observed the sun moving across the sky for thousands of years and was thoroughly convinced that the sun was moving. It was obvious, he could see it moving with his own eyes. Nevertheless the sun was standing and the earth was moving all that time.

The water-cooled furnaces have many good qualities to recommend them. They also have some drawbacks, but apparently retarded combustion is not one of them.

DISCUSSION

Ralph Briscoe[1]

In his paper the author has apparently taken into consideration the basic principles of combustion of pulverized coal in connection with the most modern design of boiler and furnace. He stated that water-cooled furnaces absorbed a large quantity of heat, thereby lowering the temperature of the furnace gas and of the fly-ash carried by the gas. As a result these entrained ash particles do not stick to the boiler tubes and the superheater elements.

In the writer's opinion, the application of pulverized coal antedated the development of the water-cooled furnace as we now know it by a good many years. There were, though, very few installations made burning pulverized fuel that did not have some water cooling of the furnace even if it was only a hearth screen. The operation of these furnaces was very interesting from the standpoint of attempting to maintain low and constant furnace temperature over a wide range of rating and maintain these conditions over long periods of operation of the boiler.

In this connection furnaces were designed of relatively large size to keep down the heat liberation per unit of volume. Also knowledge of the time element necessary for complete combustion of pulverized coal in suspension was very limited. The writer wonders if the latter was not more the reason than the former. Pulverized coal furnaces were designed for a heat liberation not much in excess of the stoker, and the stoker installations had been tolerated without water-cooled furnaces because we did not know any different. With the stoker, apart from the high furnace maintenance cost, most of the trouble due to clinker and slag was in the stoker itself. With pulverized coal burning in suspension, the ash would be in suspension and might stick or adhere to the walls with results only too well known. And stick it did in the early installations, not only on the walls but on the hearth where in some cases it was removed with chisel bars and sledges.

The use of pulverized coal had come to stay. For the expected increase in efficiency, greater flexibility and adaptability to larger installations looked very desirable to the power plant designer in comparison with the then stoker. However, something had to be done with the furnace. The early installations demonstrated that the solid refractory wall was far from being suitable, and, in fact, would be the retarding factor in the application of pulverized coal. But at this time, the air-cooled wall was developed. This generally consisted of a 9 in. refractory wall held back to another outer wall by rows of headers with an air space between the two. A part of the air for combustion was admitted with the coal and the balance circulated between the two walls.

The thought that prompted this was that the inner wall would be kept sufficiently cool with the circulating air so as to help keep the furnace temperature down somewhat and keep the refractory from melting and the ash sticking to it, but, more particularly, the writer believes it was expected to reduce the thermal stresses that would be set up in a thick, heavy wall.

Space will not permit of a review of all the interesting experiences obtained in the operation of large furnaces 25,000 cu. ft. in volume and over 60 ft. high, built with the so-called air-cooled wall.

On these refractory walls, there was a tendency to accumulate, even if it was fragile, a layer of slag over parts of the refractory surface which shaded some of the heat-absorbing surfaces, and which, in turn, resulted in softening this slag, perhaps forming a ledge and then a concentration of flame on this part of the furnace with detrimental results. There would be some coating of the front bank of tubes and what little extra cooling medium was employed, with slag or ash in different forms, necessitating periodic cleaning and scraping to bring the furnace temperature back somewhere near that desirable and tolerable.

The writer has always thought of the change in furnace temperature with this change in furnace conditions as "furnace sensitivity," all brought about by the ash sticking to the side walls, the front bank of tubes and the hearth screen. The writer wonders how much or what would be the furnace sensitivity of a completely water-cooled furnace burning pulverized coal of low ash-fusing temperature, operating at a comparatively high rating. Can the furnace temperature be maintained sufficiently low so that the ash when projected at high velocity against the tubes won't be so molten as to stick to the tubes?

The author has pointed out that almost any kind of fuel that can be pulverized can be burned. He also pointed out that temperature above that required for ignition

[1] Plant Engineer, Trenton Channel Power House, Detroit.

are not necessary, and, in the writer's opinion, are very undesirable, for, if we are to burn coals with low fusing temperature ash, the furnace temperature should be kept as low as possible. For at high ratings, we are apt to have high velocities of the gases entering the first bank of tubes and the superheater. If these gases carry the very fine ash in a molten condition at high velocity, it will be projected against the tubes.

Can a water-cooled furnace be designed with a very low sensitivity rating? Can the designer, within reason, predict in advance what the furnace sensitivity will be when burning a certain grade of coal? With the boiler proper reaching a greater perfection in design from a mechanical standpoint and with a furnace of low sensitivity and refractory maintenance costs practically eliminated, is the cleaning of the furnace and cleaning off of the tubes and the water-cooling surface to be the cause of the major outage factor as is now the case in some refractory installations?

There is another very important factor not to be lost sight of in connection with furnace sensitivity. That is the superheater design. It has been recognized for some time that a nearly straight line of temperature for the superheated steam is desirable. It seems that outside methods—that is, methods used outside the boiler setting—to obtain straight line superheat have given way to the control of the distribution of the gases over the water and steam heat-absorbing surfaces. With low furnace sensitivity, the designer's problem is much easier. It is unfortunate that the author was not asked to review the design of superheaters and the control and distribution of the gases through the boiler passes and over the superheater in connection with his paper. His knowledge of the subject in connection with large installations would have made it very interesting.

The author states that the impingement of flame against the side of the furnace does not damage the water-cooled wall. It is the writer's belief that impingement of flame against water tubes is undesirable unless circulation is exceptionally good.

He has also stated that the stability of fire is largely a matter of burner design. Has not the use of preheated air played a great part in the stability of fire, reduction of carbon in the ash and high rates of combustion? Is there an upper limit from the combustion standpoint above which it is not desirable to go? A discussion of this question would be of interest.

With the older style of furnace when only a small portion of the air for combustion was admitted with the coal, it was an interesting experiment, mostly cut and try, to determine where and in what portions the balance of the air should be admitted at each place. Contrary to some opinions combustion should not be completed close to the burner, but should envelope the whole of the furnace and be complete before entering the boiler tubes.

The changes which have taken place in the last 15 years in the application of pulverized coal, the development of the equipment to produce it in proper form and the development of the water-cooled furnace, have been so great that only those who have had experience with an installation of recent design are in a position to discuss them with authority. From the bin and feeder system of 15 years ago to the present unit system with its improved burner, improved mill and classifier, and the all water-cooled furnace is a very great step. Again it is unfortunate that the author was not asked to discuss, if only in a limited way, the part the mill with its complement of auxiliaries plays in connection with success of any pulverized coal installation. Coal in all its different forms is a very complex mixture and to reduce a larger share of its different forms in one piece of apparatus to usable material in pulverized form is an achievement.

The author in presenting the basic principles has left nothing to be desired.

E. A. Sitter[2]

The author has stated many advantages of using water-cooled furnaces and has covered them very thoroughly with the exception of the one pertaining to feedwater treatment. Before heat absorbing surfaces surrounded our furnaces the question of feedwater treatment was not of such vital importance as it is today. The installation of the water-cooled furnace has made it necessary to treat the feedwater to the extent of keeping the heating surfaces entirely free from scale and dirt and to maintain them so continuously. Not only has this practice effected a saving in maintenance costs but it has also contributed largely to higher boiler and furnace efficiencies.

Pulverized fuel fired in water-cooled furnaces makes a very flexible arrangement. Changes in steaming rate of the boiler can easily be followed, but they also set up a problem of water level control in the boiler. A sudden change in steaming rate will tend to change the level of the water because of the difference in density of water in circulation through the wall tubes. The writer would like to ask Dr. Kreisinger if he has had any trouble maintaining water level in pulverized fuel fired boilers where there were wide fluctuations in steaming rate.

Pulverized fuel is sometimes difficult to ignite in the case of starting a fire, but this is not because the furnace is water cooled. The difficulty lies in the fact that the air which carries the fuel from the pulverizer to the furnace and that supplied for combustion is at a temperature below that at which pulverized fuel will readily ignite. The temperature of the air and the coal must be raised to and maintained above the igniting temperature by lighting torches of ample capacity until such time as preheated air at reasonably high temperatures is available. A question arises regarding the fuel that should be used for the torches, What are the advantages and disadvantages of fuel oil versus natural gas?

Pulverized fuel fired furnaces lend themselves very easily to maintenance of fuel air ratios and thus maintain a low excess air value in combustion at all times; however the design must be such that an interruption in coal feed from one pulverizer will not seriously reduce the steaming rate of the boiler and the combustion control regulators must be easily and quickly adjusted to establish a new correct fuel air ratio, otherwise the furnace efficiency will be considerably lower and there is danger of losing ignition. What precautions should be taken when taking one pulverizer out of service where two are supplying fuel to one boiler? Where in the conventionally designed tangential burner will the greatest heat release occur?

The writer would like to ask the author whether it is possible to obtain bituminous coal so low in volatile matter that ignition cannot be maintained? What changes in distribution of air entering the furnace should be made for coals of high volatile content as compared with coals of low volatile matter? Where a plant has a load which varies from high rating to low rating on boilers is it advisable to select a fuel with high volatile content rather than low volatile content to support ignition at low rating loads? In the plant in which the writer is, they have always admitted the major volume of air around the coal nozzles, believing this method will stimulate turbulence. Is this method preferable to the one that admits secondary air through the regular air passages and retards the flow of air around the coal nozzles? Is it not a fact that considerable

[2] Chief Engineer of Power Plants, Chevrolet-Forge Division of General Motors Corporation.

savings can be made with a pulverized fuel plant versus a stoker fired plant where operation is on a five-day per week basis because of the fact that no banking is required?

They have had some interesting experiences in burning wet coal. Recently ⅜ in. Pittsburgh No. 8 screenings containing 10.6 per cent moisture were pulverized. No difficulty was experienced anywhere along the coal path from the bunker to the Richardson scales, to the feeders located fifteen feet above the pulverizers, in the pulverizers, nor in the coal pipes to the burners with one exception, that was in the coal pipes between the feeders and the pulverizers. The design of these pipes is such that the coal fell about 12 ft. and then turned an angle of 25 deg. to the pulverizer. It was at this turn that stoppage occurred. The design of the pipe was altered to eliminate this angle as much as possible by dividing it between two angles of approximately 11 deg. and 14 deg. respectively. While this alteration improved conditions materially it did not produce a satisfactory solution, some stoppage still occurred. It was then decided to admit sufficient preheated air to the feeder pipe to maintain 140 deg. temperature air within the pipe; this was done with satisfactory results, no stoppage has occurred since these changes were made. It appears as though preheated air could be used in the mill feeder pipes advantageously, as standard practice. The writer wonders what the experiences of other operators of pulverized fuel plants has been in this respect.

C. Showers[3]

The writer was particularly interested in the experimental data submitted by the author showing the indicated burning periods of certain sizes of fuels at various furnace temperatures and his explanation of why they are at variance with what is usually true of chemical reactions. While there undoubtedly remains a great deal to be learned about the art of steam generation by powdered fuel firing a tremendous amount of dependable data has been accumulated during the past ten years. Designers and operators can go about their work today with much greater confidence than was the case only a few years ago.

While it is true that the most important source of heat for ignition lies in the propagation of flame along the fuel stream, or along eddy currents of that stream, and that a well designed burner will maintain ignition in the open air, it is also true that for boilers up to 1,500 boiler hp. where one direct firing mill and one burner is used and continuity of operation is important, it is safer to have some uncooled refractory in the furnace wall in which the burner is located so that in case of a slight interruption in the fuel supply to the burner due to mill feeder stoppage, caused by wet coal or foreign material, the heat from the refractory will ignite the coal stream immediately when it again issues from the burner.

It might be well to point out that regardless of the fact that combustion of fuel progresses more rapidly at lower temperatures, it is also true that the rate of heat absorption by water walls drops much faster than the furnace temperature. For instance, one square foot of projected tube area will develop 2.4 boiler hp. at a furnace temperature of 2,350 deg. F. whereas the same area will only develop 1.2 boiler hp. or half as much at 1,900 deg. F., so that on a basis of first cost it is possibly more economical to design for the highest furnace temperature possible with respect to the fusion temperature of the ash and try to design the burner so that the coal particles pass through the furnace by such a tortuous path that they have sufficient time to burn before entering the tube bank.

[3] Assistant Chief Engineer, Windsor Works, Canadian Industries Limited.

J. R. James[4]

Pulverized coal firing has its advantages but there is also a disadvantage and that is the collection and disposal of fly ash in those localities where public policy demands it.

In speaking only of dry bottom furnaces there are two methods which are successful in the cleaning of the flue gases. One is the scrubbing of the gas by water sprays and the other the use of electrostatic devices. However, as more uses for fly ash develop it is reasonable to believe that the collection of the ash in a dry state will predominate, for in that condition it is in a more saleable state.

Large sums of money have been spent in research by various agencies endeavouring to discover uses for fly ash. The present situation, however, is that there is no well-known generally accepted use for this by-product. This may be explained possibly by the fact that a depression is a fine time to think and study such problems but it takes times of prosperity before private capital will venture into the use of new materials.

Fly-ash as collected by electro-precipitators has been used as follows:

1. Due to its puzzolanic properties it has been used as an admixture to Portland cement.
2. It has displaced clay as a raw product in the manufacture of Portland cement.
3. It has been used as a filler in the asphalt and rubber industry.
4. Light weight concrete.
5. Building block.
6. Insulation.

The Detroit Edison Company has developed a light weight concrete (100 lb. per cu. ft.) composed of fly ash, prepared cinders and cement. A mixture of five parts cinders, two parts fly ash and one part of cement by volume gave a concrete testing of 3,000 lb. per sq. in. at twenty-eight days. This same proportion by weight, using damp cinders and fly ash is: 1,500 lb. cinders, 650 lb. fly ash, 500 lb. cement.

This company has also developed a building block similar in shape to ordinary cement or cinder block. This block which is 18 in. long instead of the usual 16 in., is of a slate colour due in part to carbon in the ash, and for an 8 in. block weighs about 28 lb. in contrast to 40 lb. for a concrete or cinder product. It has ample strength in compression but has to be handled carefully during construction as its sharp edges are readily chipped. A bare 8 in. wall as tested at the University of Minnesota gave a heat conductivity test of 0.318 B.t.u. per sq. ft. per hr. per deg. of temperature difference. After its hollow cells were filled with rock wool it gave a coefficient of 0.16. The rock wool was removed and the spaces refilled with ordinary dry fly ash. The coefficient was 0.18.

The process for making this building block is similar to that of a sandlime products plant. A mixture of 100 per cent ash, 10 per cent hydrated lime, 0.6 per cent rosin with about 20 per cent water is mixed in a wet pan for about eight minutes. A tamping machine receives this material and forms about 360 8 in. blocks per hr. Loaded on cars the blocks are placed in a steam kiln at about 120 lb. pressure where they remain for about seven hours and are then taken to stock piles.

To date about ten homes, ranging in value from $3,000 up to $10,000, two churches, and several breweries have been constructed. At the present time, The Detroit Edison Company is constructing a six-storey service building, all the floors of which are formed of fly-ash cinder concrete,

[4] Senior Engineer, Engineering Division of the Detroit Edison Company.

about 3,500 cu. yd. In this building will be used more than 100,000 blocks.

The process used in the manufacture of the building block is controlled by the Rostone Company of Lafayette, Indiana. The three uses of fly-ash as developed commercially by this company, namely: fly-ash cinder concrete, building block and its use as an insulation in connection with the block, appear to have an encouraging future, especially so in that private capital has recently shown its willingness to take over the manufacture and sale of these products.

T. W. Jeffords[5]

The author has called attention to supposed difficulties experienced in maintaining combustion in water-cooled furnaces. An interesting experiment was run at the Mistersky power station, which throws a further sidelight on this question. In 1932 the City of Detroit faced a situation of having no place to dispose of its garbage. The Common Council instructed the Public Lighting Commission to experiment with the disposal of the city's garbage by dehydrating and burning it in the powdered coal furnaces at our Mistersky power station. These furnaces are of the usual vertical firing design, being approximately 19 ft. square at the base and 30 ft. high. In carrying out these experiments an inclined hearth was constructed on top of the water screen at the bottom and rear of the furnace. This hearth was composed of cast iron blocks, attached to the water screen, extending the full width of the furnace end to within about 5 ft. of the front wall.

The garbage was fed in on top of this hearth through openings at the rear of the furnace. The powdered coal was fed into the furnace vertically through the arch at the top of the front wall. The powdered coal flames were allowed to follow the usual U-shaped path encountered in vertical fired storage systems, excepting that the flame was shortened up so that it turned just above the garbage on the hearth. The radiant heat from the powdered coal flame drove off the moisture from the garbage as it was pushed down the hearth. Actual burning of the garbage took place, after it had become sufficiently dried, at the lower end of the hearth.

This bed of garbage at the bottom of the furnace formed a black heat absorbing surface producing an effect similar to that of a water wall. In addition, however, volumes of water vapour were driven off from this bed of garbage, thus producing a still further cooling effect upon the powdered coal flames. It was found possible to burn approximately 9 tons of dehydrated garbage per hour. The moisture content of this garbage averaged between 50 and 60 per cent, which means that it was necessary for the powdered coal flames to evaporate between 4 and 5 tons of water per hour, which passed off with the gases. At no time was any difficulty experienced in keeping the powdered coal flames burning or in carrying low ratings on the boiler. The only change which was found necessary in the operation of the furnace was to carry a higher percentage of excess air. Normally the CO_2 at the boiler outlet on coal alone averages approximately 15 per cent. It was necessary to reduce this to approximately 13 per cent while burning garbage.

It is believed that these garbage burning experiments have again proved that the powdered method of firing coal is quite flexible in that it can not only be burned in conjunction with blast furnace gas and oil but also with waste products such as rubbish, garbage, etc.

[5] Superintendent of Power Production, Public Lighting Commission, Detroit.

W. D. Drysdale[6]

This paper brings out the fact that a water-cooled furnace absorbs a large quantity of heat, thereby lowering the temperature of the furnace gas and of the fly ash carried by the gas. What provision has been made when burning low fusion ash coal, to be able to maintain the temperature of the superheated steam at a steam load output between 50 to 75 per cent of boiler rating? As higher steam pressures and superheater temperatures are coming into use, the cooling of the gases to a point of preventing the fly ash from sticking on boiler and superheater tubes becomes a major problem in maintaining the desired superheater outlet temperature.

Also, as a boiler operator and thinking of safety first operations when lighting a burner using pulverized coal, oil or gas, the safe thing to do is to open the boiler outlet damper so as to purge the furnace before applying the torch and feeding pulverized coal, oil or gas to the torch. This reduces the hazard of a puff blowing back on the operator when applying the torch to the burner.

A. C. Pasini[7]

The writer agrees with the author as to the use of pulverized fuel and the use of water-cooled walls. But the advent of pulverized fuel and the use of water-cooled walls also stimulated the development of stoker fired furnaces. The use of water walls in the Conners Creek plant stoker fired furnaces has produced a tremendous change in the design. In the old stoker fired furnaces the refractory walls had always been a source of worry because of their inherent weakness. The use of refractories also required carrying higher total air values in the furnace. With continued high ratings the replacement costs for refractory walls were very much too high. Water-cooled walls have completely changed the picture so far as stoker fired furnaces are concerned.

In the fall of 1934 the first new high pressure boiler went into service at the Conners Creek plant. This boiler is stoker fired, equipped with automatic metered air control and 100 per cent water walls. It has a furnace volume of 11,000 cu. ft. as compared to a furnace volume of 25,000 cu. ft. in the pulverized fuel furnaces at Trenton Channel. The maximum heat release in the Conners Creek furnace is 50,000 B.t.u. per cu. ft. per hr. comparable to some pulverized fuel installations and greater than most pulverized fuel fired boiler furnaces. This heat release has been maintained for as long as 12 hr. without any trouble. At this rate the dust loading in the stack was approximately 1.3 lb. cinders per 1,000 lb. dry gas. The carbon content at this loading was approximately 55 per cent. The sieve analysis at normal rating showed 30 per cent passing through a 325 mesh, 13 per cent through a 200 mesh, 28 per cent through a 100 mesh, 28 per cent through a 50 mesh and only 1.2 per cent retained on a 16 mesh.

Water walls, while an aid in cooling the gases and fly ash in large furnaces, do not tend to keep fly ash adherence from the boiler tubes where the furnace volume is small and heat release high. In the Conners Creek furnaces the tubes must be sprayed with water approximately every two days, this despite the fact the flame travel is very small on the stokers.

No trouble has been experienced in lighting fires nor in steaming at small ratings with stokers and water walls.

With metered air control equipment on our stokers, no secondary combustion has been noticed. 16.5 per cent CO_2 with no CO, can be maintained at the superheater outlet. The semi-radiant superheaters are located in the

[6] Assistant Engineer of Power Plants, Detroit Edison Company.
[7] Technical Engineer, Conners Creek Power House, Detroit Edison Company.

first pass and the convection superheater in the second pass.

As to stoker maintenance from November 1934 to January 1937, the cost of all iron replacement was 50 per cent less in the new stokers using metered air control equipment as compared to the old stoker fired furnaces. This low cost was maintained even though the new stokers operated with 360 to 400 deg. F. preheated air temperatures.

The author has not mentioned ash disposal. The Conners Creek plant is able to dispose of all its ash at a profit—no small item when one considers that the plant consumes approximately 1,500 tons of coal per day.

T. C. Tayler[8]

The fundamental way in which the author has attacked the problems of combustion of pulverized fuel makes his paper a real contribution in a broader field than just that of boiler furnaces. The best proof of a theory is to carry it to its extremes. A boiler furnace with its demands for short flame constitutes one extreme: a rotary lime kiln furnace demanding long flame is the opposite extreme.

Ideal conditions call for a flame 50 ft. long in a horizontal furnace 4 ft. 6 in. inside dia. by 100 ft. long. The cooling surfaces consist of the insulated fire brick walls and partly and completely calcined lime varying in temperature from about 200 deg. F. at 50 ft. from burner up to 2,300 deg. F. about 25 ft. from burner and continuing at this temperature as it moves to the burner. Our conditions demand that a flame temperature be maintained at 2,500 deg. F. from the burner tip to a distance of 50 ft. To hold the flame temperature down to 2,500 deg. F. at all points the walls and lime must absorb heat as generated. There will be little absorption in the first 10 ft. from burner and almost constant absorption in each foot from 10 to 50 ft. from the burner tip. Quick ignition at the burner tip is required, slow rate of combustion in the first 10 ft., then a faster but almost constant rate for 40 ft.

The problem of combustion is complicated by the facts that, first, petroleum coke is burned which is about 85 per cent fixed carbon and 14 per cent volatile, and, second, because the entire volume of combustion air is preheated to 1,000 deg. F. Moisture in fuel and cold air admitted to fuel pulverizer reduce primary air only enough to eliminate pre-ignition.

The author names three factors as necessary for quick ignition:

1. Small amount of primary air.
2. Fine pulverization.
3. Turbulence.

It is not difficult to obtain all three. Quick ignition is needed, but having obtained it the opposite problem of preventing almost complete combustion close to the burner comes up. If the above three factors give quick ignition and short flame, the opposites should give long flame. Hence one might expect to find it necessary in this case to simultaneously supply both small and large amounts of primary air, both fine and coarse pulverizing and have both great and little turbulence. These combined conditions may not be quite as impossible as might at first appear. One can have a burner that supplies a rich mixture at low velocity around the rim while it supplies a lean mixture at high velocity in the centre, both fine and coarse fuel simultaneously, and great turbulence at one point, less at another.

When burning with an exceptionally small amount of excess air and with high preheat, there is no difficulty in getting quick ignition; the difficulty is to get sufficient heat into the space 35 to 50 ft. from the burner without having too much in the space 20 to 30 ft. from the burner.

The author's paper seems to eliminate fuel sizing as a factor in control of our flame temperatures. There is evidence in the Belle Isle Lime Company that the larger particles failed to burn.

On the strength of the facts, as the author presents them, it seems that we will have to go farther with burner design to get rich mixture at low velocity around the rim and lean mixture at high velocity in the centre and also go farther in our attempts to increase turbulence without effect upon the streams from the burner. Design may take the form of means to create a slight whirl to secondary air, the burner being in the vortex but having no whirl of its own unless perhaps in the opposite direction.

It is interesting to note that instead of water-cooled walls, lime-cooled walls are used, the rotating furnace carrying the heated walls under the bed of lime to give up some heat during a part of each revolution. Controlled rates of combustion rather than high rates are sought; and retarded mixing which is difficult in a rotary kiln where all fuel and air must enter through the end wall within two feet of the burner. One seeks also to avoid cooling lime close to burner by putting a blanket of 1,000 deg. F. air between flame and lime. The author says excessive furnace temperatures are not desirable. He tries with water-cooled walls to extract heat as it is produced; this company also tries to extract heat as produced but for a different reason; namely, temperatures above 2,500 deg. F. cause overburning of lime tending to flux acid brick with basic lime.

In conclusion it is interesting that the experiences under conditions which represent the opposite extreme from boiler furnace combustion are in harmony with the author's experiences and as a result of his paper one is forced to rule out fuel sizing as a factor in plans to control flame. It is hoped, through concentrating efforts on the burner velocities and turbulence in combustion space, to eventually approximate ideal combustion conditions.

A. W. Thorson[9]

The data on furnace temperature versus time for combustion are very interesting, and seem to agree with subsequent work at Carnegie Institute of Technology on coal carbonization. It has been found that when coal is heated, the amount and composition of distilled products depend upon the rate of heating. As this rate is increased due to higher furnace temperature, more products of heavier molecular weight are distilled off which require more time for combustion. In addition, a less reactive residue coke remains as the carbonizing temperature is increased. Both tend to increase the time required for combustion.

The statement that water-cooled furnaces do not retard combustion is further borne out in a more practical way. Recent furnace designs for travelling-grate stoker firing show a replacement of the conventional front ignition arch made of refractory by a long rear arch made of water-cooled tubes which in many cases are left uncovered. The rear arch deflects the flame from the burning fuel over the incoming fresh fuel which is quickly ignited by direct contact with the flame as well as by radiant heat from the flame. The rear arch furnace responds readily to sudden demand for more steam without danger of loss of ignition because the latter does not depend on heated refractory. Results with rear arch installations show reduced solid carbon loss and increased burning rates.

There are three questions the writer would like to ask:

(1) Replacement of mill fan blades is one of the larger items of maintenance in a pulverizer plant. There has been a recent tendency to locate the mill fan on the clean-air side of the pulverizer. How much does this reduce fan

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[9] Production Department, Detroit Edison Company.

maintenance, as compared to that of a fan handling both air and coal?

(2) There has been some discussion on the relative ability of underfeed stokers and pulverized fuel to pick up load. Some with the bin and feeder system find it faster than the stokers in their plants, whereas some with direct pulverizer firing find that slower than the stokers in their system, operating on the same coal; presumably due to lack of storage in mills, and to boiler lag. The latter is reported to be a factor in the case of slag-tap furnaces where slag gives up heat when dropping load and absorbs it when increasing load, thereby contributing to boiler lag. The writer would like to hear the author's observations on this point.

(3) A recent compilation showed that of all new capacity under construction or recently placed in service, over 80 per cent was pulverized coal. Is this the result of a tendency toward a wider latitude in fuel selection? The writer would like the author's explanation of this trend.

F. J. Linsenmeyer[10]

In this short discussion of the paper the writer's views may be considered in the nature of support for pulverized fuel applications. The use of pulverized fuel has brought a great many benefits and improvements to industrial and central-station plants, it has opened up opportunities to the designer for some real ingenuity in the selection of water and steam circulation. The older form of Stirling boiler with vertical or horizontal tubes, gives way to circuits which permit steaming in any or all banks of tubes. The direct result is that the stoker furnaces have also adopted new circuits. The writer has always wondered why boiler designers resisted any attempt at steaming in the water walls. Certainly the pulverizer designers lead the way here. These same water and steam circuits may have been the incentive for high pressure plants such as the Loeffler, Schmidt and Benson boilers. While all Americans may not agree with such unconventional designs, they are adopting some of the fringes of these designs.

It seems that the very nature of the pulverized fuel approaching the suspended particle condition is in its favour as having greater potentiality for a complete combustion with minimum excess air.

Actually the fly-ash difficulty is ever present. May there not be a possibility of still better preparation of the fuel until the fly-ash will be so fine as to be suspended further in the atmosphere and carried away by the wind?

The writer believes also the particle size may be a little small. 1/1,000,000 in. is 1/25,000 micron which is fairly small. This comes well below the scale of "smokes" as indicated in the A.S.H.V.E. scale of air-borne solids. If we say *none* would go through a 1,000 mesh scale (if we had a 1,000 mesh scale) we may use this figure for comparison. Assume the particle is 10 microns.

Area of surface..	0.0003 sq. mm.
Volume of particle..........	0.0000005 cu. mm.
Volume per lb..............	30,000 cu. mm.
Particles per lb.............	600,000,000,000
Surface area per lb..........	180,000,000 sq. mm.

Compared with a single one lb. piece the pulverized coal has 600,000,000,000 times as many particles with 8,000 times the surface.

It would seem if the particles could be kept from fusing together fly-ash would be 1/10 as small or at least 1/10 the density (if as large).

Another item that the writer does not quite understand is the time allowed for combustion. It would seem that the maximum would be a second instead of two or more. The writer would close by asking for more detailed information on the final stage of combustion, namely, that of the burning of fixed carbon. Assuming 10,000 lb. coal per hr. produces 5,000,000,000 cu. ft. of combustion gases per hr. in a 900 sq. ft. furnace, then the velocity would be 150 ft. per sec. and the time therefore less than one second.

[10] Professor of Mechanical Engineering, University of Detroit.

W. D. Canan[11]

The author's paper deals largely with theory and design, but there are several matters in connection with the operation of pulverized fuel equipment which are worthy of some consideration, and the writer would therefore ask that he give us more information in connection therewith.

1st: The matter of the power consumption of the coal preparing and firing equipment, referring to auxiliaries such as the pulverizers, primary air fans and coal feeders. Is the power used by this equipment a considerable proportion of the total energy output of the boiler? When it is taken into account is the resulting overall boiler efficiency equal to or better than a stoker fired job?

2nd: Is the emission of fly-ash from the stack a serious problem, and what if anything is being done to solve it? The writer has been quoted figures ranging from 20 to 80 per cent of the total ash produced as being the amount which would pass up the stack. It would therefore appear that, especially in locations where there are a large number of manufacturing plants and residences, considerable objection would be raised to the emission of any such quantity as the above amount of ash. Some users object to using it on account of contamination of the product which they manufacture.

In addition to the fly-ash nuisance there is also the matter of the disposal of the ash taken from the boiler. This ash is not desirable for fill, nor can it be dumped into rivers. Some other method must, therefore, be suggested for its disposal if neither of the above methods of disposal are available. Some years ago several wet gas washing systems were given prominence as a means of collecting and disposing of the fly-ash, but our experience with this type of system has led one to believe that it will not satisfactorily solve the problem.

3rd: Can a pulverized fuel installation be made entirely safe from an operating standpoint? Are explosions in the boiler furnace itself due to incorrect design, or is it entirely a matter of operation? If it is a matter of operation, what, if any, safeguard can be incorporated in the design of the equipment to guard against explosions?

4th: The author has stressed the advantages of water-cooled furnaces, and their desirable features have not been overstated. Almost every boiler installation that goes in today has more or less of this type of construction. There is a tendency to cut down boiler heating surface and add water walls, and the writer is wondering how long it will be until the boiler heating surface as such disappears entirely. In this connection it might be interesting to know what proportion of the total heat absorption of a boiler of modern design takes place in the water walls.

The Author

Mr. Briscoe refers to the change in furnace temperatures caused by a slag or ash deposit on the water-cooled furnace walls and the first row of boiler tubes as 'furnace sensitivity.' Such slag or ash deposit reduces the heat absorption by these surfaces, thereby raising the temperature of the products of combustion when they enter the boiler and superheater. This higher gas temperature raises the superheat and may also result in slag or ash deposit in the superheater and boiler.

With most water-cooled furnace designs the slag or ash accumulates to a certain degree and then begins to

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drop off as fast as it is deposited. The temperature then remains nearly constant. This nearly constant condition of slag deposit and temperature depends a great on the adjustment of burners, air supply, and the fineness of coal. The slag deposit is less when the coal is fine and when the burners and the air supply are so adjusted that the combustion is nearly complete when the gases reach the boiler. Delayed combustion is the greatest factor in the deposition of slag on heating surfaces. The air supply should be adjusted according to excess air or CO_2 content in the gases leaving the furnace, and not at the exit from the boiler, economizer, or air heater, where the gases may be greatly diluted by air leakage. Careful operation and good maintenance of the mills, furnace and setting is as important for good results as good design.

Low temperature of gases entering the boiler or superheater eliminates much of the slag trouble, but there is a limit to which this temperature can be reduced, particularly in an installation with high superheat temperature. The gases must be hot enough when they enter the superheater to contain enough heat at sufficiently high temperature to produce the desired superheat. If the temperature difference between the hot gases and the steam is too small a very large and expensive superheater is required.

Large cross section of the gas passage at the entrance into the boiler results in lower gas velocity and greatly reduces the slagging of the boiler and superheater. Careful operation contributes much towards the elimination of slagging. However, with coals having very fusible ash some slag deposits must be periodically removed. Therefore, it is desirable that facilities for cleaning during operation should be provided when the steam generating equipment is designed. There are many installations which are kept in operation for many months at a time. If any cleaning of slag is necessary it is done without any interference with operation.

The temperature of superheated steam rises with rating. The following methods are used to keep the superheat nearly constant over a desired range in steaming rate.

(*a*) The superheat is kept nearly constant by a damper controlled gas by-pass which permits a varying volume of the hot gases to by-pass the superheater. The superheater is designed for the lowest steaming rate at which the full superheat is desired. As the steaming rate rises above this point, part of the volume of hot gases is made to by-pass the superheater. Thus, the rising temperature of the hot gases entering the superheater is compensated by their decreasing volume. This method of control requires a larger and more costly superheater, an idle gas pass around the superheater and a damper to regulate the volume of gases flowing through the by-pass. The regulation of the by-pass damper can be done manually or by an automatic control.

A modification of this method is used in a double boiler with a large superheater on one side and a smaller one on the other side. Varying quantities of gases are passed through the two sides. Superheat is controlled by regulating the flow of gases through the two sides of the unit.

(*b*) The superheat can be controlled by the manipulation of the fires. In this method burners are placed at different heights in the furnace. At low rating the burners located in the upper part of the furnace are put in operation and the fires are brought closer to the superheater. At high rates of steaming the lower burners are used. For superheat control over a very wide range of rating this method can be used in combination with a by-pass damper method.

(*c*) Superheat is maintained nearly constant by the combination of radiant with convection superheater. The radiant superheater is placed in the furnace as a part of the wall cooling surface, or, part of the superheating surface is placed between widely spaced boiler tubes in the first bank of the boiler. The surface in such locations is exposed to radiation from the furnace and absorbs a greater proportion of heat at low rating. The main part of the superheater is located in the usual place back of the first bank of boiler tubes and absorbs heat by convection. The steam flows first through the radiant section and then through the convection superheater. This method of superheat control is largely a matter of proportioning the amount of surface in the two parts of the superheater. It may be combined with the methods outlined under (*a*) and (*b*).

(*d*) The superheat can be controlled by a separately fired superheater. In this method the superheater is set over a separate furnace and the superheat is controlled by the amount of fuel burned. This method has the widest steaming range with constant superheat. It is also the most expensive and is now seldom used.

(*e*) The superheat can be controlled by partial desuperheating at the high rates of steaming. In this method the superheater is designed to give full superheat at the desired low rating. At higher ratings the steam is partly desuperheated after it has gone about half way through the superheating process, the extent of the desuperheating being controlled by the final temperature. The superheater is installed in two parts with the desuperheating apparatus between them. This method of superheater control is rather complicated and is seldom used in this country.

Direct impingement of concentrated flame against water-cooled walls is not desirable, but flame sweeping or brushing over the walls is not objectionable. By direct impingement is understood the condition in which the flame strikes the wall nearly at right angles a short distance from the burner. A flame is sweeping over a water-cooled wall when the flame moves nearly parallel to the wall a considerable distance from the burner. In tangential firing the flame may sweep over the walls after it has travelled nearly diagonally across the furnace.

Preheated air helps the ignition because less heat is required to bring the incoming mixture of coal and air to ignition temperature. The ignition is quicker and closer to the burner. There are practical limits to the temperature to which air can be preheated. This limit is usually set by the efficiency of the steam generating unit. If high efficiency is desired the temperature of gases entering the air heater should not exceed about 650 deg. F. It is not economical to bring the temperature of preheated air closer than about 100 deg. to the temperature of gases entering the heater because the air heater would become very large and expensive. The weight of gases is always higher than the weight of air to be heated. The specific heat of the gases is also higher than that of the air. Therefore, the temperature rise of the air is greater than the temperature drop of the gases. The weight of gases is equal to the weight of air going through the air heater plus the air leaking into the setting plus the weight of the ash-free fuel. The specific heat of the products of combustion, particularly with high hydrogen and high moisture coals, is 10 to 15 per cent higher than the specific heat of air. Usually for every 300 deg. of the temperature rise of the air there is only about 200 deg. drop of the temperature of the gases. Thus, if the temperature of the gases is to be reduced from 650 to 350 deg. F. the temperature of air would rise from 100 to 550 deg. F. If the temperature of gases entering the air heater were 900 deg. F. it would require a very large air heater to bring the temperature of air to 800 deg. F. The air temperature rise would be 700 deg. and the gas temperature drop would be about two thirds of 700, that is, about 466 deg. F. The resulting temperature of gases would then be 434 deg. The overall efficiency of the steam generating unit would then be about 2 per cent lower than when the gases leave the air heater at 350 deg. F.

A further disadvantage of the highly heated air would be the oxidation of the air heater and air ducts, more expensive expansion joints, and insulation covering. To reduce the oxidation of the air heater and the ducts they would have to be made of heat resisting steel alloy. There is no limitation to the temperature of preheated air from the standpoint of combustion.

During the last few years efforts have been made to develop a mill which would pulverize coal to more uniform fineness with lower power consumption and lower maintenance. By more uniform fineness is meant the reduction of the percentage of oversize and the superfine coal.

Mr. Sitter brought up the question of the necessity of feedwater treatment with water-cooled furnaces. The water-cooled furnace walls absorb heat at a high rate and must be kept clean internally to prevent their over heating. With internally clean tubes the temperature of the metal seldom rises over 50 deg. above the temperature of the water inside of the tube. To keep the surfaces internally clean the feedwater should be properly treated to prevent scale formation. All make-up water should be treated in a separate feedwater treatment plant. This primary treatment should be followed by a secondary treatment with phosphate which is supplied directly to the boiler through a separate line. The methods of feedwater treatment have been sufficiently developed that there is no excuse for the formation of scale inside of the boiler.

Very widely fluctuating loads require large steam drums to take care of the variation in water level and at the same time leave sufficient space in the drum to separate the water from the steam. It is much easier to obtain clean steam with a steady rating than with widely fluctuating load.

Oil torches are more stable and are preferable to gas torches for lighting pulverized coal fires. The oil torch has a hot and luminous flame and if the torch is blown out the furnace is not filled with explosive gas as may be the case with gas lighting torches. Oil leaks are more easily detected than gas leaks particularly leaks due to incompletely closed valves.

To take one mill out when two mills are supplying the fuel to one boiler the output of the mill to be taken out should be reduced in about three equal steps to the minimum output at which it will operate satisfactorily. At the same time the output of the mill to remain in operation should be increased by similar steps. The air supply should also be shifted to maintain the stability of flame. When the operator has assured himself that the flame remains stable, the mill to be taken out is shut down and the load fully taken by the other mill.

There are coals which are classed as bituminous coal with the percentage of volatile matter as low as 14 per cent. When the volatile matter drops below 20 per cent a delay in the ignition becomes quite noticeable. For burning such low volatile matter coals, provision must be made for the reduction of primary air. This is at times difficult to do in direct firing because the mill must have a definite minimum quantity of air to operate satisfactorily. This minimum air for the mill may be too much air with the coal to produce good ignition. When low volatile coal is burned in a tangentially fired furnace the air supply around the coal nozzle should be cut off and the secondary air should be supplied through the air port above the upper burner. With high volatile coal the air around the coal nozzle should be reduced to bring the ignition to the burner without the flame backing into it. The air ports above and below the burner should be kept fully open, and the air supply should be controlled by the air pressure at the burner, by regulating the speed of the pressure fan or the damper in the air supply line. Such air regulation supplies the greatest amount of energy to the furnace for mixing. The greatest heat release will occur in the centre of the furnace in the plane of the burners where the streams of coal and air meet and where the mixing is more intensive. Any mixing that is done at the burners should be done to quicken the ignition. Mixing for rapid combustion is done in the centre of the furnace away from the burner where the secondary air does not interfere with the ignition.

High volatile coal is better suited for a widely fluctuating load particularly with direct firing. The ignition is more stable because the volatile matter makes rich mixture which ignites readily even with wide fluctuation in the air supply.

Irregular flow of coal to the pulverizer due to moisture and excessive fines is one of the drawbacks of direct firing. If the hanging of coal is between the feeder and the pulverizer, hot air supplied to the pipe connecting the two may prevent the hanging, but increases the flow of air through the mill which at times may not be desirable for good ignition. If the hanging of coal occurs before the feeder it is difficult to remedy.

Mr. Showers points out the advantage of some refractory surface in a pulverized coal furnace. Such surface when hot re-ignites the fires after a short interruption in the fuel supply to the furnace. In many of the pulverized coal installations with horizontal firing such surface is on the front, or the burner wall. This wall is made of refractory for structural and economic reasons; it is easier to make the front wall of refractory than of water-cooled surface, because the water-cooled tubes have to be bent around the burners and can not be made to cover completely the burner wall. Slag may stick to such refractory surface and accumulate and may have to be removed by hand tools. In other cases the refractory may wash out and the wall require frequent patching. The re-ignition of the fuel after a short interruption may not occur promptly. It may be delayed until the furnace is filled with coal mixture and then ignite with a violent puff which causes leakage into the setting. If feeding of coal to the furnace is unreliable a small oil burner is a better security against a loss of fire.

The temperature of a pulverized coal flame even in a completely water-cooled furnace is considerably above 2,000 deg. F. At lower rating the flame may be reduced to a smaller volume but the temperature of the flame is practically as high as it is at high ratings. A match can be burned in a completely water-cooled furnace with an average rate of heat liberation of fraction of a B.t.u. per cu. ft. of the furnace volume. The flame will occupy a volume less than a cubic foot and have a temperature of about 2,000 deg. F. Furnaces are made completely water-cooled to avoid refractories in the furnace, the sticking of slag to them, and also to get away from the maintenance of such refractories.

It is largely the extent of the surface of the flame that determines the amount of heat radiated to the water-cooled walls. At low rating the surface is small because the volume of the flame is small. The amount of heat radiated to the walls is small because of the small flame surface. At high ratings the flame fills the furnace almost completely. The surface is large and a large amount of heat is radiated to the furnace walls.

Mr. James presents interesting and complete information on the use of pulverized coal ash. His discussion is a valuable addition to our knowledge about the use of pulverized coal.

Mr. Drysdale brings up an interesting point in connection with maintaining nearly constant superheat with varying steam output. This problem is more difficult to deal with in the design of high steam pressure and temperature units. The gases entering the superheater must be hot enough to give the desired superheat and they should not be too hot to cause slagging of the boiler and superheater. The designer has to work between two serious limitations. The methods for obtaining nearly constant superheat have been described in connection with Mr. Briscoe's discussion. The method outlined under the manipulation of fires promises a satisfactory solution. This method strives to maintain the temperature of gases entering the superheater nearly constant regardless of their volume.

Mr. Thorson asked three questions which can be answered as follows:

The maintenance of mill fans averages about 0.5 cents per ton of coal pulverized. If other maintenance remains the same, placing the mill fan ahead of the mill would reduce the overall mill maintenance by 0.5 cents. There are some objections to such mill fan location. The mill is put under pressure and there may be leakage of coal dust from the mill and particularly from the coal feeder. Coal dust may be forced into bearings and increase their maintenance.

It does not seem likely that a stoker installation would have a quicker pickup than a direct fired pulverized coal installation. It takes time to build up a good stoker fire that will carry heavy load over extended periods. Banked stoker fires or low rating fires are not usually in good condition for heavy load.

There is a decided trend towards pulverized coal firing which is probably due to wider latitude in fuel selection. "Change of coals upsets the operation of a pulverized coal plant to a much smaller degree than a stoker fired plant."

Explosions in pulverized coal furnaces are usually caused by faulty operation. The explosions are generally less disastrous than explosions in oil or gas fired furnaces. Coal is pulverized to make it more inflammable or combustible. The greater inflammability makes it more explosive. The greatest asset of safety is a good operator who does not take risks.

Originally the boiler was made to evaporate water. In modern high pressure steam generating units the boiler performs mostly a structural service. The boiler supplies rigid water-cooled walls, water-cooled supports for the superheater, water-cooled frame for partitions for gas passages through or around the superheater, and a water-cooled chamber for the economizer. The water evaporating duties have taken secondary place. We shall always have a boiler to perform the structural service.

A water-cooled furnace makes 25 to 50 per cent of the steam made by the steam generating unit.

Professor Linsenmeyer asks about the time required for combustion. This time depends on the size of the particles, the very fine particles burn instantaneously, the very large ones require more than two seconds because they contain many times more combustible than the very small ones, and because their combustion must be completed after the concentration of free oxygen in the furnace gases has been greatly reduced. In the last part of the path of gases in the furnace the oxygen concentration is 2 or 3 per cent. In fact some of the very large particles never burn completely.

Mr. Canan's questions may be answered as follows:

The power consumption of coal preparation and burning equipment in a pulverized coal plant is greater than it is in a stoker fired plant. In general the difference probably does not exceed two per cent of the energy represented by the boiler output, and is offset by a higher overall operating efficiency. The application of pulverized coal is about fifteen years old and has ceased to be a novelty. There must be a tangible reason for the preference for pulverized coal. There are undoubtedly some cases where stokers have an advantage over pulverized coal.

The emission of fly ash is greatly reduced by various dust collecting devices. Some of the mechanical devices can be installed at low cost. They collect most of the coarser dust which would settle near the plant if allowed to go out of the stack. The emission of stoker cinders has also become objectionable and in some cases provision must be made for collecting them. If dust collectors must be used with either firing, engineers apparently prefer to use pulverized coal.

The disposal of the collected dust is a problem that seems to lack a good general solution. There are apparently many special solutions: Mr. James presented one of them.

Ground Resistance Measurements at Large Substations

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Paper presented before a meeting of the Montreal Branch of The Engineering Institute of Canada on November 11th, 1937.

SUMMARY.—**After briefly outlining several methods of making ground resistance measurements, the author discusses some of the difficulties encountered in carrying out such tests, and describes the procedure and results obtained in a number of actual cases.**

The problem of measuring the resistance to earth of the grounding network at a large terminal station or powerhouse is quite an important one on an extensive power system. Current can flow to earth through the station ground due to breakdown of insulation, or through the grounded neutrals of power transformer banks. During a fault, currents of the order of several thousands of amperes may frequently occur. If the value of resistance is not sufficiently low, the station ground potential may be raised above that of true earth by several thousand volts. This may result in blowing fuses on telephone lines, as well as the possible breakdown of insulation on low-voltage equipment. At the same time dangerous potential gradients may result in the immediate vicinity, with consequent hazard to life.

It is quite apparent that not only must the value of ground resistance at a large substation be determined, but a reasonably accurate method of measurement should be used. Although in theory such tests are relatively simple, considerable difficulty is sometimes encountered in their practical application. It is not proposed to enter into a detailed discussion of the various methods of measuring low-resistance grounds, or of the different types of equipment available on the market today. A brief outline of the principles involved in the three best known methods is given for the purpose of showing the limitations which they impose under certain conditions. The results obtained in a number of actual cases will then be described.

A source of power, together with an ammeter and a voltmeter, can be used in any of these cases. Earth testers are also now on the market, embodying all the requisites in the form of a single portable instrument.

Methods of Measurement

The simplest method is generally referred to as the "loop-resistance" test. The series resistance of an auxiliary ground and that under test, along with the lead between the two grounds, is measured, and the required ground resistance obtained by simple arithmetic. This auxiliary ground, which is absolutely necessary in this procedure, must be: (1) located sufficiently distant from the substation to ensure that the total resistance area is covered by the loop measurement, (2) of known value, (3) of a comparatively low value if the ground under measurement has a resistance of one ohm or less. In this case a low-resistance lead is necessary between the two grounds. It is not often that all of these conditions are satisfied at any one particular location under consideration.

Some cases lend themselves more readily to the "three-point" method of measurement. Two auxiliary grounds are required, but their resistance values need not be known. They must, however, both be

(1) Located at a suitable distance from the station,
(2) Of a comparatively low value.

The loop value of each pair in turn is measured, and the resistance of the ground under test calculated by means of the well-known formula $R=\frac{R_1+R_2-R_3}{2}$. This method does not readily lend itself to the measurement of low resistance as the result in such cases is rather inaccurate, and sometimes negative in value, unless considerable care is exercised in obtaining good auxiliary grounds. In sandy or rocky territory this is rather difficult, if not impossible.

The "fall-of-potential" method is probably the most applicable in difficult cases. Auxiliary probes are again necessary, but their resistance need not be particularly low. A current is circulated through a suitably distant probe and the substation ground. By means of an intermediate probe the potential drop across the grounding network is measured. The ratio of potential to current gives the required resistance. Readings are taken with the potential probe located at various distances from the substation, and a curve drawn with resistance readings as ordinates, and potential probe spacings as abscissae.

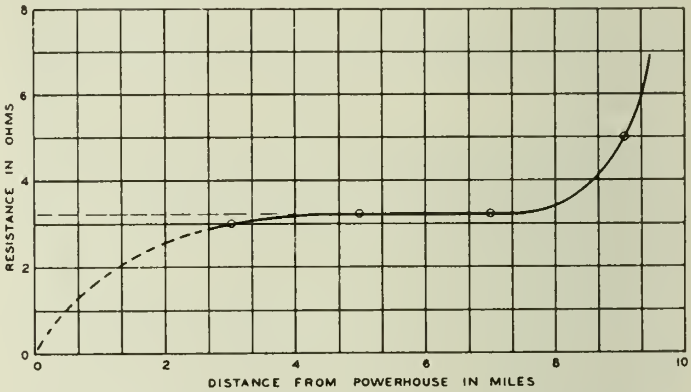

Fig. 1—Ground Resistance Curve at a Large Powerhouse.

When the curve contains a horizontal section, the test engineer knows that the auxiliary probes have been placed at a suitable distance, and a true value of resistance is given by the reading shown on the flat portion of the curve.

With these methods available, what procedure should be followed in testing a grounding network with a resistance of the order of one ohm or less, located in territory where the soil consists of pure sand to a depth of fifteen or twenty feet, and no low-resistance auxiliary ground is available within many miles? Quite obviously the "loop-resistance" and "three-point" methods are out of the question. On paper the solution is obvious, viz. use the "fall-of-potential" test, locating the auxiliary probes at a sufficient distance from the substation. In the case where water-pipe systems or transmission line ground wires are connected to the substation structure, this distance may be a matter of miles. Fortunately there is generally a telephone line from the location to a remote point, but the difficulties do not end here. In sandy or rocky soil the resistance of ordinary driven probes may well be 2,000 ohms or more. While a reading may be obtained with an earth tester, it might not mean a great deal, and in some cases sufficient energy is not available to operate the instrument through such high resistances. When using a separate source of power quite inaccurate results are very apt to be obtained unless special meters and high values of voltage and current are used. It is thus seen that the measurement of ground resistance in rocky or sandy territory is not always an easy problem, and on occasion is out of the question unless a considerable amount of time and money are expended. Each case requires special study, and the method to be employed depends upon a number of factors. A few practical examples will serve to illustrate some of these points.

Data from Field Tests

The design and measurement of the grounding network at a 220 kv. terminal station was rather interesting. At this particular location test holes showed a depth of fifteen to twenty feet of sand, a layer of hard pan, and then blue clay. Previous tests made on buried cable in somewhat similar soil had given rather disappointing results. At one site 800 ft. of No. 00 cable buried to a depth of 18 in., and attached to seven 8 ft. driven rods, had a resistance of 30 ohms. The grounding medium must obviously reach the permanently moist low-resistance clay, so that plates were out of the question for economic reasons, and the choice was easily made in favour of driven pipes. A number of one inch pipes were installed, and resistance measurements made on these by means of the "three-point" method. The following tabulation presents data obtained while driving one of the pipes in the bottom of a 14 ft. test hole.

Depth below ground level	Ground resistance
19½ ft.	420 ohms
20½ "	170 "
22 "	81 "
24 "	33 "
26 "	24 "
29 "	18 "
34 "	15 "

With these figures available, the grounding network was designed and the installation completed with 41 pipes driven to a depth of 40 ft. and nine pipes to a depth of 20 ft., covering an area of approximately 400 ft. by 500 ft. These individual grounds were, of course, connected together by heavy copper cable.

As the soil in this whole district is sandy, it would have been rather difficult to obtain good auxiliary probe points, so a conveniently located grounding network about 3½ mi. away was used. Not only was the resistance of this system known, but it was quite low—of the order of 0.13 ohms. In addition a transmission line was available between the two points with conductors of 336,400 c.m. A.C.S.R., giving a low-resistance connection with all three wires connected in parallel. The resistance of the line conductors was first obtained, and then the loop measurement made of substation ground, connecting conductors and auxiliary grounding system, from which the required resistance value was found to be 0.67 ohms. At a later date connection to overhead ground and buried counterpoise wires lowered this value somewhat. This case is unusual as one does not often have a set of low-resistance conductors leading to a low-resistance reference point suitably distant from the substation.

Another interesting case on which the author worked was that of a large powerhouse ground consisting of penstocks, a water-pipe system to the operators' houses, and a 220 kv. transmission line with overhead ground and buried counterpoise wires, all connected together. The surrounding terrain was quite rocky.

A telephone line ten miles in length was available, remote from the transmission line, with a fairly good ground, of unknown value, at the far end. At occasional points along this telephone line swampy sections were found where auxiliary probes could be driven, having resistance values of 400 and 500 ohms. An earth tester was used in the "fall-of-potential" method, and corrections applied to take care of the high-resistance potential points. The series of values obtained were plotted in curve form as shown in Fig. 1.

To obtain an accurate reading when using the "fall-of-potential" method of measurement, the potential probe point should be located at a distance from the substation of at least five times the diagonal of the rectangle covered by the station grounding network. A greater distance is preferable in most cases. A practical demonstration of this principle was obtained in measurements made on a station ground covering an area of 100 ft. by 112 ft. An attempt was made to make a test with the current probe located at a distance of 600 ft. and potential probes at intermediate points. The result was curve No. 1 in Fig. 2. A second test was completed with a telephone line to the operator's house about 1,500 ft. distant. Good results were obtained as plotted in curve No. 2, giving a ground resistance value of 12 ohms.

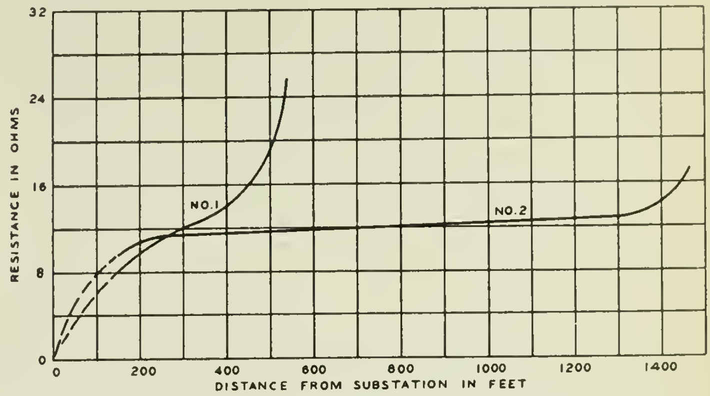

Fig. 2—Resistance Curves Taken with the Current Probe Located at a Distance of (1) 600 ft., (2) 1,500 ft.

At one location where the ground covered an area of 300 ft. by 800 ft., but was tied into a large water-pipe system, fairly good results were obtained by utilizing a section of telephone line 2.2 mi. long. The resulting data are shown in Fig. 3. In still another case a telephone circuit 2.8 mi. in length was used at a small powerhouse to measure the resistance value of the ground system, which was connected to a dam structure some 2,000 ft. distant. Reasonably satisfactory test results were obtained but longer leads would have given more accurate data.

Telephone Line Used for Connecting Leads

This method of utilizing the two wires of a telephone line as leads to the auxiliary probes is one which has been successfully used by the author in a number of cases. It is often the only way in which a connection can be made to reference points located at a sufficient distance from an extensive grounding network to ensure that the total resistance area involved is included in the measurement. The line, of course, must be cleared of all telephone and protective equipment before making the test. Certain

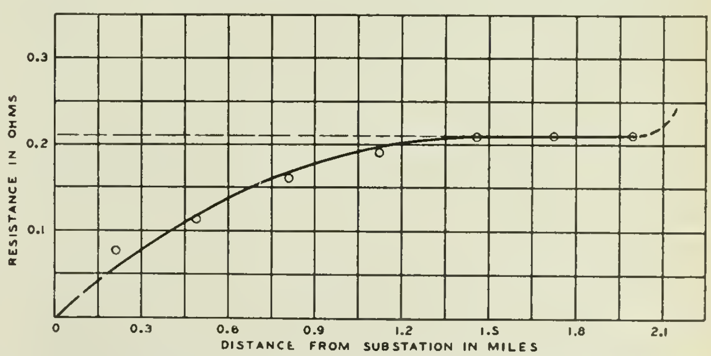

Fig. 3—Resistance Curve of a Substation Ground Which Was Connected to a Large Water Pipe System.

precautions must be taken to reduce the magnitude of inaccuracies caused by induced currents from parallel power circuits, as well as other errors which may creep into the results. In one case, after an earth tester had been used on a telephone line almost 3 mi. long in the "fall-of-potential" method, it was possible to check the result obtained against the value of resistance as measured by the "loop-resistance" test. The discrepancy between the two values was less than two per cent.

Difficulties Encountered in Tests

The difficulties encountered in conducting resistance tests on a large substation ground are recapitulated below.

(1) The area covered by the grounding network of high-voltage stations is inherently large. Whatever type of test is considered best, auxiliary grounds or reference points must be established at quite some distance to ensure the inclusion of the total resistance area in the test. Test leads up to several miles in length may be necessary.

(2) The lower the value of resistance to be measured, the more care must be taken to obtain good auxiliary grounds; the requisite low value depending upon the method used and the magnitude of the resistance to be measured. In rocky or sandy territory this requirement leads to a great deal of extra work.

(3) When the substation ground is connected to the water mains of a city, it is somewhat of a problem to decide how the measurement should be made, and what relation the value of resistance so obtained bears to any particular ground contained within the resistance area of the large interconnected ground network.

The above data have been selected from the results of a large number of ground resistance tests made by the company with which the author is associated. These tests covered all the company's substations and powerhouses, both large and small, and were for the most part commenced with very little preparation and completed in a relatively short period of time. These tests were followed up by additions to the grounding networks when a study of the various factors involved showed that improvements were necessary.

DISCUSSION ON THE PAPERS ON

Flood Control in Southwestern Ontario[1]

Presented at the Annual Meeting of The Institute, London Ont., February 2nd, 1938

O. Holden, A.M.E.I.C.[2]

For the purpose of studying methods to be used for amelioration of flood damage, far more data are required than are available at this time. Mr. Marr, in addition to the tabulation of records of past flow in the Grand and Thames rivers and their tributaries, has made a statement as to the maximum flow at the peak of the flood. It is the writer's understanding that the south branch of the river was far beyond the limits of any cross-section in which flow measurements had actually been taken. No doubt Mr. Marr has been able to supplement the published records from data collected by observers on the ground, and this, with his experience in interpreting field data of this character, has enabled him to determine the figures for maximum flow submitted.

It is to be regretted that, in such events as the recent severe floods, particularly that on the Thames river, local organizations do not succeed in collecting more accurate and more authentic data, although at such times there are so many matters of great urgency that this omission can readily be understood.

In approaching the study of flood conditions, one of the most serious handicaps is the paucity of accurate data concerning the run-off from the drainage areas. On the Thames river, for many years, only two gauges have been maintained, one on each branch near London; and on the Grand, since 1923 only one gauge, that at Galt. That is to say, in these watersheds, having a combined area of over 5,000 sq. mi. and running through one of the most densely populated sections of the province, continuous records of water level and flow on the streams are really only available at three points.

Any estimate of the distribution of flow over the various portions of the drainage area must necessarily be based on very broad assumptions. For example, the run-off from the Conestogo, one of the principal tributaries of the Grand river, which has at times contributed 47 per cent of the total run-off at Galt, has been recorded for a period of only three years.

From a study of the available records of the flow of these rivers during flood periods, one is impressed by the rapidity of the increase and corresponding decrease in discharge. These rivers are very 'flashy,' a natural consequence of the comparatively steep gradient in the upper reaches particularly, and the fact that not a single natural reservoir in the form of a lake is to be found. The writer believes that these are the main factors in giving the extremes of high and low flows that are experienced. On account of the comparatively short duration of the high flow, the volume of water involved is relatively small. If, by the provision of protective works at critical points along the rivers, a reasonable increase in flow could be passed without damage, it will be seen that the retention of a relatively small volume would be sufficient to reduce the flow to the amount within the capacity of the channels. Unfortunately, the information available with regard to the flows during the course of the floods is so meagre that some uncertainty exists as to how much surplus water must be handled to eliminate damage.

There is a further factor which, in some instances, has contributed to the increase in river levels during high flows, namely, the encroachment on the channel by various structures, which in times of extreme floods act as restrictions to the free passage of the water.

While the general subject dealt with in the papers is essentially flood control, the writer would like to draw attention to the other side of the picture, namely, the low flows. In Mr. Marr's paper low flows as well as the maxima are listed.

On the Grand river a flow as low as 26 cu. ft. per sec. at Galt is recorded, and while the hazard and loss consequent on high flows is more spectacular and more forcibly impressed on one, the disadvantages resulting from the low summer flows cannot be overlooked. It is possible that the advantages to be gained by an artificial increase in the low summer flows may be equal to those resulting from improvement of flood conditions.

The writer would like at this point to remark on the excellent service that Mr. McCubbin has rendered in indicating the contrary effects of drainage on floods under different conditions. A critical examination of his paper will show too, the difficulty of obtaining experimentally definite results in connection with so complex a subject as the effect of drainage on floods.

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[1] Papers published in The Engineering Journal, February 1938.

[2] Chief Hydraulic Engineer, The Hydro-Electric Power Commission of Ontario.

The problem is one upon which very divergent opinions are held, many of them based purely on inductive reasoning, on account of the difficulty and expense of securing accurate experimental data on the many factors that bear on the question. Thus it is desirable for everyone to consider carefully the opinions expressed in this discussion no matter how much they may differ from his own.

W. H. Breithaupt, M.E.I.C.[3]

Grand River Conservation

It is pertinent at this time to draw renewed attention to the practicability of conservation on the Grand river, which drains the central part of the peninsula of Southwestern Ontario.

The question is not new. As long ago as 1905 the writer read a paper on the Grand river before the Canadian Society of Civil Engineers. He has repeatedly since then spoken on the subject, notably at a meeting of the Hamilton branch of The Engineering Institute of Canada, in 1924.

Precipitation data on the watershed are scant, but it seems fairly well established that, though varying in cycles, precipitation has not materially changed since beginning of observation. What has greatly changed with deforestation is the rate of run-off, the carrying off of water by the streams. A great regulation asset, about 400 sq. mi. of swamp in the headwater area of the river, was, by mistaken government policy in assisting its drainage, destroyed.

The regimen of the river is regular in that large floods are always in the spring, on snow melting, and invariably originate on the upper river. They depend on water-content of the ground, on accumulation of snow, on the rapidity of its melting and on accompanying rainfall.

A topographical survey of the river from Galt to Elora and up the Conestogo tributary, made by the Hydro-Electric Power Commission after the disastrous floods of 1912 and 1913, revealed three large basins with capacities as follows:

In Pilkington Township just below Elora	2,800,000,000 cu. ft.
At Hollen on the Conestogo	1,200,000,000 " "
At Blair	1,300,000,000 " "

For the Pilkington basin a dam 2,400 ft. in length and about 60 ft. in average height would be required, not a difficult dam in view of what has been done. In the Muskingum improvement just completed in Ohio the Bolivar dam is over twice the length and height of that proposed for Pilkington. A number of the Muskingum Conservancy District dams are earth dams with permeable foundation sites.

The Pilkington dam as an earth dam would require 800,000 to 1,000,000 cu. yd. of earth, depending on detailed examination of the site, which, at 30 cts. per cu. yd. in place, would amount to at most $300,000, leaving $700,000 to complete the dam for $1,000,000. It seems imperative that the Pilkington basin should be the first to be considered, in any project of Grand river improvement. It has six times the capacity of the proposed storage at Waldemar, has more than twice the watershed behind it, and is twenty miles nearer Kitchener, the first main population centre down stream. The need of the population above Elora for river improvement does not compare with that of the cities, towns and villages below Elora.

The Pilkington storage could, on conservative estimate, give a minimum summer flow of 400 to 500 cu. ft. per sec., a boon to Kitchener in the way of water supply and as a diluent of its sewage disposal effluent. Galt and Brantford would also very greatly benefit.

There is another possibility, that of power development.

The total annual flow of the river at Galt is probably well over thirty-six billion cubic feet, equivalent to a continuous flow of over 1,100 c.f.s. With the basins mentioned and additional storage above Elora and on the Conestogo, and storage on the Speed and its branch the Eramosa, the total storage above Galt could probably be brought up to seven billion cubic feet, which should give an all the year flow of 700 to 800 c.f.s. or more at Galt.

Galt is a little more than 600 ft. higher than Lake Ontario and is near the Niagara escarpment, 18 mi. or so from the Dundas marsh and the old Des Jardins canal, which extended navigation to Dundas before Hamilton was a port.

The recorded minimum summer flow at Galt in 1937 was 26 c.f.s. and from Brantford a minimum flow of under 50 c.f.s. is reported.

Physically there is nothing to prevent diversion of say 600 c.f.s. from below Galt to Lake Ontario and developing power to the extent of 30,000 to 36,000 hp. A large natural basin at Flamboro, just above Dundas, improves the situation in that it would enable night storage and thus give more water for the next day. And as to diverting water from the river, any one who prevents the present destructive floods and gives a minimum low water period flow of five or six times what it is now should well be entitled to use of the surplus water. Furthermore the minimum flow below Paris could be greatly increased by impounding the Nith river, as could well be done a short distance above its outlet into the main river at Paris.

What an ideal solution of full conservation of the Grand river this would give, and paid for by force of the river itself, and of what inestimable value to the entire Grand river watershed!

Stanley Shupe, M.E.I.C.[4]

There are now at hand practically all the data relevant to the subject, the facts of weather statistics as presented by Messrs. Patterson and Marr, the effect of agricultural drainage by Mr. McCubbin, and the progress to date and proposals of stream regulations by artificial storage by Mr. Adams. The suggestions of Mr. W. H. Breithaupt, who is the father of the scheme in general, vary as to location and detail, but the idea of storage is apparently agreed to by all as the only answer and should therefore be proceeded with as soon as plans may be approved.

Otherwise money will surely be expended in equal or greater amounts in repairing damages, sewage treatment, water supply, loss of flats for growing trees and in other unsatisfactory outlets over the whole basin. There is also no doubt that the tendencies are toward greater extremes in river flow.

As compared to agricultural drainage, let us consider the effect of the storm drain systems in towns and cities. A normal rate of run-off for forest or swamp may be as low as 5 per cent, agricultural lands 20 per cent, residential districts 45 per cent and business districts up to 90 per cent. It is apparent that the run-off is increased and delivered to the rivers faster as settlement proceeds. In fact, storm drains are designed for concentrations of 2 in. per hr. rate for the first ten minute period, which means minimized retention of water from the average storm.

A summary follows of the meteorological records from the Kitchener station, showing an average rainfall and snowfall over five years as 22.08 and 42.55 in. respectively, also a chart compiled primarily to show snow shovelling costs in relation to amount. There, as in flood dangers, it is the amount of accumulation rather than total precipi-

[3] Consulting Engineer, Kitchener, Ont.

[4] City Engineer, Kitchener, Ont.

tation as intervening thaws may remove much from time to time.

Also in rainfall it is noted a slow rain may soak in while a fast rate of downpour is a cause for more concern. For instance, 1.3 in. of rain fell all day January 14th, 1937, in Kitchener and despite frozen surfaces, caused no harm, whereas on February 21st only a half inch fell but so quickly that severe washouts and erosions of the softened surfaces resulted and drains were taxed to capacity.

Primary treatment of sewage may be obtained up to 60 and 70 per cent at a cost of $22 per million gallons by use of a combination of: coarse screens, fine screens, detritors, settling tanks, Imhoff tanks, and septic tanks. Effluent from a primary treatment plan requires about ten times dilution to leave a stream safe for, say, boating, fishing or bathing.

Without such dilution, secondary treatment is necessitated to reach 90 per cent at a gross cost of capital and operating expenses of say $40 per million gallons per day, which is most burdensome to a municipality, since it requires additionally one or more of the following: slow sand filters, trickling filters and humus tanks, activated sludge treatment and final sedimentation, chemical precipitation, etc. to say nothing of sludge handling facilities.

Contamination of streams may not be decently tolerated, so that the minimum flows of a river are of vital concern. A very small minimum flow in a populated area practically justifies proceeding with conservation works.

The following notes as to local conditions in Kitchener may be of interest.

The usual January thaw caused some washouts but the unusual heavy rain of Sunday, February 21st, 1937, culminated in floods and severe erosions, causing immediate expenditures of $600 and more at later dates, such as storm drain on Filbert Street at Spring Street, extra inlets at Union and Esson Streets, protection as requested by the Town of Waterloo at Ferdinand Street and extra roadway repairs, and was the reason for the Board of Works deficit.

The spring floods were, fortunately, very moderate on the Grand river despite the disastrous effect along the Thames river from the excessive rains of April 25th and 26th.

The unusual open winter required street sweeping during January and February to the extent of a few hundred dollars and minimized the snow shovelling service.

To satisfy the courts, storm drains should be designed for rates of downfall of 2 in. per hr. for periods of ten minutes with corresponding reductions in rate and time spread, the run-off co-efficient being applied as a factor to suit the district concerned. It is seen that this Department is much concerned with concentrations and requests aid in securing the additional recording devices for the local Government Meteorological Station.

The following tables were compiled from records of N. C. Helmuth, local government representative:

1937	Mean Temperatures		Precipitation	
	Maximum	Minimum	Rain	Snow
January	34.3	21.16	4.25 in.	3.0 in.
February	32.32	18.63	1.55 "	4.25 "
March	31.42	19.93	....	6.5 "
April	50.17	35.48	3.97 "	1.0 "
May	65.94	45.74	2.00 "	....
June	70.26	55.40	2.12 "	....
July	79.81	58.81	2.97 "	....
August	80.81	60.26	1.98 "	....
September	67.66	47.33	1.15 "	....
October	51.81	37.52	.95 "	.50 "
November	37.83	27.23	1.00 "	2.85 "
December	28.23	19.26	....	8.00 "
			21.94 in.	26.10 in.

The heaviest precipitations occurred on January 14th with 1.3 in. and on July 11th, 1.13 in.

	1937		Five Year Average	
	Maximum	Minimum	Maximum	Minimum
Mean Temperature	52.52	37.23	53.36	35.67
Rainfall	21.94 in.		22.08 in.	
Snowfall	26.10 in.		42.55 in.	

	Mean Temperatures		Precipitation	
	Maximum	Minimum	Rain	Snow
1937	52.52	37.23	21.94 in.	26.10 in.
1936	54.50	35.43	20.05 "	69.65 "
1935	52.80	36.10	22.72 "	42.00 "
1934	53.80	33.30	15.58 "	33.50 "
1933	53.18	36.31	30.09 "	41.50 "

	Depth of Snow	Cost of Removal
1925	82.3 in.	$ 2,912
1927	61.8 "	1,554
1928	63.1 "	1,775
1929	51.0 "	4,446
1930	66.36 "	6,998
1931	51.0 "	11,775
1932	22.5 "	9,584
1933	41.0 "	5,736
1934	33.5 "	5,813
1935	42.0 "	7,451
1936	69.65 "	10,089
1937	26.1 "	7,311

E. T. Sterne[5]

With the information in the papers presented this morning, along with that in the MacIntosh Report or the Hogg Report of the Ontario Hydro-Electric Commission, sufficient information of at least one specific river is now available to make it possible to take the next steps, to put the remedial works into effect. It is true that more information would be desirable and possibly could be secured on specific points, but that is true of all engineering.

Between $400,000 and $500,000 has already been spent in Brantford to put up a dyke system as a protection against flood. Theoretically those dykes could be raised as high as Haman's gallows if need be and keep the water out, but in addition to the money expended on the dyke system there have been very serious losses from loss of time by factories during floods, loss of material, reduction of wage bills and all that goes to stop the industry of a community.

Galt, in more recent times, has had to pay a heavy toll for the same cause. There, to a certain extent, as in Brantford, the payment has been made on an individual basis. There is no redress for the factory whose cellar was flooded or to the merchant on the main street who had to take his own loss. Some of the losses in flood damage have been tremendous.

The Hydro-Electric Commission have given a very complete report of the Grand river and in respect to Mr. Breithaupt's comments, there was a perfectly definite reason, the writer believes, for selecting the dam site in the upper reaches of the river.

If the Elora dam were first built on the Grand, the river, which is dry at the summer time at Fergus, would continue to be dry and there are communities further up that need water as well as the lower communities.

[5] Consulting Engineer, Brantford, Ont.

The writer himself feels satisfied with the quality and the accuracy of the data that have been presented and does not feel free to criticize or comment on them.

There is one phase, however, that may or may not be directly connected with this particular discussion that he wishes to bring up. The discussion at this Annual Meeting of The Engineering Institute covers the control and conservation of the waters of a large area in which the engineers living in that area are definitely and specifically interested, but it is not solely their problem. Every citizen within a watershed is equally interested in that problem, but the engineers in addition have two responsibilities in any project. First, to secure the information necessary to appraise the problem and to devise from that information the solution of it. A still higher duty of the engineers is to see that that information in an accurate form is continually kept before their fellow citizens who are equally interested in the correction of the trouble.

There is another thing engineers must realize; namely, that it is only by a community effort of the people of the whole watershed that the necessary corrective measures can be actually brought about.

Mr. Adams, in his paper, indicated that as far back as 1912 deputations had approached the various provincial governments to have something done about this particular problem. They were received, the writer believes, with the greatest courtesy. They had their talk, but the river still continued to flow, rushing in the spring and with low flows in the summer months. It is always easy to persuade people that the problem is one of spring floods, of flood control. Actually flood control is probably less than half the problem. The low water flow in these rivers is a greater problem in the summer time than the flood condition is in the spring. Further, nothing has been said yet about the effect of river flow on the ground waters, on communities lower down and yet one knows that the two are definitely connected together. In places like Kitchener, as the river has gone down, the level of ground water in their wells has been going down. That water didn't come from Lake Huron or some place up there by some mysterious method. It is exactly the same with the problem here. Everybody including the farmer is interested in the problem and it will have to be undertaken in a co-operative manner.

The Grand Valley Board of Trade was formed when deputations were sent down and it was realized that it was a watershed effort and not individual effort. They approached the Government and by virtue of the fact they were working as a unit, reaching the business men of a watershed that houses 375,000 people that paid very large amounts in wages and taxes, convinced the Government that it was an area to be protected and the result was that the Ontario Government had their very able report prepared.

They also passed an Act authorizing the formation of a Commission, representative of the various municipalities within the valley. Fortunately for the writer, and unfortunately for Brantford, he happened to be their Commissioner, hence his interest in this particular subject. The problem has been under consideration for the last four years, but progress has been slow. The engineers, within the valley, have helped materially in keeping the subject alive by putting out information that was reliable and that the people as a whole could depend on.

The point has been reached where the Provincial Government is prepared and has promised to accept a very large proportion of the cost of the work to be done in the valley. The estimate of the total work there is about $2,000,000, of which they will take a proportion, but also they insist that the municipalities pay part of their way.

The project cannot be laid on the government's doorstep with no thought of its maintenance or construction. If the Federal Government takes the expected steps, it will be possible to build the immediate works that will produce the result of 350 ft. per sec. minimum flow at Brantford and a corresponding flow further up the river.

Mr. Shupe only indicated the trouble he has had from time to time with his sewage effluent. Nothing has been said of industrial effluent coming into the river at various points, industrial effluent that is objectionable and at the same time is almost untreatable in a normal municipal sewage disposal plant.

The Grand valley problem, the Thames valley problem, or the problem of any of the rivers flowing into Lake Huron or into Lake Ontario, will be individually somewhat different from the problem at Brantford. Consequently they will probably have to be treated individually, but if the work which has been laid out in the Grand valley is accomplished, and the results achieved which the engineers have predicted, then the solution of the problems in the other valleys should come with increased rapidity and with greater ease. The writer was in Miami last spring. Their problem is quite a different one, purely a flood prevention proposition. In the Grand valley it is a question not only of flood prevention but of water conservation.

The writer would like to again impress the fact that the engineers of Southwestern Ontario must be prepared to give leadership, not only as engineers, but also as citizens, in a co-operative effort within every individual watershed and between watersheds, if they are going to correct the situations in which they now find themselves.

Prof. John D. Detwiler[6]

The writer has listened with much interest to the several addresses on flood control in Southwestern Ontario. In these addresses there were presented: (1) an analysis of the meteorological conditions that preceded the major floods in our two main rivers, (2) a comparative evaluation of the surface run-off in the basins of these rivers and their main tributaries, (3) a discussion of agricultural drainage and its possible relationship to floods, and (4) a brief geophysiographical description of the watersheds involved, followed by a review of present and proposed flood control structures on the Grand river. These addresses necessitated the assembling and analysis of much data and provided very pertinent information, but the writer feels that something fundamental was omitted.

As our understanding of the significance of floods and their control broadens, a new concept will arise, namely that the solution lies not wholly in the river channels but also in part back in the headlands, where the rains fall and the snows melt; that there must be a co-ordinated scheme that combines a watershed programme with the downstream engineering fortifications.

In the country to the south, where floods and history have grown up together, and where the flood menace has been, of necessity, studied from all angles, the conviction has arisen that an adequate flood-control programme includes preventive treatment of lands from whence floods arise, as well as construction of levees, dams, revetments and other defences along the major streams. To such an extent, in fact, has this interpretation been accepted that Congress in 1936 included in its national flood control legislation, provisions authorizing the Secretary of Agriculture to carry out headwater surveys and watersheds treatment. This Act paved the way, as H. H. Bennett, Chief of the U.S. Soil Conservation Service, said in 1937, "for a scientifically sound and thoroughly practical flood-control programme."

Everyone who has studied the problem very closely must admit that we cannot afford to overlook entirely the

[6] Professor of Applied Biology, University of Western Ontario, London, Ont.

intimate relationships between run-off from denuded and eroded soils and the accumulation of waters in the main channels.

The writer recently returned from a trip to the Muskingum Watershed Conservancy District in Ohio, where he visited a 1,200 acre laboratory in which the U.S. Soil Conservation Service will attempt to find out just what effects the various soil conservation practices will have on a watershed as a whole. The project calls for the inclusion of 5,000 acres of privately owned land as an additional area from which to collect data. Watersheds, of which there are 100 on this federally owned plot, are being studied and classified for purposes of comparisons, In one of the projects outlined, for example, watersheds will be studied in pairs. One of each pair will be farmed according to the practices now in vogue and the other will be treated according to the most approved conservation methods. From the forty wells a check will be had on the effect of conservation farming on ground water levels, and from the stream gauging station, built on the stream that drains the whole watershed, will be learned the influences of these practices on stream flow and hence on floods. All in all, important and basic information will be had on the effects of approved conservation farming practice on watersheds. This may take ten years and even more, but the outline of studies has provided for a long-time investigation.

On the findings of such surveys of the watersheds involved would depend the extent to which such measures as agricultural drainage, strip cropping, contour farming, and the retirement of critical areas to forest and pasture should be instituted. That such a programme may be beneficial has been well demonstrated over large areas in the United States and in other countries. Correct watershed treatment is a co-ordinated scheme of the various approved practices and only critical areas are recommended to be retired to forests.

The writer is quite aware of the fact that our floods in the Thames and the Grand usually take place in spring and at a time when the earth may still be frozen. The extent to which this has been responsible, however, for our floods is still an assumption and based largely on circumstantial evidence. Whatever its importance may be, and it is no doubt considerable, we should remember that the major flood on the Thames, previous to the one of 1937, took place on July 11th, 1833. The single argument, therefore, that of the possible coincidence of frost and flood, cannot justify a unidirectional flood control policy—one in which watershed engineering receives no attention.

Before concluding the discussion of watershed treatment, the writer would like to draw attention to an accompaniment of floods that needs no attempt at proof, and that is the load of soil the swollen streams usually bear. When swiftly flowing, silt-laden streams meet quieter waters, they unload their burden and the result is a filling-in of a reservoir behind a dam or of a water channel. The rate of silting is largely dependent on the nature and the condition of the land from which the waters have collected, and it has been well proved that proper watershed treatment may do much to anchor the soil. Adequate watershed engineering, therefore, may serve three purposes at the same time, that of retention of water in the watershed, the conservation of the soil and the amelioration of the silting menace. On the question of silting, it is well to bear in mind that the particular reservoirs being filled in may be the only ones possible in that region due to the lack of other suitable damsites.

There are other interesting problems associated with the flood control programme: climatic research, for example, providing a knowledge of storm morphology of the region; the recreational possibilities of the artificial lakes created; the biological possibilities of these retarding basins and the improved rivers and, finally, the post-construction responsibilities. Most require at least preliminary investigation before embarking upon a construction programme. The recreational and biological possibilities, for example, may be impaired for all time to come unless provided for in the original plans.

The writer's main plea in this discussion is for an adequate investigation of the problem of watershed treatment as a part of a co-ordinated flood control programme.

Dr. H. G. Acres, m.e.i.c.[7]

Twenty-five years ago it was the writer's duty to initiate and organize the hydrometric surveys in the Province of Ontario. At that time the main problem, as related to the rivers in the southwestern portion of Ontario in particular, was to locate controls sufficiently accessible in location and sufficiently permanent to furnish reliable data over reasonably long periods.

As a matter of fact, so far as the Thames and Grand rivers were concerned, it was found at that time that the authenticity of the records must be largely discounted by reason of the naturally flat river gradients, and in the lower reaches, by shifting channel conditions; the result being that so far as winter flow and the higher stages of freshet flow were concerned, it was almost impossible to obtain inherently accurate records from the gauge heights and rating curves of the metering stations. Probably Mr. Marr, who now has charge of the operations in question, is labouring under the same disability to-day.

This phase of the situation no doubt accounts for the fact that a large number of the stations established twenty-five years ago have been discontinued. The results obtained from them were presumably not sufficiently authentic to justify operating expenses, with the result that there is now only one permanent station on the Grand river and one permanent station on the Thames.

Such being the case, it should be realized that while the statistical figures which we have available to-day are as authentic as it is physically possible to make them, compilations and unit reductions derived from them may be arithmetically precise, but their inherent authenticity is purely a matter of surmise.

Furthermore, a complete study of the problem involved requires not only the available hydrometric statistics but also much more comprehensive and accurate data than are now available with regard to the time factor of flood crests, and the manner and frequency of incidence of the flood crests of lower tributaries. This latter type of data is very essential and will require a field organization beyond and supplementary to the organization which is now functioning.

Any river improvement scheme involves two fundamental considerations, the first being the problem of flood control, and the other the prevention of flood damage. Both elements ultimately converge to the one end, but in specific cases flood control may be the preponderating factor while in other cases the prevention of flood damage may be the main element of the problem. This distinction will be referred to later.

The disabilities associated with the character and comprehensiveness of existing fundamental data, as outlined in the foregoing paragraphs, have up to the present time tinged all discussions and all reports on the flood problem in Southwestern Ontario with reservations and limitations which do not tend to influence very favourably the reaction of the public mind. Inasmuch as the public is either directly or indirectly going to pay the cost, it would appear advisable from now on to give some thought to the matter of marshalling basic facts which the public can

[7] Consulting Engineer, H. G. Acres and Company, Niagara Falls, Ont.

accept with confidence as indicating the physical and economic justification for either, or both, of the improvement schemes that have been under discussion for many years on the Grand and Thames rivers.

Despite the disabilities above referred to, there are certain facts available which could be honestly used, with good effect, to produce an active response in the public mind. Other conditions being reasonably equal, it can be assumed in the first place that inasmuch as the flood prevention and river improvement schemes now under consideration are in the public interest, the higher up in the watershed the initial improvements can be located the more evident and comprehensive will be the resultant public benefit.

In the case of the Grand river, it is an established fact that there are in the upper reaches of its basin topographical and other natural conditions which are definitely favourable to the inauguration of river improvements, so that the bulk of the residents in the Grand river watershed will be benefited by these improvements from the start. It is also a fact that the topography and the ultimate use to which the watershed should be put are such as to justify the construction of positively controlled retention dams. It is an established fact that suitable sites for such structures exist. It is also a reasonably well-established fact that such dams will control fairly well-established volumes of run-off from the higher gradient regions of the watershed.

To be more specific one should have no hesitation, with these facts in mind, in recommending to the enabling and financing authorities that work be commenced immediately on what are known as the Waldemar site and the Luther Marsh site in the Grand river basin. The authorities in question could be assured that while the results which would accrue from the construction and operation of these specific units of the Grand river scheme could not be set forth in precisely accurate figures, nevertheless assurance could be given that the ends which these works were designed to attain would be of definite benefit to the riparian interests in the lower portion of the watershed, not only from the standpoint of flood control, but also as related to the rectification of minimum flow conditions and the dilution of sewage effluents and of industrial wastes, and that, in general, the cost of these works would be amply justified by the direct and incidental benefits which would result.

It would appear that the situation which exists in the Grand river watershed at the present time identifies it as primarily a problem of flood control.

On the other hand, based upon such information as is now available, it would appear that the problem on the Thames river is primarily one of prevention of flood damage. This distinction is based upon the surmise that, while positively controlled retention basins are feasible in the upper regions of the Grand river watershed, the conditions in the Thames basin are such that free-discharge detention basins must be considered as the only feasible alternative. This would mean that in the Thames basin flood peaks would be modified, but minimum flow would not be improved, while at the same time supplementary works for the prevention of flood damage will be required at vulnerable points along the lower reaches of the river.

Mr. Adams' paper has exemplified the principle above alluded to, in connection with the availability of a sufficient number of what might be called common sense facts, to justify at this time the presentation of a construction programme free of limitations and uncertainties, and sets forth definitely the engineering features and estimated cost of the structures involved.

Mr. Marr's statistical summary is admittedly, by virtue of surrounding circumstances, a statistical summary of the hydrometric data available in connection with the two watersheds, which is subject to the limitations under which it necessarily had to be obtained and compiled.

Mr. McCubbin's discussion of the influence of artificial drainage seems to justify the statement that the effect of this is a more-or-less negative element in the present problem. The drainage systems which have already been developed in the lower reaches of the watershed are certainly an advantage rather than otherwise, inasmuch as they give a freer outlet for flood water in the low gradient sections of the watershed. On the other hand, so far as drainage in the upper reaches of this watershed is concerned, it may be assumed that the accelerated run-off, if it actually occurs, will be flattened out by the development of artificial storage, particularly in the case of the Grand river.

Mr. Patterson's paper has been most interesting, not so much by reason of its relationship to the engineering and construction phases of river improvement, but because there is in it and in the data that he has submitted, something that is of very vital importance as related to the subsequent operating problem. It might be worth while to examine the organization of the Meteorological Bureau in the light of whether or not the Bureau is organized and equipped to supply meteorological information from day to day, and possibly from hour to hour, which will furnish the operating agency with an index of when to open and when to close sluice gates. Damaging flood peaks are normally of short duration, and the operation of controlled storage basins might be very definitely influenced over periods of a very few hours at a time if meteorological information could be made available to indicate, for instance, whether a storage basin within ten per cent of being full should be let go or whether it should be held.

In conclusion, it is suggested that an effort be made from now on to make the academic aspects of this problem more or less subservient to its practical implications, and to provide something in the form of a technical and financial brief which will give facts without uncertainties, and definite assurances without reservations. In other words the time has come, paraphrasing Mr. Sterne's observations, to do some missionary work, and to defer for the time being any long-drawn-out discussion of technical implications and complexities.

Wilfred G. Ure, A.M.E.I.C.[8]

Mr. Acres is to be congratulated on the way he has discussed the general aspects of this whole subject. The writer would confine his remarks to certain local aspects, along the lines of some description of the flood effects in the upper reaches of the Thames valley and some development of Mr. McCubbin's discussion of the effect of drainage on flood run-off.

The upper watershed of the Thames, say above the city of London, is a rich agricultural country of a rolling nature, in which artificial drainage has been very extensively practised. It may be said to be all cleared land except for the odd hundred acres of bush and the small woodlots which many farmers have been farsighted enough to maintain to provide fuel for themselves during the winter. The artificial drainage is practically always in the form of tile drains up to the point where the flow of water becomes so great that a covered drain is no longer economically feasible, at which point the drain changes to an open channel. As Mr. McCubbin has pointed out it is generally the case that the outlet of the improved watercourse is a mile or more above the main stream.

Oxford county lies near the upper end of the watershed along the south and middle branches. For a good many years the tile drains in that county have been designed on

[8] City Engineer and Consulting Engineer, Woodstock, Ont.

the basis of a run-off of one-quarter of an inch per day, and for a typical drain in that type of country this basis has proved quite satisfactory. It assumes that freshet water will at times flow over the surface of the ground, the owners accepting the proposition that it is not economically sound to provide for all the water underground. A smaller basis of design was used for the earlier tile drains and quite a few of these have been found too small and have been rebuilt with larger tile.

Being located so close to the headwaters one would not expect flooding to be a very serious problem to the city of Woodstock and in fact a few thousand dollars would cover all the damage to both municipal and private property in spite of the giving way of a dam above the city. The south branch skirts the city but the river flats are only pasture land. A tributary known as Cedar creek flows through the south part of the city but the flats of this creek are mostly park lands. Generally speaking the areas subject to flood are not used for building purposes and hence damage due to flooding is not extensive.

The section between Woodstock and Ingersoll was not so fortunate. Here there are several large industries operating limestone quarries and from the very nature of their business they have to locate right in the river valley; in fact they have moved the river around so much in the course of their operations that it is almost impossible in places to determine the original location. During the flood the river broke through the embankments and all of these quarries were flooded. The total of the damage during this last flood and the cost of providing additional safeguards against future floods will run into hundreds of thousands of dollars. One quarry alone had to pump out nearly a hundred million gallons of water in order to get back into operation. Some preventive work has been done in the past summer in the way of channel straightening, involving the relocation of roads and bridges in co-operation with the municipalities concerned. When the new dykes become consolidated, it is hoped that they will withstand future floods.

During the recent flood six highway bridges, each with a span of about one hundred feet, went out on the main river streams, one on the middle branch and five on the south branch and there were several others which required extensive repairs to the foundations. Five out of these six bridges were carried on cut stone masonry abutments, generally set on wooden mudsills, and with the stone work not extending far below the bed of the stream. All failed through undermining of the foundations. Most of these bridges were old and due for replacement in any case, the one on the main highway in Ingersoll having been built in 1879. It seems a reasonable inference that these bridges had never before been subjected to as severe a flood as that of last April, because here we have five bridges of similar construction standing up around fifty years and all going out at the same time.

It is interesting to note that Mr. McCubbin's graphs of the maximum flood flow in Ontario rivers do not indicate any increase in flood flow due to the period of extensive artificial drainage following the Great War. The investigations given into the flows of the Des Moines and Iowa rivers point the same way, and the investigators state that if the extensive drainage had affected the factors of flood flow, the fact would easily have been discerned in their analysis. After listening to the papers and the discussion thus far the feeling of the speakers seems to be unanimous that the effect of drainage is practically negligible on heavy floods.

Flood prevention works cost money and somebody has to pay for them. This question has an important bearing on the distribution of the burden of the cost of such works. If the premise be accepted that deforestation and drainage of farm lands do not materially affect flooding any great distance downstream, then the basic legal principles underlying the drainage law of Ontario would relieve the upper owners from liability. Land owners in the upper part of the watershed should not be penalized because they have cleared, drained and cultivated their land, merely in order that other owners far downstream may convert to building purposes lands in the river valley which are subject to overflow when a natural sequence of weather events produces an exceptional flood, the valley under similar conditions having been subject to similar flooding since the present geology of the region was established.

S. W. Archibald, m.e.i.c.[9]

The papers which have been presented on precipitation, surface run-off, agricultural drainage, flood control, and water conservation contain the available information on the subject. In addition to flood control and water conservation, the necessity for pollution prevention must be considered.

Legal considerations, if no others, demand pollution prevention. "To send down polluted water is always actionable"[(1)], "He whose dirt it is must keep it that it may not trespass"[(2)], are but two of very many axioms contained in court decisions.

The papers given admirably present the why; the how and when remain to be dealt with. With regard to the how, it is suggested:

1. That the experience of England can be used to Ontario's benefit.
2. That existing legislation should be used.
3. That general provincial legislation is necessary.

Comparing the drainage in England with that of Ontario, the average area of 101 catchment areas of England is 459.4 sq. mi. The Thames, the third largest of these, has an area of 3,812 sq. mi. The Thames of Ontario total watershed area is 2,250 sq. mi. Our Thames compared with the Tennessee, covered by the Tennessee valley authority, is the comparison of a postage stamp with an envelope. In England, the report of the Royal Commission on land drainage presented December 1927 states a main issue, "The necessity of having a supreme authority in each catchment area which should be in charge of the main channel and banks of the river and work in closest collaboration with the drainage authority concerned with the internal drainage of the catchment area."[(3)]

With regard to the second point that existing legislation should be used, the Municipal Drainage Act R.S.O. 1927 Chapter 241, as explained by Mr. McCubbin, aims at drainage for a community and the Act does not limit the size of the area or the scope of its application. Apparently the chief objection to applying the Drainage Act, as it is, would be the right of a comparatively few individuals or a single municipality to commit a large area to works and expenditures without permitting the right to assist in determining whether or not the works are necessary, and if necessary, their nature and method of being financed.

With regard to the general legislation, while necessary amendments to the Municipal Drainage Act or a new Act would entail careful drafting and study, a suggestion for a basis for discussion would be the addition between subsections 3 and 4 of section 2 of the following section or sections:

"Where the area described to be benefited lies downstream from a drainage area comprising more than 100,000 acres, or where other sufficient reason exists, the Council of the Municipality receiving such petition may, after giving notice to the upstream municipalities of its intention so to do, apply to the Minister of Lands and Forests, or Public

[9] Consulting Engineer, London, Ont.

Works, or Municipal Affairs, or Agriculture of the Province of Ontario—in England it is the Minister of Agriculture and Fisheries—to have established a river board or catchment area on said river or part thereof."

"The Minister may cause to be prepared a map of a designated catchment area on which shall be shown... (details regarding natural and artificial drainage conditions). The Minister may appoint a board not to exceed ( ) in number:... (say one-third by the Minister, two-thirds by the Municipalities interested)."

In a paper to the American Institute of Electrical Engineers at Milwaukee June 1937, Dr. Bush, Dean of the School of Engineering, Massachusetts Institute of Technology, said: "Our Government is called upon to decide momentous technical matters, most of which are so complex that they can be fully understood, if at all, only by experts. Such questions involve finance, sociology, economics, engineering. They cannot be grasped completely and intelligently by the general public. They cannot be grasped by the elected representatives of that public, who must, in the nature of things, be specialists principally in the political art. How then are they to be decided wisely in a democracy?

Much depends upon the answer to this question. We are in competition with nations in which absolutism and intense nationalism control. The maintenance of our position, our relative standard of living, depends upon the skill with which our affairs are handled. Under an absolute ruler all specialists of every sort become government specialists. A dictator can make final, binding, prompt decisions upon weighing their recommendations. Will we, with our exceedingly loose system, be similarly able to bring to bear the best of intelligent judgment upon the technical problems of the day? We must do so, if we are to hold our place."(4)

Last week the Attorney-General of this Province speaking at Whitby is reported as follows: "Our people are coming more and more to look upon governments as the panacea of all ills, the ever-present help in time of distress and the source of all wealth. Too great an extension of social services and too much paternalism may wreck the entire economic and social structure."(5)

Also, last week, a well known Member of the Federal Parliament, speaking at Quebec, is reported as follows: "Canada, with more to do and more to do with, is doing less to take advantage of her opportunities than any other nation."(6)

It is unnecessary to labour an explanation that these statements are applicable to the question being discussed.

(1) Hodgkinson v. Ennor, 32 L.J.Q.B. 231, 8 L.T. 451.
(2) Tenant v. Goldwin, Salk. 21, 361.
(3) Report of the Royal Commission on Land Drainage in England and Wales, Section 58. (1927.)
(4) The Engineer and His Relation to Government, General Electric Review.
(5) London Free Press, January 26th, 1938. The Hon. G. D. Conant, Attorney-General of Ontario, to St. Andrew's Men's Club, Whitby.
(6) London Free Press, January 26th, 1938. G. G. McGeer, M.P., Vancouver, Burrard, to Canadian Construction Association Annual General Meeting, Quebec.

Lt.-Col. W. M. Veitch, A.M.E.I.C.[10]

Referring to conditions in London, Ont., during and immediately after the flood of April 1937, it may be noted that the section of the city known locally as London West is the only section which is protected by embankments or dykes from more than normal floods.

The April 1937 flood began on April 26th, and it is believed that up until 5 a.m. on that date the River Thames at London had not exceeded normal flood level. During the early morning, it was noticed that considerable low-lying lands were being flooded. At 11 a.m., observers reported that the flood level was rising at the rate of one foot per hour. At this time, the local newspaper was requested to broadcast by radio a warning to all citizens living in low-lying locations to prepare to vacate their homes.

[10] City Engineer, London, Ont.

Only two sections of the city reported any property damage prior to noon on April 26th. There had also been flooding of streets in West London due to water gaining entrance to storm sewers through improperly closed flap gates on their outlets through the dykes. This condition, however, happens occasionally in normal floods without serious damage.

At 1.15 p.m. on April 26th, the flood waters overtopped the earthen embankment near Dundas Street bridge. This was followed by at least two other overflows within 15 to 30 minutes. At 6 o'clock in the evening the flood waters were flowing over practically the whole length of the dykes protecting London West.

The flood appeared to reach its maximum height at 2 a.m. on April 27th, and remained at that level until approximately 4 a.m. when it began to recede. The fall of the flood level was noticeable throughout the day. At 5 o'clock in the afternoon it was again possible to walk, dryshod, the entire length of the London West protective dykes, with the exception of one small section in the southwest corner of the area which had been entirely washed away. There is some doubt with regard to both the time and the direction from which this washout occurred; it has been impossible to ascertain definitely whether the pressure was exerted by the river or by the water entrapped in London West, or a combination and weakening by both. This particular section had been known, for many years, as one of the weak sections of the embankments.

At 11 p.m. on April 27th, the area was again free of flood water, the river having again returned to a level below even normal flood levels.

From our observations, the north and south branches of the River Thames were at their flood peak at approximately the same time. This is a condition that has never happened before in the memory of the residents. In spring freshets, it is usual for the south branch to clear itself of ice before the ice in the north branch has started to move, or vice versa.

It may, therefore, be seen that the actual period of the April 1937 flood was only 28 hours. During this flood, the river rose from normal to abnormal and fell again to normal flood level in less than two days. The time taken for the rise from normal flood level to high level was almost exactly the same as the fall from high level to normal flood level—a period of 13 hours.

Flood Protective Works

Over one hundred thousand dollars has been expended in the construction of protective embankments on the river bank adjacent to West London.

Up until the flood of April 1937, we found that the hydraulic gradient of all previous floods had conformed very closely to the levels of the top of the embankments. This was not true during the last flood, for example, between Oxford Street bridge and Dundas Street bridge, the two extremities of the protective works on the north branch of the river: the normal summer level shows a difference of 7 ft. 9 in.; the difference in the top levels of the embankment is 5 ft. which in every other flood has shown a very close relation to normal flood level. The 1937 flood showed a hydraulic gradient of 2 ft. 9 in.

Between Carrothers Avenue and Dundas Street, a distance of 1,820 ft., the embankment has been faced with concrete. The elevation at the north extremity is 61.3 ft. and at Dundas Street 60.0 ft., a difference of 1 ft. 3½ in.

The maximum flood level over this breakwater was 62.2 ft. or 1 ft. 3 in. over the north end of the breakwater and 2 ft. 2½ in. at a point 400 ft. north of Dundas Street bridge.

West of Dundas Street bridge, where the flood water first entered London West, the elevation of the river bank was approximately 54 ft. The flood level at this point was 62.1 ft. The flood level, therefore, had a depth of approximately 8 ft. over what was at that time private property.

Between Wharncliffe Road bridge and Douglas Avenue, which is the westerly extremity of the earthen embankment, the flood levels were 62 ft. and 61 ft. respectively, approximately 3 ft. over the earthen embankment then in place.

In June 1937, the writer recommended to the Municipal Council that the protective embankments should be repaired or rebuilt only to such a height as would protect London West from floods of normal proportions, that is to say, that private property should be purchased and embankments erected in the two locations where private ownership of the land had made this erection impossible prior to the 1937 flood, and, further, that all embankments should be rebuilt, where necessary, to conform to a hydraulic gradient two feet below that shown in the flood of 1937. It is the writer's opinion that the cost of constructing embankments, with the necessary raising of bridges, to a sufficient height to ensure against flooding from all known floods would exceed any expenditure which the city of London might be expected to make.

The writer believed that the construction of the embankments to the levels he had indicated was all that the municipality should do and that any floods which would exceed this height should be taken care of by a flood-control programme sponsored by the government; a scheme which would protect not only London but also all municipalities on the River Thames and its branches. The writer did, at that time, submit that in his opinion it was possible to build a control dam on the north branch of the river, some ten miles from London, and, further, that a similar dam might be built on the south branch at a like distance from London. Since that time, further study has convinced him that a dam on the north branch only in the vicinity of London is necessary, and that if a dam is required on the south branch it should be east of Ingersoll. It is his opinion that these two dams would protect the whole Thames valley from flooding, always excepting floods due to ice jams.

Work Occasioned by the Flood

This work as described is only work of a municipal nature; the City Council gave very definite instructions immediately after the flood that repair work must not be done by civic employees on private property.

The work which was done immediately prior to the overflow of the banks was a hopeless attempt to withhold a situation which one knew to be inevitable. Gangs of men were employed in the filling of sand bags until such time as the flood water made it impossible for further work.

The next work was the evacuation of the people in the flooded area. In addition to all the private cars and privately-owned trucks, 17 trucks were in operation in the flood area. Five of the city trucks, in addition to many privately-owned cars and trucks, had to be abandoned while waiting for the residents to make up their mind to evacuate the area. Arrangements had already been made with the District Officer Commanding the London Military District for the use of the local armouries for the reception of the flood refugees. The military authorities immediately took the situation in hand and, before the first arrivals at the armouries, heat had been provided, army cots were on the way, army cook-stoves were held in readiness. The local Red Cross Association then took charge of all feeding and housing arrangements for the flood refugees. The evacuation of the area was a difficult task: the people showed a marked inclination to disbelieve the fact that the embankments were not sufficient to protect them from flooding. The trucks and cars were instructed to take the refugees to any address they might suggest; failing this, to the main armouries building.

The fact that there were two or three sections of the embankments where the top level was not in conformity with the hydraulic gradient was a factor in the evacuation without loss of life. The flood waters entered the area more gradually than they would otherwise have done had the embankment levels conformed exactly to the hydraulic gradient of the flood. In that case, the water would have poured over a mile and a half of embankment at exactly the same instant.

Immediately the use of trucks and automobiles had to be abandoned, another method of evacuation had to be adopted: all available boats in London were commandeered, and additional boats and crews were brought from Port Stanley. These boats worked throughout the night in total darkness and against strong and dangerous currents. One boat was swamped by, it is believed, striking an obstruction, and the volunteer rescue worker was drowned, the only death, in London, during the flood.

Advance rescue stations were established where the rescued might be taken by boat, there to be given coffee and sandwiches, make arrangements with friends for their reception or await road transportation to the main armouries. The local company of the Royal Canadian Regiment gave valuable assistance both in the transportation and in the work of the reception of the refugees at the armouries.

The work of April 27th was a work of watching as far as the Works Department was concerned. Every bridge had to be carefully inspected and guarded, and, at one time during that day, of the eleven main bridges in the city only one was in operation. The cause in most cases was the inability to proceed further after having crossed the bridge due to flood water. At 5 o'clock in the evening, as the flood receded, it was necessary to place special police on all flooded areas to prevent looting. At 11 p.m. on the night of April 27th, the writer walked along Dundas Street towards Wharncliffe Road; it was possible to reach that intersection by wading through approximately 2 ft. of mud in places. The depth of water, seven hours previously, had been from 6 to 8 ft. in this locality.

Two days ago, this had been a peaceful and orderly section of the city. Now, not a board fence was in place; garages stood in the middle of the street; motor cars lay upturned on the streets; verandah steps were torn from almost every house and piled in grotesque groups in back yards. One home that did not boast a car, far less a garage, now had three garages in the back yard. Our first reaction that night was the feeling of impossibility of ever being able to straighten out, or even clean up, this stricken area.

The work of organization of gangs started at daylight on April 28th, and by 8 a.m. gangs and trucks were already at work. Garages and out-houses had to be removed from the streets; verandah steps were a drug on the market; all were taken to the dump, and residents were instructed to claim a set that would most nearly fit their particular verandah. Teams were employed for weeks reclaiming structures of value from the flat lands along the river banks; these structures were stored in dumps and were reclaimed from there.

A very strict police guard was placed in all flood areas; no one was allowed to enter without police permission and all persons had to be clear of the area before darkness set in in the evening. Even workmen were required to wear tags which were handed in by them before leaving work each day. Residents were not allowed to again occupy their houses until they had been examined and passed by the Medical Officer of Health.

Red Cross stations were set up within the flooded area for the free distribution of medicines, water chlorination tablets, and coffee, all in an effort to counteract any epidemic which might arise.

The cost of the work made necessary by the April flood was $65,283.52 up to the end of the construction period last year. It is estimated that, to complete the repairs, approximately $10,000 more will be expended this year on replacement of sidewalks, fencing and lighting cable and standards on the embankments. The total of $75,000 is made up as follows:

Labour, material and police guard during the flood	$ 7,500
General clean-up	26,000
Repairing, raising and strengthening of embankments	33,500
Repairs to roadways, sidewalks and sewers	3,000
Repairs to bridges	5,000

Wellington bridge, a pin-connected structure erected in 1882, was damaged by the 1937 flood to the extent of $10,000. In the writer's opinion, it would have been necessary to replace this bridge within the next five years. He, therefore, recommended that any expenditure on repairs would be wasted. This bridge has now been replaced by a modern structure.

The Public Utilities Commission, who operate the electric light and power, water and parks in the city of London, lost a considerable amount of equipment during the flood. This has been repaired or replaced at an estimated cost of $50,000.

During the flood of April 1937, 745 acres, or 15 per cent of the total area of the city of London, were flooded; 4,184 persons resided in this area, representing approximately 5½ per cent of the total population. As a great deal of this area was flat, low-lying land, the assessed value of the property in the area was not great; it approximated two million dollars which is equivalent to 2.7 per cent of the total assessment. It is estimated that there were 1,064 buildings flooded and that the flood waters rose to a height 7½ ft. higher than the highest recorded flood since the July flood of 1883. The flood of that year was 3 ft. lower than the flood under consideration.

February 1938 Flood

Exactly one week after The Engineering Institute meeting in London, which discussed the matter of flood control, the city of London was again threatened by floods. On February 6th, both branches of the River Thames rose to an alarming height, or at least alarming in the minds of the citizens who had gone through the flood of 1937. Records, however, show that the flood of February was not above normal and at no time was there danger to either person or property, with the possible exception of flooded basements. The peak of the flood was reached at 3.15 a.m. on February 7th, and was 7 ft. 6 in. below the maximum height of the April 1937 flood and 5 ft. 9 in. from the top of the embankment.

As darkness came on on Sunday evening, February 6th, almost a panic ensued: memories of the last flood, coupled with advice given by persons living outside the flood area and by curious sightseers, were responsible for this condition. Movers and truckers were also to blame for the 200 persons who moved their belongings out of the flood area; they were known to be canvassing the people in the hope of obtaining work.

In order that this state of panic may not obtain again, the writer recommended to the City Council that whenever the river approaches major flood proportions official bulletins be broadcast over the radio every hour or half-hour, as necessary, and that the police will control all traffic entering or leaving the flood area and will exclude all curious sightseers from that area.

A. J. Connor[11]

Dr. Acres having asked:—"If an up-river flood-control dam were impounding water to near the maximum level and a sudden flood were impending from approaching rain, could the Meteorological Service, with its organization as at present constituted, give us sufficient warning to let the water go in time? Or could they advise us to hold it?" The writer would reply that this would involve considerable expense. If the Canadian Meteorological Service is to take over flood-warnings of the kind undertaken by the United States Weather Bureau, many additional observers and daily telegrams to Toronto would be necessary. Some fifty observers to measure daily the snow-cover, ice on the ground, water held in snow-cover, depth of soil frozen, rainfall and perhaps temperature, would be required in this region for sending daily messages to Toronto. Additional staff would be required there to keep a daily map of conditions on the Grand and Thames watersheds and so be prepared to make a forecast of probability of an expected rain causing flood and to what intensity. No suggestions to control engineers would be advisable but a forecast of flood only. The writer would point out that in a country larger than Europe, with only eleven million population, many more suggestions for federal expense were being made than the population could afford. One could not say whether such expense would be sanctioned by the Department of Transport.

In reply to a question by Col. Veitch, whether a forecast of character and intensity of spring flood could be made at the end of February, the writer replied that if a flood-warning division of the Meteorological Service were set up (as outlined in reply to Mr. Acres) one could tell at the end of February if the watershed were in such condition that a heavy rainfall would result in almost total run-off. Under present arrangements most reports were received by mail too late for such forecasts and were not sufficiently detailed in any case in respect to snow and ice covering the soil.

[11] Meteorologist, Air Services, Meteorological Division, Department of Transport, Toronto, Ont.

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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VOLUME XXI MAY, 1938 No. 5

Greetings!

This is a new editor speaking. The timorous voice and quaking knees may not immediately be apparent to the audience, but to the editor himself they are painfully in evidence. After some weeks of contemplation, and a few days of experience, the magnitude of the undertaking has more fully dawned upon him, and with this appreciation comes some realization of the obligations and opportunities of the position. Who would not be nervous under such conditions?

The change of editors on any established publication is always an important development. Unfortunately, the mere passage of time makes many changes necessary, which of themselves may not be desirable. This change answers that description. Under the previous editorship The Journal has attained unusually high ranking with all members of The Institute and readers everywhere. It has been interesting, attractive and dignified, a credit to its editor and to The Institute which it represents. It seems unfortunate, therefore, that the guiding hand which has done its work so well for the past many years should have to be lifted now, but it would not be fair to hold it longer to its task when the desire and need of rest and change have been so clearly expressed by Mr. Durley himself and by his physician. It is a great comfort to his successor to know that the wisdom, experience and ready assistance of Mr. Durley has been made available to him, without which the outlook would be most discouraging. With it much should be accomplished.

The new editor, and general secretary, has much to learn to be equal to his task. He has great need of the patience, tolerance and kindly assistance of the membership. With these, he hopes to realize his ambitions and to make the most of the opportunities which are now his. There is a great chance in this position to render a real service to the engineers of Canada. It is his sincere wish, and his determination, to be equal to this opportunity. To this end he asks your patient indulgence during his initiatory period, and your kindly assistance throughout his entire term of office. After all, The Journal is largely a co-operative effort, and without the loyal and helpful assistance of many members, its publication in useful and acceptable form would not be possible. The new editor will be very grateful for the help which you may give him.

"A Three-Fold Cord Is Not Quickly Broken"

Recently the President of The Engineering Institute tendered a dinner to the President and members of the Dominion Council of Professional Engineers, during their three-day conference in Montreal. During the course of the evening he explained to them that his own concept of the function of the Engineering Triad—the Provincial Professional Associations, the Dominion Council and The Engineering Institute—was "United we stand, divided we fall."

Believing that an understanding by all engineers of the basic issues discussed by the President is in the best interests of the profession, the Council of The Institute has directed that his remarks to the Dominion Council appear on the editorial page of The Journal. Accordingly, on page 248, will be found a summary of what was said. Members are asked to read it carefully, for we believe that therein may be seen the suggestion for a solution of a problem that is interesting and vital to us all.

The Journal Looks at Itself

Changes in the form and content of The Journal have been under consideration for some time. The Publication Committee, at a recent Council meeting, made a very interesting and comprehensive progress report on the whole situation, based on the returns of the questionnaire which was recently submitted to the members, and investigations of engineering journals published in New York by the Founder Societies, and certain other commercial publications of interest to engineers. Out of these investigations and deliberations some considerable good will come, but the process will probably be one of evolution rather than revolution.

A notice appearing in last month's issue gives the first outward sign of these possible changes. A prize has been offered by the committee for the best suggestion for a new cover design. An amplification of the rules and regulations that will apply may be found elsewhere in this issue. It is hoped that many members will give the matter thought. You may not win the prize but your recommendations cannot help but be of assistance to the committee, and eventually you may feel that you share in the credit for any improvements that are brought to pass.

Presidential Activities

On May 1st at Halifax a special meeting of Council was held, which was attended by all five Maritime Councillors and by a delegation from Headquarters including the chairman of the Finance Committee, Vice-President J. A. McCrory, and the Chairman of the Special Committee on Professional Interests, Councillor F. Newell. By direction of Council, the chairmen of the four Maritime Branches, also former Vice-President McKiel, of Sackville, and Mr. J. A. Fowler of Halifax, were invited to attend.

* * *

Arrangements were made for the President and the General Secretary to visit the various Maritime Branches, on the following dates:—

Halifax, April 30th to May 2nd
Sydney, May 3rd
Moncton, May 4th
Saint John, May 5th

* * *

The annual meetings of the Toronto Branch on Thursday evening, May 12th, and of the Niagara Peninsula Branch at Niagara Falls on Friday evening, May 13th, will be attended by the President and the new General Secretary.

According to present plans, it is expected that following a special meeting of the Hamilton Branch early in October, these officers will make a tour of all the Branches in Western Canada.

The Nova Scotia Agreement

In the March issue of The Journal, there appeared a draft of the proposed agreement between The Institute and the Association of Professional Engineers of Nova Scotia as recommended by accredited representatives of both bodies. While there is understood to be some doubt about the Association's legislative authority to complete the agreement precisely in the form negotiated, the necessary preliminaries have now been completed as far as The Institute is concerned. As already announced, the new enabling By-law No. 76 was approved by an all-time record vote. Pursuant to the authority in this new By-law, the three necessary conditions have been met by The Institute so far as an agreement with the Nova Scotia Association is concerned, namely, the Agreement has been published in The Journal, it has been approved by letter ballot of The Institute Council with only one dissentient opinion, and it has also been approved almost unanimously by letter ballot of the Corporate Members of The Institute resident in Nova Scotia. The practically unanimous verdict thus given by the interested Institute electorate is most gratifying, as showing The Institute's definite support of the idea of an entente with the Nova Scotia Association.

It is a point of interest to note that at no time during the negotiations has The Institute Council made any suggestion for immediate action on the part of members of the profession in Nova Scotia looking to closer co-operation with The Institute. Should the Association for any reason think it desirable to make haste slowly in this important matter, the Council of The Institute will be found quite agreeable to such a course.

Ballot on the Nova Scotia Agreement

In accordance with Section 76 of the By-laws, the proposed agreement between The Institute and The Association of Professional Engineers of Nova Scotia has been submitted to the corporate members of The Institute resident in that province.

The ballot was returnable on April 20th and was canvassed with the following results:

Total valid ballots received...	63
Votes approving agreement...	61
Contrary votes...............	2

Meeting of the Dominion Council of Professional Engineers

Knowing that the general membership of The Institute is greatly interested in the functioning of the Dominion Council of Professional Engineers, the editor of The Journal has asked the President of the Dominion Council for a brief summary of the Conference held recently in Montreal. The Journal is pleased to publish the following report which has been submitted by C. C. Kirby, M.E.I.C.

The Dominion Council of Professional Engineers met in Montreal, April 4th to 6th, at the offices of the Corporation of Quebec. Representatives from seven Provincial Associations attended the meetings.

The principal business before the meeting was consideration of the differences between the various Provincial Associations of Professional Engineers in respect to Charters, By-laws and methods of procedure, with special reference to those features governing inter-Provincial practice.

The Council agreed upon a number of recommendations to be made to the Councils of the constituent Associations with a view to obtaining a greater degree of reciprocal action in the exercise of the privileges of inter-Provincial practice and transfer of registration.

The meeting regretted the absence of Manitoba from these deliberations and passed a motion that the Association in that Province be again asked to co-operate.

It was agreed that steps be taken to obtain approval of the member Associations for the formation of a Central Examining Board and basic details for such a Board and its functions were considered and agreed to.

The committee on admission of foreign engineers to temporary practice in Canada reported on the co-operation obtained from the Department of Immigration on this matter. Mr. P. M. Sander is chairman of this committee.

The meeting received a communication from the Secretary of The Engineering Institute advising it of the negotiations then proceeding with the Association of Nova Scotia for a form of local co-operation in that Province. The status of somewhat similar proposals for other Provinces was also discussed. It was noted that these proposals do not in any way alter the functions of the Associations concerned or provide any machinery to achieve the objectives and purposes for which the Dominion Council is constituted.

The officers of the Dominion Council for 1938 appointed were; President, Mr. C. C. Kirby; Vice-President, Mr. Archie B. Crealock; third member of Executive Committee, Mr. H. Cimon. It was agreed that no Secretary should be appointed for the present.

On Monday evening, April 4th, the Dominion Council were the guests of the President of The Engineering Institute of Canada at a dinner at which local members of The Institute Council were present. This afforded an opportunity for making the acquaintance of the new General Secretary of The Institute.

On Tuesday, April 5th, the Dominion Council were the guests of the Council of the Quebec Corporation at luncheon.

The Dominion Council of Professional Engineers at Meeting April 4th-6th, 1938, at Montreal

Reading from left to right:

F. W. W. Doane, M.E.I.C.—Halifax. Representative for Nova Scotia. Formerly City Engineer of Halifax, now in private practice. Was a student member at time of foundation of E.I.C. in 1887.

D. A. R. McCannel, M.E.I.C.—Regina. Representative for Saskatchewan. City Engineer of Regina. Former member of E.I.C. Council.

P. L. Lyford—Vancouver. Representative for British Columbia. Vice-President B.C. Association, acting as substitute for Mr. C. V. Brennan, President of the Association, who was unable to attend. Mr. Lyford is a consulting forest engineer.

C. C. Kirby, M.E.I.C.—President and representative for New Brunswick. District Engineer of New Brunswick District, Canadian Pacific Railway at Saint John. A former member of E.I.C. Council and a member of the Committee of 13 which framed the "Model Act" in 1919.

H. Cimon, M.E.I.C.—Quebec. Representative for Quebec Corporation. Engineer for Price Brothers. Member of E.I.C. Council.

Archie B. Crealock, M.E.I.C.—Vice-President and representative for Ontario. Registrar of the Association of Ontario. A former member of Council of E.I.C. Consulting Bridge Engineer, Toronto.

P. M. Sauder, M.E.I.C.—Lethbridge. Representative for Alberta. Manager, Lethbridge Irrigation District. Former member of E.I.C. Council.

"All for One and One for All"

The President Entertains the Dominion Council

The following paragraphs contain the remarks made by the President at an informal dinner given by him to the President and members of the Dominion Council during the time of their recent three-day meeting in Montreal. These are the remarks referred to in the editorial columns under the heading, "A three-fold cord is not quickly broken."

'It is my conviction that wherever and whenever The Institute Council may appropriately do so, it should co-operate frankly and freely with the Dominion Council. Should the day come, which many in The Institute fondly hope for, when compacts are completed between The Institute and all eight provincial associations and a common Dominion-wide membership has been achieved, it is conceivable that the associations might desire to have the Dominion Council associated in some form with the Council of The Institute.

'Pending that time, my concept of the inter-relation of The Engineering Institute of Canada, the associations and the Dominion Council can be briefly summarized as follows:—

1. The associations under provincial enactments will, of course, continue to supervise the actual practice of engineering in their respective provinces by administering the licensing laws.
2. As it is not constitutionally feasible for the provincial associations to be consolidated into one federal corporation, they must continue to function as provincial bodies.
3. For the purpose of encouraging uniformity in licensing procedure, the maintenance of high standards of entrance qualification and in general for the strengthening of legal control over the practice of engineering, the associations will no doubt desire to maintain a co-ordinating agency like the Dominion Council.
4. The associations will be wise if as such they confine their functioning very largely to the objectives set out in the three previous paragraphs.
5. The Engineering Institute of Canada is the only federally constituted purely professional national engineering organization in the Dominion that embraces all divisions of engineering. Because of its fine traditions, its half century of service and its twenty-five active branches, The Institute is so constituted that it can, if properly financed, function well and worthily for the entire profession in nearly everything but matters of registration and licensing and those provincial activities that are ancillary thereto.
6. While all three—the associations, the Dominion Council and The Engineering Institute—should function freely and positively in their respective spheres, and while there may be some overlapping and some duplication, there should be close cooperation in supporting each other's general objectives. If such co-operation can be effectively maintained for a few years, the inevitable result will be an approach to a common membership between The Institute and the associations. When that time comes, the Engineering Profession should be getting into a position to enjoy a prestige comparable to that of the other professions.

'Manifestly the above functional outline is not a complete picture of the Engineering Profession in Canada, because it does not comprehend the activities of certain established branches in the Dominion of the "Founder Societies" and other important engineering bodies of the United States. In this respect the situation in the Province of Ontario is the most complicated, and, to a much less extent but for the same reason, it is confused in one or two of the Western Provinces. However, it is hoped that the multiplicity of organized engineering bodies in Canada will not be further increased, for those in authority among the governing bodies of the American Societies will come to realize that while their membership in Canada may grow, the setting up of new branches north of the international boundary line will inevitably add confusion to, and therefore will weaken, an already unduly complicated engineering profession. Notwithstanding the existence of branches in Ontario of the American Society of Mechanical Engineers and the American Institute of Electrical Engineers, I believe that eventually a pact between The Engineering Institute and the Ontario association comparable to that for Nova Scotia will be found desirable and feasible. I think members of the said branches of American bodies having regard to the well-being of the whole profession in Canada will not seriously object to an Association-Institute compact.

'Then again in certain parts of the Dominion where mining is very active, there is an understandable preference for the Canadian Institute of Mining and Metallurgy, and with this preference there is a natural hesitation for some mining engineers to support an Association-Institute compact. I believe a clear understanding between the Councils and the Secretariat of The Engineering Institute and the Canadian Institute of Mining and Metallurgy, particularly as to the purposes of the new By-Law No. 76, will clarify this situation.

'It seems obvious to me that The Engineering Institute having been very largely responsible for the inauguration of the Provincial Associations must now be prepared whole-heartedly to do that which any parent would do when he realizes that his numerous offspring have come of age, that in their own right they are as strong and as wise as he and that each has very special opportunities for rendering notable service for the good of the family. Surely such a parent would take advantage of every opportunity for a family council. And that is precisely what I think this and similar occasions should be: not a meeting of representatives of the Associations, the Dominion and The Institute Councils, but rather a meeting of selected administrators of the engineering family taking counsel regarding the individual and the collective welfare of its members.

'Perhaps all I have attempted to say about the Associations, the Dominion and The Institute Councils might be epitomized by Dumas' famous motto for the "Three Musketeers"—

"All for one and one for all."

'I am sure the members of the Dominion Council will understand that the motive which prompted this attempt of one member of The Institute Council to clarify but not to codify the relationship between the provincial associations, the Dominion Council and The Engineering Institute of Canada is simply and solely an earnest desire to promote concord and co-operation primarily within this engineering trinity and secondarily between it and other recognized engineering bodies.'

Montreal, April 4th, 1938.

The Canadian Institute of Mining and Metallurgy

By invitation, the President was privileged to represent The Institute at the annual banquet of the Canadian Institute of Mining and Metallurgy at the Royal York Hotel, Toronto, on March 16th, when he felicitated this great sister society upon the splendid contribution its members have made in the development of Canada.

Council Holds Meeting in Toronto

Seated (left to right): W. E. Bonn, Councillor, Toronto; F. A. Gaby, Past-President, Toronto; Robert W. Angus, Honorary Member, Toronto; E. Viens, Councillor, Ottawa; Arthur Surveyer, Past-President, Montreal; E. V. Buchanan, Vice-President, London; G. J. Desbarats, Past-President, Ottawa; J. B. Challies, President, Montreal; L. Austin Wright, General Secretary, Montreal; F. Newell, Councillor, Montreal; J. A. McCrory, Vice-President, Montreal; C. E. Sisson, representing chairman of Toronto Branch; J. L. Busfield, Councillor, Montreal; H. A. Lumsden, Councillor, Hamilton. Standing (left to right): H. J. A. Chambers, Councillor, Walkerville; W. R. Manock, Councillor, Niagara Peninsula; L. F. Grant, Councillor, Kingston; J. A. Vance, Councillor, Woodstock; O. O. Lefebvre, Past-President, Montreal; O. Holden, Councillor, Toronto; R. H. Findlay, Councillor, Montreal; W. R. Boyle, Councillor, Ottawa; de Gaspe Beaubien, Treasurer, Montreal.

Council Meets in Toronto

One of the best attended and most successful meetings that has been held by Council in a long time took place on Friday, April 22nd, 1938, at two o'clock p.m., in the Royal York hotel. President Challies was in the chair, and six past-presidents and two vice-presidents were present. Robert W. Angus, Hon.M.E.I.C., and C. E. Sisson, M.E.I.C., representing the chairman of the Toronto Branch, were guests. Every branch in Ontario, with the exception of two, was represented. A party of ten came up from Montreal, this bringing up the attendance figure to an unusually high number.

A Joint Dinner

A resolution was passed unanimously at the Council meeting in London in January of this year, favouring close co-operation with the Councils of the Provincial Professional Associations. Towards this objective a definite step was taken on Friday, April 22nd, when a joint dinner was held at the Royal York hotel, Toronto, by the Council of The Institute and the Council of the Association of Professional Engineers of the Province of Ontario. The purpose of the gathering was the promotion of friendly relationships between the two bodies and their members, and from all appearances the objective was readily reached. Approximately fifty councillors, past-presidents and guests shared the good food, and the progressive ideas that were advanced by the speakers of both organizations.

The chair was occupied by Eric P. Muntz, M.E.I.C., a past councillor of The Engineering Institute, and President of the Ontario Association, who opened the proceedings with an excellent talk on the engineering situation in Ontario, leading up to a toast to The Institute. President J. B. Challies, one of the founders of the Ontario Professional Association, replied, paying a tribute to that body in which he reciprocated the good wishes of Mr. Muntz, concluding with a toast to the Ontario Association. Several speakers followed in alternating order, all urging definitely the advantages and desirability of friendly co-operation between the two engineering organizations. It was a great compliment to all the speakers that the attention of the entire company was held without interruption for over two hours. The additional speakers on behalf of The Institute were Past-Presidents J. M. R. Fairbairn, C. H. Mitchell, Arthur Surveyer and O. O. Lefebvre.

Journal Cover Prize Competition

In the April issue of The Engineering Journal an announcement was made of a prize of $25.00 to be given for the best cover design submitted to the committee by members of The Institute. Below are further notes for the guidance of contestants.

Designs submitted should contemplate a finished size of cover—8¾ in. by 11¾ in.

In selecting the design to be used, consideration will have to be given to cost of reproduction, and therefore a design which can be reproduced in one colour may be preferable to one requiring two colours.

It is apparent that some form of illustration on the cover is the general desire, the design should therefore be sufficiently flexible to carry a picture in either a horizontal or vertical position, or possibly covering the whole space. It must also be borne in mind that notwithstanding such variations being made from issue to issue, there must be sufficient standardization of some part of the design to insure instant recognition of the publication.

It is not expected that contestants should do more than submit their *idea* in the best possible pictorial form, that is to say, they need not prepare a drawing which in itself is immediately suitable for reproduction.

The Publication Committee does not guarantee to use any design submitted, but does undertake to award the $25.00 cash prize to the member who submits the design which in the opinion of the Committee is the best.

Any design which is accepted becomes the property of The Engineering Institute of Canada without further obligation.

Members are not limited to the submission of one design only.

Designs should be submitted to:—

THE CHAIRMAN,
E.I.C. Publication Committee,
2050 Mansfield Street,
Montreal, P.Q.

Closing date July 1st, 1938 (previously announced as June 1st).

OBITUARIES

Edward Henry James, M.E.I.C.

Edward Henry James, M.E.I.C., died in Montreal on April 1st. Mr. James was born at Farnham, Surrey, England, on December 30th, 1886. His technical education was obtained at the City and Guilds Institute, London, from which he received the diploma of Associate in 1906. In 1907 Mr. James entered the firm of A. Handyside & Company Limited, Derby, England, remaining until 1909 when he entered the employ of Easton Gibb and Son Limited, Rosyth, Scotland. He continued his work of drafting and design until 1910 when he was made assistant engineer and placed in charge of sinking monolith foundations. In 1913 Mr. James came to Canada and became associated with the Foundation Company Limited in Montreal. Here he was assigned small foundation work and later made assistant superintendent at Little Current, Ont., on the construction of railway terminals and timber docks. His work with this company also included the laying of bridge foundations at Bear River, N.S. In 1914 Mr. James left the employ of the Foundation Company, joining the J. S. Metcalf Company Limited where for a few months he was on the design of an extension of No. 1 Elevator, Montreal.

Mr. James served overseas with the 2nd Canadian Signals and 92nd Field Company of the Royal Engineers. He later became instructor in explosives and Assistant Bridging officer G.H.Q.

On his return to Canada Mr. James became associated with A. D. Swan, consulting engineer, Montreal, and went to Vancouver where Mr. Swan was the Harbour Board's consultant engineer. In 1920 Mr. James became resident engineer in charge of all Mr. Swan's work in British Columbia. This work included the construction of the Ballantyne Pier, the Wallace Dry Dock and the Second Narrows Bridge in Vancouver and foundation work for No. 1 Elevator extension and No. 2 Elevator. During the six years Mr. James spent in Vancouver he supervised the construction of harbour works valued at ten million dollars. In 1926 he entered into partnership with Mr. Swan. Prior to the inauguration of the National Harbours Board he was consultant to the Montreal Board of Harbour Commissioners. Among other works on which Mr. James was occupied during recent years was that of the construction of the harbour of Port Alfred, Que.

Mr. James joined The Institute as an Associate Member in 1920, becoming a Member in 1925.

Adhemar Mailhiot, M.E.I.C.

Members of The Institute and of the Quebec Corporation of Professional Engineers will learn with deep regret of the sudden death, on April 21st, 1938, of Dr. Adhemar Mailhiot, Dean of the Ecole Polytechnique of Montreal. Dr. Mailhiot was born at Ste.Julienne, Que., on March 11th, 1884. He received his early education at the primary school of St. Brigide of Montreal, and then entered the classical colleges of L'Assomption and Montreal, attending the latter from 1899 to 1906. In 1910 he graduated from the Ecole Polytechnique with the degrees of civil, chemical and mining engineer. Upon graduation he was appointed Assistant Professor of Geology and Mining at the Ecole Polytechnique, but did not take up his duties until he had finished a year's post graduate studies in mineralogy and geology at the Ecole Nationale Superieure des Mines and at the Musée d'Histoire Naturelle in Paris. Dr. Mailhiot held the Assistant Professorship from 1912 until 1918, when he became Professor of Mining, Engineering and Metallurgy. In 1920 he was named Professor of Mineralogy and Geology at the University of Montreal.

In 1913 when the International Geological Congress met in Canada Dr. Mailhiot acted as French secretary on

Dr. Adhemar Mailhiot, M.E.I.C.

their geological trips as well as taking an active part in the organization of the congress.

In 1935 Dr. Mailhiot received the honorary degree of Docteur ès Sciences Appliquées from the University of Montreal and in the same year became Dean of the Ecole Polytechnique. He contributed greatly to our knowledge of Canadian geology and mineralogy, having been in charge of many important surveys in the Gaspé, Abitibi and Eastern Townships districts. He published a number of scientific papers dealing with different topics in these fields, many of which were published by the Geological Survey and the Quebec Bureau of Mines as well as in the Transactions of the Canadian Institute of Mining and Metallurgy, in the Revue Trimestrielle Canadienne and in the Canadian Mining Journal.

Dr. Mailhiot acted as consulting engineer and mining geologist for a number of public bodies and mining companies in Canada and in the United States, among these organizations being the Consolidated Mining and Smelting Company, Limited, the Quebec Streams Commission, the Beauharnois Power Company, Limited, the Aqueduct Commission of the City of Montreal and the Montreal Public Service Corporation.

Dr. Mailhiot was Director of the Provincial Mines Laboratory, and served until his death as the first registrar of the Corporation of Professional Engineers of the Province of Quebec, in the founding of which he took a prominent part; he was also active in the work of the Canadian Institute of Mining and Metallurgy.

Dr. Mailhiot joined The Institute as a Member in 1933, and his death will be a great loss to The Institute and to his friends and associates in it. A resolution was passed by Council extending the sympathy of The Institute to Mme. Mailhiot and her family and to the Ecole Polytechnique.

PERSONALS

J. L. Busfield, M.E.I.C., and F. S. B. Heward, A.M.E.I.C., recently visited New York on behalf of the Publication Committee of The Institute, and spent some time discussing "Publications" with the American Society of Civil Engineers, American Society of Mechanical Engineers, and also with the Founder Societies Library organization. Needless to say, they were given a most cordial reception, information and data of every description being freely placed at their disposal.

J. P. Coates, A.M.E.I.C., has recently been appointed Assessor and Building Inspector for the City of Trail, B.C. For his services in the War, Mr. Coates was granted the rank of Honorary Captain, R.E., in 1920. Since that time he has been employed by the Department of Public Works, British Columbia, as locating and resident engineer.

J. K. Wyman, A.M.E.I.C., is now General Superintendent of Elevators, National Harbours Board, Montreal. Major Wyman is a graduate of McGill University, having received the degree of B.Sc. in civil engineering in 1910, and until he began his service overseas was connected with the John S. Metcalf Company, the Bathurst Lumber Company and the Foundation Company of Canada. He has a very distinguished War record, and subsequent to demobilization in 1918 he served in the military engineering service in India until March 1924. On his return to Canada Major Wyman became connected with the Department of Railways and Canals. In 1927 he took over the duties of superintendent of the government elevator at Port Colborne, Ont. For the past year Major Wyman has been superintendent of the Prescott Elevator, National Harbours Board, Prescott, Ont.

Thomas Foulkes, A.M.E.I.C., has accepted the position of Superintendent of Material Handling on the staff of the J. R. Booth Company of Ottawa, Ont. Mr. Foulkes graduated from the University of New Brunswick in 1926 and since that time has been associated with the Canadian General Electric Company, the Spruce Falls Power and Paper Company at Kapuskasing, Ontario, and latterly with Montreal Cottons Limited at Valleyfield, Que., as Assistant Mechanical Superintendent.

S. G. Porter, M.E.I.C., of Calgary was at Headquarters recently to attend a meeting of the committee on Western Water Problems. A programme of papers on this important topic was mapped out, to be delivered later at an appropriate time and place.

A. U. Sanderson, A.M.E.I.C., chief engineer, Water Supply Section, Department of Works, City of Toronto, Ont., attended the Annual Convention of the American Water Works Association, which was held in New Orleans, Louisiana, April 24th to 28th.

Trevor Holland, S.E.I.C., has just been appointed vice-president of Brandram-Henderson Limited. Mr. Holland graduated from McGill University in civil engineering in 1932. After spending a year at the University of Paris, he returned to Montreal and joined Brandram-Henderson Limited as plant engineer. The construction of a modern varnish plant, as an addition to the Brandram-Henderson headquarters' plant in Montreal, was recently carried out under his supervision.

H. B. Dickens, A.M.E.I.C., has been appointed co-ordinating officer by the British War Office for the new filling factory at Glascoed, South Wales, and will be stationed at the Woolwich Arsenal. The factory will take over two years to build and will cost about £2,500,000. For the past year Mr. Dickens has been with H. A. Brassert and Company Limited, Karabuk Iron and Steel Works, Karabuk, Turkey, as resident and civil engineer. Mr. Dickens was surveyor and assistant manager at the Amrir tin mine, Nigeria, West Africa, during 1913-1915 and was on active service in the Cameroons and Nigeria, West Africa, from May 1915 to September 1919. Following the War, Mr. Dickens was engaged on timber limit surveys in Northern Ontario, later joining the engineering staff of the Underwriters' Survey Bureau, Toronto. In 1923 he was employed with Frank Barber and Associates; in 1924 with the township of East York, and in 1925 with the Welland Ship Canal at Port Colborne, Ont. Later Mr. Dickens was associated with Messrs. Lang and Ross in connection with the Flin Flon mine and then accepted a position with the Dominion Reinforcing Company at London, Ont. Prior to leaving Canada Mr. Dickens held the position of reinforced concrete designing engineer for the city of Hamilton, Ont.

Harold L. B. Seifert, S.E.I.C., is now employed with the Canadian Cellucotton Products, Niagara Falls, Ont. Mr. Seifert graduated from McGill in 1937, receiving the degree of B.Eng. in chemical engineering.

Past-President J. M. R. Fairbairn, M.E.I.C., Chairman of the International Relations Committee of the Council, early in April presented the new General Secretary of The Institute to the New York officials of the Founder Societies of the United States.

W. Lawrence Langlois, A.M.E.I.C., has recently been appointed engineer of Hastings County, Ontario. After his graduation from the University of Toronto in 1923, Mr. Langlois became assistant town engineer with the Canadian International Paper Company, at Temiskaming, Que. He then joined the staff of the City of Hamilton Department of Works during the construction of the waterworks filtration plant. Latterly he has been assistant district engineer with the Ontario Department of Northern Development, at Sudbury, and divisional engineer in charge of the Renfrew district.

R. E. McMillan, A.M.E.I.C., has accepted a position with the Montreal Cottons Limited, Valleyfield, Que., as assistant mechanical superintendent. Mr. McMillan graduated from McGill in 1926 in electrical engineering. Prior to taking his present position Mr. McMillan was plant engineer for the British Rubber Company of Canada, Montreal, until 1937 when he entered Canadian Industries Limited, Montreal.

Dr. John Stephens, M.E.I.C., Professor of Mechanical Engineering at the University of New Brunswick, is being retained as consulting engineer for the hydro-electric power development on the Upsalquitch river, near Campbellton, N.B.

Harry J. Crudge, A.M.E.I.C., building engineer of the Canadian National Railways in Moncton, has been appointed to the advisory committee of the National Research Council of Canada in the preparation of a national building code. Mr. Crudge has been located in Moncton since 1915 but prior to this was connected with the engineering department of the Canadian Pacific Railway in Montreal. He has served as a councillor of The Institute and is past-president of the New Brunswick Association of Professional Engineers.

Horace L. Seymour, M.E.I.C., of the Extension Department, University of Toronto, recently gave a week's lecture course at Timmins, Ont., on the establishment of a community centre. Mr. Seymour has been retained for the third year as consultant for the Town Planning Commission of Saint John, N.B., which intends to complete the planning of that city.

J. N. McCarey, Jr.E.I.C., is now employed in the engineering department of the Wabi Iron Works, Limited, New Liskeard, Ontario. Mr. McCarey, a graduate of Queens University in 1935 with the degree of B.Sc., has been with the Canadian International Paper Company, Temiskaming, Quebec.

Hugh A. Lumsden, M.E.I.C., county engineer for the County of Wentworth, Ontario, and councillor for the Hamilton Branch, is to be congratulated as the author of a handbook for roadbuilders entitled "Road Construction and Maintenance" which has recently been released by Davis-Lisson Limited, Hamilton, Ont.

A. V. Armstrong, A.M.E.I.C., is now sales manager of Canadian Cutler-Hammer Limited, Toronto, Ont. Mr. Armstrong, who is a graduate of McGill University, was formerly manager, power apparatus and special products, Ontario Division, Northern Electric Company Limited.

ELECTIONS AND TRANSFERS

At the meeting of Council held on April 22nd, 1938, the following elections and transfers were effected:

Member

HUTTON, Charles Hyde, B.A.Sc., (Univ. of Toronto), chief engr., Hamilton Hydro-Electric System, Hamilton, Ont.

Associate Members

CAMPBELL, William Fisher, technical work for County of Haldimand, Cayuga, Ont.
ENOUY, William George, B.A.Sc., (Univ. of Toronto), manager, Montreal District Office, H. H. Robertson Co. Ltd., Montreal, Que.
McGUGAN, Angus, (Royal Tech. Coll., Glasgow), designing engr., Williams and Wilson Ltd., Montreal, Que.
WYCKOFF, Edwin Gerald, B.A.Sc., (Univ. of Toronto), i/c of mfg. depts., Otis-Fensom Elevator Co. Ltd., Hamilton, Ont.

Juniors

CAREY, Roger Packard, B.Eng., (N.S. Tech. Coll.), instr'man., Dept. of Highways of N.B., Sackville, N.B.
LAMB, John Alexander, B.Eng., (Univ. of Sask), 520 Markham Street, Toronto, Ont.
RAYMER, Denzill Edwin, B.A.Sc., (Univ. of Toronto), detailer, plate and boiler dept., Dominion Bridge Co. Ltd., Lachine, Que.
RETTIE, James Robert, B.Sc., (Univ. of Man.), engr., Anthes Foundry Ltd., Winnipeg, Man.
RUSSELL, Leonard James, B.A.Sc., (Univ. of Toronto), dftsman., Horton Steel Works Ltd., Fort Erie North, Ont.
TURNBULL, John G., B.Sc., (Queen's Univ.), field engr., Brunner Mond Canada, Amherstburg, Ont.

Transferred from the class of Associate Member to that of Member

FLEMING, John Murray, B.Sc., (Univ. of Man.), president and general manager, C. D. Howe Company Ltd., Port Arthur, Ont.
LeCLAIR, William James, (Univ. of Toronto), secretary-manager, White Pine Bureau, Toronto, Ont.

Transferred from the class of Junior to that of Associate Member

BROWNIE, Frank Austin, B.Sc. (Univ. of Alta.), asst. engr., Northwestern Utilities Ltd., Edmonton, Alta.
CHISHOLM, Donald Alexander, B.Sc., (N.S. Tech. Coll.), res. engr., Dept. of Highways of Nova Scotia, Mulgrave, N.S.
McKAY, Robert Donald, B.Sc., (N.S. Tech. Coll.), sanitary engr., Dept. of Public Health of Nova Scotia, Halifax, N.S.
TAYLOR, Morley Gladstone, B.Sc., (N.S. Tech. Coll.), M.Sc., (Mass. Inst. Tech.), acting gen. mgr., Venezuela Power Co. Ltd., Maracaibo, Venezuela.

Transferred from the class of Student to that of Junior

WILSON, Thomas Whiteside, B.A.Sc., (Univ. of Toronto), salesman, Hugh C. MacLean Publications Ltd., Toronto, Ont.

Students Admitted

CALLUM, John P., (Queen's Univ.), 363 Cromwell St., Sarnia, Ont.
CAMERON, Adam K., (McGill Univ.), 1511 Crescent St., Montreal, P.Q.
CRAIG, Clarence Edward, (Queen's Univ.), 82 Taylor Ave., Kirkland Lake, Ont.
COX, Robert Edward, (Grad. Montreal Technical School), 1986 Rachel St. E., Montreal, P.Q.
DOUGLAS, Lloyd Robert, (Univ. of Man.), Franklin, Man.
DUNCAN, G. Paterson, (Univ. of Man.), 601 Rosedale Ave., Winnipeg, Man.
HAYWARD, Vernon A., (Univ. of Alta.), 10523-127 St., Edmonton, Alta.
HUBBARD, Sewell Fortescue, (McGill Univ.), 3429 Peel St., Montreal, P.Q.
KAY, Bruce E. A., (McGill Univ.), 1390 Sherbrooke St. W., Apt. 16, Montreal, P.Q.
KAYSER, James N., (McGill Univ.), 317 Claremont Ave., Mt. Vernon, N.Y.
KING, Hector I., B.Sc., (Univ. of N.B.), Bathurst, N.B.
MacDONALD, Arthur Lamond, (N.S. Tech. Coll.), Queen Hotel, Halifax, N.S.
MacKENZIE, John James, (Univ. of Man.), 419 Kingston Crescent, St. Vital, Man.
MAGEE, Edward D. B., (R.M.C.), Royal Military College, Kingston, Ont.
MARTIN, Percival Ralph, (McGill Univ.), 4540 Coolbrook Ave., Montreal, P.Q.
McPHERSON, Eugene Lionel, (Univ. of Alta.), Box 67, Vulcan, Alta.
NEAL, Eugene L., (Queen's Univ.), 159 Bergemont Ave., Quebec, P.Q.
RAMSAY, Robert D., (Queen's Univ.), 147 Kathleen Ave., Sarnia, Ont.
SILVERBERG, David Max, B.Sc., (E.E.), (Univ. of Man.), 291 Manitoba Ave., Winnipeg, Man.
SIMPSON, Charles Cecil, B.Sc. (E.E.), (Univ. of Alta.), 11631 95A Street, Edmonton, Alta.
SPENCER, George H., (R.M.C.), Royal Military College, Kingston, Ont.
STANLEY, James Paul, (McGill Univ.), 559 Lansdowne Ave., Westmount, P.Q.
THOMPSTONE, Robert Edward, (R.M.C.), Royal Military College, Kingston, Ont.

Annual Meeting of the A.S.T.M.

The 1938 (forty-first) annual meeting of the American Society for Testing Materials will be held at Chalfonte-Haddon Hall, Atlantic City, June 27th to July 1st. Among other interesting features of this meeting there will be a symposium on the subjects of impact failure and impact testing. This symposium will present an integrated series of papers covering the basic theories underlying impact tests, data on the factors affecting impact and papers covering the practical application of impact tests to metals, organic plastics and welds.

BOOK REVIEWS

Engineering Law

By R. E. Laidlaw and C. R. Young. University of Toronto Press, Toronto, 1937. 380 pp. $5.00.

Reviewed by Harry D. Anger, K.C.

The authors of the above book, R. E. Laidlaw, assistant regional counsel, Canadian National Railways, special lecturer in Engineering Law, University of Toronto, and C. R. Young, Professor of Civil Engineering, University of Toronto, are filling a long-felt need by their work. As they state in their preface, it has grown out of courses of lectures in Engineering Law and Engineering Contracts and Specifications given by the authors for many years to students in engineering. No other work published in Canada has hitherto been available and works published abroad require too much adaptation to be satisfactory here.

The authors throughout have the practising engineer in mind and have presented those phases of law which concern his acts, duties and liabilities, and, in so doing, they have consistently treated their subjects from the viewpoint of the engineer rather than of the lawyer. To the same end, they have avoided technical legal terms and highly subtle legal distinctions, appreciating that in important matters engineers will consult their legal advisers.

A further attractive feature of the volume is its conciseness, comprising but 380 pages in all, including comprehensive index and appendices of forms. Nevertheless the work has a wide scope as is indicated by the following synopsis of contents: Duties and Liabilities of Engineer; Contracts; Specifications, General Conditions; Agreements; Arbitration, Expert Evidence; Trade Unions; Combines, Industrial Disputes; Workmen's Compensation; Promotion and Organization of Companies; Building Trades, Factories, Shops, Public Buildings; Railways, Highways, Boundaries, Surveys, Easements, Drainage; Professional Engineering Legislation.

An engineer is required to have a working knowledge of the general rules of law affecting his profession and covering both public and private rights. This requirement imposes a very real burden upon him. For instance, statutes or regulations passed under their authority, or local municipal by-laws, require that special notices be given, permits be obtained, plans be approved and filed, inspection be made, and safety measures be adopted. An engineer's ignorance of such statutory or local law might make the work impossible to execute or use, and expose his employer to penalty or demolition, the engineer suffering accordingly. Again, the engineer must have knowledge of building restrictions, rights of air and light, right of support, the effect of conditions and provisions in building contracts, the effect of building alterations on those provisions and any security bonds held by his employer, and other matters that affect his advice to his employer. When one realizes that absence of the required legal knowledge is evidence of the engineer's want of reasonable care, one can appreciate the practical guiding assistance afforded to the engineer by this volume. Furthermore, the care expended on the agreements and other forms required by the engineer and appearing in the context with discussion or in the appendices, should be of the greatest assistance. All in all, both the author and the engineering profession are to be congratulated upon the excellence of this work.

Roads, Construction and Maintenance, a Handbook for Roadbuilders

By Hugh A. Lumsden. Davis-Lisson, Hamilton, Ont., 1938. 128 pp., 6¾ by 4 inches, $2.00

The responsibility of planning and executing important main highway projects in Canada generally falls upon the officers of government departments or municipal corporations, who are guided by wide experience and the results of experiment and research dealing with their special branch of engineering. But there are many engineers, road superintendents and contractors, who are concerned with highway construction and maintenance on a somewhat smaller scale. To these in particular the concise reference book which Major Lumsden has prepared will be a valuable aid in their work.

The author deals with the many aspects of the subject from his own point of view as engineer for an important Ontario county and much of his material is drawn from his own experience. As examples of the practical nature of his advice, one may mention such points as the instructions for taking a traffic census, hints on weed killing, his remarks on surface treatment and retreading, or the notes on snow control and removal. In regard to nearly all of the topics of which he treats, a number of cost figures are given, which, while they do not avoid the necessity of detailed estimates, do make it possible to form an approximate idea of the cost of a proposed piece of work. Major Lumsden rightly emphasizes the importance of proper cost-keeping methods.

Of handy pocket size, the little book is well indexed, its diagrams are clear and a list of recent text books serves as a guide to more detailed study of special points. It is legibly printed and suitably bound; there are a few typographical errors (e.g. Deisel for Diesel) which might well be corrected in a later edition.

ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

American Institute of Electrical Engineers: Year Book, 1938.

Institution of Civil Engineers: List of Members, 1938.

Institution of Mechanical Engineers: Proceedings of the General Discussion on Lubrication and Lubricants, October 13th-15th, 1937. Vols. 1 and 2. London, 1937.

Institution of Water Engineers: Transactions, Vol. 42, 1937.

Royal Society of Canada: Transactions, 3rd series, Vol. 31, Section II.

South Wales Institute of Engineers: List of Members. March 1938.

Reports, etc.

Bell Telephone System, Technical Publications, Monographs: Radiation from Rhombic Antennas, Transmission Theory of Plane Electromagnetic Waves, On the Ionization of the F_2 Region, Transmitted Frequency Range for Circuits in Broad-Band Systems, Variable Frequency Electric Circuit Theory, Resistance Compensated Band-Pass Crystal Filters for Unbalanced Circuits, Irregularities in Broad-Band Wire Transmission Circuits, The Dielectric Properties of Insulating Materials, Magnetic Generation of a Group of Harmonics, Radio Telephone Noise Reduction by Voice Control at Receiver, The Vodas, Extending the Frequency Range of the Negative Grid Tube, Energy of Lattice Distortion in Cold Worked Permalloy, Minimum Noise Levels Obtained on Short-Wave Radio Receiving Systems, Electron Diffraction Studies of Cuprous Oxide, Preparation of Large Single Crystals of Sodium Chloride, Optical Constants of Rubidium and Cesium, Superstructures in Alloy Systems, Progress in Nonferrous Metals and Alloys During the Past Few Years.

British Standards Institution: Specification for Nickel Silver Sheets and Strip of 10 to 30 per cent Nickel Content. Feb. 1938.

Canada Dominion Bureau of Statistics, Transportation and Public Utilities Branch: Central Electric Stations in Canada. Ottawa, 1938.

Canada Geological Survey: Eagle-McDame Area, Cassiar District British Columbia; Little Southwest Miramichi-Sevogle Rivers Area, New Brunswick; Geology of Woodstock Area, Carleton and York Counties, New Brunswick; Mining Industry of Yukon, 1936; Mineral Resources, Usk to Cedarvale, Terrace Area, Coast District, British Columbia. Ottawa, 1936-1937.

Canada Bureau of Mines: Gold Mines in Canada. Ottawa, Jan. 1938.

Canadian Pacific Luncheon Club, Montreal: The Drought Area of Western Canada and Some of the Measures Adopted to Meet the Problem, by S. G. Porter. Feb. 16, 1938.

Edison Electric Institute: Treatment and Inspection of Creosoted Pine Poles, Feb. 1938.

Electrochemical Society, Preprints: An Electro-Washing Process, Corrosion Characteristics in the Distillation of Fatty Acids; Structure of Electro-deposited Copper Alloys; Film Potential Values of Copper, Brass-Steel, Brass-Zinc-Steel, in Sea Water, with a Note on Marine Growths; Use of Electrolytic Chlorine for the Manufacture of Cellulose; Differential Dynamometer as an Instrument for Conductimetric Methods of Analysis, Pt. 1 Design and Calibration, Pt. 2 Operational Characteristics; Amalgam Activities and Standard Electrode Potentials; Rational Unit for the *pH* Value; Behavior of Lead Anodes in a Sulfate Electrolyte with Particular Reference to the influence of Cobalt Salts.

Engineering Foundation: Annual Report 1936-37.

National Harbours Board: Annual Report, 1937. Ottawa, 1938.

New Brunswick Electric Power Commission: Eighteenth Annual Report for the Year Ending October 31, 1937.

Nova Scotia Power Commission: Eighteenth Annual Report for the twelve months period ended November 30th, 1937. Halifax, 1938.

Ontario Department of Mines: Mineral Production of Ontario in 1937. Toronto, 1938.

Single Tax Association of Canada: Canada's Economic Maladies, their Cause and Cure, being the Brief submitted to the Royal Commission on Dominion Provincial Relations. Toronto, 1938.

U.S. Department of the Interior Bureau of Mines: Metal-Mine Accidents in the United States: 1935. Washington, 1938.

U.S. National Research Council Highway Research Board: Roadside Development. Washington, 1938.

University of Toronto: Model Tests on Spillways in the Power Dam at Abitibi Canyon, by Robert W. Angus and J. B. Bryce; Water Hammer in Pipes, Including Those Supplied by Centrifugal Pumps, Graphical Treatment, by Robert W. Angus. (Bulletins Nos. 150 and 152.)

Technical Books, etc.

Handbook of Culvert and Drainage Practice. 2nd ed. Canada Ingot Iron Company, Guelph, Ont, 1937. Price $3.00.

Biography of Paul Dyer Merica. (Supplement of John Fritz Medal Book, New York, 1938.)

CORRESPONDENCE

The Editor,
The Engineering Journal.

Dear Sir:—

Issue of February 1938 (p. 104) carries an article by Professor W. J. Smither entitled, "A Statical Determination of the Reactions at the Points of Contra-flexure in the Columns of a Steel Mill Building Due to an External Wind Load." The article gives an interesting graphical solution of this well known problem. This writer has never seen quite the same method used before. The solution differs from the more or less standard graphical method principally in the construction of the final force triangle (*NMB*), and there is admittedly less construction involved than in the corresponding part of the standard solution. However, it seems that the saving in the construction is completely offset by having the vectors for the two reactions come out to an odd scale. It will require an additional graphical construction or an equivalent analytical computation to finally get the numerical values for the reactions.

The loading used in the example given in this article seems rather odd. It is quite possible that Professor Smither in order to simplify the presentation merely assumed a system of forces without attempting to figure them from an assumed wind velocity. The writer believes, however, that it is very doubtful if the assumptions made for the position of the points of contra-flexure in the columns and also for the distribution of the horizontal force between the two reactions are valid for this loading if applied to a bent of the usual proportions. I doubt if sufficient attention is paid to the validity of such assumptions.

Respectfully submitted,
R. M. Hardy,
Dept. of Civil Engineering,
University of Alberta.

Edmonton, Alta.
March 31st, 1938.

New and Revised C.E.S.A. Specifications

The Canadian Engineering Standards Association has issued the following new and revised Standard Specifications:

S 6—1938. Standard Specification for Steel Highway Bridges. 3rd ed. March 1938. Price $0.50.

G 26—1938 and G 27—1938. Standard Specifications for Commercial Bar Steels. 3rd ed. March 1938. Price $0.50.

B 44—1938. Safety Code for Passenger and Freight Elevators. March 1938. Price $0.50.

Copies of the above may be obtained by writing to: The Secretary, Canadian Engineering Standards Association, Room 3064, National Research Building, Ottawa, Ont.

Boulder Canyon Project Final Reports

The U.S. Bureau of Reclamation is publishing a series of forty-one bulletins on the Boulder Canyon Project. They will be grouped under seven headings: introduction, hydrology, preparatory examinations and construction, design and construction, technical investigations, hydraulic investigations, cement and concrete investigations.

Bulletin 1—Model Studies of Spillways and Bulletin 2—Model Studies of Penstocks and Outlet Works are now available for distribution at $1.00 per paper bound copy and $1.50 per cloth bound copy in the United States, Canada and Mexico. For distribution to other foreign countries, the prices are $1.15 per paper bound copy and $1.70 per cloth bound copy. A review of these two bulletins will appear in the next issue of The Journal.

Orders for copies may be addressed to the U.S. Bureau of Reclamation at Denver, Colorado, or Washington, D.C.

The Sanitary Analysis of Drinking Water

Donald C. McCrady, S.E.I.C.[1]

Paper presented before the Peterborough Branch of The Engineering Institute of Canada, April 8th, 1937.

The examination of drinking water has in recent years become a very specialized science; a great amount of labour has been expended in experimentation, in attempting to find suitable methods of employing a laboratory analysis of a water sample, to confirm decisions which, by ordinary inspection, might be made on the supply. Emphasis must, however, be laid on the fact that this visual inspection of the supply and its surroundings for possible sources of pollution, is still of extreme importance, and that the analysis of the water in the laboratory is merely a check, not a definite test in itself. A simple example will illustrate the point. Samples taken from a brook may yield satisfactory analytical results; but if inspection discovers a sewer, discharging intermittently into the stream above the point of collection of the samples, the water is evidently unsafe despite the results from the analysis. (The samples were obviously taken at a moment when the water was not appreciably polluted.) The examination of a supply, then, consists of first, an inspection of the location itself, and second, a laboratory analysis of samples collected from the supply. Any decisions on results from the inspection are based on common sense and require no explanation. This paper will therefore be devoted principally to the methods which are employed to-day, of examining drinking water samples in the laboratory from a sanitary standpoint; obviously this does not include chemical tests for acidity, hardness, iron and so on, which are also performed in the health laboratories which deal with drinking water samples. The author had the opportunity of being employed with the Quebec Provincial Bureau of Health Laboratories in Montreal for several summers, so that the methods which will be discussed are as employed in these laboratories. Sanitary analysis, however, is practically a standardized procedure to-day throughout Canada and the United States.

In order to set up laboratory methods of testing water for its safety, one must first consider what evidences of danger might be found. A water is dangerous when it contains pathogenic, or disease organisms, such as typhoid, dysentery, and others. It is impractical, however, to examine a sample for these bacteria; principally because they do not occur in large numbers, and the chance of finding them in a small sample, such as would be placed under a microscope, is slight. Some other method for detecting a dangerous water is therefore necessary, and the principle which is employed is that pathogenic organisms, practically wherever they occur, are present in conjunction with the intestinal discharges of man or animals. Examination is made, therefore, for traces of feces and urine in the water, and if they are found, the supply is condemned; this is justifiable, since the presence of such matter in a drinking water supply, even if at the moment of sampling it does not contain disease bacteria, constitutes a potential danger. This fecal matter would not generally occur in large concentrations in the water, so that methods of extreme accuracy must be employed to detect its presence.

The material itself consists of partially decomposed chemical compounds, mostly of an organic nature, and containing a large proportion of nitrogen. There are very large numbers of various types of bacteria present, nearly all of them being quite harmless, which grow well at 37 deg. C. (body temperature). These are the organisms which decompose or oxidize the organic material; one group may carry the oxidation process to a certain point, and another may carry it a little further, and so on. That is, a single group of bacteria does not necessarily perform completely the process of oxidation. There is one particular organism among these groups of fermenting bacteria which always occurs in feces in large numbers, and seldom or never anywhere else; it is known as the Bacillus Coli, and is ordinarily quite harmless. The indications of the presence of sewage are therefore nitrogenous organic material in considerable quantity and in various stages of oxidation, large numbers of bacteria which grow well at 37 deg. C., and many organisms of the Coli type. Examinations are therefore made for all three of these indications, and the results, considered together and in conjunction with the inspection of the supply, determine whether or not the water is safe for the community. It is interesting that the only specific organism for which a test is made, namely the Bacillus Coli, is generally a non-pathogenic one.

One series of tests to be made is of a chemical nature, tests for the organic materials present in sewage, although obviously examination cannot be made for all the chemical constituents. It has been mentioned that sewage contains a large proportion of nitrogen. This is combined with other elements to form organic materials which yield ammonia gas when treated with a strong alkaline permanganate solution. After the bacteria present have processed the material to a certain extent, the nitrogen is converted to free ammonia gas which dissolves in the water present. After further oxidation, nitrites and finally nitrates are formed from the nitrogen content of the original organic material. Tests are therefore made for these four nitrogen compounds. First, a portion of the sample is treated with permanganate solution and tested for ammonia gas. The result is known as the "albuminoid ammonia" content of the water, and is a rough measure of the amount of unstable organic material present. A second test is made on a portion of the sample for "free ammonia" gas. Finally, the nitrite and nitrate contents of the sample are determined. The author will not attempt to dwell on the reactions which are employed, as they are complicated, and would add little to the interest of this paper. It may be noted, however, that these reactions are all of a colorimetric type; that is, a definite amount of reagent of known strength is added to a certain quantity of the sample, and, after certain manipulations, a pigment is formed in the water, the intensity of colour depending on the concentration of the substance being determined. The shade of colour of the mixture is compared with those of fixed standards set up for the purpose, each colour standard representing a definite concentration of the substance for which the test is made. Free ammonia gas can be detected down to 0.001 parts per million by weight in the water; quantities over 0.06 parts per million lead to suspicion. These figures are mentioned, merely to indicate the order of precision of the methods which are used, and similar precisions are secured in examining for nitrites and nitrates. The chemical examination is of extreme importance in cases where the bacterial content of the water is likely to be indefinite or slight, and the accurate methods are necessary due to the fact that the concentrations of the materials are generally small.

The second examination of the water sample is made for the number of bacteria which grow well at 37 deg. C. A cultural method is used for this purpose; that is, the bacteria are allowed to grow under favourable conditions, until indications of their growth may be detected. The principal piece of apparatus which is employed is a so-called "plate" or "petri-dish." This consists of two circular glass dishes, each about three inches in diameter, with vertical sides about one-half inch high, which fit into one another, forming a flat, circular box. A measured quantity, say 1 cc. of the sample, is placed in the dish by means of a graduated pipette. About 15 cc. of culture medium are added, and mixed well with the sample by rocking the dish to and fro. This medium consists of food for the bacteria, and agar, dissolved in water. The food includes peptone, which supplies the necessary nitrogen and carbon, and beef extract, supplying mineral and accessory constituents. Agar is a material similar to gelatin in that it will form a jelly when dissolved in water and allowed to set. The medium is thus poured into the plate, mixed well with the sample, allowed to set, and finally the plate is incubated at 37 deg. C. for about 24 hours. Now each organism present multiplies by growing to a certain size and breaking in half; each half then grows to that size and breaks again. This occurs about every fifteen minutes, so that during the 24 hours, an extremely large number of new bacteria are formed. These are all held in practically the same position as the original organism by the jelly-like property of the agar. The point is, that wherever there was originally one quite invisible germ, there are, after the period of incubation, millions of bacteria, all crowded together, forming a visible spot or "colony" in the transparent medium. The area of the plate, the depth of medium, and quantity of sample are so chosen, that it is unlikely more than one organism was originally located at the same point in the plane; that is, underneath one another. The number of colonies may easily be counted with the aid of a magnifying glass, and the result is the number of bacteria present in the 1 cc. of sample chosen, which grow well at 37 deg. C. Naturally chance enters into the problem; that is, every cc. chosen may not contain the same number of bacteria. Rough figures only, however, are required, and the "plate" method supplies the information desired.

The most important set of tests which are performed on the water sample determine the Bacillus Coli content of the supply. It has been mentioned that organisms of this type occur in feces in large numbers, and seldom in other materials. The Bacillus Coli is one of the Coli-Aerogenes group of bacteria, and differs from the Aerogenes bacillus in that the latter is found principally in top soil and on plants. Since the presence of Aerogenes in a water is an indication that dirt is entering the supply, a condition which is, of course, undesirable, no attempt is made in routine work to differentiate between Coli and Aerogenes: the presence of any of the Coli-Aerogenes group is considered an indication of undesirable contamination.

The tests for members of the Coli-Aerogenes group, or "B. Coli" as they are commonly termed, are based on certain characteristics of the organisms in question, which are as follows. First, B. Coli ferments lactose (milk sugar) with the production of certain gases. Second, it is aerobic, or grows in the presence of air. Third, it is not a spore-former; the spore is a seed-like state into which some bacteria change, and when in that state, the organism is able to resist extremely unfavourable conditions. The spore appears under the microscope as a highly refractile body, rounded in shape, similar to a small glass bead, whereas the bacillus appears rod-shaped and quite opaque. Finally, the B. Coli is "Gram-negative." Bacteria may be separated into two general groups, Gram-positive and Gram-negative, according as they do or do not retain the blue components of a certain "Gram" stain, consisting of red and blue dyes. Thus B. Coli, when so stained, appears under the microscope as a short red-coloured rod. The tests based on these characteristics are arranged in such an order that the examination constitutes a process of elimination, and they follow one another in logical sequence.

The first characteristic of the Coli group which is considered, is that it ferments lactose with the production of gas. A piece of apparatus, known as a fermentation-tube, is employed. It consists of an ordinary test tube containing the liquid medium, in which is inserted a small

[1] Mr. McCrady was awarded the John Galbraith Prize for this paper for the prize year 1936-37.

inverted vial which is also filled with the medium. A definite quantity, say 10 cc., of the water sample is placed in the tube, and the whole is incubated at 37 deg. C. for about 24 hours. As gas is formed, part of it rises to displace the liquid in the vial, and can readily be seen. The medium consists of peptone, beef extract, and lactose dissolved in water. The incubation is done at 37 deg. C. because the B. Coli grow well at that temperature. If any gas is formed in the vial, the result is considered positive. If not, then the examination need not be continued, as it is certain that no B. Coli were present in the portion of sample chosen. Suppose the result is positive; then the next test is made on material from the fermentation-tube, since there are bacteria which do ferment lactose with the production of gas, but which are not of the Coli group.

The B. Coli is an aerobic organism; consequently, if some of the material from the fermentation tube is spread over the surface of a suitable agar medium and incubated, any Coli organisms present will grow and produce colonies, such as were obtained by the "plate-count" method. The plate is employed for this test, and is made up with a layer of agar jelly in it. This jelly contains water, agar, beef extract, peptone and lactose, together with two dyes, methylene-blue and eosin. A small amount of material from the fermentation tube is transferred to the plate, by spreading it over the surface of the jelly with a platinum needle. The plate is incubated at 37 deg. C. for 48 hours. The B. Coli, in growing and multiplying, produces certain organic alcohols and acids, which dissolve the dyes present in the medium, and when these liquids evaporate, a layer of concentrated dye is left on the surface of the colony which is formed by the bacterial growth. That is, the Coli colony has a characteristic bluish-green colour which is not produced by most of the other bacteria which are likely to be present.

There are, however, some bacteria which produce this type of colony aerobically, and which do not ferment lactose, and even some which do ferment lactose, and yet are not of the Coli group. Therefore, one of the colonies is chosen for confirmation; a small amount of material from the colony is transferred to another lactose fermentation tube and the latter is incubated as before, in order to ascertain whether or not the organisms forming the colony are among those which produced a positive result during the first fermentation test. If the result is negative, another colony is chosen, and when two or more colonies have been examined, all giving negative results, the original portion of the sample taken is considered to be free from bacteria of the Coli type. If one of these colonies gives a positive result, some of the organisms in the colony are then stained with Gram stain and examined under a microscope. Since spore-formation is favoured by mass growth on a medium more favourable than one containing dyes, some of the colony is transferred to a simple agar medium, in which the organisms can multiply profusely. After incubation, a secondary culture is thus produced, some of which may be spread on a microscopical slide, and stained.

Examination of this slide may lead to three possibilities. First, spores may be present. Second, Gram-positive (blue-coloured) bacteria may be present. Finally, Gram-negative (red-coloured) bacteria may be present. If either spores or Gram-positive organisms, or both, are found, all the positive results so far obtained may be due to these organisms, even though there are Gram-negative bacteria present as well. Thus, in order to confirm the presence of the Coli type, Gram-negative organisms alone must be found on the slide. In the event that the final result is negative, another colony must be chosen from the agar plate, and the procedure repeated. If two or more colonies yield negative results, B. Coli are considered to be absent from the volume of sample taken.

Thus far, the examination which has been described is strictly qualitative, giving a result positive or negative for the portion of water chosen. It gives no indication of the Coli content of the sample. However, the tests are made quantitative by using a number of portions of the water. Suppose five 10 cc. quantities are completely examined. The results will be in the form 0 out of 5, 1 out of 5, 2 out of 5, and so on, as positive. If the result is 4 out of 5; that is, of five 10 cc. quantities of water, four of them indicate the presence of B. Coli, the most probable number of organisms of this type present in the sample per 100 cc. is then 16. This figure is based on the laws of probability and is arrived at by purely mathematical formulae. One might expect the figure to be 8, since 40 out of the 50 cc. examined indicated positive results. However, the positive result in any one portion might have been due to more than one organism, and mathematically a result of 4/5 indicates that most probably there was an average of two B. Coli organisms present in each quantity of the sample chosen. The figures for the various possible results are: 1/5, 2; 2/5, 5; 3/5, 9; 4/5, 16. The result 5/5 is indeterminate, since any number of B. Coli greater than 4 may have been responsible. Since this result is frequently encountered, a second series of tests is performed on five other portions of the sample, each of 1 cc. The figures for the possible results of this series of tests are: 1/5, 22; 2/5, 52; 3/5, 91; 4/5, 160. The range of results which may be obtained from this combination of tests of five 10 cc. portions and five 1 cc. portions of sample is thus from 2 to 160 bacteria of the Coli-Aerogenes type per 100 cc. of water. It is well to notice that the quantitative result is not very accurate, since chance enters so largely into the problem. But for practical work, this method of testing has proved satisfactory.

The three different examinations which have been described furnish information regarding the nitrogenous content of the water, the bacterial count at 37 deg. C., and a rough estimate of the number of organisms of the Coli-Aerogenes group which are present. With this information, together with that obtained from a visual inspection of the surroundings of the supply, an expert can usually estimate the degree of potability of the water. It is difficult to state any limiting values of the test results, as many exceptions and special cases enter into their interpretation. The author will attempt to illustrate the method of interpretation, by a few simple examples.

Suppose upon inspection of the surroundings of a shallow well, a cesspool is found to be located, say 50 ft. away. In this case, regardless of test results, the supply would very likely be condemned; in all probability the results would indicate a poor water, but it is just possible that an uncontaminated sample might be obtained at a time when no sewage was reaching the well. If, however, the source of contamination were at a distance of 500 ft. from the supply, or at a distance great enough to prevent immediate condemnation of the water, some material from the cesspool might reach the well; but after having travelled so great a distance underground, the bacteria should have been filtered out. Furthermore, most of the organic material present should be completely decomposed, the nitrogen converted to the nitrate form. The question is whether the soil has performed this process of filtration satisfactorily. If the pollution was extremely heavy, the soil might have become "loaded"; that is, undecomposed material might be distributed throughout the soil between the cesspool and the well; in such case, the bacteria might be transported in this material, and finally contaminate the water.

Under these conditions, if any B. Coli are found; that is, more than one or two per 100 cc., the supply is usually condemned regardless of all other test results; the reasons for such a decision have already been explained. If the pollution were slight, however, no B. Coli might be present in the sample at the moment of collection, and judgment, therefore, would have to be based upon the chemical test results. If a large amount of both "free" and "albuminoid" ammonia are found (more than 0.06 parts per million), together with varying amounts of nitrites and nitrates, the supply would probably be condemned; for these results show that the soil is loaded, and that the water contains organic material in various stages of decomposition. Presence of only "free" ammonia in large quantities, or of only "albuminoid" ammonia, is usually of little significance. Decomposition of vegetable matter might have yielded "albuminoid" ammonia, whereas inorganic reactions might have produced "free" ammonia in the water. The nitrite results supplement the others; if there is doubt regarding the significance of the ammonia content of the sample, for example, the presence of an excess of nitrites in the water would serve to confirm the doubt of its quality. If, however, these three nitrogen forms are found only in traces or not at all, the presence of a large amount of nitrates (30 to 50 parts per million) in the sample serves as an indication that, although the soil may be functioning properly as a filter, and although the organic material is being decomposed before it reaches the well, the soil must be reaching the saturation point. That is, the water may be safe for the moment, but at any time the extremely heavy pollution may penetrate through the soil and contaminate the well water.

Low bacterial plate counts are of particular importance in the case of well water; for if any of the other test results are almost but not entirely satisfactory, a low plate count is reassuring. A well water may be perfectly safe, however, even though it contains thousands of bacteria per cc., for a mass of still or slowly moving water, especially if it contains a trace of vegetable matter, is well adapted to the growth of harmless bacteria. A high plate count, therefore, may be of little significance.

In the control of a city water supply which is filtered and chlorinated, a plate count at 20 deg. C. is of great importance. Here, the purification system is expected to remove practically all of the organisms, and a sudden increase in the plate count means that this operation is not being performed successfully. The presence of B. Coli in excess of one or two per cc. in such a supply would also lead to suspicion of its quality. The nitrogen tests, on the other hand, are of little use here, and, in fact are not often performed on treated waters.

The foregoing examples serve to illustrate briefly how the laboratory results are employed. No one test is usually employed to determine the potability of a supply; it is the combined results from all the various tests which decide. And often the information obtained from an inspection of the supply and its surroundings is of greater importance than any number of test results.

The author has not attempted to describe the detailed methods of rapid manipulation of the apparatus employed in the examinations indicated, but such methods are obviously necessary when one considers that over ten thousand samples were analysed last year in the Quebec laboratories, and numbers of a similar order in other provincial laboratories.

Methods are changing with new discoveries and the extensive research which is being conducted. But the fundamental principles have been, and probably will be for some time to come, essentially those described. The laboratories do a vast amount of work for the cause of sanitation, and it remains for the public to co-operate fully, by rigidly obeying all regulations concerning water supplies, and by collaborating with the health departments for the examination of those supplies which are not known to be safe.

BRANCH NEWS

Border Cities Branch

J. F. Bridge, A.M.E.I.C., Secretary-Treasurer.
F. J. Ryder, Jr.E.I.C., Branch News Editor.

The regular monthly meeting and dinner was held Friday, March 18th, 1938, at the Prince Edward hotel. The speaker for the evening was W. L. Thompson, A.M.E.I.C., sales and service engineer, the Bailey Meter Company Limited, Montreal.

T. H. Jenkins, A.M.E.I.C., introduced the speaker to the 33 guests who had gathered to listen to his paper on "Meters and Combustion Control."

Meters and Combustion Control

After a brief synopsis of the history of metering, Mr. Thompson explained that since the advent of the steam engine it has always been desirable to have some method of visualizing and recording just what was happening inside of the boiler with various loads and operating conditions. The present metering devices are the outcome of a great deal of experimental work and the results of overcoming the many difficulties that were encountered.

A meter consists mainly of a primary and secondary element. The primary element is some type of orifice inserted into the medium to be measured so as to create a pressure differential in the flow of that medium. Following are some of the types of orifices used depending on the conditions and the medium to be metered: circular concentric, circular eccentric, and segmental orifices, terminal flow nozzles, adjustable orifices, and standard venture tube. In placing the orifice, one must remember to keep the flow of medium in a straight line leading to orifice to prevent swirling and to thus avoid creating a false pressure differential. When an orifice is set into a pipe line one must see that it is flush or even a little back of the interior surface of the pipe.

The secondary element consists of some mechanical means of transferring this pressure differential to some recording device, the Duvell system being used by the Bailey Meter Company. The differential produced varies as the square of the flow so that at ten per cent of flow there would hardly be enough power to overcome the friction in the mechanical parts. In metering, then, the problem is to obtain enough power to overcome the friction and yet not to create such a pressure differential as to cause a loss of pressure in the line. Bailey meters measure and record steam flow, gas flow and gas temperature, these records being of great assistance to the operator.

Combustion control depends principally on a pilot valve which is accentuated by any drop or rise in the pressure. This valve in turn operates the necessary control to feed more air, fuel or water to the boiler. The steam flow measurement is the most important, as all other controls revolve about this. Mr. Thompson passed around typical charts of actual performances. He also illustrated his talk with slides and diagrams, showing views of actual installations.

Boyd Candlish, A.M.E.I.C., moved a hearty vote of thanks to Mr. Thompson, to which everyone agreed.

Edmonton Branch

M. L. Gale, A.M.E.I.C., Secretary-Treasurer.
J. A. Brownie, Jr.E.I.C., Branch News Editor.

One of the Edmonton Branch's most enthusiastically greeted programme announcements in many months was that for the March 15th meeting. Over sixty members and guests were in attendance at the Corona hotel to see the Bethlehem Steel Company's sound motion pictures of the "Building of the Golden Gate Bridge."

The picture was a well edited description of the spectacular project with emphasis on the structural steelwork. Although the film was designed to be of general interest rather than of interest only to engineers it was very much enjoyed by the large audience.

Deputy branch chairman W. E. Cornish, A.M.E.I.C., presided.

Halifax Branch

R. R. Murray, M.E.I.C., Secretary-Treasurer.
A. D. Nickerson, A.M.E.I.C., Branch News Editor.

One of the largest meetings ever held by the Halifax Branch gathered at the Halifax hotel on March 24th, 1938, for the regular monthly meeting. I. P. Macnab, M.E.I.C., chairman of the Branch, presided.

H. S. Johnston, M.E.I.C., councillor for the Halifax Branch, announced that the ballot recently taken on the amendment to the By-Laws of The Institute was very decidedly in favour of the amendment. The final draft agreement of co-operation between the E.I.C. and the N.S. Professional Association is now completed, and has been approved by the Council of the A.P.E.N.S., and by the executive of the Halifax and Cape Breton Branches of the E.I.C. Legislation prepared by the A.P.E.N.S. to make this agreement legal is now ready for introduction into the Provincial House. Following a ballot of the Nova Scotia members of the E.I.C. it is expected that the agreement will be signed late in April of this year. Financial arrangements will become effective on January 1st, 1939.

New Steam Electric Generating Plant at Sydney

W. S. Wilson, A.M.E.I.C., chief engineer of the Dominion Steel and Coal Co., of Sydney, N.S., was the principal speaker of the evening. His paper was illustrated with numerous photographs and it was followed with very keen interest by the members.

Large quantities of blast furnace gas are available for fuel at the steel plant in Sydney, but this gas must be supplemented by coal to provide continuous energy. The old power plant consisted of 40 boilers designed to burn blast furnace gas, but provided with auxiliary grates for burning coal when required. Gas was burned at an efficiency of about 70 per cent.

A growing demand for electricity, and for process steam, coupled with a desire for a more efficient power plant led to studies for a new plant. The final design selected provided for two boilers having an output of 185,000 lb. of steam per hr. each, and designed to burn either blast furnace gas or pulverized coal or a combination of these two in any proportion. The new units are of the four drum type and operate at 500 lb. pressure. Superheated steam from the boilers is supplied to a new 10,000 kw. turbo generator unit, and the exhaust at 150 lb. pressure (the old working pressure) is used to supply various processes and services in the steel plant. A reducing valve is provided to supply steam at 150 lb. pressure when the turbine is not operating. Steam at the reduced pressure is de-superheated before entering the service main.

Since condensate from many of the plant services and processes cannot be recovered, about 50 per cent new feed water is required. An elaborate water treatment plant is provided. After three months of operation there is no scale in the boiler. Due to the abrasive action of dust present in the unwashed blast furnace gas, a fan of special design having blades ¾ in. thick is required to move it. This is driven by a 300 hp. variable speed turbine.

Coal is pulverized very fine before being fed to the boiler. Traps in the stack remove all fly ash from the chimney. The amount of fuel entering the unit is automatically regulated by the steam pressure, and the exact quantity of air required for combustion is regulated automatically by the volume of fuel entering the unit. This applies both for gas and pulverized coal or for any combination of the two. Explosion ducts are provided in both furnaces.

Tests on the new units show that an efficiency of approximately 80 per cent is being obtained from the blast furnace gas. With pulverized coal it is possible to generate 1 kw.h. per 1.08 lb. of coal. Automatic controls are used very extensively throughout the plant. A staff of three men per shift operate the boiler room.

Canadian materials were used as much as possible in the construction of the new plant. The turbine unit was made in Switzerland and the boiler drums in the United States.

A hearty vote of thanks was extended the speaker. Numerous questions from the floor were answered by him. A number of students from the N.S. Technical College were present at the meeting.

Hamilton Branch

A. R. Hannaford, A.M.E.I.C., Secretary-Treasurer.
W. W. Preston, S.E.I.C., Branch News Editor.

Speaking before the annual joint meeting of the Hamilton Branch E.I.C. and the Toronto Section, American Institute of Electrical Engineers at the Westinghouse Auditorium on April 8th, 1938, Dr. Joseph Slepian, Fellow A.I.E.E. and Associate Director of Research for the Westinghouse Electric and Manufacturing Company, described the ingenuity of research engineers in developing the ignitron to rectify heavy alternating current, that is, to change it to direct current.

Mercury Arc Rectifiers and Ignitrons

Research on rectification, stated the speaker, was based on a study of the unsteady electric arc turning on and off very rapidly. A device was needed which would change from a conductor to an insulator in a fraction of a second. Under certain conditions gases were found to have this property. Dr. Slepian explained the phenomenon by the theory of ionization, and described how an obstructing layer due to "space charge" formed near the cathode, and let only a small amount of current pass between the electrodes even at high voltage. To improve this condition a cathode of suitable material could be heated to the proper temperature as in the thermionic tube, but the same result was obtained by striking an arc: a "cathode spot," taking the place of the heated electrode, was formed at the cathode and permitted high current density at low voltage. On this principle the construction of the mercury rectifier is based.

The mercury arc rectifier, continued Dr. Slepian, consists of a glass bulb with a pool of mercury at the bottom, and a metal electrode in contact with the mercury, and an anode near the top of the bulb. With the current flowing in an auxiliary circuit, the metal electrode is pulled a short distance out of the pool. An arc leaps to the mercury and forms a cathode spot on it. The mercury is continually boiling away but, being a liquid, flows back to the pool. In the main circuit, alternating current, which reverses its direction 120 times a second for 60 cycle current enters at the upper anode and passes to the cathode spot. Direct current leaves the rectifier.

About 1927 electrical engineers were puzzled by the fact that the cathode spot formed at random intervals on the anode, causing an arc-back or short circuit. The explanation is still in doubt.

"It occurred to me," Dr. Slepian said, "that if the cathode spot on the mercury pool could be put out every other half cycle when it was not needed to carry the back flowing current, it would be impossible for the cathode spot to form on the anode."

He accomplished his task with an auxiliary relay tube, and introduced the ignitron. In it the auxiliary electrode which dipped in the mercury was carborundum, and the cathode spot formed when a certain current density was reached.

The ignitron is used extensively in electric welding. In the past it has not been possible to generate direct current with sufficiently high voltage to carry it over long distances, but it is predicted that the ignitron, now capable of rectifying 600 volt alternating current, will revolutionize the transmission of electric power.

W. J. W. Reid, M.E.I.C., chairman of the Hamilton Branch E.I.C., introduced the speaker, subsequently turning the meeting over to R. E. Jones, chairman of the Toronto Section A.I.E.E. W. P. Dobson, testing engineer of the Hydro-Electric Power Commission of Ontario, moved a vote of thanks to the speaker, coupling with it the thanks of the combined Engineering Societies to the Canadian Westinghouse Company for its hospitality. After the meeting refreshments were served to 174 members and guests.

Members of the Hamilton Branch, meeting at McMaster University on April 12th, heard their fellow member, Charles E. Church, A.M.E.I.C., patent solicitor, explain how inventors may get the greatest protection for their creations. Introduced by A. B. Dove, A.M.E.I.C., Mr. Church spoke under the caption,

Patent Laws for Engineers

The granting of rewards to individuals in England were known as monopolis before 1623. The favoured courtier could collect a tax on common articles of merchandise and necessities of life. The system became a burden and all monopolies were repealed in the reign of James I. Under the same Act patent laws were established whereby inventors were granted patents for 14 years from date of issue on inventions which did not harm the state. A necessary provision was that the inventor had to keep someone informed in the use of his invention so that it would not be lost at his death. A public record of the description of an invention was first required in the reign of Queen Anne.

The United States Congress in 1790 enacted the first American patent statute giving a monopoly for 17 years from issue. The latest Canadian Patent Act of 1935 provides the same period of protection. Nowadays the Canadian Patent Office issues about 300 patents per week, and the U.S.A. Office about 700 to 800.

The first question an inventor asks, stated Mr. Church, is "Does the invention contain novelty which can be patentably protected?" The inventor must see something others have failed to see. It may be something absolutely original or it may be a distinct improvement on another person's idea. Herein lies the most contentious question in patent law. Patents have been granted and later declared void in the courts on the grounds of lack of invention. The best test of an invention is its acceptance by the buying public. In the law of patents the person who makes the final or decisive step is the inventor. Before an inventor completes his invention he should learn if his idea is really new. This information is secured by searching the prior patents; usually only those of U.S.A.

The second question asked: "Is it possible to obtain patent protection that is sufficiently broad to protect the inventor against infringement?" To be a sound venture the invention should be one which could not readily be replaced by another construction, not infringing the patent but attaining the same end. Assuming the invention be worthwhile, the breadth of protection secured under the patent depends on the skill and knowledge of the patent attorney drawing up the specification and claims, and prosecuting the application before the Patent Office. Mr. Church advised inventors to obtain a thorough grasp of their written claims, and to test them by devising many different constructions that would apply to the invention, and seeing that the wording in the claim protected them against these constructions. It is often a question of competition rather than of infringement.

The third question is, "If the invention is put on the market, will it be free from infringing somebody else's prior patent?" A patent is not a license to manufacture or market the invention. It simply gives the inventor the right for 17 years to exclude all others from making or using anything within the scope of the patent claims. Another inventor may make a model of the patented invention with the idea of improving it, but if he is using it for his or others' commercial gain he is infringing. An invention may contain new and patentable matter, and at the same time infringe somebody else's prior patent which is still in force. If the earlier invention had limited sale both inventors will benefit by holding a cross-license. The inventor of the prior patent gives the inventor of the improvement a license to manufacture under the prior patent, and the inventor of the improvement gives the inventor of the prior patent a license to use his improvement.

Frequently an invention made in one field is applicable in another field. All possible applications should be specified in the patent.

Mr. Church closed with a motion picture of the John's conveyor which was developed from an invention of a machine for filling bags with powdered material such as cement. He also showed a number of slides of amusing old inventions and read the humorous specifications which accompanied them.

Mr. Church was thanked on the motion of E. Muntz, M.E.I.C. W. J. W. Reid, M.E.I.C., was chairman and attendance 52. Refreshments followed.

Lethbridge Branch

E. A. Lawrence, S.E.I.C., Secretary-Treasurer.
R. F. P. Bowman, A.M.E.I.C., Branch News Editor.

The Lethbridge Branch held a dinner-meeting at the Marquis hotel on the evening of Saturday, February 19th, 1938, at which the members entertained their ladies.

During the dinner Mr. and Mrs. George Brown's instrumental quartet provided music, followed by vocal solos by Mrs. C. Geiger and Professor Tink.

The speaker of the evening was Major F. G. Cross, M.E.I.C., Superintendent of Operation and Maintenance of the Irrigation Branch of the Canadian Pacific Department of Natural Resources. Major Cross is an artist of nation wide repute and an Associate of the Royal Canadian Academy, and he addressed the meeting on "Art." The value of art as a relaxation from the stresses of everyday life was emphasized together with its significance in making for us a better and fuller life.

Major Cross outlined the historical development of modern painting and dwelt on the different matters of technique which the artist must consider. Following his address he exhibited some of his work to illustrate the matters he had discussed.

London Branch

D. S. Scrymgeour, A.M.E.I.C., Secretary-Treasurer.
Jno. R. Rostron, A.M.E.I.C., Branch News Editor.

As a mark of appreciation of the services and efforts of the ladies at the Annual General Meeting, the Executive decided to turn the next regular meeting of the Branch into a "Ladies Night." Accordingly on March 30th a dinner meeting was held at the Hotel London to which the ladies were invited and a social evening enjoyed afterwards.

The Chairman presided and proposed a toast and hearty vote of thanks to the ladies for their splended co-operation and efforts in connection with the 52nd Annual and General Professional Meeting of The Institute held in London on January 31st to February 2nd inclusive. Much of the credit for the harmonious gathering, spirit of good will and fellowship which prevailed was due to the ladies and this "Ladies Night" had been dedicated as a token of appreciation by the members of the Branch.

Mrs. Buchanan and Mrs. Wolff responded suitably to the toast.

Greetings and good wishes were also extended by the Chairman to the Vice-President, E. V. Buchanan, M.E.I.C. Councillor J. A. Vance, A.M.E.I.C., in a short address referred to the past efforts and record of the London Branch and Mr. Buchanan's relation to it. Brief speeches were also made by V. A. McKillop, A.M.E.I.C., and H. F. Bennett, M.E.I.C.

Vice-President E. V. Buchanan duly responded and proposed a toast to the Ontario Association of Professional Engineers, which was suitably replied to by W. C. Miller, M.E.I.C., recently appointed councillor to that body. Mr. Miller outlined the purposes and aim of the Professional Association as relating to engineers generally and The Institute in particular.

After the dinner a delightful social evening was enjoyed by all, some of the party participating in bridge. Entertainment was provided in the shape of moving pictures of the Canadian Rockies, this being a film produced by the Sky Line Motor Club. The whole was interspersed by music, and an informal concert was thoroughly appreciated.

About thirty-four were present, and the hope was expressed unanimously that such an evening might be repeated very soon.

Montreal Branch

E. R. Smallhorn, A.M.E.I.C., Secretary-Treasurer.

Radioactivity

On March 24th, 1938, Dr. Karl K. Darrow addressed the Montreal Branch on the subject of "Radioactivity," discussing its nature, the progress made in the study of natural radioactive bodies from 1896 to 1933 and the very remarkable developments from 1933 to date made possible by the advent of transmutation. The importance of radioactivity in modern physics, its medical applications and the personalities of its important investigators have brought it to the attention of the general public. Dr. Darrow entered the Bell Telephone Laboratories (then the Engineering Department of the Western Electric Company) in 1917 after study in the United States and Europe. He has been engaged largely in writing on various fields of physics and allied sciences, and it was a priviledge to hear such an authority on this subject.

The meeting was a joint one with the Sigma Xi Society. The chairman was Dr. A. Norman Shaw.

Soil Mechanics in Foundation Engineering

Professor William P. Kimball addressed the Montreal Branch on March 31st on the subject of "Soil Mechanics in Foundation Engineering." Professor Kimball is professor of Civil Engineering and Soil Mechanics at the Thayer School of Civil Engineering at Dartmouth College, and has been connected with the foundation investigations for a number of projects, including the Huey P. Long Bridge at New Orleans and the San Francisco-Oakland Bay Bridge. He is a graduate of Dartmouth College.

Professor Kimball's paper described the contributions which have been made to the design and construction of foundations by the relatively new science of soil analysis, soil mechanics. It described applications of soil mechanies to practical work. The treatment of the paper being specific but not highly technical, it was of general interest to engineers rather than for specialists in soil mechanics. The topics discussed included: settlement observations and similarity of foundations, exploration of soil conditions, general methods of soil analysis, control and interpretation of field loading tests, use of allowable bearing values, soil mechanics in building codes, the effects of piles on soil, and general methods of settlement predictions. Lantern slides illustrated the paper.

Dr. O. O. Lefebvre, M.E.I.C., was chairman.

THE DESIGN AND CONSTRUCTION OF PIE IX BOULEVARD BRIDGE

The paper presented before the Montreal Branch on April 7th by Dr. S. A. Baulne dealt with the recently completed multiple-arch bridge over Riviere des Prairies, between the Island of Montreal and Isle Jesus. This structure, known as the Pie IX Boulevard Bridge, embodies several unique and interesting features; the principal one being the combination of steel arch ribs with a composite steel concrete post and deck system. Dr. Baulne discussed the general features of design, fabrication, erection, and construction methods used, illustrating his paper with lantern slides.

Chairman: Ernest Gohier, M.E.I.C.

TECHNICAL MEN IN INDUSTRY

On April 14th three short papers were presented before the Montreal Branch. Mr. Paul Gnaedinger, of the Dominion Rubber Company discussed, "Methods of Cost Control in Industry"; Mr. B. K. Reid, of Canadian Industries Limited, spoke on "Technical Sales Work" with particular reference to the marketing of Neoprene, and Dr. A. R. M. MacLean, Technical Director of the Elmhurst Dairies Limited, delivered an address on the "Application of Research to Industry." The three papers stressed particularly the effect of the technical man on these phases of industry. A discussion followed.

J. L. Busfield, M.E.I.C., acted as chairman.

RAILWAYS PROGRESSING TOWARDS CONTINUOUS RAIL

Mr. Harcourt C. Drake, Director of Research of Sperry Products, Inc., Brooklyn, N.Y., spoke to the Montreal Branch on April 21st on the subject "Railways Progressing Towards Continuous Rail." Mr. Drake described briefly the development of continuous rail from 1889 to 1937, when the longest recorded single stretch of 7,770 ft. was laid. He also discussed the behaviour of continuous rail in track; its performance under temperature variation; and the restraining forces preventing abnormal movement. The development of the flash butt weld, and the equipment and methods used for welding, transporting, and laying were described. The paper concluded by reviewing the advantages gained by the use of continuous rail. Interesting motion pictures and lantern slides were shown in connection with this paper.

J. M. R. Fairbairn, M.E.I.C., acted as chairman.

JUNIOR SECTION

On Saturday, April 23rd, the Junior Section visited the plant of Crane Company, Limited, Montreal. This visit included trips through the most modern valve plant in Canada, the foundry, chromium and nickel plating departments, pipe fabricating shops, electric and acetylene welding departments, and galvanizing department (both hot-dip and electric processes). Following the trip a motion picture of the Crane Company's Chicago works, entitled "Flow," was shown.

Ottawa Branch

R. K. Odell, A.M.E.I.C., Secretary-Treasurer.

At the noon luncheon, March 24th, 1938, an address was given by P. G. Johnston on the recently-formed Trans-Canada Air Lines, of which he is vice-president. Mr. Johnston briefly traced the history of flying in Canada and told what it is hoped to accomplish with the Trans-Canada Air Lines. W. F. M. Bryce, local chairman, presided.

TRANS-CANADA AIR LINES

"We are trying to develop a system of air lines in Canada," Mr. Johnston stated, "that can compare with anything in other countries. It means insistent and diligent study and the formation of a closely-knit organization which can function without any extraneous interference." Haste is being made slowly, the speaker continued, so that the result can merit the full patronage of the people of Canada.

Canada for a number of years has been the only large country without a regular scheduled airmail service, Mr. Johnston told his audience, although on the other hand the airplane has played an important part in the opening up of the northern areas of the country.

At the present time experimental flying operations over the Trans-Canada Air Lines are under way with five airplanes in use, each having a cruising speed of 165 miles an hour. By early fall it is intended to have another ten added to the equipment which will have larger power units and a faster speed. Inasmuch as the type of flying will be somewhat different to most flying hitherto, a special training school is being maintained at Winnipeg for pilots, ground despatchers, and mechanical personnel.

The Trans-Canada Air Lines will be affiliated with the Canadian National Railways and it is not desired unnecessarily to duplicate services. The new organization will therefore make use of some of those already in existence for the railway system itself, such as the purchasing, medical, publicity and other departments.

When the system is in proper operation much of the flying will be at night. Leaving Montreal at eight o'clock in the evening, mail will reach Vancouver in time for the first afternoon delivery on the following day. The air route will be by way of Ottawa, Toronto, North Bay, Winnipeg and Lethbridge with connections at a number of points for other cities off the main route. Passengers and express will also be carried and by connecting lines and railways, transportation to most parts of Canada and United States will be very much speeded up. The speaker, however, would make no definite predictions as to when the complete service would be put into operation.

ELECTRONIC DEVICES

"Electronic Devices" was the subject of a noon luncheon address given on April 7th, 1938, by J. T. Thwaites, Jr.E.I.C., of Hamilton. The address, which was of a technical nature, was illustrated with lantern slides and actual examples.

Mr. Thwaites described some of the types of devices from the simplest to the more complicated, mentioning that the radio furnished probably the most well-known example of the use of electronic devices at the present day.

Some rather remarkable operations were carried on by such means, stated the speaker. Lighting effects to fit the mood of the music played in the ballroom of the new Canadian National hotel in Vancouver would be operated by a system of 45 electronically controlled circuits. By such means it would be possible for the orchestra leader to choose the mood in his music and the lights would be changed to suit the mood. With this system it would require a million years to run through all possible sequences of variations of colours and lights.

In the electric welding of various metals, where either spot and seam welding is required, electronic control makes it possible to carry on such work continuously much more accurately and effectively than by manual control. The welding of stainless steel, for instance, which was formerly a bugbear to the welding engineer, is an example. Brass also can be so welded and also copper, even though no one has yet been able to measure the plastic range of the last mentioned. The extremely fine control of heat possible by electronic devices enables this metal to be handled with very great accuracy. With some of the modern alloys, also, such accuracy of control is likewise becoming more and more necessary and here again these electronic devices have their place.

W. F. M. Bryce, A.M.E.I.C., local chairman, presided.

Peterborough Branch

W. T. Fanjoy, A.M.E.I.C., Secretary-Treasurer.
J. L. McKeever, Jr.E.I.C., Branch News Editor.

At the regular meeting of the Peterborough Branch held on February 24th, 1938, the speaker was Mr. J. H. Daynes of the Air Conditioning Division, Canadian General Electric Company, who spoke on the subject of "Air Conditioning."

Mr. Daynes pointed out that there is an erroneous idea on the part of the general public to the effect that air conditioning is a very new art. On the contrary it had a start as early as 1897 and was considerably applied in the early part of the present century by the textile industry. Its application to the furthering of human comfort however, is fairly new and the speaker directed his remarks more particularly towards this phase of air conditioning.

Air conditioning was defined as the simultaneous control of temperature, humidity, air motion, and air purity. The term has been used very loosely and in a misleading fashion by various vendors, and there has therefore been a demand to standardize terms. Equipment may be described as "Winter Air Conditioning," "Summer Air Conditioning," or "Year Round Air Conditioning," if it performs the functions according to the following chart:—

Year Round {
*Heating
*Humidifying
*Cleaning †
*Circulating †
*Ventilating †
Cooling †
Dehumidifying †

*Winter. †Summer.

Equipment not completely fulfilling one of these groups of functions should be otherwise described.

The psychometric chart was shown and explained and it was stated that this chart was of the same importance to the air conditioning engineer as the steam tables to the mechanical engineer.

Winter and summer comfort charts were shown. It was pointed out that these were not necessarily indicative of the healthiest conditions because these were not exactly known. However, it was assumed that the healthiest conditions were approximately those of maximum comfort.

Mr. Daynes mentioned that practically all germs are carried on dust particles hence the importance of filtering. Proper dry filters will remove 95 per cent of the dust from the air.

The members of the Branch took considerable interest in the subject judging by the discussion which followed the presentation of the paper. The attendance was 59.

The Branch meeting held on March 10th was the annual "Students' and Juniors' Night." A. L. Malby, Jr.E.I.C., the chairman of the Students' and Juniors' Section of the Branch, introduced the speakers, who were R. E. Edson, S.E.I.C., J. R. Demarais, S.E.I.C., M. F. Carriere, S.E.I.C.

Mr. Edson spoke on "Sand Casting of Crank Shafts for the Automobile Industry." He described in detail the building up of the moulds from the sixteen separate sections for each shaft and pointed out the precautions taken to keep the dimensions of the finished casting within the extremely close limits demanded. Mr. Edson's paper was very well illustrated with slides and he followed through the whole process from the making of the moulds to cleaned casting ready for the various machining operations.

Mr. Demarais chose as his subject "The Purification of Water," and although he made mention of the processes involved in treating water for industrial purposes, he concentrated on the filtration of water for town and city use. The speaker described in detail the construction of the two main types of sand filters in general use and told how the precipitation of suspended matter and the extraction of bacteria were effected.

Mr. Carriere spoke on the subject of "Metallic Arc Welding." He mentioned the other welding processes in general use and then briefly recounted the history of arc welding in order to emphasize the tremendous growth in its application in a comparatively short time. Mr. Carriere went on to describe the nature of the arc and the relation of the required current and voltage to the type of material to be welded.

In thanking the speakers, V. R. Currie., A.M.E.I.C., the Branch chairman, urged upon them the desirability of entering their papers for the annual prize.

The attendance was 38.

At the regular meeting of the Branch held on March 24th, 1938, the speaker was Mr. T. B. McKeown of the Ethyl Gasoline Corporation, Toronto, and his subject was of course "Ethyl Gasoline." Mr. McKeown had with him a sound film, "The Long Road," the showing of which took up a large part of the meeting. This film showed the progress of transportation up to the time when the gasoline engine came into common use, and from then on, showed the search for a fuel which would increase the output of the engine and at the same time prevent knocking. Many varied compounds were tried mixed with the gasoline, some of which had a certain beneficial effect, but a compound known as tetra-ethyl lead was finally adopted.

By means of quartz windows in the cylinder walls and high speed cameras, the film showed the difference in the burning of a gasoline which caused knock and one which did not. With ethyl fluid added to the gasoline, the burning spread from the plug points at an even rate across the piston head whereas with ordinary gasoline which knocked, a sudden ignition of the unburned gasoline took place, starting from the side opposite the spark plug.

Following the showing of the film, Mr. McKeown showed some slides of power curves, etc., with different gasolines and explained the meaning of octane number as well as the necessity for setting the spark to suit the octane number of the gasoline used.

Many questions were asked which were ably answered by Mr. McKeown and it was quite evident that the Branch had spent an extremely interesting evening. The attendance was 57.

STUDENTS AND JUNIORS SECTION

The final meeting of the season of the Students and Juniors Discussion Club was held on April 4th, 1938, at which the speakers were A. DeMaio, S.E.I.C., on "Plant Layout," and Mr. V. B. Coxworth on "Photo Cells and Their Applications." Eight meetings have been held since the Club was formed last autumn and the willingness of the members to contribute papers combined with the efforts of the chairman, A. L. Malby, Jr.E.I.C., have made the Club a distinct success. Before the close of the meeting elections were held for the office of chairman for next season. The successful candidate was W. F. McMullen, S.E.I.C., under whose energetic leadership the success of the second season of the Club should be assured.

Saguenay Branch

C. Miller, A.M.E.I.C., Secretary-Treasurer.
J. W. Ward, A.M.E.I.C., Branch News Editor.

On February 11th, 1938, T. M. Moran, A.M.E.I.C., chairman of the Industrial Management Section of the Montreal Branch, delivered a paper to the Saguenay Branch entitled "Technical Men in Industry."

TECHNICAL MEN IN INDUSTRY

The technical graduate's training prepares him for administrative positions of a general character and in connection with production, development and distribution.

Management is primarily the leadership of men. Obviously such a function needs an ordered body of knowledge to which all who carry administrative responsibility can refer—a set of principles and a proved technique which will serve as a guide in the discharge of administrative duties.

Such an applied service will not be developed through theory alone but rather by the combination of the best abstract and technical thought on management with the practical experience of those actually engaged in responsible tasks.

To this end facilities of The Engineering Institute may well be utilized, and in forming its recently established Industrial Management Section, the Montreal Branch has had this purpose in mind.

PAPER UNLOADING FACILITIES AT PORT ALFRED

On February 25th, Mr. Frank Calder, of the Aluminum Company of Canada, Limited, addressed the Saguenay Branch on "Paper Unloading Facilities at Port Alfred."

A large proportion of Saguenay terminals business consists in handling of paper for water shipment. Prior to the construction of the paper storage shed at Port Alfred the paper had been handled directly from the mills to the side of the boats by train and to a lesser extent by truck.

Shipments from the mills could therefore only be made at the time boats were available at Port Alfred to receive the paper. The result was that the Roberval and Saguenay Railway was compelled to provide a large amount of rolling stock which could be used only intermittently during the summer and not at all during the winter. The investment required for this rolling stock was more than the railway was justified in making. They therefore rented equipment from the Canadian National Railway when and as required.

With the idea of smoothing off this intermittent traffic and also to provide storage for both mills, construction of a paper storage shed and handling equipment was commenced in October 1936, and completed sufficiently to receive paper for storage at the beginning of April 1937.

The general layout of the plant consists of a train shed, paper storage shed and conveyors. The cars of paper are spotted in the train shed, the paper unloaded and placed on a conveyor which takes it to the storage shed. Here it may be rolled off for storage, but for direct loading it passes on to other conveyors which take it to the wharf where it is then handled by the ships' gear. Consolidated Paper Corporation's paper is handled by a conveyor direct from their finishing room to the storage shed.

Saskatchewan Branch

J. J. White, M.E.I.C., Secretary-Treasurer.

The annual meeting of the Saskatchewan Branch of The Institute was held on March 18th, 1938, in the Kitchener hotel, Regina. Forty-five persons sat down to a very enjoyable dinner.

Stewart Young, M.E.I.C., the Branch chairman, was in charge of the meeting which assembled as a joint meeting of The Engineering Institute of Canada, the Association of Professional Engineers of Saskatchewan and the American Institute of Electrical Engineers. Immediately after dinner the chairman suggested that the entertainment be provided in order that the Branch could assemble in annual meeting later.

Moving pictures were screened of the Boulder Dam, on loan from the United States Department of the Interior, Bureau of Reclamation. Mr. D. D. Low read a brief synopsis of administration and construction of the dam.

Subsequently the guests retired and the meeting convened as an annual meeting of the Branch. The general business of reading of minutes, reading of the business and financial statement which was prepared for presentation to Headquarters for the year, auditors' report and the reports of the various committees were all approved by the meeting.

The Branch Councillor, R. A. Spencer of Saskatoon, was present to give his report as Councillor and also give a report as chairman of a Joint Committee on Consolidation. Progress is undoubtedly being made with regard to consolidation within the province, and after considerable discussion all members felt that some form of consolidation would be consummated within the next year.

The report of the scrutineers showed the following officers had been elected for the coming year:—

Chairman	I. M. Fraser, A.M.E.I.C., Saskatoon.
Vice-Chairman	J. McD. Patton, M.E.I.C., Regina.
Executive	A. P. Linton, M.E.I.C., Regina.
	P. C. Perry, M.E.I.C., Regina.
	E. K. Phillips, A.M.E.I.C., Saskatoon.
Nominating Committee	H. R. MacKenzie, M.E.I.C., Regina.
	C. J. McGavin, M.E.I.C., Regina.
	W. E. Lovell, M.E.I.C., Saskatoon.
	H. M. Bailey, A.M.E.I.C., Yorkton.
	J. C. Todd, A.M.E.I.C., Rosetown.

Mr. Young declared these officers elected and installed the new chairman, Professor I. M. Fraser, who thanked the members for the honour conferred upon him.

A. P. Linton presented a Past-Chairman's Gold Badge to Mr. Young, at the same time thanking him for the splendid work he had done for the Branch as Chairman and Councillor.

Sault Ste. Marie Branch

N. C. Cowie, Jr.E.I.C., Secretary-Treasurer.

The Sault Ste. Marie Branch of The Engineering Institute of Canada held a general meeting at the Windsor hotel, Sault Ste. Marie, Ont., Friday, March 4th, 1938.

This, a dinner meeting, was attended by twenty-two members and guests.

Following the dinner and a short business meeting, the chairman, J. S. Macleod, A.M.E.I.C., introduced E. M. MacQuarrie, O.L.S., M.E.I.C. Mr. MacQuarrie presented a timely and interesting paper on the subject, "Development of the Helen Mine." The speaker reviewed the history of this iron ore deposit, its growth since its discovery, its extent, properties and the methods used so far in mining the property. Following this, Mr. MacQuarrie discussed the methods now proposed for extracting, handling and transporting the ore and for bringing it up to a commercial grade.

Toronto Branch

J. J. Spence, A.M.E.I.C., Secretary-Treasurer.
A. E. Berry, M.E.I.C., Branch News Editor.

The meeting of the Toronto Branch on January 20th, 1938, was given over to a paper on "The Application of the New Science of Seeing to Lighting," with J. W. Bateman, manager of the Lighting Service Department of the Canadian General Electric Company, as the speaker

The fundamental question on lighting design is the one dealing with the objective to be accomplished. Definite and measurable scientific facts have come out of an orderly programme of research.

Man has been essentially an outdoor creature, with eyes evolved to function in daylight and for long distance seeing. Man's plan of living is in contrast to nature's plan.

Light is the one controllable factor in seeing. The four factors in seeing are: size of object, the contrast, time, and light. More light is only part of the story. One of the most undesirable factors of quality is that of glare.

Modern lighting installations are adopted to the science of seeing. Office lighting utilizes three kinds of lighting—indirect, semi-indirect and semi-direct. In industrial lighting the need for higher intensities of illumination has been realized.

Street and highway lighting is related to modern transportation and accidents. Present-day automobile headlights are still inadequate to provide the necessary light under the conditions encountered.

STUDENTS NIGHT AT TORONTO BRANCH

A novel plan was adopted at the meeting of the Toronto Branch on February 24th, 1938. On this occasion the programme was given by engineering students at the university. The evening opened with an interesting film on the "Golden Gate Bridge." Then five students competed for prizes, each giving a paper on a subject of his own choice. The material offered and the manner in which it was presented was excellent. The competition was closed and the judges had difficulty in making the decision. The final winners were: First prize, I. W. Smith; second prize, a tie between Bernard Etkin and J. L. Hemphill.

Vancouver Branch

T. V. Berry, A.M.E.I.C., Secretary-Treasurer.

The modern manufacture of lubricating oils was the subject of an address given by Dr. W. F. Seyer, Associate Professor of Chemistry, University of British Columbia, before the Vancouver Branch on Wednesday, March 16th, 1938, in the Georgia hotel.

Dr. Seyer, who has been directing research at the University of British Columbia for a number of years on the treatment of the hydrocarbons of petroleum and the extraction and refining of lubricating oils, traced the use of animal and mineral oils in the lubricating of machinery during the latter part of the last century to the present use of mineral oils from petroleum in the lubricating of modern high speed machinery.

The speaker discussed the characteristics both physical and chemical of modern lubricating oils under the headings—1, viscosity; 2, viscosity index; 3, volatility; 4, chemical stability.

Flow sheets were exhibited by Dr. Seyer which indicated the modern methods of separation of the waxes and sludges from the lubricating oils of varying viscosity indices by means of propane and sulphur dioxide treatment.

Excellent slides of a large refining plant were also shown.

The vote of thanks to Dr. Seyer was proposed by Dr. Victor Dolmage, M.E.I.C. The attendance was 32.

Winnipeg Branch

J. Hoogstraten, A.M.E.I.C., Secretary-Treasurer.

At a general meeting held on Thursday, March 17th, 1938, thirty-eight members and visitors were present to hear Mr. P. C. Watt, Terminal Manager, United Grain Growers Terminals, Ltd.

THE HANDLING OF GRAIN IN LARGE ELEVATORS

In 1883, the first terminal elevator at the Head of the Lakes was built at Port Arthur, with a capacity of 250,000 bushels. During the next five years, the Canadian Pacific Railways established a few terminal elevators at Fort William, but these had very little in the way of grain cleaning equipment, and were actually considered as a part of the transportation system. During that period, before grain fields became infested with weeds, the problem of grain cleaning did not exist, and elevators were constructed primarily for the purpose of transferring grain from cars to boats, and later for storage purposes.

The railway companies began to realize, in about 1910, that the handling of grain through terminal elevators was no longer a matter of transportation, but was fast becoming a highly technical business. Thereupon they began to lease their elevators to private companies, and in a few years were entirely out of the business of operating terminal elevators.

A modern terminal elevator consists, commencing at the top, of a head floor, garner floor, scale floor, distributing floor, and bin floor. Below these are the workhouse or cleaner bins, and then the main floor or cleaning deck.

Elevating legs for receiving and shipping are of 20,000 bushel per hour capacity at the Port Arthur plant. Many kinds and varieties of grain cleaning and separating machines are required, and in most elevators, it is this equipment which limits the rate of operation of the plant.

The cleaning and separating of grains might be described as involving length, breadth, thickness and weight of the materials handled. The cylinder machines, depending for efficient operation on the proper balance between weight and centrifugal force, have proved to be the most flexible type of equipment.

In the construction of the five million bushel terminal at the Head of the Lakes, the tanks were built farther apart, and the interspaces divided into four bins, each capable of holding two or three carloads of grain. The effect of this change from the conventional design was to provide a total of 406 bins of various sizes as against 190 bins in the standard design. It was found that in the years which followed the construction of this elevator, the tremendous increase in the number of grades more than justified the additional expenditure involved.

Moving pictures, depicting various aspects of the problem of grain handling were then shown, followed by a discussion in which G. L. Shanks, A.M.E.I.C., N. M. Hall, M.E.I.C., G. C. Davis, A.M.E.I.C., and T. L. Woodhall, S.E.I.C., took part.

The vote of thanks, proposed by Professor G. L. Shanks, was heartily responded to.

At a meeting held on April 7th, 1938, the E.I.C. prize winning papers were presented by Messrs. J. W. McBride and R. T. Harland, students in engineering at the University of Manitoba.

Mr. McBride spoke on "The Effect of Boundary Layer Control on the Efficiency of a Draft Tube." After developing the various formulae involved, Mr. McBride showed, by applying his theory to an actual draft tube of the Moody spreading cone type, that the efficiency could be raised from 93 to 94.7 per cent by controlling the boundary layer by suction.

Mr. Harland spoke on "An Analysis of a Low Power Hydro-Electric Plant," and gave a description of the No. 3 unit in the power house at Chateau Lake Louise, where he has been employed for several summers. The efficiency of the unit and the design of a proposed governor were fully discussed.

The presentation of these papers was followed by a lively discussion, and the vote of thanks proposed by D. M. Stephens, A.M.E.I.C., was cordially responded to by all those present.

BULLETINS*

Pipe Joints.—The Dresser Manufacturing Company Limited, 60 Front Street, West, Toronto, Ont., has just released a 16-page booklet on their No-Thread Fittings Style 65. Unique types of self-contained pipe joints that connect pipe without treading are described.

Heat.—"Heat" is the title of a 48-page booklet published by the Canadian Johns-Manville Company, Toronto 6, Ont. The five chapters of the book deal with the history of heat; the three methods of heat transfer and the use industry makes of this knowledge; the development of methods of heat conservation; modern materials available for conserving heat and the specific uses of these materials. Illustrations and charts accompany the text.

Electric Snow Melters.—Canadian General Electric Company Limited, 212 King Street West, Toronto, Ont., have published two pamphlets on the characteristics of electric snow melters and their installation and operation.

Conduits.—"Transite Conduit and Korduct" are subjects of a 21-page booklet published by the Johns-Manville Company Limited, Laird Drive, Toronto, Ont. This booklet includes data on the strength, resistance to corrosive soils and electrolysis of the transite conduit in underground distribution systems and information on the use of transite korduct in concrete envelopes. Many pictures are used to illustrate the text.

Oil Seal. In a 12-page pamphlet the Garlock Packing Company of Canada Limited, Montreal, describe their new oil seal called the

*Copies of these bulletins may be obtained by writing to the companies mentioned

Garlock Split-Klozure. This new patented oil seal can be easily installed without dismantling the machine.

Dust Arresters.—A 4-page leaflet has just been received from the Northern Blower Company, Cleveland, Ohio, describing their Norblo Screen Type Dust Arresters.

Meter Testing.—A 4-page descriptive leaflet has been received from Bepco Canada Limited, Montreal, covering "Crompton" apparatus for meter testing, D.C. potentiometers, indicating dynamometer wattmeters and moving coil and moving iron instruments. These instruments comprise a range which has been designed by Crompton Parkinson Limited.

Roofs.—A new 36-page brochure "Johns-Manville Bonded Built-up Roofs" has been received from Canadian Johns-Manville Company, Toronto 6, Ont., which contains complete detailed specifications on all J-M built-up roofs. Drawings illustrate the applying of roofing materials to various types of roof decks. Various methods of base and cap flashing are outlined accompanied by diagrams to show how flashing should be installed. Roof insulation is also gone into with detail.

Grinding Machine.—Brown & Sharpe Manufacturing Company, Providence, R.I., have issued a 2-page leaflet on a new grinding development, a plain grinding machine which, being electrically controlled, offers more profitable production grinding.

Kelvin Medal Awarded to Sir Joseph J. Thomson

The seventh award of the Kelvin Gold Medal has been made to Sir Joseph J. Thomson, O.M., D.Sc., F.R.S., Master of Trinity College, Cambridge, in recognition of his eminent services to engineering science. A brief account of the establishment of this award will no doubt be of interest. It may be recalled that the executive committee of the Memorial Fund to Lord Kelvin, set up by a general committee representative of 19 British and American institutions, decided that the balance of the fund, after defraying the cost of a window to the memory of Lord Kelvin in Westminster Abbey, should be applied to the establishment of a Kelvin Gold Medal. The window was unveiled in July, 1913, but the award of the first medal, which it was decided should be presented triennially as a mark of distinction in those fields of engineering work or investigation in which Lord Kelvin was particularly interested, was delayed by the European war. It was not until 1920 that the first award was made to the late Dr. W. C. Unwin, F.R.S. The second medal was awarded to Dr. Elihu Thomson in 1923; the third to the late Sir Charles A. Parsons in 1926; the fourth to Mr. Andre Blondel in 1929; the fifth to the late Marchese Marconi in 1932; and the sixth to Sir John Ambrose Fleming in 1935. The trust and administration of the Medal Fund are in the hands of the Institution of Civil Engineers, and the award is dealt with by a committee, sitting in London, and consisting of the presidents for the time being of the Institutions of Civil, Mechanical, Electrical and Mining Engineers; the Institutions of Naval Architects and Mining and Metallurgy; the Iron and Steel Institute; and the Institution of Engineers and Shipbuilders in Scotland. Recommendations received from similar bodies in all parts of the world are taken into consideration when the award is discussed. The medal for 1938 will be presented to Sir Joseph J. Thomson by Lord Rayleigh at the Institution of Civil Engineers on May 3, at 5 p.m., and after the presentation Sir Frank Smith, K.C.B., F.R.S., will deliver a lecture entitled "Disorderly Molecules, Refrigeration and Engineering." Sir Frank was elected an honorary member of the Institution of Civil Engineers at a meeting held on February 22. At the same meeting, H.M. Leopold III, King of the Belgians, H.R.H. The Crown Prince of Sweden, and Sir Robert Elliott-Cooper, K.C.B., senior past-president of the Institution, were also elected honorary members.—*Engineering.*

Joint Meeting of Canadian Chemical Association and Society of Chemical Industry

An important gathering of chemists and chemical engineers will meet in Ottawa in June, when the annual meeting of the Society of Chemical Industry, the great British industrial chemical society, will be held in conjunction with the twenty-first Canadian Chemical Convention. A large party of British chemists, including representatives of Government technical departments, professors and industrialists, headed by Lord Leverhulme, Governor of Lever Brothers, Ltd. and of Uni-Lever, Ltd., will visit Canada on this occasion and they will be joined in Ottawa by many chemists from the United States. Canadian chemists from all parts of the Dominion will be the hosts of the British and American visitors.

The meetings in Ottawa extend over three days, June 20 to 24. Technical sessions will be held each morning. Visits to plants and to places of interest around Ottawa and various social functions complete the programme. Dr. L. H. Baekeland, the well known American industrial chemist, inventor of bakelite, velox photographic paper and many other important chemical developments, will be the recipient of the Messel Medal. There will be a symposium on "The Utilization of Canada's Natural Resources Through Chemical Research."

In addition to the meetings in Ottawa, the British party, accompanied by many American and Canadian chemists will visit some of the chemical centres and principal cities in Eastern Canada.

Congratulations to the R.A.I.C.

The Hon. W. D. Euler, Minister of Trade and Commerce, has announced the result of a Dominion-wide competition for an architectural design for the Canadian Government pavilion to be erected at the World's Fair which will be held at New York next year. The competition gave Canadian architects an opportunity to produce a distinctively Canadian design for the special pavilion to represent Canada. The Royal Architectural Institute of Canada was appointed by the Department of Trade and Commerce as its adviser in judging the competition. The first award, carrying with it the commission to prepare detail drawings and specifications, went to W. F. Williams of Nelson, B.C.; the second to Ernest Barott, of Montreal; and the third to Ross and Macdonald, also of Montreal.

A Shaft Sinking Job at Falconbridge

A sinking of a shaft through a 100 ft. layer of overburden at the Falconbridge Nickel property, as described at the Toronto meeting of the Canadian Institute of Mining and Metallurgy by R. M. Oliver, the company's chief mine engineer, involved some interesting features. Consisting of gravel, sand, and boulder, with bands of very fine silt, the overburden usually is found to contain a layer of water-bearing quicksand adjoining the rock surface, which in previous shafts sunk at Falconbridge had given considerable trouble. The method of sinking through this overburden, briefly described below, was adopted after several other plans had been considered.

Sinking proceeded with a shaft crew of seven men and a leader by digging inside of a steel shield, which was jacked down as the work advanced, one man being stationed at each corner during jacking to keep the shield level. Sand was prevented from running in at the corners by plugging with burlap. Working three eight-hour shifts, an advance of approximately six feet a day was made.

The chief difficulty was encountered at a depth of about 100 ft., where, after sinking through a three and a half foot ledge, it was found that the shaft had hit a knoll, and that the bedrock fell away very steeply on one side, and was almost a sheer cliff on one corner. Dowel holes were drilled, and a twenty-inch wall of concrete was poured inside the shield to a height of five feet around the portion of the shaft down to rock. Interlocking steel piling was then driven around the remaining third of the shaft inside the timber, and hammered with air drills on to the rock.

The cost of sinking through the overburden to the bearing in rock totalled $35,225, or $282 a foot, the figures being exclusive of any cost of plant or power.

Eldorado's Operations at Great Bear Lake

Mining and milling methods, and other features in the operation of Eldorado's pitchblende-silver deposits at Great Bear lake, are the central topics of a paper by E. J. Walli, superintendent, and by other members of the company's staff, which appears in the February issue of the Bulletin, Canadian Institute of Mining and Metallurgy. Discovered by Gilbert LaBine in 1930, the mine is situated twenty-eight miles south of the Arctic Circle and 1,140 miles by airline from Edmonton.

To overcome the problem of transportation the company embarked upon both water and air freighting on its own account, and now operates a Bellanca plane with a payload of 4,400 pounds, and a complete water transportation system. Modern steel boats, oil tankers, and barges were added to the fleet last season. As a result of direct ownership of carriers, water-borne freight is now quoted to the mine at $110 a ton, as compared with $240 a ton four years ago.

To avoid delays and shut-downs, well-equipped shops, with complete facilities for general repairs, are maintained at the mine, and lumber is also manufactured on the property. All buildings are of modern, well-insulated construction, and offices and men's quarters are provided with steam heat, running water, electric light, showers, and washrooms. A recreation hall, equipped with two billiard tables, and a sundries shop are provided for the use of employees.

Skilled labour is brought in on one-year contract, and with the assistance of the skilled men, others are trained on the property with very good success.

Food supplies are shipped in during the water navigation season. Fresh vegetables are secured from posts along the Mackenzie river, and these supplies are augmented by fresh fruits, greens, and meats brought in by airplane.

The general geology, structure, and ore deposition and mineralization are among the features discussed by J. P. Ryan, assistant superintendent, in his section of the paper. He also outlines the methods employed in mining the ore-bodies. D. A. G. Smith, concentrator superintendent, comments on the special problems encountered in the concentration of the ores, and notes that the test work of the Department of Mines and Resources at Ottawa has been of invaluable aid in reaching the present efficiency.

—*Canadian Institute of Mining and Metallurgy.*

Preliminary Notice

of Applications for Admission and for Transfer

April 30th, 1938.

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 1938.

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

BRYDEN—DONALD CHARLES, of 115 Gerard St., Winnipeg, Man., Born at Birmingham, England, July 27th, 1904; Educ., B.Sc. (E.E.), Univ. of Alta., 1928; 1928-30, ap'tice course, Can. Westinghouse Company, Hamilton, Ont.; 1930 to date, power sales engineer, Winnipeg Hydro-Electric System, Winnipeg, Man.
References: J. W. Sanger, H. J. MacLeod, W. E. Cornish, R. H. Andrews.

CHAPUT, OMER Jr., of Arvida, Que., Born at Ottawa, Ont., July 10th, 1914; Educ., B.Sc. (E.E.), Queen's Univ., 1936; 1936 (May-Aug.), with L. H. Carreau, patent attorney, Ottawa; 1936-37, gen. engrg. work, Saguenay Power Co.; Feb. 1937 to date, apprentice engr., at present on constrn., with Aluminum Co. of Canada, Arvida, Que.
References: A. C. Johnston, R. H. Rimmer, L. T. Rutledge, D. S. Ellis, R. A. Low, F. L. Lawton.

CLARKE—ROBERT ARTHUR, of Lewisville, N.B., Born at London, England, July 12th, 1884; Educ., 1902-05, Crystal Palace School of Engineering, obtained all diplomas, 1905; 1903-05, ap'ticeship, dist. engr.'s office, London, Brighton & South Coast Rly.; 1908, instr'man., Sir John Mowlem Co.; 1909-10, instr'man., Benguella Rly. Survey, Portuguese Angola, West Africa; 1911-14, chief asst. engr., Bolivar Rly. Co., Venezuela; 1910-11, chief asst. engr., Lagos Govt. Rly., West Africa; 1914-15, acting in charge, Public Works Dept., Lagos Govt., Lakoja Niger Province, W. Africa; 1932-34, chief field engr. on refinery constrn., in Mexico, U.S.A., and Montreal; 1934-36, inspr. on paving constrn. in the maritimes, for Milton Hersey Co. Ltd., Montreal; 1937 to date, res. engr., highway divn., Prov. of N.B., Dept. of Public Works, Fredericton, N.B.
References: G. B. Mitchell, P. B. Motley, H. W. B. Swabey, C. G. Grant, M. F. Macnaughton, D. G. Anglin.

COOK—CLARENCE ARTHUR, of 301—31st St. W., Saskatoon, Sask., Born at Saskatoon, Nov. 20th, 1907; Educ., B.Eng. (Civil), Univ. of Sask., 1933; 1928 (summer), surveying, rodman and chainman, Phillips, Stewart & Phillips, Saskatoon; 1929-30-31 (summers), A. W. Heise Co. Ltd., estimating, dfting, designing and constrn. on work which included Saskatoon power house, dairies, bakeries and office bldgs.; 1933-36, with the Hi-Way Refineries, Saskatoon. Stillman having complete charge of one shift. Work included charge of operation during running; also mtce., design of improvements, chem. testing, lab. work, design of fuels, all chem. work pertinent to refining. Products manufactured, gasoline, distillates, kerosene and diesel fuels; at present, teacher at Bedford Road Collegiate. Subjects—senior chemistry, senior maths., junior science (chemistry and physics), junior maths.
References: E. K. Phillips, E. H. Phillips, R. A. Spencer, C. J. Mackenzie, G. M. Williams, J. J. White, W. E. Lovell.

DERNIER—HERBERT CLARENCE, of Moncton, N.B., Born at Shediac, N.B., June 27th, 1909; Educ., B.Sc. (C.E.), Univ. of N.B., 1933; 1930 (summer), student asst., Forest Survey Work; 1933, mechanic i/c of maintenance of constrn. machinery for Stewart Construction Co., Sackville, N.B.; 1935-37, junior instr'man, and 1937 to date, senior instr'man, N.B. Highway Department.
References: E. O. Turner, J. Stephens, A. F. Baird, J. H. McKinney.

DESLOOVER—JEAN RAYMOND, of Montreal, Que., Born at Paris, France, Aug. 8th, 1902; Educ., B.Sc. (E.E.), McGill Univ., 1923; R.P.E. of Quebec; 1923-25, ap'tice course, Southern Canada Power Co. Ltd.; 1925-29, junior engr., and 1929-38, project engr. and co-ordinating engr., Power Corporation of Canada Ltd.; at present, engr. with the Quebec Electricity Board, Montreal, Que.
References: J. S. H. Wurtele, J. H. Trimingham, P. T. Davies, C. V. Christie, J. H. Beauchemin.

DOW—WALTER KERR, of Arvida, Que., Born at Glasgow, Scotland, Oct. 10th, 1913; Educ., B.A.Sc. (Elec.), Univ. of Toronto, 1937; 1933-34, asst. to elec. engr., Neon Luminations Ltd., Liverpool, England: 1936 to date, ap'tice, Aluminum Company of Canada, Arvida, Que.
References: A. C. Johnston, J. W. Ward, R. H. Rimmer, G. B. Moxon, C. H. Mitchell.

DRIEDGER—EDWIN WILFRID, of 979 Hall Ave., Windsor, Ont., Born at Rosthern, Sask., Sept. 26th, 1911; Educ., B.Eng. (Civil), Univ. of Sask., 1933; 1937 (2 mos), surveying, field and office work, Dept. Highways Ont.; at present, dftsman., Canadian Bridge Company, Windsor, Ont.
References: J. G. Campbell, H. J. A. Chambers, P. E. Adams, R. A. Spencer, C. J. Mackenzie.

FLEMING—FREDERICK ALEXANDER, of Peterborough, Ont., Born at Toronto, Ont., March 11th, 1913; Educ., B.A.Sc. (Elec.), Univ. of Toronto, 1936; With the Can. Gen. Elec. Co. Ltd. as follows: 1936-37, transformer test, induction motor testing, switchgear testing; 1937, wiring devices and appliance engrg., and distribution transformer engr.; Oct. 1937 to date, meter engrg. dept.
References: E. R. Shirley, V. S. Foster, L. DeW. Magie, W. T. Fanjoy, G. R. Langley.

HUBER—ALBERT LLOYD, of Montreal, Que., Born at Kitchener, Ont., March 19th, 1895; Educ., Complete Mech. Engrg. Course, I.C.S. Private study; 1913, Ottawa Car Works; 1913-15, Lloyd Blackmore & Co.; 1915-17, Gas Engine & Power Company; 1917-19, R.A.F.; 1919-22, chief dftsman., Consolidated Shipbldg. Corpn., design of marine boilers of the water tube type, steam and gas engines, also pipe layout work; 1922-27, chief dftsman. and planning dept., General Motors Corpn., Oshawa; 1927-29, sales engr., Webster Inglis Ltd.; 1929 to date, chief engr., Eastern Divn., Link-Belt Ltd., Montreal. Designing of engrg. contracts and taking full responsibility for same.
References: R. S. Eadie, R. H. Findlay, G. H. Midgley, W. S. Wilson, A. P. Theuerkauf, R. Ford.

JONES—ALLAN JOHN, of Cypress Park, Caulfield P.O., B.C., Born at Nanaimo, B.C., Sept. 8th, 1906; Educ., B.A.Sc. (Civil), Univ. of B.C., 1928; 1926-27-28 (summers), rodman, instr'man., Geol. Survey of Canada, instr'man., Municipality of Point Grey; 1928 (June-Nov.), engr., Yukon Gold Co. Ltd., Dawson, Y.T.; 1929-31, detailer and minor design, dam. power house and substation work, reinforced concrete and struct'l. steel constrn., B.C. Elec. Rly. Co. Ltd.; 1931, asst. engr., on constrn., Burrard Bridge contract; 1932, asst. engr., B.C. Bridge and Dredging Co. Ltd.; 1933-35 (intermittant), i/c survey parties, transitman, etc., Underhill & Fraser, Dom. and B.C. Land Surveyors; 1934 (Feb.-June), designing, small power house, B.C. Elec. Rly. Co. Ltd.; 1936 (Feb.-Dec.), res. engr. on suction dredge work, and from Jan. 1937 to date, engr., purchasing agent, and asst. mgr., B.C. Bridge and Dredging Co. Ltd., Vancouver, B.C.
References: W. R. Bonnycastle, E. E. Carpenter, A. Peebles, E. C. Luke, W. A. Richardson, W. B. Greig, W. H. Powell.

MacKELL—THOMAS EMMETT, of 4580 Circle Road, Montreal, Que., Born at Ottawa, Ont., June 28th, 1903; Educ., Matric., Lisgar Collegiate, Ottawa, 1923; 1924-27, wireless operator, Royal Candn Corps of Signals; 1927-30, plant engrg. dept., Bell Telephone Co. of Canada; 1930-33, cable constrn. test engr., Northern Electric Company. (Loaned to C.P. Telegraphs and Sask. Govt. Telephones on Contract); 1930-31, C.P. Telegraphs, supervising and testing carrier cable installns.; 1931-32, Trans-Canada carrier systems; 1934-37, wireless operator mechanic, Grade A, R.C.A.F.; 1937 to date, engrg. asst., plant engrg. dept., Bell Telephone Company of Canada, Montreal, Que.

References: C. E. Frost, T. H. Doherty, E. Baty, H. J. Vennes, D. J. McDonald.

MINSHALL—HARRY HUGH, of 3895 West 22nd Ave., Vancouver, B.C., Born at Ingersoll, Ont., Dec. 17th, 1902; Educ., 1920-23, Hamilton Technical Institute; 1923-24, asst. transitman, W. S. Gibson & Sons, Toronto; 1926-27, formwork, detailer and instr'man. with some estimating, Northern Construction Co. Ltd., Vancouver; 1928-29, supt. and engr., Sydney Junkins & Company, Vancouver; 1929 to date, with Dominion Bridge Company Ltd., Vancouver, as follows: 1929-30, field engr., on erection of struct'l. steel work; 1930-32, res. engr. on constrn. and erection of struct'l. steel for various bldgs. and bridges; 1932 to date, engr. of erection, incl. work on reconstrn. of Second Narrows Bridge, Patullo Bridge, and Lion's Gate Bridge.

References: A. S. Gentles, J. Robertson, W. G. Swan, W. Smaill, J. P. Mackenzie, A. L. Carruthers.

STROYAN—PHILIP BATEMAN, of 1155 Lagoon Drive, Vancouver, B.C., Born at Derby, England, Dec. 17th, 1900; Educ., B.A.Sc., Univ. of B.C., 1924; R.P.E. of B.C.; 1922-23-24 (summers), chainman on watershed survey, Vancouver Water Board, and instr'man. on hydro-electric survey of Lillooet River; 1924-26, with Sydney Junkins Co., as designer and detailer on reinforced concrete and struct'l. steel work for C.P.R. pier at Vancouver; 1926-28, with A. E. Coffin & Son, general contracting business, Vancouver; 1928-30, also 1931-33, with Vancouver School Board, architects' dept., bldgs., playgrounds, walks, roads, etc.; 1930, with J. R. Grant, M.E.I.C., as reinforced concrete designer on Burrard Bridge, Vancouver; 1933, with John S. Metcalf Co., on design of grain elevators at Seattle and Vancouver; 1934, with W. G. Swan, M.E.I.C., as reinforced concrete designer on Fraser Bridge, New Westminster; 1935, with Consolidated Mining and Smelting Co., as designer on plant constrn. at Trail, B.C.; 1936, with Vancouver School Board as clerk of works on school constrn.; 1937 to date, asst. supt. and engr., Board of Park Commissioners, City of Vancouver, B.C.

References: A. S. Wootton, J. R. Grant, W. H. Powell, W. G. Swan, T. V. Berry, J. B. Barclay.

SUTHERLAND—GORDON ALEXANDER, of 99 Home St., Winnipeg, Man., Born at Winnipeg, Oct. 31st, 1913; Educ., B.Sc. (E.E.), Univ. of Man., 1934; 1935-36, mech. dftsman., Fetherstonhaugh & Co., Patent Attorneys, Winnipeg; 1937 to date, designing engr., Kipp-Kelly Ltd., Engineers, Winnipeg, Man.

References: T. Kipp, H. L. Briggs, R. H. Andrews, E. P. Fetherstonhaugh, J. Hoogstraten, J. W. Sanger.

FOR TRANSFER FROM THE CLASS OF ASSOCIATE MEMBER TO THAT OF MEMBER

ARMSTRONG—ARNOLD VICTOR, of Toronto, Ont., Born at Montreal, Que., Oct. 9th, 1901; Educ., B.Sc. (E.E.), McGill Univ., 1923; 1919-22, summer work with Shaw. Water & Power Co., Riordon Pulp Mills, Montreal Tramways Company and Dominion Bridge Co. Ltd.; 1923-31, engr. in sales dept., English Electric Co. of Canada Ltd., St. Catharines, Ont. and Toronto, i/c of estimating dept., and of handling of elect'l. machy. jobs and contracts of all classes in the power apparatus field incl. generating plant, switchgear, transformers, motors and control, rly. equipment, steam and hydraulic turbines; 1932-34, illumination engr. with Northern Electric Co. Ltd., Toronto, i/c of illumination divn.; 1935-38, with same company as engr. in charge of power apparatus and special products divns. for Ontario, covering motors and control, switchgear, transformers, generating plant, condensers, rectifiers, etc., also municipal signal systems incl. fire alarm, police alarm systems, traffic signal systems, police radio, also broadcasting station equipment and public address systems; March 1938 to date, sales manager, Canadian Cutler-Hammer Ltd., engrg., designing, and manufacturing and applying electric control apparatus. (*St. 1920, Jr. 1929, A.M. 1936.*)

References: R. E. Smythe, F. J. Bell, A. G. Dalzell, S. Shupe, G. E. Sancton, C. V. Christie.

CRASE—GEORGE HOBART, of 440 Durie Street, Toronto, Ont., Born at Butte, Montana, Sept. 27th, 1892; Educ., B.C.E., Univ. of Mich., 1915; 1915-17, dftsman, Pittsburgh Des Moines Steel Co.; 1917-18, engr., 1918-24, contracting engr. and sales manager, Canadian Des Moines Steel Co., Chatham, Ont.; 1924-30, contracting engr., 1930-35, district manager, and 1935 to date, general sales manager, Horton Steel Works Ltd., Toronto, Ont. (*A.M. 1930.*)

References: W. R. Manock, W. Storrie, W. L. McFaul, H. G. Acres, T. H. Hogg, J. C. Keith.

DICKENS—HARRY BLUNDELL, of 20 The Grove, North Cray, Kent, England, Born at Nottingham, England, May 17th, 1892; Educ., I.C.S., Surveying, Mapping and Civil Engrg.; 1913-15, Amiri Tin Mine, Nigeria, West Africa; 1915-19, active service in the Cameroons and Nigeria; 1921, timber limit surveys in Nor. Ontario; 1922, dftsman., Underwriters' Survey Bureau, Toronto; 1923, instr'man., i/c survey dfting., Frank Barber and Associates Ltd., Toronto; 1924, instr'man., East York Township; 1925-28, Welland Ship Canal, i/c section dfting office, and employed as engr. for constrn. of breakwall and docks; 1928-29, surveyor on trans. line location in Sask.; 1929-30, chief engr., London, Ont., office, Dominion Reinforcing Steel Co. Ltd.; 1931-32, reinforced concrete designing engr., City of Hamilton; 1933, civil engr., John Lewis Partnership, London, England; 1934, designing engr., Johnson's R-C Engrg. Co., Westminster; 1935-36, chief designing engr., Twisteel Reinforcements, New Malden, Surrey; 1936-38, civil engr., Ebbw Vale Steel Works development, for Richard Thomas & Co., with H. A. Brassard & Co.; also civil engr., Karabuk iron and steel development, Turkey, for same company; Feb. 1938 to date, co-ordinating officer, design and constrn., for new filling factory, Glascoed, for the War Office. (*A.M. 1925*) (*R.P.E. of Ontario since 1927.*)

References: A. R. Hannaford, S. W. Archibald, J. R. Rostron, R. Henham, J. J. Murphy, W. M. Veitch.

MANNING—RALPH CLARK, of Toronto, Ont., Born at Hamilton, Ont., Aug. 15th, 1895; Educ., B.A.Sc., Univ. of Toronto. 1917; R.P.E. of Ont.; 1915-16-17 (summers), instr'man, Toronto-Hamilton highway, asst., D.L.S. party, Sask.; 1918-20, dftsman., Union Pacific R.R.; 1920-24, dftsman., checker, designer and estimator, Truscon Steel Co., Youngstown, Ohio; 1924-26, chief engr., Truscon Steel Co., Chicago, Ill.; 1926-30, sales engr., and designer, Jones and Laughlin Steel Corpn., Buffalo and Toronto; 1930 to date, engr. and manager, Canadian Institute of Steel Construction, Toronto, Ont. (*A.M. 1930.*)

References: A. H. Harkness, A. R. Robertson, E. A. H. Menges, G. L. Wallace, C. R Young.

MICHAUD—J. ARTHUR, of 254 St. Clair Ave. East, Toronto, Ont., Born at Rimouski, Que., July 31st, 1886; Educ., 1905-07, Univ. of Toronto; 1903-05 (summers), chainman, rodman, levelman, topog'r.. location surveys, Toronto and Niagara Power Co., and Toronto Niagara and Western Rly.; 1907-08, with Buffalo, Lockport and Rochester Rly., John Inglis Co., Toronto. Miller & Cummings, contractors, Toronto; 1909, joined staff of Dept. of Public Works of Ontario, dfting., making surveys, inspections, reoorts, specifications and estimates. Supervising constrn. of various public works, incl. bridges, roads, dams, docks, river improvement, drainage, water supplies and sewage disposal plants under chief engr. With same department to date, as asst. engr., and from 1925 to date, in responsible charge, designing and directing execution of public works. (*A.M. 1923.*)

References: J. L. Morris, A. E. Berry, J. M. Gibson, A. U. Sanderson, G. L. Wallace, A. Hay.

O'HALLORAN—JAMES, of Quebec, Que., Born at Montreal, Que., May 27th, 1900; Educ., B.Sc. (Mech.), McGill Univ., 1921; R.P.E. of Que.; 1918 (summer), Dom. Topog'l. Survey; 1929 (summer), and 1921-24, engrg. dept., Abitibi Power & Paper Co. Ltd.; 1924-27, gen. paper mill engrg. work, Price Bros. & Co. Ltd., Kenogami, Que.; 1927 to date, with the Anglo-Canadian Pulp and Paper Mills Ltd., Quebec, i/c of engrg. dept. and mech'l. dept., covering all constrn. and maintenance work done by the company. (*St. 1919, Jr. 1922, A.M. 1934.*)

References: A. A. MacDiarmid, C. M. McKergow, A. B. McEwen, F. S. B. Heward, K. S. LeBaron, G. F. Layne, E. Brown, L. B. Kingston.

RYBKA—KAREL RUDOLF, of Toronto, Ont., Born at Vienna, Austria, Jan. 28th, 1910; Educ., Mech. Engr., 1923, D.Sc., 1937, Technische Hochschule, Prague; R.P.E. of Que., R.P.E. of Ont.; 1924-28, various engrg. positions in Prague; 1928-32, with Walter J. Armstrong, M.E.I.C., Montreal, designing dftsman., on mech.'l. and elect'l. equipment for many large bldgs., incl., Royal York Hotel, Toronto, Dominion Square Bldg., Montreal, T. Eaton College St. Store, Maple Leaf Gardens, Toronto; 1932-34, private practice in Montreal, designing mech'l. and elect'l. equipment for bldgs., consltg. and reporting; 1934, first asst. and design engr. at Montreal, and from Jan. 1935 to date, i/c of office at Toronto for Walter J. Armtrong, M.E.I.C., Consltg. Engr., i/c design and supervision of work in Ontario, designed and supervised mech. work for many large buildings in Toronto and outside. (*A.M. 1931.*)

References: W. J. Armstrong, C D. Carruthers, C. R. Redfern, G. L. Wallace, S. W. Hall, E. A. Cross.

WHITAKER—ALBERT WILLIAM, Jr., of Arvida, Que. Born at Philadelphia, Pa., April 4th, 1892; Educ., B.S. in Chem. Engrg., Univ. of Penn., 1913. Granted degree of Chem. Engr. in 1930; With Aluminum Co. of America as follows: 1913-15, ap'tce chem. engr., 1916-17, design and constrn. engr. in special (nitride) research; 1917-18, i/c mech'l. and elect'l. mtce., and 1918 (July-Oct.), supt., Niagara No. 1 Works; 1918-26, supt. of carbon electrode plant, Massena Works; With the Aluminum Co. of Canada Ltd., at Arvida, Que., as follows: 1926-28, supt., carbon electrode plant, 1928-30, supt., dry ore plant, 1930 to date, gen. supt., from 1935, complete responsibility for design and constrn. of new "Bayer" ore plant and large extension to Aluminum Plant capacity. (*A.M. 1931.*)

References: S. J. Fisher, E. P. Muntz, H. R. Wake, A. I. Cunningham, R. S. Eadie, N. D. Paine, N. F. McCaghey.

FOR TRANSFER FROM THE CLASS OF JUNIOR

BAIN—ARCHIBALD MARCUS, of Montreal, Que., Born at Rounthwaite, Man., Nov. 15th, 1901; Educ., B.Sc., Univ. of Man., 1928. M.Sc., McGill Univ., 1929; 1924-26 (summers), recorder and observer, Geod. Survey of Canada; 1927-28, engr. i/c location party, Manitoba Good Roads Board (summers); 1929 to date, struct'l. designer, Dominion Bridge Co. Ltd., Lachine, Que. (*St. 1926, Jr. 1930.*)

References: F. P Shearwood, R. E. Jamieson, R. S. Eadie, F. Newell, D. C. Tennant, D. B. Armstrong.

LeBOUTILLIER—WILLIAM PERCY CECIL, of Kenogami, Que., Born at Quebec, Quebec, June 19th, 1904; Educ., B.Sc. (Civil), McGill Univ., 1927. Grad. R.M.C., 1926; 1927-28, student engr., and 1928-29, asst. district engr. and bldgs. cable engr., Bell Telephone Co. of Canada, Montreal; 1929 to date, with Price Bros. & Co. Ltd., Kenogami, Que., 1929-31, asst. to the engr. i/c operating records at Kenogami paper mills, 1931-37, i/c of this dept., responsible for compilation of records of all mill operations; computation of steam power; block pile surveys, design of charts and graphs on mill operations, costs, etc., for management control; 1937 to date, asst. groundwood supt., responsible under the supt. for the manufacture of 450 to 500 tons per day of mech'l. pulp for use on newsprint and cardboard machines. (*Jr. 1929.*)

References: A. B. Sinclair, J. Shanly, N. D. Paine, W. J. Gathercole, G. F. Layne.

FOR TRANSFER FROM THE CLASS OF STUDENT

ARCHER—MAURICE G., of 195 St. Cyrille St., Quebec, Que., Born at Quebec, Oct. 4th, 1910; Educ., B.Eng. (Civil), McGill Univ., 1933; R.P.E. of Que.; 1933 (4 mos.), Dept. of Highways, Quebec; 1934-36, designer and supervisor, Z. Langlais, C.E.; 1936 to date, designer and supt., Archer & Dufresne, Consltg. Engrs., Quebec, Que. (*St. 1933.*)

References: J. St. Jacques, R. Dupuis, A. Lariviere, R. Sauvage, A. R. Decary.

BARNHOUSE—FRANK WILLIAM, of 77 Burnaby Blvd., Toronto, Ont., Born at Edmonton, Alta., May 19th, 1909; Educ., B.Sc. (E.E.), Univ. of Alta., 1934; 1927-29, summer work with Fred Davies, elect'l. contractor, Edmonton; 1930-31, constrn. work, Calgary Power Company; 1932-33, i/c installn. electric equipment of Diesel electric plant and gold dredge for McLeod River Mining Corpn.; 1933-34, operating Diesel electric plant for same co.; 1934-35, test course, 1935-36, student engr., and 1936 to date, wire and cable sales engr., Can. Gen. Elec. Co Ltd., Toronto, Ont. (*St. 1933.*)

References: C. E. Sisson, E. C. Williams, H. J. MacLeod, W. M. Cruthers, R. S. L. Wilson.

BOOTH—KEITH ALEXANDER, of Kenogami, Que., Born at Austin, Man., June 15th, 1907; Educ., B.Sc. (E.E.), Univ. of Man., 1934. B.Eng. (Mech.), McGill Univ., 1936; 1929 (summer), dfting., H.E.P.C. of Ontario, Belleville; 1936-37, asst. to engr. i/c records office, and 1937 to date, engr. i/c records office, Price Bros. & Co. Ltd., Kenogami, Que. (*St. 1936.*)

References: N. D. Paine, J. Shanly, A. B. Sinclair, A. Cunningham, W. P. C. LeBoutillier, A. A. MacDiarmid, H. Cimon.

CROTHERS—DONALD COVERDALE, of 950 Richards St., Vancouver, B.C., Born at Ottawa, Ont. Oct. 17th, 1910; Educ., B.Sc. (Mech.), Queen's Univ., 1937; 1928 (summer), shop work, Canadian Locomotive Co., Kingston, Ont.; 1934 (summer), mill operator, McIntyre Porcupine Mines; 1935-36 (summers), shop work, and 1937 to date, sales engr., Canadian Ingersoll Rand Co., Vancouver, B.C. (*St. 1935.*)

References: L. M. Arkley, L. T. Rutledge, D. S. Ellis, L. F. Grant, E. Winslow-Spragge, S. R. Newton.

HAMILTON—WILLIAM GARRISON, of Chester Basin, N.S., Born at Pictou, N.S., Feb. 28th, 1911; Educ., B.Eng. (Mining), N.S. Tech. Coll., 1935; 1935-36, asst. mining engr., Canadian Johns-Manville Co. Ltd., Asbestos, Que.; 1936-37, assayer and sampler, Tashota Goldfields Ltd., Tashota, Ont.; June 1937 to date, mill supt. and chief assayer, mine apprentice project, Lacey Gold Mine, Chester Basin, N.S. (*St. 1930.*)

References: W. P. Copp, S. Ball, H. R. Theakston, G. H. Burchill, I. P. MacNab.

INNES—EDWARD PATRICK NELLES, of 80 Robinson St., Hamilton, Ont., Born at Simcoe, Ont., July 2nd, 1910; Educ., B.Eng., McGill Univ., 1934. R.P.E. of Ont.; 1926-29 and 1931-33 (summers), mechanic and dftsman., Canadian Canners Ltd., and Canners Machinery Ltd.; 1930 (summer), Meteorological Service of Canada; 1934 (summer), dftsman., designer, Canadian Machinery; 1934-35, National Research Council oil burner laboratory; 1934 to date, with Canadian Canners Ltd., Hamilton, Ont., engaged in gen. industrial engrg. work, incl. plant layout, steam plant erection and mtce., fuel cost analysis, testing and repairs of instruments and process control apparatus, elect'l. costs, constrn., set up of food industry process equipment, at present i/c of engrg. dept. (*St. 1935.*)

References: E. Brown, C. M. McKergow, R. W. Boyle, J. H. Parkin, B. F. Haanel, R. E. Jamieson, R. DeL. French.

PRESTON—WILLIAM WALFORD, of 25 Walnut St. North, Hamilton, Ont., Born at Hamilton, Oct. 29th, 1910; Educ., B.Sc. (Civil), Queen's Univ., 1935; 1934-35 (summers), gen. asst. to county engr., and summer 1936, asst. to county engr., H. A. Lumsden M.E.I.C.; 1935 (winter), asst. surveyor, instrument and tape work for excavations; 1936 to date, struct'l. steel detailer, Hamilton Bridge Company, Hamilton, Ont. (*St. 1935.*)

References: R. E. Butt, A. R. Hannaford, A Love, H. A. Lumsden, F. L. Smith, H. B. Stuart.

ST. JACQUES—GUSTAVE FERNAND, of 425 St. Joseph Bld. West, Montreal, Que., Born at Montreal, April 4th, 1911; Educ., B.A.Sc., C.E., Ecole Polytechnique, Montreal, 1936; 1934-35 (summers), Federal Public Works; 1936 (6 mos), Brown Corporation Paper Co.; 1936-37 (5 mos), with the Consolidated Paper Co., Three Rivers; With the Consolidated Paper Corpn. Ltd., Port Alfred, Que., 12 mos. as asst to chief engr. on municipal works, and at present asst. engr. (*St. 1935.*)

References: C. H. Jette, A. Frigon.

THOMAS—JAMES LESLIE, of 1445 McGill College Ave., Montreal, Que., Born at Ottawa, Ont., Dec. 23rd, 1904; Educ., B.Sc. (Mech.), Queen's Univ., 1930; 1930 (May-July), efficiency engr., Dominion Rubber Co.; 1930 (July-Nov.), concrete inspr., Chats Falls Development Board; 1930-32, sales engr., Canadian Blower & Forge Co. Ltd., and Canada Pumps Ltd., Montreal, and 1933-35, i/c of Ottawa office of same company; 1935 (July-Dec.), designing engr., Simmons & Hawker Ltd., London, England; 1935-37, designing engr., The Distillers Co., London, England; 1937-38, hydarulic engr., John Stadler M.E.I.C., Montreal, Que. (*St. 1928.*)

References: K. O. Elderkin, E. A. Ryan, J. Stadler.

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HARDING—CHARLES PERCY, of 69a St. Germain Blvd., St. Laurent, Que., Born at Edinburgh, Scotland, Jan., 12th, 1884; Educ., Scottish Technical Schools; British B.O.T. 1st Class Marine Cert.; 1901-07, ap'ticeship, Bow McLachlan & Co., Paisley, Scotland; 1907-12, marine engr., Wm. Burrell & Sons, Glasgow, Scotland; 1913, Canada Iron Corpn., Midland, Ont., investigating and reporting on fuel conditions of blast furnaces; 1913-15, constrn. then res. engr., paymaster and supt. of constrn., Liquid Air Company, Toronto; 1916, designer of power plant, Can. Electro Products, for Shaw. Water & Power Co.; 1916-18, designing engr. on marine work, Canadian Vickers, Montreal; 1919, engr., supervising conversion of lake steamers for deep sea service and designing engr. of C.N.R. Steamships shipyards, N. E. McClelland & Co. Montreal; 1920-25, various engagements of short duration; 1925-26, chief engr., tank steamer, Imperial Oil Limited; 1926-28, designing engr., steam lines, crane and development of patented machines for Lake St. John Pulp and Paper Co., for John Stadler, M.E.I.C.; 1928-29, designer and consultant with C.P.R., central steam heating plant for Toronto Terminals Rly. Co.; 1929-30, designer of special appliances and processing schemes, Dominion Rubber Company; 1930-31, designing engr. on steam, exhaust and piping arrangements and water cooling in connection with two Foster Wheeler boilers for Monterey Light & Power Company, Mexico, for Montreal Engineering Company; 1931-36, sales agency work on own account; 1936, design of extension to boiler house and brine lines installn., Canadian Celanese Ltd., Drummondville; 1936-37, Babcock-Wilcox Co., Galt, Ont., on design of ash sluicing system and dust handling system for N.S. Steel & Coal Corpn.; 1937 to Feb. 1938, design of Lake Sulphite Pulp Co. boiler house layout, mill steam lines, and pumping arrangement, for John Stadler, M.E.I.C., Montreal. (*Affiliate 1925.*)

References: F. A. Combe, E. A. Ryan, F. S. B. Heward, J. T. Farmer, R. W. Mitchell, J. Stadler.

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Sewage Disposal

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SUMMARY.—This paper deals with principles and processes rather than equipment and describes five common types of treatment used in various plants, as well as some of the patented processes. The disposal of sludge by incineration and digestion, and the pollutions of streams is also given considerable attention.

In the Province of Quebec very little is done in the way of sewage treatment. The town of Noranda is the only municipality with a plant capable of a high degree of purification. Apart from Noranda, a few institutions and eight or ten small towns partially treat their sewage. All told less than two per cent of the sewage discharged from municipal systems in this province is given any treatment at all.

The reason Quebec has less artificial agencies (sewage treatment plants) than some other Canadian provinces and most American states, is because this province has more abundant natural agencies for purifying sewage in close proximity to its larger centres of population. In other words, most of the cities are situated on the St. Lawrence and its larger tributaries.

It would appear appropriate therefore in a paper of this kind before the Montreal Branch to discuss rather fully the principles on which sewage treatment practice is based and the purification it is practicable to achieve, rather than enter into a detailed description of the equipment, and of the capital and operating costs of the various types of sewage treatment plants. Those desiring such particulars are referred to a paper read before the Montreal Branch about three years ago by Edmund B. Besselievre and published in the January 1935 issue of The Engineering Journal. This concise and comprehensive paper bears the title "Modern Sewage Treatment Practice" and is well worth reading. To keep in line with Besselievre, gallons referred to herein mean U.S. gallons. His figure of 100 gal. per capita per day will be taken as the average dry weather sewage flow. As a matter of fact it is a commonly accepted figure.

Sewage teems with bacteria. George W. Fuller in "Sewage Disposal" writes, "In 1894 the author computed from his studies of Massachusetts sewages that on an average, city sewage contains some 320 billions of bacteria to each person connected with the sewer system." It is the daily number that is referred to. Fortunately most of these bacteria are harmless or useful, but as the discharges of human beings account for a lot of them, the germs of intestinal diseases such as typhoid and dysentery may be present. The removal or destruction of bacteria is therefore one of the reasons why sewage is treated and from the hygienic point of view it is the most important reason. Another reason for treating sewage is that it always contains organic matter, which being a bacterial food constitutes a rich culture medium for more bacteria, hence its decomposition by bacteria is capable of creating a nuisance. Although there is comparatively little of this organic matter, less than a pound of it in a ton of sewage, it is the main factor nevertheless, in the capital costs, operating costs, and difficulties of sewage treatment.

Sewage varies greatly in its composition not only between different towns but from hour to hour in the same town. The dry weight of the suspended solids in say 1,000,000 gal. of sewage from one town may average almost twice that in another. Moreover different sewages do not react alike to similar treatment. For instance the percentage removal of suspended solids by a fine screen or a sedimentation tank under the same load conditions may average 50 per cent or more higher in some plants than it does in others. The same is true of the day to day results in the same plant. Usually the reason for such disparities is more or less obvious, but it quite often remains obscure even when one knows, or rather thinks he knows all the facts. Repeated qualifications are so tiresome and confusing that it is proposed to sacrifice accuracy to clarity in this paper, by dispensing with a recital of exceptions to statements concerning designs, efficiencies, quantities and costs. In short, practically all figures are averages. For instance where later on it is stated that two hours settling will remove from sewage 50 per cent of its suspended solids, it would be closer to the truth to say from 30 to 60 per cent depending upon the character of the sewage. For the same reason all living organisms found in sewage or which have anything to do with its purification are called "bacteria" irrespective of their type, or whether belonging to the lower orders of plants or animals.

The average quantity of sewage discharged in a day from a sewerage system serving 10,000 people will at 100 gal. per capita amount to 1,000,000 gal. If the sewage is allowed to remain practically quiescent in a tank some of the solids it contains will settle to the bottom. The most of them which can be separated from the sewage in this way will settle after two hours' detention. This deposit will be called herein the "settleable solids" and for 1,000,000 gal. of sewage amounts to about 1,000 lb. dry weight.

If it were practicable to pass the 1,000,000 gal. of settled sewage through a laboratory filter, another 1,000 lb. dry weight of solids would be removed from it. These solids were too finely divided to settle and are appropriately referred to as the "non-settleable solids." The ton of solids, that is to say, the combined weight of the settleable and non-settleable solids, constitute what is known as the "suspended solids" and in spite of their complete removal the filtered sewage is not clear, it is still a cloudy liquid.

The cloudiness is caused by the "colloids," that is to say, semi-solid matter which passes with the liquid even through a laboratory filter. In practice usually the non-settleable solids and the true colloids are removed from the sewage by the same treatment, and as there is not a great deal of difference between them except perhaps to technicians, "colloids" from now on will be considered herein to include both non-settleables and true colloids.

Although the preceding definitions of both settleable solids and colloids are not strictly correct nothing that really matters is misrepresented thereby. The points worth remembering are, that 1,000 lb. of solids, at least two-thirds of which are potentially offensive, can be removed from 1,000,000 gal. of sewage simply by two hours' sedimentation. Also that the colloids cannot be removed to any useful extent even by prolonged sedimentation. Moreover they amount to 1,000 lb. in 1,000,000 gal. of sewage, and not only make it cloudy but are, if anything, more offensive than the settleable solids.

Dead organic matter whether originating in toilets, kitchens, laundries, abattoirs or elsewhere is capable of creating a nuisance from offensive odours, but as everybody knows can be rendered inoffensive by burning. This idea is as old as the hills. It was an injunction of Moses, that unclean matters were to be carried outside the camp and burnt. When organic matter is burned all that happens to it is that it combines with the oxygen of the air.

Since organic matter is rendered inoffensive by oxidization it is logical to infer that its affinity for oxygen is a measure of its potentiality for creating a nuisance. In sewage treatment practice technicians determine the five day, rather than the total, oxygen demand of a sample of sewage or plant effluent and call it the "Bio-chemical Oxygen Demand" of the sample, commonly expressed by the abbreviation B.O.D. It is synonymous with pollution. Some of the B.O.D. is due to the solids and some to the liquid. For an easily remembered distribution the following statement may be taken as substantially but not strictly true, viz. one third of the B.O.D. of sewage is contained in the settleable solids, one third in the colloids, and the remaining third in the liquid. Probably one would not be so far out to take the same distribution for the bacterial content of sewage.

Bacteria are not peculiar to sewage, but are widely distributed in the air, soil and surface waters, ready to seize upon and render organic wastes inoffensive. By bacterial action organic matter is oxidized at quite ordinary temperatures without the evaporation of its moisture as must be done before it can be burned. In fact, moisture is necessary to the activities of the bacteria. The so called aerobic bacteria will convert organic wastes into inoffensive forms by oxidization, without any nuisance whatever, provided the conversion takes place in the presence of air, or to be more exact in intimate contact with oxygen. If free oxygen or air becomes exhausted, the anaerobic bacteria take over the job. These bacteria derive the oxygen for their own needs from the organic matter itself and in time convert it into a sort of humus which although not completely oxidized is inoffensive. However while this is going on very objectionable gases and odours may be released. Anybody who has broken a rotten egg has become acquainted with that form of anaerobic decomposition called putrefaction. Only an insignificant part of the ceaseless supply of organic wastes the world over is converted into an inert and inoffensive form by incineration. It is the bacteria which accomplish this herculean task, and although it is true that disease germs can cause pestilence and death, the useful bacteria really keep the world fit for life. These myriads of tireless workers constitute therefore a great economic asset. Probably there is no country in the world which could afford to trade its bacteria (disease germs excluded) for Canada's gold mines.

Expressions herein to the effect that sewage solids, or the liquid, or sewage as a whole, or other organic wastes of any kind have been "stabilized" or rendered "stable," mean that these potentially offensive matters have been so changed by oxidization or otherwise that they will no longer create a nuisance.

One or more of three yardsticks are commonly used as a measure of the efficiency of sewage treatment processes, viz. the percentage removal of suspended solids, B.O.D. and bacteria. As will be explained, sewage treatment renders sewage unobjectionable in the aesthetic sense by removing or transforming the polluting matters in it, and from the hygienic point of view by removing or killing the bacteria it contains. In this connection it must be noted that the efficiency of sewage treatment plants will be expressed in terms of *removals* only, irrespective of whether the purification is effected by the removal, transformation, or destruction of the objectionable contents of the sewage. Moreover whenever the weight of solids is mentioned herein, it means their dry weight unless otherwise plainly implied by the context.

It is now proposed to describe in the inverse order of the degree of purification effected, five fairly common types of sewage treatment plants, viz. "fine screening," "plain sedimentation," "chemical precipitation," "trickling filters" and "activated sludge." To give some idea of the actual and relative weights of the solids removed, it is assumed that the plants described serve 10,000 people, that is to say, have a capacity for treating on the average 1,000,000 gal. per day.

These five treatments remove or reduce by somewhat different methods some of the solids, B.O.D. and bacteria contained in the crude sewage. The means by which the solids which have been removed from the sewage are disposed of in a stable form are common to all except perhaps fine screening plants, the solids removed by which are called "screenings" and by the other four plants "sludge." Where bacterial removal is of prime importance all of the treatments except perhaps "activated sludge" must be supplemented by sterilization with chlorine to reduce the bacterial content of the plant effluents to a reasonable count. Taking Fuller's estimate already referred to, there would be 2,000,000 bacteria in a glass of the effluent from a plant with a bacterial efficiency of 99 per cent although possibly but not probably without a single disease germ amongst them. Therefore in describing the plants their efficiencies will be compared, in the first instance, with respect to the removal of suspended solids and B.O.D. only, deferring for the time being a discussion of bacterial removals and sludge disposal.

Irrespective of the type of plant, pre-treatment devices are practically always provided in the form of bar screens to remove the larger solids, and grit chambers or detritors to remove the grit. Detritor tanks are comparatively small affairs providing for a detention therein of only a minute or so, because the bulk of the grit settles out readily at a velocity of flow through the tank of about one half to one foot per second. Of course both the large solids and the grit could be removed in a sedimentation tank along with the settleable solids and skimmings but it is obviously better to get rid of them in advance of the piping valves pumps, etc., in the main plant.

Some recent installations install a so called comminutor instead of a bar screen to comminute the coarser solids without removing them from the sewage thereby rendering some of the larger floating solids settleable by liberation of their buoyant gases. In other plants a so called shredder is provided to comminute the coarse screenings removed from the sewage by a bar screen. The shredded solids are returned to the crude sewage or otherwise disposed of. In many plants a so called grease separator is provided immediately preceding the primary settling tank, in the form of a tank equipped with compressed air diffusors. The tank is comparatively small, providing for a detention of about five minutes only, and it is stated that the air used amounts to from 0.10 to 0.20 cu. ft. per gal. of sewage.

In most fine screening plants the sewage is passed through a slotted plate in the form of either a revolving drum or a revolving disc. The slots are usually 2 in. long and anywhere from 3/64 to 1/8 in. wide. Screening plants remove from 5 to 15 per cent of the suspended solids.

In a plain sedimentation plant the sewage is passed slowly through a tank providing two hours nominal detention. That is to say, the volume of the tank is equal to the average quantity of sewage passing through it in two hours. A plain sedimentation plant removes 33 per cent of the B.O.D. and 50 per cent of the suspended solids amounting to 1,000 lb. per 1,000,000 gal. treated.

Fig. 1—Circular Sedimentation Tanks Equipped With Up-flow Magnetite Filters.

Sewage enters tank at centre and flows radially under baffle and up through filter. Note solenoid washer suspended from rotating arm.

Though vastly improved in appearance the settled sewage is still quite cloudy because of the colloids in it, and unless promptly and adequately diluted, may in a matter of hours, rather than days, become a nuisance.

If a clear effluent together with better removal of both suspended solids and B.O.D. is desired, it can be obtained by dosing the sewage before it enters the settling tank with a coagulant, usually lime and some iron compound such as ferric chloride. The special field of usefulness of such chemicals in sewage treatment is to render the colloids settleable. About 80 per cent of the suspended solids, amounting to 1,600 lb. per 1,000,000 gal. treated, will be removed in the sedimentation tank together with about 900 lb. of solids due to the chemicals, and in addition with some sewages a substantial weight of solids in solution may be precipitated.

Chemical precipitation, as this treatment is called, will produce an effluent of very satisfactory appearance because enough of the colloids have been flocculated and settled out to remove most of the cloudiness. However this treatment does not help much towards the removal of the organic solids in true solution. Consequently the B.O.D. of the crude sewage is reduced only 65 per cent or so.

Apart from chemical storage and chemical feeding facilities and the enlarged capacity of sludge disposal equipment, the additions to the plant structures involved in the conversion of a plain sedimentation plant into a chemical precipitation plant would be limited to the provision of a mixing and flocculating tank ahead of the settling tank, with compressed air facilities or mechanical stirrers. Their combined capacity is equivalent to about one quarter that of the settling tank. For the results obtained the capital cost of a chemical precipitation plant is relatively low, but operating costs are another story. At current prices in the Montreal district, the chemicals required to treat 1,000,000 gal. of sewage for 80 per cent removal of suspended solids might amount to about $10.

Chemical precipitation plants permit of great flexibility in respect to the degree of purification accomplished, ranging practically all the way from a settled effluent (no chemicals) to the effluent resulting from what might be called maximum chemical dosage with 90 per cent suspended solids, and 75 per cent or more B.O.D. removed. Slightly lower figures, 80 per cent and 65 per cent are taken, because often enough these removals approximate the economic limits of the process as a continuous treatment. It is well to bear in mind however that unless the characteristics of the sewage are known in advance, prophecies with respect to operating efficiencies and costs may be wide of the mark with any treatment, but particularly so in the case of chemical precipitation.

If still better purification is required, that is to say if it is desired to carry the attack against the liquid sewage itself, the sanitary engineer takes a lesson from nature and turns to bacteria to help him out. Given a sufficiency of air (oxygen) and of the proper kind of bacteria and surroundings where they can thrive, these organisms can be relied upon in large measure to oxidize or otherwise stabilize the pollution in solution and at the same time convert the colloids into settleable solids just as chemical precipitation does.

Obviously an oxidization process is not such a simple treatment as plain settling. The plants cost much more to build, and are more troublesome and costly to operate and more likely to be a nuisance. There are three kinds of these oxidization plants, which in the order of their development are "contact beds," "trickling filters" and "activated sludge" plants. As trickling filters and activated sludge plants have in large measure superseded contact beds in modern practice on this continent, a description of the contact beds will be omitted.

In a trickling filter plant the primary tank effluent, that is to say the effluent from a plain sedimentation plant, is distributed as uniformly as practicable over a bed of gravel or broken stone from five feet to ten feet deep. Six feet to eight feet is the common range. It is better practice to place the filter medium in a tank with tight walls so that if found expedient the beds can be temporarily flooded to help control the fly nuisance to which trickling filters are at times subject. In operation the sewage has a free discharge from the bottom of the bed. Consequently there is a loss of head involved equal to the depth of the bed plus the head required to distribute the sewage over it. The latter varies according to the method of distribution. For plants of moderate capacity anyway the revolving distributor is at least as good as any and for it 18 in. is sufficient.

The stone in the filter becomes coated with organic matter teeming with bacteria over which the sewage passes in thin films on its descent through the bed. As there is a free circulation of air the stage is set for natural purification. Consequently a good deal of the pollution in solution is oxidized and about 20 per cent of the suspended solids applied to the bed, i.e. 200 lb. per 1,000,000 gal., are gasified or liquefied. Although the bed is too coarse to act as a strainer, the treatment tends to render the colloids settleable. The effluent from a trickling filter is therefore settled in a final sedimentation tank or humus tank, as it is commonly called, for one hour or more. About 85 per cent of both the suspended solids (1,700 lb. per 1,000,000 gal. treated) and B.O.D. are removed overall, and the final effluent though somewhat cloudy is quite stable. It will be noted that sewage sprayed on to the surface of the bed containing all its original colloids and two-thirds of its original B.O.D. will be collected at the bottom after five minutes or so with scarcely one-fifth of its B.O.D. remaining and with its colloids so largely converted into settleables, that a reasonably clear final effluent issues from the humus tank. This great improvement is effected by bacteria, one might say almost in the twinkling of an eye, a conspicuous example of many hands making light work.

It entails very considerable additions to the structures in a plain sedimentation plant to make a trickling filter plant out of it. Half an acre will be required to filter 1,000,000 gal. per day and roughly speaking, the volume of the filter tank plus the humus tank is about 15 times the volume of the plain sedimentation tank, but their combined surface area is about 24 times as great, because the settling tanks are nearly twice as deep as the filter. Moreover between 5,000 and 6,000 cu. yd. of broken stone are required for the filter bed besides the distributors and underdrains.

In activated sludge plants even better results are achieved by a system which differs more in form perhaps than in principle from trickling filters. The settled sewage is passed through a tank providing five or six hours detention where it is aerated, and the effect of the treatment is not only to oxidize much of the pollution in true solution, but it also renders the colloids settleable, by flocculating them into clusters. The most of this floc is removed when the effluent from the aeration tank is subjected to two or three hours settling in a final sedimentation tank. Some of the sludge from this tank is re-circulated through the aeration tank, the quantity amounting to from 20 to 25 per cent of the sewage flow. Because of the re-circulated sludge the sewage in the aeration tank contains a heavy load of flocculated solids, amounting to 10 tons or more dry weight per 1,000,000 gal.

The air is blown into the sewage in fine bubbles from diffusers placed at or near the bottom of the tank. In their escape to the surface the bubbles keep the floc in suspension and in constant motion, thereby sweeping, or in a sense, filtering out of the sewage bacteria and finely divided solid impurities, which become incorporated in the spongy floc particles. Consequently with an abundant supply of air (oxygen) the floc becomes rich in oxidizing bacteria, in other words becomes so called activated sludge. In essentials the conditions are quite similar to the conditions prevailing in a trickling filter. That is to say, the sewage is brought into intimate contact with myriads of bacteria thriving in an environment much to their liking, with its abundance of oxygen, water and food in the form of organic matter, the "fat of the land" to them. Naturally the return to the aeration tank of a voluminous portion of this floc, as a dilute sludge, accelerates the purification of the effluent from the primary settling tank constantly flowing into the aeration tank.

Both the volume and the area of the aeration tank plus the final sedimentation tank, are roughly five times that of the primary sedimentation tank. Therefore in converting a plain sedimentation plant into an activated sludge plant very considerable expenditures are required, not only for the additional structures but also for the air compressor equipment and for the piping and diffusors in the aeration tank. This treatment when it is working well, will approach closer to perfect purification with respect to bacterial, B.O.D. or suspended solids removal, than any other purely artificial treatment. The solids removed from a 1,000,000 gal. of sewage amount to at least 1,800 lb.

The efficiency of the various plants is summarized in Table I.

Table I

Plant	Percentage Removals of		
	Sus. Solids	B.O.D.	Bacteria
Fine screens (2 in. by $\frac{1}{16}$ in. slots)	10		10
Plain sedimentation	50	33	40
Chemical precipitation	80	65	65
Trickling filters	85	85	80
Activated sludge	90	90	97

The relative efficiency of the oxidization processes as indicated by round numbers in Table I is somewhat low for the activated sludge treatment. However, as nitrification is effected to a greater degree in trickling filters, the B.O.D. removal is not perhaps a fair criterion of the purification accomplished by this treatment, if one considers that nitrates may be useful as a sort of standby at critical junctures when the oxygen content of the stream receiving the effluent approaches depletion.

The average bacterial removals as listed in Table I are, it will be noted, rather low for all the plants except activated sludge. Moreover the percentage removals are subject to wide variations, particularly in the less efficient plants. Consequently where the bacterial efficiency of the treatment is important, as it may be to protect water supplies or bathing beaches, all but one or two per cent of the disease germs surviving the treatment process are killed by the application of a sterilizing agent. As chlorine is the agent commonly used, it alone will be considered herein. Wherever chlorination is adopted for other purposes in sewage treatment it always effects at least partial sterilization. The additional capital cost entailed in providing a chlorination plant is comparatively moderate. The equipment for feeding the chlorine requires very little floor space. After the application of chlorine to the effluent it must be detained in a tank or an outfall pipe or both from 5 to 15 min. before its discharge into the receiving body of water, but effluent storage can be dispensed with where pre-chlorination is practised. Since chlorine incidentally is an oxidizing as well as a sterilizing agent, chlorination permanently reduces the B.O.D. of the effluent to a real but variable degree and appreciably arrests decomposition, so as to place the effluents of practically every treatment process more nearly on a par with respect to demand for oxygen at and immediately below the point of discharge. As will be explained this may under certain circumstances be of great practical and economic importance in sewage treatment.

In the following tabulation (Table II) the performance is shown of the five treatment plants under discussion, when supplemented by chlorination. S.S. = suspended solids. Chlorine per M.G. = the chlorine required to effectively sterilize 1,000,000 gal. of the effluent from plants treating fairly fresh sewage.

Table II

Plant	Removals of		
	S.S.	B.O.D.	Chlorine per M.G.
Screens	10 per cent		120 lbs.
Plain sedimentation	50 "	50 per cent	85 "
Chemical precipitation	80 "	75 "	55 "
Trickling filters	85 "	90 "	35 "
Activated sludge	90 "	95 "	20 "

If the crude sewage is stale or becoming septic when it arrives at the plant, the chlorine required to sterlize the effluent from a screening plant or plain sedimentation plant will be considerably more than shown in Table II. For uniformly high removals it is particularly important in the case of these two plants to apply enough chlorine to leave a residual of two or three pounds in 1,000,000 gal. after 15 min. contact. On the other hand it should be remembered that a lot of chlorine can be saved, if one is content to tolerate somewhat less than 98 or 99 per cent bacterial removal, which requires complete satisfaction of the chlorine demand of the effluent to leave a residual.

In 1931 Dearborn, Michigan, installed a sewage treatment plant in which the effluent from a settling tank was filtered through a bed of magnetite sand three inches deep cleaned by a solenoid washer. While not constituting a complete treatment in itself, this patented device developed by Laughlin of New York, worked without trouble from the start, and is now installed in eleven plants with a combined capacity of 275,000,000 g.p.d. Its function is to supplement sedimentation by removing some of the colloids and rendering them settleable. Its adaptability as an aid to established sewage treatment processes, is indicated by the fact that of the eleven installations, eight are incorporated in plain sedimentation and chemical precipitation plants, three in trickling filters, and one in an activated sludge plant. The effective size of the filter medium in these installations ranges from about 0.60 mm. to 1.0 mm. and the rated capacity of the filters from 2 to 3 g.p.m. per sq. ft.

Apart from Owen's published accounts of the operation of the Dearborn plant, the only records of magnetite filters to which the author has had access, were from more or less experimental installations furnished by the company controlling this equipment. The largest installation in the Minneapolis-St. Paul plant is just nearing completion, and the Denver plant has been placed in service only recently. However from the data to hand the indications are that magnetite filters improve the efficiency of a plain sedimentation plant in removing suspended solids as shown in the following table.

Table III

Removals of Suspended Solids by

Plain Sedimentation	Plain Sedimentation + Magnetite Filters
30 per cent	55 per cent
40 "	63 "
50 "	70 "
60 "	75 "

It will be noted that when the tank has an off day, the filters do more than usual. In fact all of the records so far examined show that the use of magnetite filters with any kind of pre-treatment, results in a more uniform, as well as a better effluent.

When magnetite filters are incorporated in chemical precipitation plants less chemicals are required. It would appear that usually the saving in the cost of chemicals due to the filters would amount to from one half to one third for 90 per cent removal of suspended solids and from one half to two thirds for 80 per cent removal. Moreover the quantity of chlorine required to sterilize the effluent from any kind of plant would probably be reduced by 25 per cent or more if the effluent were filtered. The author wishes to make it clear that all these figures relating to magnetite filters are merely his own approximations based on fragmentary records.

A competitive type of filter has recently been installed in four small chemical precipitation plants in New Jersey with a combined capacity of about 5,000,000 g.p.d.

For reasons stated near the beginning of this paper the preceding description of five different types of plants is confined to what might be called conventional designs, suitable for treating sewage without any unusual characteristics emanating from industrial wastes or other sources. Moreover, the tabulated efficiencies of these purification processes indicate only a reasonable expectancy. Actual performances may be better or worse. It is to be noted also that of the two main reasons for treating sewage, it is the removal of suspended solids and B.O.D., that is to say, of pollution, rather than the removal of bacteria, which calls for the more expensive and more complicated

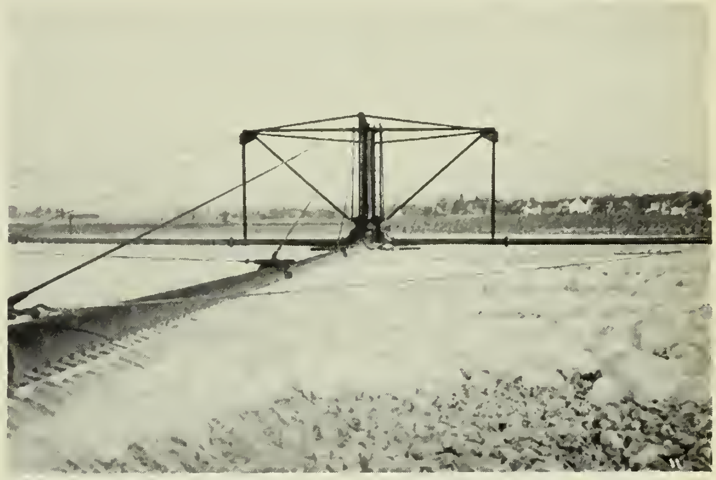

Fig. 2—Trickling Filter Equipped With Hankin Revolving Distributor.

Photo shows bed starting to clear itself of snow after shut down in winter.

plant, because by chlorination of the effluent even the simplest and cheapest kind of a plant can compete fairly well with the best available in so far as bacterial removal is concerned.

Plants handling heavy loads of abattoir, brewery, canning and such wastes sometimes bear little resemblance to any which have been described. A single installation may embody in its design fine screening, chemical coagulation, aeration and treatment by trickling filters. On the other hand some of the steps in the process can be wholly or partially dispensed with, in plants treating a relatively weak sewage. For instance, in a few activated sludge plants, including one of the earliest and largest on this continent, there is no primary settling at all. The effluent from the grit chambers or detritors is passed through fine screens, and thence directly to the aeration tanks. Moreover, in some recent activated sludge plants, and very large ones at that, there is neither fine screening nor sedimentation in the ordinary sense ahead of the aeration tanks. The detention in the primary settling tanks is so short that they do not amount to much more than glorified grit chambers. According to report, research and experiment indicate that both the capital and operating costs of the oxidization processes may be substantially reduced by modification of their conventional design. This is particularly the case in respect to the trickling filters. If what is expected or hoped for in the way of high filter rates is only partially realized this fundamentally sound and reliable process will become competitive in a much wider field.

Quite a few developments in sewage treatment have appeared as patented processes. Two or three of them about which the author happens to know something will be briefly described. A 9,000,000 g.p.d. chemical precipitation plant of the Guggenheim type has been in service in New Britain, Conn., for about a year now. The treatment includes primary settling for 1 hour, 1½ hours' aeration and 2 hours' final settling. Enough sludge is returned from the final settling tank to the aeration tank to maintain a load of suspended solids therein of about 1,500 parts per million (1,500 p.p.m.), equivalent to 6¼ tons per 1,000,000 gal. A coagulant is applied to the sewage as it enters the aeration tank and sometimes also at the inlet to the primary sedimentation tank. The total dose per 1,000,000 gal. at New Britain is stated to average about 70 lb. of iron in the ferric state and the air less than 0.20 cu. ft. per gal. It will be noted that apart from the use of chemicals the Guggenheim plants are very similar to activated sludge plants, but cost less to build, because the tanks are scarcely half the size and much less is required in the way of air equipment. It is claimed that less chemicals will suffice if more air is used, and that within limits the quantities of air and chemicals used can be varied to suit local prices, also that the effluent can be chlorinated to a residual with 25 lb. of chlorine per 1,000,000 gal. The Guggenheim process is believed to have been adopted at New Britain in preference to conventional oxidization or chemical treatments because of the particular characteristics of a widely fluctuating load of industrial wastes carried by the sewage. From unofficial figures it would appear that so far the plant has yielded an effluent satisfactory to the State authorities (30 p.p.m. suspended solids and 45 p.p.m. B.O.D.) at a total cost (fixed + operating) of about $1.00 per capita per year.

A small plant was installed by the Bio-Reduction Co. at Davidson, N.C., about three years ago. Chemical coagulation and circulation of sewage solids constitute part of this treatment also. An iron salt is used for coagulation, but whereas in the activated sludge and Guggenheim plants sludge from the final settling tanks is returned, at Davidson it is the so called bio-loam, the fairly dry stabilized solids, which are re-circulated. The sequence of events in this treatment is as follows: the screened sewage is dosed with about one ton dry weight of bio-loam per 1,000,000 gal., mixed for 20 min., settled for 20 min. in the primary settling tank, dosed with 50 lb. more or less of iron as a ferric salt, flocculated for 20 min. and finally settled for one hour. The sludge from the primary and final settling tanks is mechanically de-watered and stabilized under aerobic conditions in ten days or so. It undergoes such active oxidization in the stabilizer that most of the water is driven off. The introduction of the bio-loam accelerates the clarification of the sewage by sedimentation, and it is further claimed absorbs all odours and breaks down the organic matter.

At Davidson, the effluent was filtered through charred bio-loam. The company controlling the process advise that their method of stabilizing sludge under aerobic conditions yields an end product in the form of bio-loam, particularly rich in fertilizing properties and dry enough for the purpose as removed from the stabilizer. They are further confident that this method of stabilizing and drying is applicable to the sludge from any kind of a treatment plant. It would appear therefore that it is this feature of the process wherein very complete de-watering of the sludge solids is incidental to their stabilization which possesses the most important and interesting possibilities. The effluent it is claimed compares favourably with an activated sludge effluent in every particular. However in so far as the engineering profession in general is informed, this process is still in the experimental stage.

A large plant 45,000,000 g.p.d. recently completed for Niagara Falls, N.Y., is attempting something new in making a sort of filter out of a Riensch Wurl screen by applying a layer of a cheap grade of fine coal to the screen through which the sewage is filtered. Peak loads during wet weather can be taken care of by omitting the coal and allowing the installation to function as a fine screening plant. On the face of it, the treatment would appear intermediate in efficiency between fine screening and plain sedimentation.

Experiments at Woonsocket, R.I., Baltimore, and Lancaster Pa., give promise of greatly increased efficiency in the removal of grease and scum in grease separators by the injection of chlorine gas into the air used for grease flotation. Fifteen to 25 lb. of chlorine per 1,000,000 gal. treated with only five minutes or so detention effected a marked improvement. "Aero-chlorination" as it is called may therefore solve or at least ameliorate a troublesome feature of plant operation, because grease is a real hindrance to the efficiency of some treatment processes and is a help to none. Moreover, it is a trouble which is likely to become worse because of the trend to get rid of all sorts of municipal wastes by means of the sewers.

If aero-chlorination fulfils its early promise in combatting grease it will not be the first instance where chlorine has supplied the answer to an operating puzzle. Whenever troubles persist in cropping up in any step of the treatment, which seemingly might be remedied by a sterilizing and oxidizing agent, it does not cost much to try chlorine, nor does it take much time because usually if chlorine will serve the purpose at all it acts with immediate and telling effect. Moreover permanent chlorination facilities can usually be fitted into any stage of any treatment process with but little trouble and at a moderate capital expenditure. Although its most important role is the destruction of disease germs chlorine is a multidexterous agent in the sewage disposal field, preventing and curing odours, protecting concrete against disintegration and metals against corrosion, maintaining suitable conditions in sludge thickeners, correcting pooling on trickling filters and bulking of activated sludge. In fact chlorine may be useful for some purpose all along the line, in the sewers, in the treatment plant, and even in the stream receiving the effluent, either to control undesirable growths or to afford relief from seasonal nuisance by arresting the decomposition of a partially purified effluent until the stream merges with a larger body of water or receives accessions from less polluted tributaries.

So far no reference has been made to the major problem of sewage treatment, the disposal of sludge (solids removed from the sewage). No matter how pure the effluent discharged from any plant, the solids as removed from the tanks will usually show a high bacterial count and will become offensive in a day or two, somtimes in a few hours. It will be recalled that the dry weights of solids in the sludge removed from 1,000,000 gal. of sewage by a plain sedimentation, chemical precipitation, trickling filter and activated sludge plant amount respectively to 1,000, 2,500, 1,500, and 1,800 lb. To explain the 1,500 lb. for trickling filters it will be recalled that the total of 1,700 lb. removed includes 200 lb. digested in the filters. It will also be recalled that the 2,500 lb. for the chemical precipitation plant was based on using both lime and ferric chloride for coagulation. Where ferric chloride alone is used the weight of solids in the sludge would be reduced by about one third.

A few plants dispose of the sludge as a fertilizer, in which case, unless used locally, it is usually de-watered and dried to such a low moisture content that bacteria cannot live in it. That is to say, the organic sludge solids while still potentially offensive will remain stable so long as they are kept dry. So far the use of sludge in the fertilizer field has not had an impressive record as a business venture, and although it is a growing practice to get rid of at least part of the sludge in this way, it is not likely to supplant two other methods for stabilizing sludge, viz. digestion and incineration. Digestion is an old, incineration a comparatively recent, method. Unless one goes into details, a description of the disposal of plain sedimentation sludge by digestion or incineration or both is applicable for the most part to all sewage sludges and the description will therefore be confined to the disposal of the sludge from 1,000,000 gal. of plain settled sewage which contains 1,000 lb. dry weight of suspended solids.

As drawn from the sedimentation tank the sludge is mostly water, the solids constituting only a small proportion, say from 4 to 8 per cent of the mixture. Calling it 6 per cent, the sludge from 1,000,000 gal. of sewage amounts to 2,000 gal. or one fifth of one per cent of the volume of the sewage from which it was derived. If the sludge is held in a tank for a day or two it tends to concentrate by flocculation and sedimentation. Sludge thickeners, as these tanks are called, are usually provided with a mechanism for gently stirring the sludge, and sometimes as much as 50 per cent of the water can be drawn off as a supernatant. The 2,000 gal. of 94 per cent moisture sludge can therefore be thickened to say 1,500 gal. of 92 per cent moisture sludge.

Fig. 3—Aeration Tank in Activated Sludge Plant.
Note surface agitation from escaping air.

Prior to the advent a few years ago of sewage sludge incineration, concerning which more anon, digestion was the only practicable method for stabilizing it. Sludge is digested by detention in heated (80 deg. to 100 deg. F.) tanks called digesters for two or three months, where by decomposition, mostly on an anaerobic basis, it is converted into stable humus compounds.

About 30 per cent of the 1,000 lb. of solids in the sludge is an inert ash, but the balance, the so called volatiles, have a high calorific value and as a whole raw (undigested) sludge solids may approximate 8,000 B.t.u.'s to the pound. With 50 to 60 days two-stage digestion about two thirds of the volatiles disappear. Consequently 1,500 gal. of raw sludge containing 1,000 lb. of solids (about 30 per cent ash), with an average calorific value of 8,000 B.t.u.'s, will be digested to 750 gal. or less of digested sludge containing 530 lb. of solids about 55 per cent ash, having a calorific value of 5,000 B.t.u.'s.

The digesters are provided with gas tight roofs and the gases evolved during digestion are collected and burned, or used as a fuel for internal combustion engines. In the latter case about 25 per cent of the heat in the gas is converted into work and upwards of 50 per cent can be recovered from the jacket water and exhaust gases. Depending on design and capacity one b.hp. hour is available from about 9,000 to 12,000 B.t.u.'s supplied to the engine. For the 1,000,000 g.p.d. plant under consideration the engine output would average about 20 hp., equivalent to 1 hp. for every 500 people tributary to the plant.

Of course the greater the proportion of organic industrial wastes in the sewage, the higher the removal of solids, and the more complete their digestion, the greater the average daily per capita gas yield. The dependable power available is influenced also by the gas storage provided and by seasonal fluctuations in the strength of the sewage. Some unofficial figures to hand of digester-gas-engine driven generator output, indicate one kw. for every 500 people served by the plant, a plain sedimentation plant at that, with only 50 or 60 days two stage digestion, and about one day's gas storage.

Two particularly valuable features of digestion are that it renders the sludge solids inoffensive and accomplishes this result without creating any nuisance, because all the gases are burned at temperatures destructive of odours. Moreover it reduces the bulk and weight of the solids by about 50 per cent. For the digestion periods and temperatures already mentioned it also probably kills all the disease germs except perhaps an occasional die-hard. However digested solids cannot be burned as readily as raw solids, and lose 50 to 60 per cent of their nitrogen and phosphoric acid during digestion. Moreover such of these fertilizing constituents as remain, are of a lower order of availability for plants than they are in the undigested solids. Nevertheless a dressing of digested sludge is often worth while, because its humus compounds not only enrich the land but have a beneficial physical effect on some soils.

The 750 gal. of digested sludge containing 530 lb. of solids issue from the digester as a somewhat viscous fluid from which 70 to 80 per cent of the water has to be separated to leave the solids in a convenient form to handle. In the past open or covered beds of sand were usually provided for this purpose but current practice, in the northern part of this continent anyway, resorts to mechanical de-watering on vacuum filters. The sludge must be conditioned for filtration by treatment with a coagulant which for the sludge under discussion may be iron in the ferric state such as ferric chloride alone, or ferric chloride and lime. The filter cake, as the de-watered solids are called, will contain from 65 to 75 per cent moisture. It can be stored in a pile without any nuisance and will accumulate at a rate of roughly 1⅓ cu. yd. per day which is equivalent to about 1⅓ cu. ft. per year for each person served by the plant.

Although digestion and de-watering suffice to stabilize the solids removed from sewage, the accumulation of filter cake may in itself become a disposal problem. The quantity of cake per capita may be much greater than in the case cited. In the first place, 0.20 lb. per capita per day used herein as a basis for the suspended solids in sewage is low for large manufacturing cities. Moreover in a plain sedimentation plant the removal of solids is low and their loss during digestion high compared to more complete treatments. If Greater Montreal for instance were located on a small stream, instead of on a very large river, necessitating the treatment of the sewage of about 1,000,000 people by the activated sludge process, a single year's accumulation of digested sewage solids in the form of filter cake would cover about 10 acres if stored in a pile 10 ft. high. Obviously that would not do at all on Montreal Island. Prior to 1935 the only alternatives would be to use it for filling low areas, to transport it to a locality where it could be allowed to accumulate, or to sell it for fertilizer purposes. None of these alternatives can be regarded as a permanently satisfactory method of disposal, but today the answer would be found either in incineration alone, or in the sale of part of the sludge for fertilizer with incineration of the remainder. Modern incinerator equipment can be used either for burning sludge or for drying it for sale. If none of it were sold, the disposal problem is vastly simplified by incineration, because the ash bulks only about 15 or 20 per cent of the cake. Moreover the ash is entirely suitable for filling which is more than can be said of the cake.

The first plant to resort to incineration for the disposal of sewage sludge is at Dearborn, Mich., where early in 1935 a Nichols Herreshoff incinerator was put in service to burn the sludge from a chemical precipitation plant. Like their other pioneer venture with a magnetite filter the Dearborn incinerator seems to have worked satisfactorily from the start. Since then Nichols incinerators have been installed in, or adopted for, fifteen or more sewage treatment plants including the large installations at Minneapolis-St. Paul, Cleveland, and Detroit, while a competitive furnace developed by the Combustion Engineering Co. has been adopted for Buffalo and by the Chicago Sanitary District for two very large plants, Calumet and South West Side. The ultimate capacity of the latter is about 500,000,000 g.p.d., a world record for size.

The reason for its immediate and extensive adoption is because incineration is the most expeditious, certain, and inoffensive method available for the destruction of the potentially offensive organic wastes and potentially dangerous disease germs in sewage sludge. Once incineration became available digestion was no longer imperative because the solids removed from the sewage could be de-watered and burned before decomposition sets in. Indeed it may happen at times that solids entering the plant with the sewage in the morning leave it before night on their way to the ash pile.

Judging by current practice there is a conflict of opinion with respect to the advisability from economic or other points of view of installing digesters.

If digesters are adopted smaller vacuum filter and incineration plants will suffice partly because there are less solids to handle but particularly because peak loads of sludge can be stored in the digesters. It is rather difficult to make out a case for the digestion of activated sludge, because it is the richest in fertilizing properties, the most troublesome to digest and the aeration tanks afford an opportunity for considerable peak load storage.

The relatively small quantity of solids removed by fine screening plants contain less moisture, are easier to de-water and burn more readily than sludge. Screenings are de-watered by roll presses, centrifuging and perhaps by other methods. Furnaces for burning screenings were developed and in service long before the first sewage sludge incinerator was installed at Dearborn.

It is reported that the digested sludge of one large plant in Europe serving 500,000 people is de-watered by centrifuges of the Escher-Wyss type. On this continent centrifuges for de-watering both fine and coarse screenings (ground) are in service but so far there is no plant solely dependent on centrifuges for de-watering sludge except possibly at Collingswood, N.J.

The preceding meagre account of digestion itself, and of the economics of digestion in sewage sludge disposal will for lack of space have to suffice. The author wishes however to refer briefly to another important factor in this connection, a comparatively recent development called "elutriation." Genter originated the idea a few years ago and Keefer confirmed his laboratory work by extensive field tests at Baltimore.

The kind and average quantity of coagulant required for conditioning unelutriated raw and digested sludges for vacuum filtration is listed in Table IV below. These figures are after Dr. Fischer," The Economics of Various Methods of Sludge Disposal," Sewage Works Journal, March 1936. The chemical dose is expressed as a percentage by weight of the suspended solids in the sludge. Although not shown in the table the digested sludges of the first four plants can also be conditioned by using from six to seven per cent of ferric chloride alone. Note that for some sludges the quantities of coagulant may vary widely from those tabulated.

Table IV

Plant	Raw		Digested	
	CaO	$FeCl_3$	CaO	$FeCl_3$
Plain sedimentation	10%	+ 3%	10%	+ 2%
Chem. precipitation ($FeCl_3$)	10%	+ 5%	12%	+ 2%
Chem. precipitation ($FeCl_3$ + CaO)	8%	+ 3%	10%	+ 2%
Trickling filters	12%	+ 3%	12%	+ 2%
Activated sludge	0%	+ 6%	0%	+ 8%

The chemicals add to the weight of the solids in the filter cake. The increase in weight is 0.66 lb. for each lb. of ferric chloride converted into ferric hydroxide, and 1.78 lb. for each lb. of lime converted into calcium carbonate. Obviously therefore where lime has to be used the additional weight may be an appreciable factor in the cost of the subsequent disposal of the cake.

There is not much to the elutriation treatment itself. It consists simply in diluting and washing digested sludge solids with relatively pure plant effluent or other water and again concentrating the washed solids to a thicker final sludge by sedimentation. This removes from the original sludge undesirable chemical compounds that accumulate in the sludge liquor during the natural processes of decomposition or digestion, which if left in the sludge render the use of more chemicals imperative for sludge de-watering. Elutriation eliminates the use of lime entirely and materially reduces the amount of ferric chloride normally used on unwashed sludges. This treatment therefore may effect an important saving in the operating cost of vacuum filters because the cost of chemicals is the major item of expense. But this is not the whole story. Elutriation largely frees digested sludge from the gelatinous precipitates which smear and blind the filter cloths, and makes it easier to turn out an odourless cake under odourless operating conditions. Moreover there is only one chemical to look after and as lime is never used, generally there is considerably less filter cake to dispose of.

The first installation was at Washington, D.C. It has now been installed or definitely adopted in ten or more large plants serving a population of about 5,500,000 people. Washington and Winnipeg are the only plants so far in service. Both are of the same type, plain sedimentation with digestion. The author's information about the merits of elutriation in practical operation is limited to the results at the Winnipeg plant which has been in service a few weeks only. However so far all concerned are satisfied it was worth while adopting.

Nature has provided sewage purification agencies both on land and water. In primitive times when but little water was used for washing or cooking, human wastes were effectively disposed of by burial. The essential attributes of an agency for the inoffensive destruction of organic wastes may all be found in the surface layers of the soil; bacteria, air, moisture and a certain capacity for the absorption of odours. Some animals seem instinctively aware of this providential provision. Quoting from Rideal, "It will be noticed that the instinctive effort to cover their dejecta is most prominent in the carnivora, in which the matters are most nitrogenous, and therefore more highly offensive, whereas in the herbivora no such natural propensity is observed."

With the use of more and more water about the house, domestic wastes which in earlier times, though full of moisture, could be handled and disposed of more or less like solids, were converted into a liquid (sewage) of much greater weight and volume. To get rid of the sewage pits were dug from which the sewage leached away into the ground. These cesspools as they are called still suffice for isolated dwellings but cannot satisfactorily cope with a large volume of sewage. Consequently the installation of a system of sewers is usually an imperative sequel to the installation of a water supply system.

Sewerage systems were in use long before artificial sewage treatment processes were developed and where for reasons referred to later crude sewage could not be discharged into rivers or other bodies of water, it had to be disposed of on the land. Of course the liquid has to get away somewhere as fast as it is applied and sandy soils are therefore better adapted to such a purpose than clay soils.

The first sewage treatment plants were in effect irrigation schemes on a small scale. That is to say, the sewage was used to irrigate growing crops thereby getting rid of it with but little offence, purifying it to a high degree, and presumably realizing on its value as a fertilizer. This natural method of sewage treatment required large areas compared with modern sewage treatment plants. As much as a 100 acres might be required to dispose of 1,000,000 gal. per day of sewage. Because of this and certain other drawbacks sewage farming or broad irrigation, as this method of sewage disposal was called, is being superseded by modern sewage treatment processes in the Old Country where it originated, but it is still quite common in some countries.

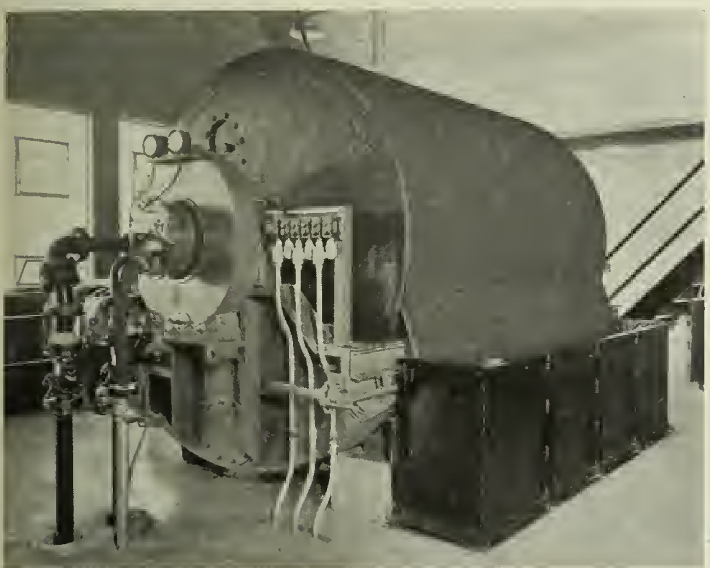

Fig. 4—Continuous Vacuum Filter.

The de-watered sludge (filter cake) is released from filter cloth by air pressure and removed from steel blade and from the drum.

Where natural deposits of sand and gravel occur, such as the glacial drifts of New England, sewage can be disposed of on the land at much higher rates than are suitable for irrigation. About 15 acres will suffice for 1,000,000 gal. per day. If the sewage is pre-settled the capacity of the filters is about doubled. The natural surface is levelled off into beds separated by low embankments and the beds are underdrained by tile laid in trenches. Facilities are provided for applying the sewage intermittently and this particular land treatment is called intermittent filtration.

These old fashioned filters are simple affairs compared with modern plants, but when not overloaded and given proper attention yield a better effluent than any artificial process. Where a high degree of purification is required for a relatively small quantity of sewage, from an institution say, and natural deposits suitable for the purpose are handy, intermittent filters are still as good a choice as any, perhaps even in this climate.

As already stated practically all of the sewage in this province and a great deal of it elsewhere is disposed of by dilution. That is to say, it is discharged directly into rivers or other bodies of water with but little if any pre-treatment. Whether or not this practice is accompanied by offensive conditions in the rivers depends mainly on the degree of dilution. The Chicago Drainage Canal Commission about fifty years ago expressed the opinion that the canal would not become a nuisance if enough water were diverted from Lake Michigan to maintain a flow of $3\frac{1}{3}$ cu. ft. per sec. for every 1,000 people contributing sewage to the canal. This is equivalent to an average dilution of 21.5 to 1 (at 100 gal. per capita). As a matter of fact it proved insufficient at Chicago.

Considering the great variety of conditions encountered the world over in the disposal of sewage by dilution, with respect to the character of both the sewage and the diluting water, the range is surprisingly small between dilutions which are safe against a nuisance and dilutions which are not. Commenting on the data collected during the investigation at Chicago, the chief engineer of the Commission said: "that information in regard to sewage disposal by dilution was available from Paris, Hamburg, Magdeburg, in Europe, from a large number of cities in England, from the Blackstone River in Massachusetts, and the Des Plaines River in Illinois, and that when all this information was plotted, it was astonishing to note the correspondence of these different data, and the indication from all of them that a dilution of from 2.5 to 5.0 c.f.s. per 1,000 people, appeared to be satisfactory."

The reason the organic matter in sewage can be inoffensively disposed of by dilution is because the essential agencies to that end are present in the water. That is to say, as the sewage is dispersed throughout the diluting water its organic matter is brought into intimate contact with bacteria and with the oxygen dissolved therein. Consequently its decomposition proceeds on an inoffensive aerobic basis, and as the store of oxygen begins to be depleted thereby, the water strives as it were to replenish it by absorption from the atmosphere. If re-aeration is equal to the task, well and good, but if it is not, and the oxygen is exhausted the river water reeks with putrefactive odours. Long before this stage is reached fish life for the most part has become extinct.

It goes without saying that if full advantage is to be taken of dilution, sewer outlets must be so located as to insure prompt dispersion of the sewage in the river water. Otherwise the theoretical dilution based on the total river flow is no measure of the actual dilution. If discharged close inshore the sewage may hug the shore for surprisingly long distances down stream. The fact that it has been subjected to what is called complete treatment is not always a valid excuse for a shore outlet. Down stream bathing beaches on that side of the river might be nearly as well off if an outlet discharging at midstream were substituted for the treatment plant.

Irrespective of the size of the river dilution sometimes has its limitations with respect to the satisfactory disposal of the heavier and lighter suspended solids in crude sewage. If the velocity of the river is low in the vicinity of the sewer outlet, accumulations of sludge may become objectionable even if the oxygen is never exhausted in the overlying water. Moreover floating solids of obvious sewage origin are less likely to be broken up and may be stranded on the beaches. To enjoy immunity from such troubles care must be exercised in the location of outlets whether into the Little River St. Pierre or into the St. Lawrence. Although multiple outlets at points of maximum velocity will help a lot in preventing such local nuisances, generally speaking the special field of usefulness of the dilution method of disposal is the oxidization of the colloidal and dissolved organic substances in sewage. No artificial sewage treatment process will do it better, and to save the cost of such treatment by utilizing this natural agency is frequently just as proper and sensible as hanging out the wash to dry on a bright clear day, instead of resorting to artificial heat indoors.

The degree to which sewage must be treated before it is permissible to discharge it into a river or other body of water depends of course not only on the dilution afforded by the river but also on the use which is to be made of it. So far the discussion has been confined to the prevention of a public nuisance by so restricting the pollution that the receiving body of water will not be offensive either to sight or smell. Higher standards however may be imperative as a public health measure, or for other reasons such as the preservation of fish life. This province is mostly concerned in keeping its rivers fit for sources of municipal water supplies, because over 80 per cent of the water so used is derived from rivers. Usually however surface supplies are not safe without filtration, and modern water filtration coupled with chlorination is a reliable treatment for rendering moderately contaminated supplies safe and suitable for domestic use. In a sense this treatment puts repentance on a par with innocence, in as much as the typhoid rates of some cities using a filtered water from a polluted source compare favourably with the rates reported for cities enjoying a water supply drawn from virgin sources.

The control of the pollution of rivers to keep them fit for bathing is a difficult problem for health authorities to handle. Modern standards require a much lower bacterial content in the water at a bathing beach than at a domestic water supply intake to a filtration plant.

These standards will be hard to live up to considering uncontrollable pollution reaching the rivers from surface run-off and from storm water overflows. While this is a matter concerning which the author is imperfectly informed one may perhaps be permitted to wonder whether the sanitary benefit from keeping many of, the rivers fit for bathing according to modern standards is commensurate with the cost.

The total population served by municipal sewerage systems in the Province of Quebec is about 1,700,000 and at least 75 per cent of the sewage from these systems is discharged directly into the St. Lawrence, or into tributaries with short runs to the St. Lawrence. The bulk of the sewage originates in the vicinity of Montreal. That is to say, the drainage from 1,200,000 people, more or less, is discharged into the St. Lawrence and the branches of the Ottawa in this district. The minimum flow of the St. Lawrence just below Montreal approximates 225,000 c.f.s. equivalent to about 185 c.f.s. per 1,000 people immediately tributary to it. Considering that in the light of experience a flow of from 5 to 10 c.f.s. is sufficient to assimilate the sewage from 1,000 people without a nuisance, the St. Lawrence will obviously continue immune on that score for many a day.

One reaches the same conclusion from a check of its ability to satisfy the oxygen demand of the sewage. About 150 tons of oxygen per day would suffice to stabilize the sewage from a population of 1,200,000 people, whereas the oxygen content of the daily flow of these rivers past the Island of Montreal amounts to 5,000 tons probably during the warm weather and to 50 per cent more in the winter. The St. Lawrence with its lake expansions and rapids is generously equipped with the means of self purification of the pollution discharged into it. Moreover most of the disease germs do not as a rule survive longer than a few weeks after their discharge from the sewers. Consequently storage rids the water in the great lakes of the disease germs discharged into them. In so far as water borne disease germs in St. Lawrence river water is concerned the population inhabiting the immense watershed west of Port Hope or thereabouts is not a factor. The commission of five engineers reporting on the proposed Montreal water intake in 1936 estimated that filtration of Ottawa river water would cost the City $400,000 a year more than it does to treat St. Lawrence river water. If the St. Lawrence were not as big and clean as it is, it might also cost the City around $2,000,000 a year for the fixed and operating charges of sewage treatment plants and works incidental thereto.

A survey of the cities and towns in this province not situated on the St. Lawrence shows that with two exceptions, all of any size discharge their sewage into rivers affording dilutions which, while not comparable to the St. Lawrence, are away beyond the danger zone so far as nuisances are concerned. It would appear therefore that for the present and immediate future anyway, Quebec's necessities if any can be satisfied with a sedimentation plant here and there, supplemented probably by chlorination. A plant of this type is compartively simple and cheap both to build and to operate, and is more of a help to the rivers than one might infer from its B.O.D. removals. If filtration also is provided one can reasonably count on a practically sterile effluent with removals of from 65 to 75 per cent suspended solids and from 50 to 60 per cent B.O.D. With some sewages pre-flocculation and longer settling might prove a satisfactory substitute for filtration.

Before attempting more one should be very sure of the need of it and should bear in mind it is particularly true of sewage treatment as of most endeavours of life that the closer we approach perfection the less we get for what we do. Under present economic conditions neither public nor private expenditures begin to cope with the multitude of public health demands. And perhaps at times the money spent in polishing effluents would yield higher dividends in health and happiness if placed at the disposal of Social Agencies.

Aircraft Engine Selection and Installation

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Paper presented before the Aeronautical Section of the Ottawa Branch of The Engineering Institute of Canada on April 29th, 1937.

SUMMARY.—The author outlines the more important features that are to be considered in the selection of engines, keeping in mind the conditions under which the machine is to operate. Air cooled or liquid cooled, location of the engine itself, fuel system exhaust system, controls, propellor, cabins, cowling, fire protection, are some of the features that are given consideration.

The installation of aircraft engines embraces a very large field. In the past an engine was selected for various reasons and fastened to the airframe by some precarious method which would satisfy the constructor. Various connections including the fuel line and throttle were attached rather easily, for at that time the engine was a relatively simple affair.

From time to time various accessories were added to the engine. This required new controls, and of course an override, in case the automatic features of the control got out of order. In addition, engines became more discriminating with regard to their diet and their method of consuming this diet. Then too, speeds became much higher and it was discovered that odds and ends jutting out into the slipstream caused a considerable increase in the drag of the aeroplane.

These points and a great number of other equally important factors have led to a very large amount of research in connection with the best way in which various bits and pieces may be located so that they will function in a satisfactory manner.

Unfortunately, the subject of engine installation is a very large one, if one is to consider all the factors. To cover all the work that has been done, in detail, would require a cumbersome volume which would be out of date before it was finished. On the other hand, one cannot generalize too freely, or the relatively minor features will be neglected.

It is the intention of this paper to treat some of the more important points and summarize them as briefly as possible.

Choice of Powerplant

In most cases the choice of the powerplant is made before the aeroplane passes the design stage. Reasons for the choice are largely economic and include the important points of reliability and service. If the engine is at all cranky the chances of the aeroplane being a success are extremely slim.

In spite of the large number of engines available, many of these will immediately be ruled out of the final choice for various reasons, such as power range, service facilities, reliability, cost, type, etc.

Provision must be made for accessory drives, and automatic controls must be given serious attention.

Provided that all engines within the required power range have an equal number of the desired characteristics, it becomes necessary to select a type; that is, whether it shall be air or liquid-cooled. Whether the engine shall be radial, in-line, V, X, H or flat will depend upon the actual engine selected.

In this country at the present time, the air-cooled radial engine is more used than any other type. This is largely due to the fact that service facilities have been better for this particular type of engine than for the liquid-cooled variety. In addition to this, there has been the feeling that water-cooled engines are not for this climate, because of the low temperatures experienced in winter. This latter point actually has little bearing on the matter as suitable anti-freeze solutions are available which are entirely satisfactory, and starting presents no difficulty.

There are, however, one or two other considerations in connection with the final choice between the two main classes of engines.

Against the liquid-cooled engine there is the addition of an extra circuit in which trouble may develop. Unless the operator of commercial machines is convinced that his aeroplane is not going to be stranded miles from civilization, in winter, with a leaky cooling system, he is going to be doubtful about purchasing this type. At the present time it may be safely assumed that the cooling systems of liquid-cooled engines will give entirely satisfactory service, and local hot spots are fairly well eliminated.

The whole question of cooling the larger power engines is due for serious consideration. Figures given by Mr. H. Wood,[(1)] show that while the fin area of a large air-cooled engine was increased 90 per cent the cooling increase was only 40 per cent. In the liquid-cooled engines it was generally only necessary to enlarge the radiator and liquid passages. The use of cylinder baffles and twin row engines has been the answer of the manufacturers of air-cooled engines to this problem, and it is highly probable that ducted cooling will be used for both types in the future. This will be more fully covered in the section on cooling.

Component	Liquid-Cooled Mr. Wood	Air-Cooled Mr. Wood	Air-Cooled Mr. Anderson
Propeller	360	360	371
Cowling	60	100	71
Mounting	60	100	51
Exhaust system	35	120	87.5
Radiator	63		
Header tank	15		
Pipes	8		
Coolant	115		
Oil cooler	10	25	30
Fuel pipes	20	25	8.5
Oil pipes	10	10	13
Tanks	110	110	
Carburettor inlet duct and valves			22.5
Generator			35
Starter			32
Misc.			27.5
Weight of engine			1,163
Total, exclusive of engine	866 lb.	850 lb.	749 lb.

Fig. 1—Table of Weights, Air-cooled vs. Liquid-cooled Engines.

In the higher powers the liquid-cooled engines have some advantages over the air-cooled engines. Operating temperatures of the various parts may be more readily controlled and fuel and oil consumptions are slightly lower, although this latter difference is becoming less and less.

The choice of air-cooled engines is more varied on this continent than is the case with liquid-cooled engines, but in Europe and particularly in England, France, Germany and Italy the liquid-cooled engine has kept pace in development with the air-cooled engine.

In general, engines may be classified as military, commercial and private. The military engine is required primarily to give a maximum of power, whether or not economy is obtained; although economy and reliability are still of importance if the range of the aircraft is to be great.

Commercial engines are required to give many hours of reliable service at a minimum cost.

Engines for private aeroplanes are expected to perform in much the same manner as engines for commercial ships, although the power range is much lower.

Particularly among the engines of larger power it is the custom to supply powerplants in quite a range of models. For instance, one engine may be direct drive or geared. It may also be normally aspirated, moderately or fully supercharged.

To avoid a duplication of engine parts and to increase the performance of aircraft, the practice is growing on this continent of using an engine which is fairly highly supercharged. This engine will be rated at a certain power when operated on, say, 87 octane fuel. When 80 octane fuel is used, the rated manifold pressure and power are necessarily less. In consequence, production costs may be lessened and the purchaser, if he has been operating on a low octane fuel, may at any time increase the power by changing to a higher grade of fuel, assuming of course that the aircraft can stand the added power.

The fully supercharged engine as originally designed, was intended for use with the fighter and interceptor aircraft. The moderately supercharged engine was intended for use in flying boats and other aircraft where good take-off was desired, and with a rated altitude in the order of 5,000 ft. It was also intended for long range with low fuel consumption. Normally aspirated engines were intended for use in bombers, reconnaissance and co-operation aircraft with long range and low consumption. The present demand for performance has led to the practice of using supercharged engines for practically all purposes.

Reverting to the comparison of liquid-cooled and air-cooled engines, it is interesting to compare weights for an engine of 1,000 hp. given by Mr. Wood(1) of Rolls Royce and a second table of weights given by Mr. Anderson(2) of the Wright Aeronautical Corp. These will be found in Fig. 1.

In some ways this list would appear to favour the liquid-cooled engine, as in this case the rams-horn exhaust stubs are considered. If a collector ring or manifold and tail pipes were considered as in the case of the air-cooled engine, it would mean an additional 80 to 100 lb.

The weight of the engine in Mr. Anderson's list includes reduction gear, magnetos, ignition system, automatic controls, propeller hub attachment parts, cylinder baffles and accessory drives.

No doubt there are numerous points in the above tables of weight which are open to criticism, but they give some indication as to the relative weights and the difficulty in comparing the two types.

Location of Engine

While it is theoretically possible to locate the engines wherever the designer may wish, it is surprising how few places are actually practicable when a particular type of aeroplane is considered.

Figure 2 gives a few of the conventional arrangements, and also shows how hard it is to be original in engine location.

The arrangement of the wing or wings of the aircraft is outside the scope of this paper and no attempt will be made to consider this problem other than to state that there is a strong feeling among the operators that for commercial aircraft in this country, a high wing monoplane is desirable so that the danger of damaging the wings during taxiing and docking will be minimized. This fits in well with the demands of a suitable location for the engines if they are to be mounted in the wings, as they are then well clear of the water or ground, permitting the use of large diameter propellers without the necessity of unduly long undercarriage struts.

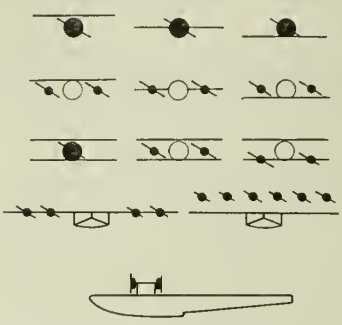


Fig. 2—Engine Arrangement in Various Designs.

Owing to the difficulty experienced by operators, of starting engines in the winter, the preference lies with single engine aeroplanes.

When engines are mounted on the wing, they should be fitted to the leading edge, or better still, in the wing. A pusher arrangement is slightly more efficient but the problem of providing a suitable driveshaft and steady bearing at the relatively thin trailing edge makes this almost impracticable at the present time. The driveshaft of course has been used for some time.

At the present time engines are being planned or built which may be enclosed in the wing structure. This would appear to be very desirable and would of course involve ducted cooling before it can be considered successful.

The disposal of the cooling air without destroying the air flow over the wing, presents a rather difficult point.

In multiple engine aircraft, the nearer the engines are to the centre line of the aeroplane the less "crabbing" will be necessary when flying with one of the engines cut-out, but placing the engines too close to the fuselage will cause interference.

An interesting engine installation recently produced is that of the Empire Boats. Among the more outstanding features is the exhaust arrangement whereby the tail pipe is brought out through the top surface of the wing, discharging into a region of relatively low pressure, reducing the back pressure on the valves and directing the sound upwards.

Fig. 3—Nacelle and Servicing Platform of Empire Boat.

Except in the experimental Atlantic ships, fuel tanks are placed in the wings close to the motors, thus simplifying the plumbing.

Oil coolers are hidden in the leading edge and air enters and is discharged through slots. The cabin is heated by air passing over the exhaust pipe, but the heater muff is enclosed in the wing.

For examination of the engines, part of the leading edge folds down providing a service platform on which the mechanic may stand. This is shown in Fig. 3. The controllable cowling is also shown in this illustration.

Mounting

It is generally conceded that a tubular metal engine mounting is the strongest for a given weight. This mounting must be so designed that all parts of the engine which require adjustment or removal may receive the attention they demand without undue interference, otherwise the maintenance will be expensive or neglected.

Where possible, a careful examination of the actual engine itself is desirable, as important points do not always show up on the engine assembly drawings, which often enough are only drawings of an earlier engine due to the fact that changes are continually being made in the engine. This is particularly true where only a limited number of engines are being purchased.

Examination of the present trade journals shows a large number of interesting methods of mounting engines, and there is a tendency towards more originality.

Figure 4 shows an engine mounting used by the Bristol Company about 1924. With this arrangement the engine compartment could be opened like a cupboard door. While this undoubtedly would have the advantage of making the rear of the engine more accessible, it would necessitate very flexible controls and cables which are not desirable. The actual fastening would also tend to become cumbersome.

Where possible the mounting should be bolted to the engine and where the mounting is connected to the airframe as few bolts as possible should be used. It is not likely that this number will be less than four. This will permit the removal of the powerplant unit for inspection or service with a minimum of effort. It will of course be necessary to make provision for breaking all controls, wiring and piping at this section, but this is desirable from the standpoint of noise transmission from the engine to the airframe.

Figure 5 shows flexible mountings used with the Bristol Pegasus engine.

The stress requirements of the mounting are similar to those of the fuselage and may be found in detail in the British Air Ministry Publication A.P. 1208 Leaflet B3.

Actually, the engine, mounting, cowling exhaust system and all associated parts should be assembled by the engine manufacturer and sold as a unit.

Fuel System

The installation of the fuel system is of course extremely important. The location of the fuel tanks depends upon the aeroplane design.

Everybody has heard in the past two years of 100 octane gasoline. Perhaps it is not fully understood what this means to the engine. Nearly all the modern engines in commercial work are supercharged. With a supercharged engine it is not possible to open the throttle fully when on the ground owing to the fact that the density of the charge will be too great and the engine will be severely damaged by detonation. Most of the modern engines in use in this country are designed to operate on 87 octane fuel although perhaps using 80 octane fuel. With any fuel there is a limiting manifold pressure. If the anti-knock quality of the fuel available is raised, it is permissible to use a greater manifold pressure with a resulting increase in engine power. This of course must be covered by type test certificate for the engine. At the present time 100 octane fuel is comparatively expensive, but it is becoming the practice to have two fuel tanks—one relatively small tank for 100 octane fuel for take-off and the other tank or tanks for the 87 octane fuel which is used for cruising. The same principle may of course be applied to 80 and 87 octane fuels.

Figure 6 shows a good arrangement for the fuel systems of a twin engine aircraft.

Unless duplicate fuel pumps are used, a gravity tank of at least 30 minutes capacity at full throttle, must be fitted. The head of fuel must of course be suitable for the carburettor.

Fig. 4—Swinging Engine Mounting of the Bristol Brandon Biplane.

A fuel gauge must be fitted to warn the pilot when only 30 minutes' supply of fuel is left.

When a pump is used, a pressure gauge must be supplied.

A filter must be fitted between the tank and the carburettor.

The flow of fuel at the carburettor intake must be 10 gal. per hr. plus 120 per cent of take-off requirements or 100 per cent in excess of the engine requirements at full throttle level flight at sea level; full rich.

Figures given by Mr. Anderson(2) for common practice in the U.S.A. are as follows:

Fuel consumption 30 gal. per hr. or 300 hp. ⅜ in. O.D.
Fuel consumption 60 gal. per hr. or 600 hp. ½ in. O.D.
Fuel consumption 100 gal. per hr. or 1,000 hp. ⅝ in. O.D.
(The figures given are in U.S. gallons.)

When flexible tubing is used the dimensions are taken as inside diameter.

Fuel line temperatures should be kept as low as possible and must not exceed 140 deg. F. with the present fuels. This is to avoid vapour lock.

Great care must be taken to arrange the piping bends so that they will not be too abrupt. There should be as little surface roughness in the lines as possible. The flow through the lines should be relatively slow so that air or vapour bubbles will not be drawn into the carburettor. These bubbles of air or vapour may easily cause failure of the engine. Fuel lines should not rise and fall in their passage towards the engine.

When passenger aircrafts are carrying large quantities of fuel, jettisoning valves for the fuel tanks are required. The outlets must of course be carried to a point where the escaping fuel will not be ignited by the engines.

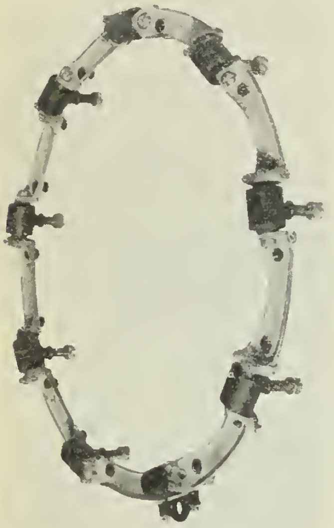


Fig. 5—Bristol Flexible Engine Mounting.

The selection of a fuel gauge is of prime importance. The author has seen very few that do not appear to be out of order a large part of the time. A fuel gauge which is not accurate is more dangerous than no gauge at all.

Control Gear

The early engine controls were extremely simple. The pilot simply reached into the engine and pushed the necessary lever. There was no backlash and if he didn't lose a finger in the exposed gearing the adjustment was made.

As aeroplanes improved the engine was moved further and further from the pilot. It then became necessary to extend the controls. At first, these controls were relatively simple. Usually there was the throttle, mixture control and possibly the ignition advance. We now have in addition oil cooler controls, heater controls, cabin heater controls, cowling controls, gun gear controls, fuel jettisoning controls, fuel tanks selector valves, flap controls and as many others as the designers can devise. In addition automatic controls have been designed with an additional control to cut these out in case of emergency.

Where possible push-pull rods with ball bearings are as satisfactory as any. Unfortunately it is not possible to use these in all places.

Bowden cables are apt to give a certain amount of slackness although certain of these have been improved to a marked degree. These generally use chain or rollers in conjunction with rods for the straight sections. The controls are of course especially formed for a particular installation.

Hydraulic control gear is used and has proved satisfactory. It is necessary when using this type to be sure that the fluid used will not become sluggish at the lowest temperatures encountered nor leak past the pistons at the high temperatures. Great care must be taken to avoid trapped air in the system.

Controls must be arranged to open or turn on with the lever in the forward or down position. The mixture control must be linked with the throttle to give full rich when the latter is closed.

Spring loading of controls is advisable to take up slack or where there is the least possibility of failure of the control gear.

As many of the engine controls as possible should be fully automatic and should be operated by flying conditions or by the engine, and should not pass back to the cockpit. This takes the responsibility away from the pilot and permits him to devote more attention to flying and navigation.

At the present time there are a number of automatic engine controls which are more or less satisfactory in operation and which give more accurate adjustment than the pilot can maintain.

For the benefit of those who are not familiar with the more common of the automatic controls a brief résumé is given here.

Supercharger Regulator or Boost Control

When an engine is supercharged it is the intention of the designer that the engine shall not be operated above a certain boost or manifold pressure. To permit this pressure to be maintained to the rated altitude the supercharger will naturally develop more than the rated boost below the rated altitude. To ensure as far as possible that the rated boost will not be exceeded the designer has provided a boost pressure gauge on the instrument panel on which is marked the take-off boost, the rated or international boost and the recommended cruising boost. From this the pilot may see what the boost or manifold pressure is at any time.

Either through ignorance or carelessness there have been cases where the engine has been severely damaged because this boost has not been carefully watched. In addition, with the modern aircraft the pilot is kept busy navigating and flying. The engine manufacturer may now provide a boost control unit. This unit will permit the throttle lever to be fully opened without exceeding the rated boost. To permit the extra boost for take-off, there is an override control. There is one feature against this type of control and that is this change-over or override control. It is possible for a pilot to attempt to take-off with the rated boost control in operation. In some cases this is over 300 hp. difference and may easily mean the difference between a good take-off and a crash. It is very well to say that the pilot should watch this, but the number of controls is on the increase and it is possible to forget.

These automatic boost controls consist of a sylphon on which the manifold pressure acts, and which actuates a servo motor. This servo motor admits oil from the pressure lubrication system to a plunger moving it in or out as the pressure variation dictates and the effective length of the throttle lever is varied correspondingly, opening or closing the throttle to correct the manifold pressure. (See Fig. 7.)

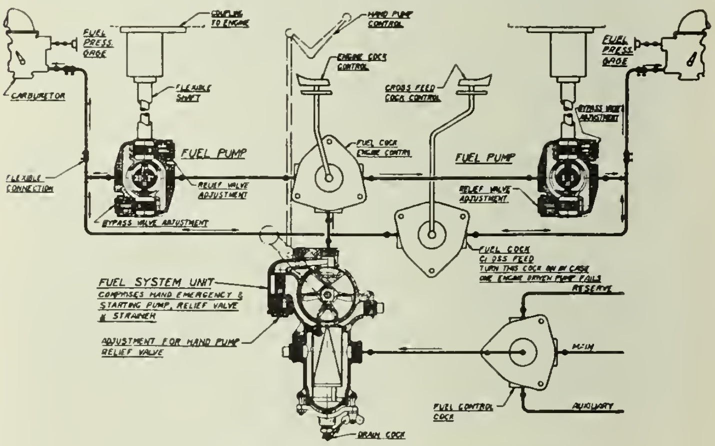


Fig. 6—Typical Twin Engine Fuel System.

Naturally, as the aircraft climbs the boost pressure would tend to drop if the throttle were not opened. The automatic unit takes care of variation in altitude.

One of the drawbacks to this type of control is the fact that when the throttle is opened past the point at which the rated boost is obtained, no further opening of the throttle occurs. This leaves quite an appreciable "dead" spot in the throttle lever's travel. The variable datum boost control has been designed to eliminate this.

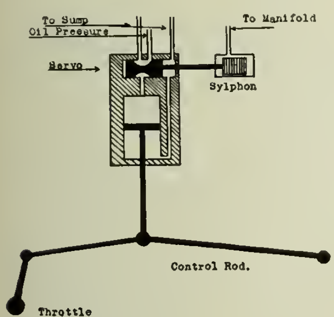
When the throttle lever is moved a coarse pitch thread moves the control sylphon bodily so that there is no dead spot on the travel of the throttle lever. (See Figs. 8 and 9.)

Automatic Mixture Control

As the mixture of an engine becomes progressively weaker the power at first becomes greater then falls off. At the same time the temperature increases to a maximum but falls off rapidly shortly after the power begins to fall. (See Fig. 10.) Of course the mixture cannot be leaned out too far at rated power as the cooling capacity of the engine is not great enough, but at cruising speeds and power a very considerable saving in fuel can be accomplished by running at a reduced mixture.

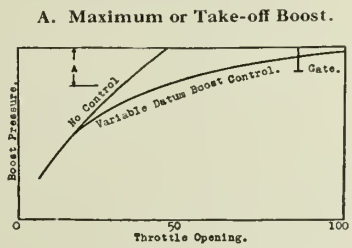
There are several automatic mixture control devices on the market. The Hobson Penn automatic mixture control has an automatic rich and an automatic weak position with a super rich position for emergency power. Those in use in the U.S. work on the same principle with the positions marked automatic cruise, automatic climb, automatic take-off and full rich. It has been claimed that the installation of an automatic control will give 20 per cent better consumption than the best manual control.

Details of these controls have appeared in the technical press.[3, 4] Both types are controlled by a sylphon which automatically compensates for changes in altitude by controlling the pressure balance.



AUTOMATIC BOOST CONTROL

Fig. 7—Diagram of Automatic Boost Control.



Boost Pressure at Various Throttle Openings With and Without Variable Datum Boost Control.

Fig. 8—Throttle Opening vs. Boost Pressure.

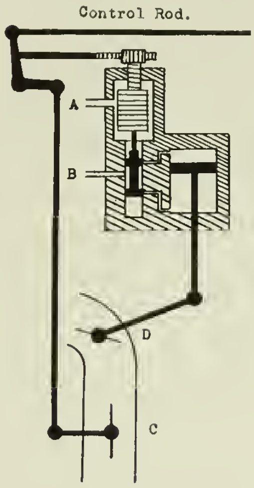
Ignition Control

The Hobson Company have developed an automatic ignition control which is governed by the manifold pressure. This unit retards the spark for starting and idling. For cruising the ignition is advanced fully and somewhat retarded for full power. For take-off the spark may be even more retarded. As the aircraft passes its rated altitude the ignition does not advance even though the manifold pressure drops. A carburettor heater control may be combined with this unit to provide warm air for cruising and idling and cold air for full power. An override should be fitted to give warm air and prevent freezing of the carburettor when necessary. It should be remembered that the temperature of the venturi is anywhere from 50 to 80 deg. F. below the atmospheric temperature.

Propeller Control

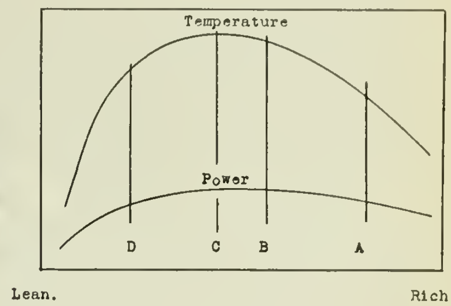
With modern engines the controllable pitch propeller is becoming a necessity. There are two general classifications of the control of this device. The propeller may be set in one of two positions or it may have the constant speed control. Oil pressure from the engine holds the pitch of the propeller against the force of the counterweights which tend to twist the blades in the opposite direction. A governor which is driven by the engine, controls the amount of oil pressure which will act on the pistons actuating the propeller pitch. Provision will have to be made in either case for control of the device from the cockpit.

Provision should also be made for cowling control, either the adjustable front cowling or controllable outlet low drag cowling. The oil heater, cabin heater, fuel cocks, starter control, fire extinguisher, and possibly fuel jettisoning valves must be considered.



A. Blower Pressure.
B. Blower Suction.
C. Main Throttle.
D. Auxilliary Throttle.

Fig. 9—Variable Datum Boost Control.



A. 12 per cent Richer than B for Take-off.
B. Normal Rich Automatic.
C. Weakest Mixture for Maximum Power.
D. Cruising Mixture.

Fig. 10—Effect of Mixture on Temperature and Power.

All these controls must pass from a point within easy reach of the pilot to the location of the part to which they apply.

A great deal of thought should be given to the path of these controls as they must not foul parts of the engine which require attention thus interfering with service routine. The opinion of the pilot and mechanic has a large influence on whether the aeroplane will be a success or failure.

Exhaust System and Cabin Heater

At the beginning of this section it should be stated that the author has a very healthy regard for the influence of carbon monoxide on the human body, and if in the opinion of some readers, this topic is unduly stressed it will be appreciated if it is remembered that this is an honest opinion.

The problem of conducting exhaust gases from the engine to a point where they will pass well clear of the aeroplane without unnecessary noise, drag, and back-pressure still remains a difficult problem.

Some cabin aircraft draw the air from the cabin by means of ventilators, and if the exhaust passes near the fuselage, a very appreciable amount of this gas is inevitably drawn into the cabin through small openings and joints with the result that the concentration of carbon monoxide is higher than the safe limit.

Tests conducted by the N.A.C.A. resulted in the statement that 0.02 per cent of carbon monoxide in the air at sea level is the maximum allowable limit. At 15,000 ft. this limit drops to 0.005 per cent.

The practice of taking the cabin heat from the exhaust system of aircraft engines, while a comparatively simple arrangement and rather attractive from the point of view of saving waste heat, still leaves a lot to be desired. It only requires a small perforation or crack in the tube to cause a lethal dose of carbon monoxide to enter the cabin. For this reason an exhaust system that can be readily examined is desirable.

It is not necessary for carbon monoxide to kill the pilot outright to provide a crash. It is only necessary for it to affect his judgment. An exhaust system that is hard to remove may not receive proper attention.

The poppet type exhaust valve in spite of salt cooling still remains an overworked part of the modern engine. Excessive back-pressure in the exhaust will shorten the life of these valves and is to be avoided as far as possible. Five to six inches of water is about the maximum advisable back-pressure, and of course should be less if this can be managed.

Besides having a low back-pressure, the exhaust system if it is to be effective must be low in weight and drag and must damp the exhaust flame.

Mr. Wood stated that the conventional tail-pipe gave a resonant note which was very annoying to the pilot. This would indicate the need for an efficient silencer.

The Rolls Royce Company makes use of a rams-horn type of exhaust. For each bank of six cylinders there are three lobes each serving two cylinders. These three lobes project through the side of the cowling and together make a streamline form. The exhaust issues through slots in the bottom. For aircraft where the engine is mounted in the nose of the fuselage this would not appear to be good as there is no provision for carrying the exhaust past the cabin or cockpit. It is claimed, however, that there is a

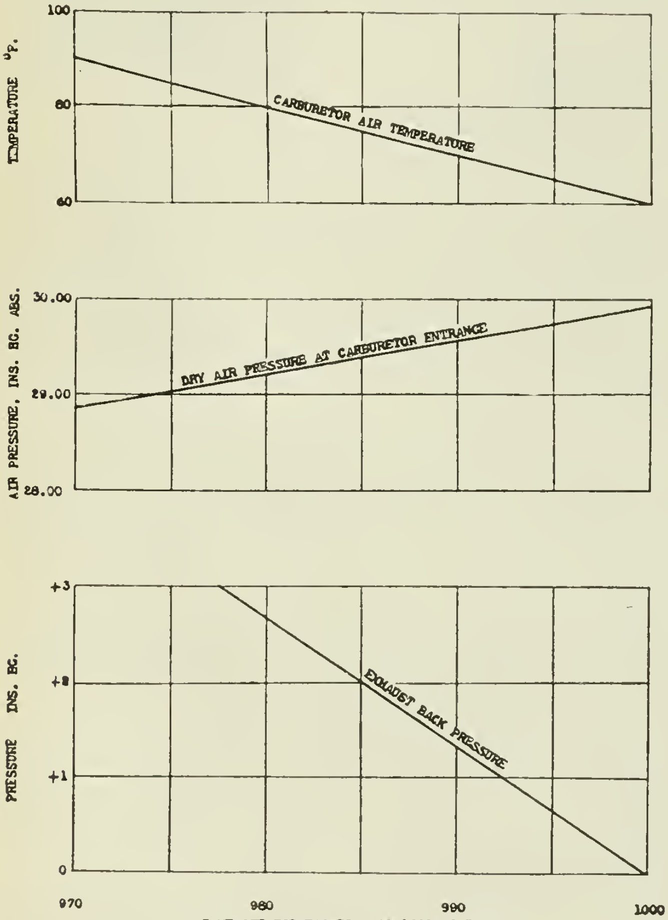


Fig. 11—Relation of Back Pressure and Temperature to Engine Power.

reduction in weight of 40 per cent over the conventional tail-pipe. The sound reduction over open exhaust stacks is 6 decibels and there is an appreciable reduction in drag.

Collector rings on radial engines may be designed to reduce the noise of the engine appreciably. Where the collector ring is used it should be easily removable for examination and should have flexible connections between each cylinder for expansion.

Whether the collector ring should be placed in front or behind the cylinders appears to be an open question. Both methods are still in use.

In Mr. Anderson's paper(2) the size of the exhaust collector may be calculated from the following:

Cross section area = hp. per cylinder by number of cylinders exhausting into ring by 0.04.

Where an internal heater pipe is used the factor 0.04 should be increased to 0.045.

Mr. Anderson also states that no part of the ring should be within 1½ in. of the cylinders.

Figure 11 shows the relation of exhaust back-pressure to engine power.

Proper attention to the arrangement and location of the exhaust outlet will help to reduce the back-pressure even with quite a long tail-pipe.

Stainless steel is probably the best material for the construction of the exhaust system.

Figure 12 shows the exhaust arrangement of the Wright Cyclone engine.

Silencers of varying merit have been designed for aircraft engines. Up to the present time a sound reduction of about 25 decibels with a back-pressure of ¼ to ½ lb. would appear to be the most satisfactory. This particular type is of the acoustic variety. No figures on the life of the sound absorbing material are available.

Most cabin heaters obtain their heat from a muff on the exhaust pipe or by a tube inside the exhaust pipe through which air passes. (Fig. 12.)

As stated earlier this method leaves a great deal to be desired from the point of view of exhaust gas contamination, but it is attractive from the standpoint of saving otherwise waste heat. Any other secondary circulating system while desirable puts the weight up and introduces complications, although this method is in use also.

Mr. Wood(1) has suggested that warm air from the radiator and oil cooler could be used for this. The air would pass through a ducted radiator and from here to the cabin or through a by-pass to the outside. This is on the face of it a great advantage and if carefully designed would remove the objections to other types, although it would not be so easy to apply to air-cooled engines.

Heater muffs if used should not be exposed if this can be avoided. A particularly good installation is that of the Empire flying boats where this muff is enclosed in the wing.

Care should be taken to ensure that the outlet from the heater will not discharge a hot blast at one part of the passenger or pilot while there is a cold draught striking him elsewhere.

Carburettor Air Heater

To give proper distribution and freedom from icing of the carburettor it is necessary to provide some means of heating the intake air.

There are several methods of doing this. The scoop which fits around the cylinders nearest the intake has been used with satisfactory results, but it is apt to cause uneven cooling of these cylinders. Alternatively a heater muff or a pipe running through the collector ring in the same manner as the cabin heater is used very effectively. Oil jacketing of the carburettor is another method of obtaining this heat, although it adds to the plumbing of an engine. With the exhaust type heater it is important to avoid contamination by exhaust gases as this can cause an appreciable drop in engine power, and detonation.

There should be a heater control which will be automatic, as intake air that is too hot will cause a large drop in power and reduce the anti-knock value of the fuel. Figure 11 shows the effect of air temperature on engine power.

A good thermometer should be fitted. The air intake should be so arranged that it will not take in dust during take-off or landing, and the area of the duct should be at least 10 per cent greater than the combined areas of the venturis.

Cowling

Many forms of cowling have been developed for aircraft engines. Those designed for liquid-cooled engines, with the exception of the forming of the actual material, are relatively simple when compared with the cowling required for the air-cooled engine. All that is required is that the engine shall be covered so as to cause as little drag as possible. This is of course apart from the accessories, radiator and oil cooler. In the case of air-cooled engines, the cowling must permit the proper amount of air to be directed against the parts of the engine requiring it.

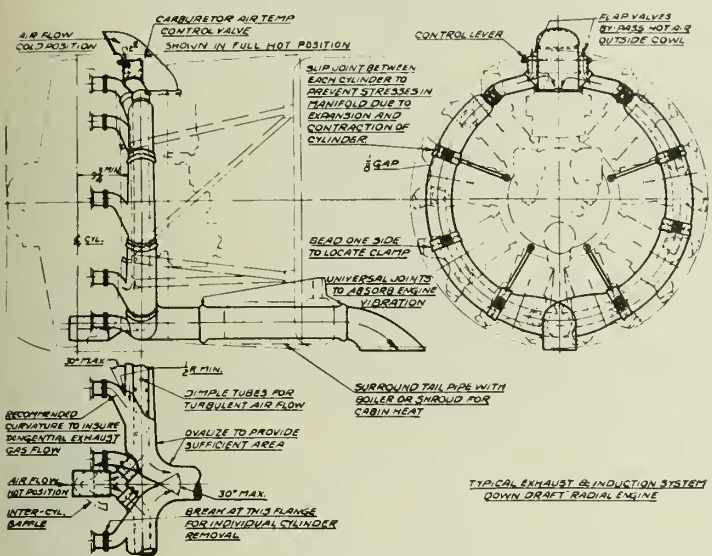


Fig. 12—Exhaust Arrangement of Wright Cyclone Engine.

For routine inspections, the cowling must be easily removable. It must also be light, and still be rigid enough for flight. These factors do not make for ease in design particularly where a limited production is in question.

Cowling fasteners when fitted must indicate clearly whether or not they are in the locked position.

For all engines, the cowling must permit the cooling of the accessory compartment, and must not permit any part of the engine to reach too high a temperature. This of course does not include the work of the cooling fins.

In the case of in-line air-cooled engines, it is sometimes necessary to fit an involved system of cooling ducts to obtain adequate cooling of all cylinders.

Many types of cowling have been developed for radial engines, starting with the circular trough of the rotary engines.

Probably the first important development was the Townend ring. This was closely followed by the low-drag cowling developed in the U.S. by the N.A.C.A. This consists of what might be considered as an extended Townend ring, and some models have controllable flaps on the trailing edge. An inner cowling is also used.

In conjunction with these two types of cowling, it has become necessary to use inter-cylinder baffles, both between cylinders and between the head and the cowling to secure the required air flow. The design of these baffles is a very tricky problem, and fortunately for the aircraft designer is done by the engine manufacturer.

Several interesting forms of cowling are in development among which is the Wright reverse flow cowling. (Fig. 13.)

Cooling must be provided for some of the accessories such as the magnetos, and where generators are heavily loaded, they must be cooled. The temperature of the accessory section should not exceed 140 deg. F. with the present gasoline and preferably should be considerably lower than this. If the accessory compartment reaches too high a temperature, trouble may be experienced with vapour lock.

There should be no unfilled holes in the cowling as these cause drag. The minimum requirements for accessory cooling on all Wright engine models is a pressure drop of 1 in. of mercury across the baffles at 1,300 r.p.m. on the ground and 3 in. of mercury at rated power and speed in flight; this is a reasonable figure for all similar engines. For high altitude aeroplanes of the future the cowling may have to include the supercharger intercooler. An example of this is shown in the Bristol altitude record aeroplane.

Oil Cooler

As a part of the heat of the engine is removed by the lubricating oil (1,400 B.t.u. per min. for 1820-G2 Cyclone engine) an oil cooler is necessary. The shape of the element may vary with different designs, but the unit consists of a cooler through which the oil from the engine passes on its way to the tank. Provision is made so that the oil may be by-passed when the temperature is low. The installation of the oil cooler must be very carefully considered from the point of view of drag and efficient cooling. The piping must be so arranged that the oil will not solidify and prevent proper circulation. A control of course must be fitted to operate the by-pass. An automatic oil cooler which maintains constant oil viscosity has recently been developed. Provision should be made for winter starting.

Wiring

The modern engine necessitates a considerable amount of wiring. These wires should be of the best quality and armoured. The cables should be carefully supported to avoid movement and should be kept as far away from the fuel lines and carburettor as possible. All wires leading back to the aeroplane should be removable at the firewall so that the engine may be removed as a unit without having numerous wires dangling from it.

The ignition cables and magnetos now supplied by the manufacturer are radio shielded in many cases. This also helps to protect them. Ignition switches should be within easy reach of the pilot and shall be off when pointing down.

Batteries should be in an accessible position so that they may receive proper attention.

Fire Protection

All transport aeroplanes must carry hand fire extinguishers. If the cabin is divided into separate compartments, then each compartment must have at least one extinguisher. One extinguisher must be within easy range of the pilot.

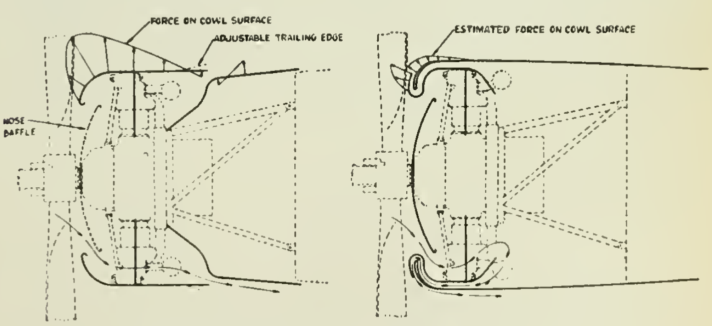


Fig. 13—Wright Reverse Flow Cowling.

While this is all that is required by the regulations, it is much safer to have a built-in extinguisher unit, piped to the various points where fire may be expected; particularly the engine and fuel system.

There are a number of types of extinguisher available. Probably the carbon dioxide snow apparatus is the most satisfactory. When other types are used it should be ascertained whether or not the fluid used will freeze in the temperatures apt to be encountered.

All fuel vents and drains must be carried well clear of the cowling.

The fuel lines must not pass within four inches of the exhaust pipe.

Except in the engine bay, the exhaust pipes may not pass through the fuselage.

INSTRUMENTS

A fire-proof bulkhead must be fitted between the engine and the fuselage or wings. Asbestos mill board $\frac{3}{32}$ in. thick between 24 gauge aluminum or duraluminum sheets satisfies the minimum requirements.

In addition to the conventional speed, fuel reserve and pressure, oil temperature and pressure, boost gauge, ammeter, air intake temperature and cylinder temperature instruments there are a number of instruments which have been developed which are of use to the pilot and should be fitted, particularly where the cost is not prohibitive.

An indicator is desirable to show when ice is forming in the carburettor. This instrument may of course be omitted when automatic de-icers or heater controls are fitted. An oil flow indicator should prove of value, for although the pressure gauge and thermometer are fitted it is possible that these will not tell the whole story.

An exhaust gas analyzer fitted to the tail-pipe gives the pilot a close check on the mixture control

A carbon monoxide indicator which will operate continuously and warn the pilot when the concentration reaches a dangerous figure.

SUMMARY

To summarize briefly the requirements of a good installation, the engine should be mounted as an easily removable unit which will function under all conditions of flight. All parts should be easily accessible for maintenance and care should be taken that as little vibration as possible is transmitted to the airframe.

REFERENCES

(1) H. Wood, Liquid-Cooled Aero Engines, Society of Automotive Engineers Jour., Oct. 1936, p. 400.

(2) P. A. Anderson, Air-Cooled Radial Engine Installation, Society of Automotive Engineers Jour., Sept. 1936, p. 341.

(3) Flight (Aircraft Engineering Section), May 30, 1935, p. 31.

(4) Automotive Industries, May 2, 1935, p. 642.

Figures 3, 4 and 5 appear through the courtesy of the Bristol Aeroplane Company and Figures 6, 11, 12 and 13 through the courtesy of the Wright Aeronautical Corporation.

57th Annual Meeting of the Society of Chemical Industry and 21st Annual Chemical Convention, Ottawa, June 20th-22nd.

More than usual importance attaches this year to the Annual Convention of the Canadian Chemical Association and the Canadian Institute of Chemistry. The meeting is held in conjunction with the Society of Chemical Industry of London, England, and a large delegation from overseas will land at Quebec on June 17th. There will be many distinguished members and visitors from abroad and from the United States.

The programme begins in Quebec and takes in Shawinigan Falls, Ottawa, Sudbury, Toronto, Hamilton, Niagara Falls and Montreal truly an ambitious undertaking. The principal sessions will take place in Ottawa, commencing with the presidential address of Viscount Leverhulme. Many excellent papers will be presented there, and the chief social events will also take place in that city. The president's reception and the annual dinner and dance at the Chateau Laurier are at the top of the list. At these functions the Engineering Institute will be represented by President J. B. Challies, who is also reading a paper on "Water Power and the Electro Chemical Industry" as part of the symposium on "Natural Resources of Canada and Their Development through Chemical Research."

The Convention comes to Montreal on June 28th to July 1st, when tours of industries and sightseeing, golf, luncheons, dinners, and a smoker make up an interesting looking programme.

The Engineer and the Law of Supply and Demand

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This report is published in The Engineering Journal in accordance with instructions issued by Council at the meeting held in Toronto April 22nd, 1938. Further reference to it wil lbe found on the editorial page.

Having been appointed by the Council of The Engineering Institute at the meeting held November 16th, 1937, to report on "The Present Supply and Demand for Technically Trained Engineers," I found on investigation that the subject covers so extensive a range of different branches of employment, and is of such vast importance, as to make anything approaching a complete survey of the subject a task entailing not only great expense but a tremendous volume of work. In addition to these considerations, it is evident that the rapidity of change in all engineering fields might render the report antiquated as soon as it could be published. This present report, therefore, is a superficial review of the matter as it appears to one whose record is a long experience in one branch of industry. Industry is one of the most fertile fields of future employment for young engineers.

Such a report, to be of any benefit, should be a provisional guide for young students, indicating the probable opportunities for them when they have graduated from the university, and also a suggestive guide to the professors, of the type and extent of study which will be of most service to these students in procuring employment, and for the eventual attainment of their success. Assuming that our universities, at present, are obliged to play the part of technical and business colleges and that the majority of their graduates follow an engineering course to fit them for financial success, it should be kept in mind that most of them require remunerative work as soon as possible after graduation. Also it has often happened that when a student entered college in prosperous times he planned his training as he and his advisors saw the future judged by the then existing conditions. These conditions were apt to change, and often did change, by the time the student graduated, and they have at times changed very significantly and suddenly. There is always a probability that many of the scientific processes of manufacturing construction will also change, thereby throwing much of the scientifically trained employment into channels very different from those current when the student matriculated. The man may then find on graduation that he has been cast ashore in lean years, having specialized in the wrong course.

The question arises too as to whether the general training is for the few who will eventually advance to the higher positions or whether it aims at fitting the great majority to earn a living immediately on graduation. It must, in this connection, be realized that the number of leading professional engineering positions is not large and is not nearly adequate for the number of graduates in engineering who complete their education every year in our colleges. In fact, there are not nearly enough berths of a truly professional nature in all classes of engineering to meet the increasing demands for them. If therefore, the supply of engineering graduates is not diminished in the future, is it not desirable that the college training should fit them to engage in allied lines of work, where their education in engineering would be of great advantage to their prospective employers? To indicate just what some of these allied lines are, and what courses are best suited to preparation for them, is therefore the objective of this report.

A great number of investigations, questionnaires, and inquiries have been made from time to time by various groups of engineers, but they have nearly all dealt with past history, and have been answered from a financial point of view, and dealt for the most part with the question of past and present earnings, salaries, and remuneration. It is the question of the future opportunities that engineers are required to think about at present, and how future engineers may be prepared for them in the most efficient way.

Perhaps our universities are trying to combine the objectives of the university and the business institutions. The university aims at educating a man irrespective of, or at least not primarily with respect to commercial returns, while the business college enables a man to understand the commercial affairs of his community, and to carry on the business by which he earns financial remuneration for his support. It would also enable him to superintend or direct the trade of engineering works.

Such, theoretically, are the functions of the training schools, but practically speaking it is of course of paramount importance that the graduate in engineering should find employment as soon as possible after completing his course, not necessarily or, even primarily for the sake of earning a living wage, but so that he may have an opportunity of applying his recently acquired knowledge while it is fresh in his mind; and also it is desirable that he should utilize the engineering data and reasoning with which it has been the object of his college to furnish him. It is very necessary that he should have an opportunity during the most receptive years of his life to practise some of what he has learned theoretically—viz. the years which follow his graduation.

Engineering, purely, as a separate profession, is vanishing rapidly from view, but it is expanding very greatly as allied with other professions, as a contributor to all that is scientific in commerce, and as a necessity in trade. As a consequence of this trend of engineering toward the allied employments, the training colleges must realize the fact that engineering is largely connected with commercial business, and that nearly all business and commerce is at its root primarily derived from engineering principles of an immense and varied type which are constantly touching our everyday life with a peculiar importance. We find evidence of and readily recognize the fact that an increasing proportion of engineering graduates must find their life occupation in this semi-engineering calling and employment. What this employment is to be and what training will best fit the engineering student for it, is the objective we are really seeking. A very superficial forecast of some of the prospects of employment for the young graduate is here suggested as a guide for the future, but as already implied it must of necessity be curtailed and inadequate in its information:—

1. *Industrial.* Such positions as shop superintendent, foreman, shop inspector, plant engineer and many others, have been, and perhaps still are looked upon by some as only to be filled suitably by mere mechanics. But most of these positions, indeed practically all of them, can, by the application of scientific principles, be made into engineering positions, and in this way increase their efficiency so greatly as to warrant a much higher remuneration than is earned by the majority of engineers engaged along the old professional lines. In these cases a graduate of any of our universities would be required to attain a certain

degree of practical skill, either in his long summer vacations or as a postgraduate training. Work in the shop for a certain period is almost imperative in such a course. These berths can be made the stepping stones to the very highest positions in the plants, provided the candidate has the cultural and social qualities required.

2. *Contracting.* Contracting, which has already become an engineering business (profession?) in the large corporations, and to a certain extent in the smaller firms, practically all partakes of the nature of engineering, even if in a simple method and to a modest extent. For this reason it is desirable that contracting undertakings should be directed by men with engineering knowledge and training. The labouring men who are to be directed in such work are constantly becoming more intelligent and it is less necessary now to do the driving by the old rough methods which were so common in former times. It is becoming more and more customary to recognize that the positions of superintendent, foreman, etc., can be often better filled by educated engineers than by skilled forceful and vigorous artisans.

3. *Sales Engineer.* We come now to the very modern but necessary member of the industrial plant, the sales engineer. His work represents a line of employment of recent birth, and there is every reason that it should act an important part in the future as a result of the rapid, intensive and, scientific development of the modern products of industry. The development has made this office requisite and necessary to the sale of products of the modern plant. Very many engineering products must have special engineering qualities and the engineering designs as well as scientific advice must be supplied by the producer when the product is to be marketed. Here again engineering knowledge is greatly in demand by the producers, and investigation shows that this line of employment is growing very rapidly. It is likely that it will continue to increase since the average products of all industries tend to become engineering specialities.

4. *Business and Commerce.* All business is connected with the trading of material, or of work produced which is, or should be scientifically directed; and therefore engineering knowledge is not only of great value in most of the occupations in business but it is especially useful in the management of all big commercial enterprises. There are many graduates who are endowed with a commercial turn of mind or who are not suited to the intensive concentration of strictly professional engineering questions who should, and do, find their best prospects in commerce connected with engineering trade.

In this connection it is possible that much can be done to improve the prospects of employment for engineering graduates, by showing those who are in charge of small and medium sized plants (which are to be found in nearly all classes of industry) the advantage to be gained by employing men with engineering training. If such employers would offer the young graduates opportunities of applying their technical knowledge it would be of great benefit. It would help solve the problems of many employers and also the question of finding technical work for the unemployed engineers.

5. *Research.* The candidates and appointments for employment along the line of research will undoubtedly be multiplied as science delves deeper and deeper into the unknown. Each discovery leads inevitably to more discoveries and points to previously unsuspected principles of truth. To some natures this seeking after new discoveries will provide the very greatest gratification, satisfaction and pleasure in the daily occupation of a never-ending pursuit. The enjoyment of the research worker in such efforts toward new discoveries means far more to him than any colossal financial returns.

6. *Consulting Engineering* is probably the aim of many young men when they enter college, but under existing conditions a conservative estimate of the future would indicate that very few graduates can hope to find enough private practice to enable them eventually to earn a livelihood. It is regretted that our Provincial Associations of Professional Engineers have not done more to encourage and preserve for the competent independent professional engineer the work of general designing and of the supervision of engineering works and projects. If all engineering projects could be legally controlled by licensed engineers, the community would be in a much safer condition and would undoubtedly be better served than it is at present. Under existing conditions and for the sake of the reputation of professional engineering, only the exceptionally clever graduate who is prepared to spend many years acquiring post graduate experience, should contemplate engaging in consulting engineering practice.

7. *Chemical, Electrical, Municipal, and Mining Engineering*, and employment with the railways, and big corporations with highly organized scientific departments are not here touched upon, since they should be reviewed by those very conversant with the openings for employment along their own particular line. These positions too, require greater specialization than the occupations already considered.

It is very difficult to forecast the course which the complete college training in any province should aim at. There is, however, one question which is specially important to us in Canada, viz. should all our colleges, situated as they are in such different environments, specialize on the peculiar requirements of their own districts, or should they all offer courses which are essentially the same and so fit the majority of their graduates to take up work which may force them to leave their own province or possibly to emigrate from the Dominion when the time comes for them to seek employment?

There are of course many occupations, other than those mentioned, which can be filled by graduate engineers with great advantage to their employer, but to try to give a full and useful account or advice about them, without a thorough and exhaustive investigation would be extremely dangerous. The salient fact regarding the future engineer's employment is that owing to our changing conditions only the few can hope to be assured of precisely the employment that they contemplated when they entered on their college course, but it can be recognized that the application of scientific engineering is widening and that general engineering is intruding itself into almost every sphere of modern life. The study of it in any form cannot fail to advance the prospects and success of those who are sincere in their effort to earn a livelihood by engineering, and who are willing to apply their technical knowledge to any type of commercial venture.

Are You Looking for a Job?

Advice to the Young Engineer

C. R. Armstrong

General Employment and Safety Supervisor, Bell Telephone Company of Canada, Montreal.

An address delivered before the Junior Section of the Montreal Branch of The Engineering Institute of Canada, January 17th, 1938.

It is my understanding that the Junior Section of The Engineering Institute has been studying the problem of the individual's adjustment from graduation to a place in industry. Your attention has been directed, I am informed, to the proportionately large number of engineers who have accepted positions believed to be suitable and after some experience have found it expedient to change their associations and try again. Time has been wasted, years have gone that might have been used to better advantage in another field, and suitable adjustment becomes more and more difficult to attain.

Worse than this by far is the condition of that unknown number who, perhaps after more than one trial, find themselves compelled by economic necessity and the weight of home responsibilities to carry on amid uncongenial associations, with remuneration far below their considered worth, with uninteresting and monotonous work, and with an outlook for the future that holds slim possibilities for any real improvement. In dealing with any phase of the problem of individual maladjustment in industry, you are tackling one of the most serious and vital situations of to-day, considered from the broad social standpoint.

Latest research in industrial relations is showing conclusively that the present unrest is traceable as much or more to individual maladjustments as to the economic factors of earnings and working conditions. The worker who is unhappy about his daily work or who hates his boss tends to dwell upon his unhappiness and readily decides to blame the whole miserable situation upon the corporation which hires his efforts, but not his interest. This is the state of mind upon which the propaganda of the professional agitator flourishes. This is the sentiment which, when fanned into the flame of action, may burst our present industrial organization wide open, if something is not done about it.

No one is much concerned about the effect of the professional agitator upon the engineering mind. But, if the same reaction is prevalent among the graduates of universities as with industrial employment, there is small hope for a counteracting leadership to throw its influence on the side of the stability and orderly progress which are essential for economic and social well-being. This is what is meant when I say that I consider you are engaged upon one of the most important social problems of the day—the proper adjustment of the graduate engineer to economic and industrial life. If, by assisting in this discussion on the initial interview, I can contribute something to your broader study I will consider it a privilege to have had the opportunity.

Before leaving that point, however, it might be well to point out there is no justification for becoming unduly pessimistic. In my experience and yours, we have met many who, in their daily associations, appear to be reasonably "happy about the whole thing." There is reason to believe they are in the majority even though they may not be heard from persistently. It is with the others we are concerned—those who graduate with engineering degrees into wholly unsatisfactory positions in industrial life. Why has this happened and what can be done to prevent it in the future or at least to substantially reduce the frequency? More particularly we are concerned with the initial employment interview—where has it failed and what can be done about it?

It is not my intention to deal with ideals—things as we may conceive they should be. More can be gained by dealing with facts even when these may seem to be hard and unsympathetic, considering it is a wholly human relationship that is under review. The situation we will try to describe is the meeting between the recent graduate of an engineering school and the representative of an industrial organization.

The young engineer is leaving behind his academic career with its peculiar interests and worries, to plunge into a completely different environment. He is usually young, keen, inexperienced and anxious to get started. He is delighted that the long grind of studies and preparation is over and he looks upon this next step as an adventure. He looks forward to his future success—seldom considering the possibility of failure.

From my experience, I would say that by far the greatest number of recent graduates are sensible, level-headed young men free from the conceit which is usually attributed to them. It is their inexperience rather than their conceit that creates most of the difficulties of the first interview.

They are quite indefinite in what they ask for. They are indefinite because they have not more than a hazy conception of what there is to ask for. They want a job, of course. Almost invariably they want a job with the possibilities of success. What kind of a job and what they mean by success are points to which they have seldom, if ever, given a great deal of attention. It is doubtful if they always have the necessary knowledge to weigh the relative merits of different jobs as they relate to their own interests and capabilities. This point I will bring up again later.

The representative of the industrial concern may carry any one of many titles: employment manager, superintendent, chief engineer. His position makes little difference to his purpose in the interview—his experience and outlook may make a great deal of difference to his conduct during the interview. No matter what his title may be he is acting in the capacity of representative of the concern that hires him. It is his business to protect their interests and their interests are invariably financial. If he employs an engineer he commits his company to the expenditure of money. A return for that expenditure is demanded. The better the return, the better the job that has been done. To put it plainly, the interviewer approaches the interview from the standpoint of a business transaction. Those he represents need a commodity—are ready to pay a reasonable price provided the commodity is up to the required standard. Otherwise, he cannot be interested.

The situation is quite similar to that of the salesman and the purchasing agent. The young engineer is the salesman and the interviewer the purchaser. The product is the engineer's present and potential capabilities. The interviewer's decision will be based upon his opinion of the relation of these capabilities, as he sees them, to the needs of his enterprise. Are they or are they not the best that can be procured for the amount of the purchase price?

That is something the interviewer has to decide. It does not, however, close the deal. At some stage in the interview, if it is to be carried through to a successful conclusion, the scene shifts and the applicant takes his place as the purchaser. From his standpoint it is not an impersonal product he is considering, it is, or can be presumed to be, his entire future economic life. Does he want to close the deal? Now the interviewer becomes the salesman. He has to sell his proposition to the desirable applicant. The applicant has a free choice to close or not to close and just as much time and effort is required to determine if the job suits the applicant as to decide if the applicant suits the job. In the long run it is probably the more important consideration.

The graduate who accepts a job without first finding out all he can about it and its possibilities is either a fool or an ignoramus. The employment man who declines to give as fair and accurate a picture as circumstances permit, will and should fail to bring into his organization any but the most desperate those who feel pressed to accept any form of employment for the time being and take a chance.

When I say the scene shifts I do not mean there is a definite point in the interview when the trend of the conversation undergoes a sudden change. The well-conducted interview is an exchange of facts and ideas from beginning to end. The applicant is endeavouring to supply the interviewer with facts about himself and to secure from the interviewer facts about the job and the organization. The interviewer, if he understands the first principles of his job, will be just as honest and sincere in his efforts to give as to receive facts and impressions. This process of exchange carries on right through the interview, sometimes one phase predominating and sometimes the other.

I am at this point, in fact all through this discussion, thinking of industry in terms of large corporations. Supposing the graduate accepts a position upon graduation which turns out to be absolutely unsuitable. He seeks employment elsewhere. Let us assume he retains his job while seeking another. He explains his position to the interviewer who immediately becomes suspicious. It is astonishing, the confidence one large corporation has in the fairness and wisdom of another. If he is dissatisfied there, he will be dissatisfied here, is the first reasoning of the employment man. In the interests of his firm he is immediately on guard. Let us assume the young engineer resigns, and starts out to seek employment again. The first question he faces is "Why did you quit?". The implications are obvious.

The task of the recent graduate in the employment interview is a sinecure when compared with that of the graduate of two or three years employment. The latter must be unusually impressive to break through the initial defence of the interviewer, have an exceptionally reasonable story to explain his desire for a change, or apply to a firm which is acutely in need of new employees of his standing. In the last instance it is the applicant's turn to be on guard and ask the question "why?"

This should not be taken to mean that once employment in one company is accepted the individual is condemned to work there all his life. There are means of gaining employment other than the cold unintroduced application at the employment office. It is, however, wise to point out to your friends who will graduate, the importance of getting correctly placed in the first instance. Later adjustments do present peculiar difficulties and these difficulties are steadily growing with the increase in importance, from the standpoint of employment, of the large corporation. Experience is dictating this employment policy. In many instances this opinion of the employment man has been borne out by experience. The probability is that the man who seeks to shift jobs often is shiftless. It is unfortunate that the poorly-adjusted man of high capabilities suffers through the standard set by the average.

The interviewer, it has been said, looks upon the interview as a business deal. The applicant can do nothing to alter this and is well advised to realize its truth and equip himself as well as he can for the situation into which he is entering. The intelligent interviewer is not concentrating upon recruiting or selecting the best man. That term is much too abstract. In the first place if one attempted to define the "best man" he would run into many difficulties. Obviously the best for one situation may not be the best for another. The interviewer, then, is trying to select a man from among those available who is most suitable for the position that is or may be available. The interview becomes a process of attempting to fit the characteristics of the man into the characteristics of the position and observing the nature of the result. The decision of the interviewer will be based not so much upon his opinion of such generalities as the all-round abilities of the applicant, as upon the mental picture he forms of the applicant in the job.

It can be assumed the interviewer knows a good deal about the position to be filled; if he doesn't he should not be interviewing. With this knowledge he can, or should, be able to describe in general terms the type of man he needs. During the interview he is trying to discover if the qualities that go to make up this type predominate in the applicant. It is now time to become analytical. What is there in each job that calls for peculiar traits in the individual? What are the personal characteristics that make one man more suitable than another for a particular situation? I am not going to attempt to describe in detail industrial jobs that are open to graduate engineers. It is easier and I believe more profitable to generalize. Let me explain.

An addition may be called for by the chief engineer for what he looks upon as his technical section. The immediate job is mostly assisting in work of an experimental nature. The future is industrial research. This technical section will, in all probability, be a group set apart from the general activity of running the business. Budgets and estimates, sales variations and production schedules will never become a part of the duties. The day-by-day occupations will resemble more the scientific research laboratory than the hurly-burly of industrial management. Speedy judgments will not be called for. Patience to carry through month by month, trial and error experimentation is an absolute essential. That type of mind that revels in mathematical formulae but does not require the stimulation of social contacts to keep up interest and enthusiasm; the man who chooses the laboratory in preference to the football field; the potential scientist in contrast to the potential man of business, will fill the bill. There are a few right jobs for the scientific student in industry but there are thousands of wrong ones. There are some industries that can use his services to good advantage, but there are many that cannot.

There is another type of engineer whose work is rather difficult to describe. Let us call him the methods engineer. His position calls for the same type of patience, the same ability to keep going month after month on hope without immediate tangible results. To capably fill this position one must have all the attributes of the student. He studies operating methods, methods of doing the work in the plant and the operation of machines. He tries to find improvements. But he must do more than discover improvements, and it is this that inclines me to separate his job from the first class. He must have, or be able to develop, the ability to put over his ideas to practical men such as plant managers and superintendents. He must think in terms of the student and talk and write in the language of the craftsman. Many of his duties can be carried out only with the co-operation of the operating staff. Usually he is called upon to put his suggestions into writing in a form that will not be misunderstood by practical people. He will have to take his place in that great modern industrial institution, the conference. If you like, he is the industrial, literary scientist. I think you will agree that a considerable number of graduates, even from among the so-called outstanding men, fail to qualify. No useful purpose would be served in going on to describe other variations of the technical engineer.

Next in order I would refer to what has been called the operating engineer. He is the man who lays out or plans the job, usually in relation to some form of construction. He is not much concerned with research. He learns all about the accepted methods and standards of the work of his concern and prepares the plans from which the field or plant forces do their work. He sets the detailed rules to be followed. This type of work calls for a set of abilities and interests different from those that bring success in the more speculative jobs. It is work for the doer, the man who gets satisfaction out of direct accomplishment, in psychological terms, the extrovert.

The job of the sales engineer calls for a man with a make-up almost the opposite of that of the research engineer. It has been said that the successful salesman is born not made. However that may be, the adult individual who has had born in him, or who has acquired, a nervous or too modest response to strangers finds it impossible to develop the particular poise of the successful salesman.

So far we have been considering those positions in industry that carry the title of engineer. I know there may be differences of opinion at this point but from my experience I will say frankly that, if engineering graduates will insist upon looking upon themselves solely as professional men and will undertake only those jobs labelled engineering, they will, by thus limiting their future to the one relatively narrow field, seriously miss some of the brightest opportunities of the future.

The industrial scientist has his place, and an important one. But the greatest need is for well trained and capable men in the field of Industrial Management. The large and growing corporations need and will continue to need, probably more than anything else, men capable of handling the intensely difficult tasks of industrial leadership—trained men, big men, men who can visualize the significance of things as they fit into the larger pattern. Men of normal intelligence can be trained to do accurate and painstaking work. They may be trained to direct others to do detailed work efficiently. But when this average man is assigned a position of higher rank and greater responsibility he finds it impossible to grasp the essentials of the broader situation and before long is floundering in difficulties. The hardest positions to fill are those requiring broad executive ability and the peculiar characteristics of leadership. The field of industrial leadership offers the greatest opportunities for those capable of shouldering that responsibility.

The chief engineer is not chosen for his engineering ability. He is often far behind in technical skill and knowledge. He is chosen for the same reason that any other executive is chosen, because he has definite administrative powers. He can see and appreciate the broad picture of company purpose and activity, and can co-ordinate the work of his own department to serve the broader needs. The technical expert of all levels must, by the nature of things, be subordinate to the executive head. We should, therefore, include in our classification of job possibilities those that give, or lead to, the experience necessary for executive leadership.

If I am ever asked to advise a young graduate of known ability and promise, I will without question suggest he get into the business or operating end of the business and let his success be dependent upon his demonstrated ability and not upon his academic degree. This will sound like old-fashioned advice. Like many other things that are old-fashioned its truth is again coming to be fully appreciated.

I have dealt at considerable length with these points because in so doing I have, I think, described a good deal of what is in the back of the mind of the interviewer. His assignment is not merely to hire a man for a job. It is to bring into his peculiar organization a man with the peculiar qualities that will become an asset to the business and, coincident with that, provide the man with reasonable prospects for a successful career. And by successful career I mean, as will be discussed later, one that makes use of his predominant personal characteristics as they are and as they are likely to become.

Turning to the other side, what can the applicant do to aid in carrying the interview through to a satisfactory conclusion without unnecessary delay? The answer is quite simple.

The first and most important step should take place some time before the date of the interview. It is an honest self-appraisal, if possible with the aid of a friend in whom the applicant has confidence. This somewhat painful process should not be directed by the general question "How good am I?". It will take years of experience to answer that. It should lead up to answers to two important questions: (1) What am I best fitted for? and (2) What do I like? It should not be impossible to come to a reasonably intelligent judgment from a review of recent college experience. The student has spent years labouring over such subjects as mathematics, mechanics, economics and accounting in some form, and has had experimental and mechanical experience in the laboratory. Which of these have been hardest to get interested in? In which have the results been poorest? Which, if any, have been reasonably easy but tiresome? Which have become progressively more interesting the more deeply they have been investigated?

Then there is the other side, class and college social and athletic activities. Have they been uninteresting, or participated in no more than necessary? Is associating with other people tiresome? Perhaps an honest review will indicate to the graduating student that he did pretty well in these things and found real enjoyment, or that he had been elected to office frequently and enjoyed it.

This self appraisal does not call for a psychological examination in technical terms. It is not scientific treatment that will get the best results at this stage; it calls for the application of some good horse sense. Surely anyone with enough grey matter to go through to a university degree, and clever enough to fool a host of professors into believing he has mastered a score of subjects, is capable of looking back over the events of the past four or five years and appreciating their significance in relation to himself. If he can't do that let him apply for a pick and shovel job and find his proper level.

If applicants could learn to do all this in preparation they would earn the eternal gratitude of all interviewers. I suppose I have asked hundreds of times "What kind of a job do you want?" Hundreds of times I have been rewarded with the answer "Some place where I will have a chance to get ahead." Who doesn't? Then begins the long digging process of question and half answer. 'What subjects did you find most interesting? Why? What have you done in addition to going to college? How did you find this and what did you think of that? Eventually, if both parties have enough patience, the applicant will tell something of himself, what he has been good for and what he has been interested in, and a mutual decision will be reached that the job the interviewer has in mind is not suitable. A great deal of time has been wasted because the applicant was not prepared.

But now, suppose the applicant has reviewed his past activities as suggested, and, after the preliminaries necessary to form the contact with the interviewer, tells his story plainly and simply. He is acting as a rising young business man should, he is putting his cards on the table and explaining the uses to which he believes his product can be put. That is the way any business deal should start.

Now the interviewer has his chance. He can explain the conditions of employment in his concern, and in general terms the nature of the duties of the job he has in mind and the nature of the work to which the first position may lead. By this time all the cards are on the table and it is a relatively simple process to determine if the qualifications of one party fit the needs of the other. A satisfactory conclusion can be reached because two supposedly intelligent people have before them the data for the solution of their problem.

Much is being said and written about the technique of the interview and the science of interviewing. I do not propose to deal at any length with this because it applies chiefly to the interviewer. The applicant, in my opinion, needs no technique, in fact is better off without one. His policy consists first of all in deciding what he wants and why he wants it. If he clearly and naturally explains this to the interviewer he has done his share.

I do not think the interview should be looked upon as a psychological examination probing into degrees of intellect, memory, imagination, social adjustments, etc. It can't be. Such examinations take a great deal of time and no industry is, so far as I know, equipped with a personnel capable of conducting them. The interviewer looks upon the applicant as a behaving entity and not as a synthesis of functions. He forms certain impressions of the individual from what he is told and how it is told. He is looking for a man of business and will be impressed by the applicant who conducts himself throughout the interview as if he were one. I feel, therefore, we are not missing much in passing over lightly the technique of interviewing as it applies to adult graduate applicants. If we were dealing with interviewing of a different kind, interviewing, for example, those already employed endeavouring to uncover true mental attitudes in connection with the relation of workers to their conditions of employment, it would be a totally different matter.

It was mentioned earlier that the normal applicant has not given much thought to the meaning of the success he says he is seeking. In most cases he is thinking somewhat hazily of his future earning power. If he were to define minimum success he would probably begin speaking of so many thousands of dollars per year. From one standpoint this is not so unwise for one starting on an industrial career with the advantages of a college training. Nearly all the important positions in the larger corporations command salaries of considerable size. But the question I would like to raise is this: Is each man who fails to rise to the level of such important posts, a failure? I hope not.

For each one who climbs to a position of power and earnings measured in the tens of thousands of dollars there are some thousands of others who do not get there. But our whole background from the cradle to college graduation is permeated with the thought that success in such extreme terms is available for those who apply themselves. I heard recently of an American couple living in Montreal who returned to the United States for the birth of their first child. Quite seriously they called our attention to the clause in the constitution which requires that the President of the United States must be born within the boundaries of that country. Incidentally it was a girl. That is, after all, but an exaggeration of the attitude of a host of parents. Their child will have opportunities denied them. With these he will climb to a position of wealth and power. These opportunities become a terrible responsibility. Driven into the growing child is the slogan "strive to succeed;" "work to get on top." Anything else will be failure. Hope beclouding judgment, capabilities are imagined that are not there. The fall is hard, the disillusionment is great, because the aim has been unreasonably high. Application and some luck will bring success but not in the sense referred to. There is but one president and one chief engineer of importance for each several thousand workers. If everyone is a candidate many must be defeated.

The man who fails to land a job big enough to challenge his ability and hold his interest is unfortunate. The man who is grasping and gasping in a position for which he is not fitted is even more to be pitied. Much of the maladjustment of which we spoke is not a maladjustment between the man and his work at all. It is a maladjustment between the man as he is and as he has come to think of himself. His work is often quite suitable from every standpoint save that of his own foolish hopes and ambitions.

My final suggestions to the applicant approaching the employment interview are quite simple.

1. Avoid, as well as you can, over anxiety and self-consciousness. If you are the right man for the job the interviewer is as much in need of you as you are of his job. If not, it is better for both to find it out at once. Failure to land a job is not failure in the broader sense.
2. Try to forget it is yourself who is the object of the bargain.
3. Come with a well prepared description of what you have and have not been able to do.
4. Be prepared to judge the kind of thing that will appeal to you and will in all probability hold your interest.
5. Tell your story frankly and openly.
6. Demand equal frankness in return. Beware of the interviewer who oversells the advantages of the job and of his firm. You have just as much right to study him as he you. Stay with it until you are satisfied you have the facts.
7. Do not be discouraged with failure to sign up on the first attempt. You will have probably 30 to 40 years to work. A few weeks' effort spent in making as sure as you can that you are starting right on that long journey is not so serious a matter after all.

And I would like to add this. Approach the first interview with as much as possible of the carefree attitude of an adventurer rather than with that horrible grim determination to forge ahead at all costs. Find the type of work you are sure you will like, aim for congenial surroundings, start out with the idea that work itself, even in dark modern industry, can be a pleasure, and let the future take care of itself.

DISCUSSION ON

Canadian Steam-Electric Power Plants

Paper by C. A. Robb, M.E.I.C.[1] presented before the General Professional Meeting of The Engineering Institute of Canada, at London, Ontario, on February 2nd, 1938, and published in The Engineering Journal, March 1938.

Johnstone Wright[2]

Data and a brief commentary on the development and performance of Central Power Stations in Britain follows:

Power Station Design Features, etc.

Under the national scheme the retention of small capacity stations located adjacent to the load centres, peak load stations, and the reconstruction of old stations, are all governed by careful investigation into the question of policy and economics of generation and/or transmission.

With regard to the range of fuel and variation of furnaces designed to burn any available fuel or mixtures of fuel in this country, only a few cases of solid and gaseous mixtures are in use, and comprise pulverized coal and/or blast or coke oven gas.

On the other hand the geological structure of the British coal fields results in the volatile content of the coal varying from 5 per cent to 35 per cent within a range of a few miles. As a consequence, many firing equipments and furnaces must be so designed as to operate under widely varying volatile constituents. On the pulverized fuel firing equipments wide ranges in the proportions of primary, secondary, and tertiary air supply are necessary, whilst on stoker equipment of either the retort or chain grate types, a similar wide range must be made in the proportions of the primary and "over fire" air quantities.

Industrial Aspects

The use of by-product steam for generation purposes produced in either refuse destructors or by the burning of the final surplus of blast and/or coke oven gas at steelworks (after supplying the metallurgical heating requirements at works) is only undertaken after careful investigation into all the commercial factors of the case. It would appear that the value of such steam is represented by the incremental operating costs of steam production in a base load station, because these supplies are, in general, of an intermittent nature.

Interchange of energy is a feature in conjunction with certain steelworks electricity supply contracts providing the proportion between electricity imports and electricity exports has a commercially economic value. The maximum price paid for steelworks electricity exports is again fixed by the incremental cost of electricity production at the base load generating stations.

Diesel engines as a factor of power development influence the economic competitive tariff according as they are used (*a*) for electricity generation or (*b*) for direct mechanical drives. In case (*b*) the public utility company has to take into account that only the difference between the capital charges attributable to the engine drive and electric drive is available.

Electric boilers for use in conjunction with space heating apparatus are in frequent use, but to the best of my knowledge no such boilers are ever used for power steam production.

Design Cycles

During the earlier years of trading under the national scheme, a standardized cycle of 650 lb. g. 850 deg. F. with regenerative feed heating in four or five stages to 340 deg. F. to 350 deg. F. has been adopted. The station heat consumptions are established at a low level and when viewed in conjunction with the initial cost per kilowatt installed and the simple operating layout, commercially justify the cycle adopted.

At the North-Eastern Electric Supply Company's Dunston power station, a combined re-heating and regenerative cycle was adopted in conjunction with the same initial and terminal conditions.

The North Metropolitan Electric Supply Company have nearing completion a 53,000 kw. capacity plant, operating on a 2,000 lb. g. 950 deg. F. re-heating and regenerative cycle.

The London Power Company are also extending the Battersea station with a 100,000 kw. capacity plant designed to operate on a 1,400 lb. g. 965 deg. F. straight regenerative cycle. The 85,000 kw. low pressure section will also be capable of operating on the existing boiler plant designed for 600 lb. g. 350 deg. F. feed. This scheme should be commercially very successful, as it allows of the maximum output being installed on the site, and also of a maximum flexibility between new and existing plant.

Operating Data and Factors

Usually the spinning reserve in any area is limited to a maximum of 15 per cent. On the other hand the plant in individual stations might be run at from 85 per cent to the M.C.R. load depending on the local conditions in that area.

Superposed Plants

The commercial operating conditions under the national scheme have to date not been conducive to the wide application of superposed plants. Investigation has established that, in general, superposed plant must be justified on a commercial rather than on a heat consumption basis.

Steam Generating Plant—Trend of Design

Before proceeding with any remarks regarding the trend of design, it is considered necessary, first, to establish that the standard designs of 650 lb. boiler plant have proved extremely flexible. When fitted with either pulverized or retort firing equipment, these boilers have demonstrated that they may be loaded or unloaded at the rate of 20 per cent per min. without interfering with the natural circulation.

It would appear that the trend in boiler design to meet the ever increasing pressures, may be broadly divided into two sections: (*a*) the continued use of natural circulation and (*b*) the adoption of forced circulation systems.

(*a*) Natural Circulation Types

The adoption of a high head design where the cross drum is located at a high elevation relative to the furnace and convection tubes in a straight tube boiler design. In addition to improving the natural circulation, the design provides a very straight path for the gases, which should materially improve the availability factor in service.

An alternative design known as the Cantieny boiler embodies a special circulating system. Intermediate headers are provided to separate out the steam bubbles generated in the furnace water screens. Further, the water is fed to the furnace screens throughout the whole length of the main boiler drum.

(*b*) Forced Circulation Types

(i) The Loeffler system, which is designed for approximately 2,000 lb. operating conditions, employs a steam circulating pump which drives saturated

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steam through the tubes forming the furnace walls (i.e. a radiant superheater) and the convective superheater located in the first pass of the boiler proper.

(ii) The Lamont system where the water from the main drum is forced through the water walls of the furnace by means of a separate circulating pump. The London Power Company have installed the largest boiler in the world of this type in their Deptford West power station extensions, for a duty of 400,000 lb. per hr.

(iii) The Velox boiler where the water is circulated at high speed through evaporator tubes forming the water wall of a combustion chamber. This boiler has to date been developed to be suitable for firing with any liquid or gaseous fuel, and the company are making intensive research to its application with powdered fuel firing. Although to date no Velox boilers are installed in the power stations in Britain, solely on account of the high price of fuel, it has been successfully applied on the continent and in New Zealand in conjunction with water power development schemes. The boiler is capable of being raised from cold to full output in a period of 4-5 min.

Manufacture

Due to the continued research into the science of welding, manufacturers are prepared to offer welded drums for pressures up to, and in some cases over, 650 lb. per sq. in. pressure.

Louis Elliott[3]

The writer has been much interested in the author's paper on Canadian steam development, and feels that he has rendered a service to the American engineering fraternity, in summarizing conditions and current practice in Canada.

The amount of electrical energy generated by Canadian plants has been increasing rapidly, more than doubling during the last decade as compared with about one half that rate of growth in the United States—although in the latter country, generation trebled during preceding ten years. Canada shows an extraordinarily high average energy consumption—1,950 kw.h. per capita. This reflects low average energy rates and high industrial and residential use, as well as enterprise put into development of load. It would appear that in a number of districts, established rates favour residential consumers at the expense of other classes of business.

The author brings out the wide spread in cost of energy for residential service in Canada—varying from about 1 cent up to nearly 8 cents for the different regions. This wide range emphasizes the irrationality of any general "yardstick," for determining reasonableness of rates. Another question as to applying a "yardstick" arises from difference in incidence of taxation under various conditions: for instance, Professor Robb points out that for commercial stations, taxes in 1935 amounted to nearly 21 per cent of total expenses, whereas for municipal plants taxes accounted for only about 1 per cent of total expense.

Canada is magnificently endowed with water power resources, in many parts of its great territory, and future prosperity will doubtless be bound up with the utilization of this hydraulic power. It is not improbable that during the next few decades commercial and technical developments will demand tremendous blocks of electrical energy, for chemical and related industries. To fulfil such a demand, Canada will be most favourably situated.

With this in view, and considering also the occurrence and character of Canadian coals, it is probable that steam generation will continue to play a relatively minor part. Whereas in the United States steam power is much more important than hydro-electric, and new hydraulic plants will be developed more for peaking or relatively low-load-factor service, steam stations in Canada, in the sections with large water powers available, will probably continue to supply kilowatts rather than kilowatt-hours. The author cites a capacity factor in 1934, in Canada, equivalent to about 4,000 kw.h. per kva. of hydro-electric capacity, and about 1,300 kw.h. per kva. of steam installation.

The author points out that at the present time Canadian steam stations "do not occupy a favourable position on the basis of thermal efficiency." This condition is perhaps to be expected, as a very large proportion of total energy production in Canada has been by hydraulic plants, and highly efficient steam plants can seldom be justified for low capacity factors. In future situations demanding large thermal plants to carry base load, Canada will find it worth while to provide highly efficient steam capacity.

The author, by charts and in discussion, brings out in striking fashion the rapid increase in fixed charges per unit of output, as load factor drops. This is a condition which seldom receives the attention to which it is entitled.

Generous supplies of lignite are available in a number of districts in Canada. For high-moisture high-volatile fuel similar to the Canadian lignite, experience at Trinidad station of Texas Power and Light Company has proved that a pulverized coal plant can be made successful and economical. It is therefore to be expected that as larger steam plants are built in Canada, utilizing lignite as fuel, the pulverized coal method of burning will be adopted in a larger measure.

The author cites the advantages of "topping" extensions, which have been quite "fashionable" in the United States during the past two or three years. It is the usual experience that these superposed extensions, which are rather expensive per unit of capacity, are economic only when capacity factor of superposed and corresponding low-pressure units can be made very high. It is seldom that a "topping" extension can be justified by fuel saving alone.

Common practice in the United States, for a good-sized steam development, is to use 1,200 lb. (or higher pressure) 900 to 950 deg. F. for a superposed installation, and 850 lb. 900 deg. F. or 650 lb. 825 deg. F. for a condensing unit. For smaller plants and low-load-factor service, 400 lb. 750 deg. F. or lower steam pressures and temperatures are still used.

J. A. Powell[4]

The writer most heartily endorses the use of a load duration curve in studying the plant requirements and detail studies of the component equipment before actual design is begun on a plant to eradicate prejudices and pet theories.

On a growing system requiring additions from time to time there is no such thing as a fixed set of operating conditions. The new unit or plant always takes the primary load and other units or plants take their position in the system loading according to their respective fuel costs. A new addition may have a load factor of 75 to 80 per cent to start with yet later on in its life its load factor may drop to 10 to 25 per cent.

It is the writer's opinion that no plant can ever be discarded for reason of obsolescence. Boilers may have to be replaced due to age and poor efficiency, but these can be replaced by ones of higher pressures and the installation of a topping turbine, which gives the plant a new lease on life. If the load factor on the plant does not justify top-

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[4] Vice-President, E. M. Gilbert Engineering Corporation, Reading, Pa.

ping, efficient new low pressure boilers may be added as a more economical step than building a new plant.

In some systems the primary unit may operate for 8,000 hr. per year, while peak and stand-by units may operate only from 500 to 600 hr. per year.

For these reasons the interest of the designing engineer should be cost per kw.h. including fixed charges, fuel, labour and maintenance and not B.t.u. per kw.h.

The attached duration curve was actually used in the study of a system in which 1,400 lb. pressure boilers and a 20,000 kw. topping turbine exhausting at 250 lb. was to be installed. This system had four plants utilizing pressures of 1,400, 350, 250 and 200 lb. gauge boiler pressure.

The installation of the 20,000 kw. topping unit in plant "B" was the most economical of several plans considered for providing additional power to this system and replacement of boiler equipment unfit for longer use.

System Plant Capacity—Hours Use and Generation

	Capacity kw.	Hours	Kw.h. annually
Station A	......	8,010	322,000,000
Station B			
Unit No. 2	30,000	8,000	148,000,000
Unit No. 1	30,000	5,910	98,300,000
Station C			
Unit No. 6	30,000	7,750	214,000,000
Unit No. 7	20,000	8,000	119,500,000
Unit No. 5	25,000	4,160	75,000,000
Unit No. 4	10,000	1,850	12,500,000
Station D			
Unit No. 1	10,000	2,300	19,500,000
Unit No. 2	5,000	1,000	4,840,000
Unit No. 3	5,000	850	3,710,000
Unit No. 4	10,000	600	3,810,000
Purchased	......	500	440,000
Hydro	......	8,760	117,900,000
			1,120,000,000

G. A. Gaffert[5]

This paper appears to be a very thorough and detailed presentation of the power situation in Canada involving considerable technical information on the performance of Canadian stations and an admirable comparison with stations in the United States and Great Britain. Unfortunately, the author has not chosen some of the really outstanding stations in the United States in making his comparisons on economy, and several stations such as the Port Washington, South Amboy, State Line and Richmond stations, would give a somewhat different picture. Also the English stations cited have higher steam pressure and temperature conditions and compare more nearly with the following American stations:

Station	Pressure and temperature	Average heat rate—1936
Edgewater	600—835 deg.	13,840
Trenton Channel	390—710 deg.	13,800
Michigan City	650—750 deg.	13,300
Richmond	400—670/800 deg.	13,300

It would seem that the Canadian plants have not taken full advantage of the extraction cycle in that only two heaters are used in the average plant and a maximum of three extraction heaters are used in one plant. It is our experience that when fuel is costly, i.e., 20c. per million B.t.u., three or even four extraction heaters are economically advisable, as it is possible to pay for these heaters in a relatively short time out of annual fuel savings.

The author's comment about the elimination of slag screens is not quite correct, as practically all of our large boilers still have slag screens for the definite purpose of preventing slag from entering the superheater sections or more remote parts of the boiler, which it would be rather difficult to clean by hand. Reference might particularly be made to furnaces at West End, Columbia, and Fisk stations, wherein slag screens play a very important part.

It also seems that where fuel transportation is high, a condition that prevails in Canada, more development work should be encouraged on the burning of local lignite deposits. Even though the boiler efficiencies obtainable would not be of the order obtained with bituminous coal, the lower fuel cost should, in the long run, produce lower power cost.

The author's comment about erosion of turbine blading is also rather interesting, for several American manufacturers are now resorting to Stelliting on turbine blading for the purpose of eliminating erosion on the last stages operating in the moisture zone.

The author notes that condensing surface has been reduced to a rather low figure of .562 sq. ft. per kw. This is a rather dangerous conclusion to reach, for although Canada is favoured by cold condensing water, many condensers located in warmer climates must use larger surfaces to attain higher vacuum. In other words, it is necessary to provide either greater surface or more circulating water to obtain equal vacuum with warmer water.

We also feel that there is a definite tendency toward a unit plant but the conditions of reliability for any one system have not yet approached a status where a one boiler, one turbine plant is generally accepted as being the logical line of future development.

[5] Mechanical Engineer, Sargent and Lundy Engineers, Chicago, Ill.

John M. Drabelle[6]

The author has made a very valuable contribution to the science and art of the steam power generation and as in the tabular data furnished a most convenient review of practices in reference to new steam power developments. Since the date on the Cedar Rapids station was originally furnished the equipment has gone into regular operation and while at this writing no tests have been made the following observations will be of interest.

No difficulty of any kind has been experienced with inner water wall which divides the main furnace into two separate furnaces. There seems to be a decided cooling effect from this wall and as a result very little slag has accumulated on the first row of tubes that look at the fire.

In respect to the water-cooled stoker no operating difficulties of any kind have developed, but certain changes have been made by the manufacturer, the American Engineering Company, in the pushers in order to get a more uniform distribution of coal over the active surface of the stoker. Over-fired air is now available as well as preheated air and smoke difficulties are being rapidly eliminated.

In respect to the turbine which is of the topping type, no difficulties whatsoever have been experienced with the unit. The pressure control which is of the bellows type and makes use of an orifice has given excellent control of the unit. No difficulty has been experienced in connection with any of the piping. This being low carbon moly steel.

The only difficulty that has been experienced has been with the boiler feed pumps which have caused some difficulty and have occasioned outages.

[6] Mechanical and Electrical Engineer, Iowa Electric Light and Power Company, Cedar Rapids, Iowa.

A. K. Spotton[7]

There is one point not mentioned in the paper relative to the utilization of small power plants using reciprocating engines exhausting into low pressure turbines. Some recent installations show that such combinations give high efficiency; in one British unit of this type, about 20,000 lb. steam per hr., 5.9 lb. per B.h.p.

Professor N. M. Hall, m.e.i.c.[8]

The author is to be complimented on his concise presentation of a mass of information on the state of power generation by steam in Great Britain, South Africa, United States and Canada.

The situation in Canada stands out in bold relief on account of the small size and generally poorer thermal performance.

The wide use of water-generated power has delayed the development of Canadian steam stations in the provinces blessed with abundant water power. But as the economical sites are developed, the steady increase in energy requirements will necessitate co-ordination with new fuel stations to pick off peak loads. This will be followed by their assuming more and more firm power. The author has outlined the trends in the design of such stations in the light of developments in less favoured countries.

The relatively good thermal performance of British and South African stations, raises the question as to whether their records are based on lower calorific values; which would give them an unduly favourable comparison with North American stations, where the gross value is used.

Although in many provinces coal prices are relatively high, this is somewhat offset by the lower weighted average temperature of circulating water. This however is of lesser importance with the increasing use of the regenerative cycle.

The recent development of high pressure boilers and low heat drop turbines exhausting into existing station headers, should find many applications in Canadian practice.

The broad bibliography and comprehensive tabulation of installed equipment and operating data, add greatly to the value of the paper. The absence of several provinces from this tabulation sharply indicates that they have been amongst those favoured by abundant and cheap hydraulic power.

S. R. Parker[9]

There has been a great amount of discussion on the proper methods of burning coal and the associated question of the proper design of the furnaces and grates for the most efficient use of the coal within contiguous and economical freight hauls from present or proposed plant sites.

While great improvements have been noted in the last 25 years in this connection, which have resulted in the cutting of coal used per kw.h. generated by more than one-half, the progress, when we take into account the great number of steam plants that we have, does not seem to be as great as it might have been. Actually, there are 250 steam-electric generating plants as compared with 316 which are driven by water turbines. This lack of progress is stressed by the author in his conclusions where he states that "thermal performance of Canadian steam-electric plants does not compare favourably with that of plants of comparable size in other countries." This aspect of the situation is worthy of very careful analysis and is a challenge to all Canadian engineers engaged in this phase of the work in view of the fact that the potential coal resources of Canada are great as compared with other sections of the world and generally speaking available water resources in the coal areas are reasonably distant from centres of population.

Wide variations, as far as burning characteristics are concerned, of the coal available are possibly a contributory factor to the poor results obtained and this would seem to reflect, to some extent, on the ability of the design engineers to provide the correct design features which are most suitable for the coal characteristics within contiguous and economical freight haul of the plant location. In fairness, however, it must be conceded that the design engineer has been severely handicapped in co-ordinating design to obtain the best efficiency results by not having available for his use observed data on combustion results taken by trained observers.

The main responsibility for this situation largely rests with the executives of the operating companies who have shown a tendency in the past to consider their steam power plants as units in which maximum efficiency and continuity of service were not compatible terms. It is hoped that the interest taken in these papers and the missionary work done by certain eminent engineers in this line of endeavour will result in steam power plants being considered as complex operating units where, by proper co-ordination of technical skill with manual dexterity and operating experience, continuous service and economical operation are both practical and possible. The situation has been aptly summarized by Prof. A. G. Christie in his paragraph on "Personnel of Boiler Plant" in his paper read before the American Institute of Mechanical Engineers in September, 1936 in which he states that:

> "Nowhere in the power plant has there been a greater change in the type of operator than in the boiler room. Turbine efficiency is largely fixed by the original design, but boiler room efficiency is only secured by constant vigilance. Hence highly trained, intelligent, alert men are needed for economical operation of this section of the plant in contrast to the strong-backed coal passers of former years."

A comparison of the operating, and particularly, supervising staff in Canada and in other countries, employed in the power industry will indicate that during the past 25 years Canada has not progressed to the same extent as other countries in recruiting and training staffs to secure the constant vigilance necessary to obtain the greatest efficiency from the equipment produced by the design engineer.

While holding no brief for the design engineer the writer considers that he is not in a position to produce the best design for the local conditions unless he has available operating data taken by trained observers to enable him to co-ordinate this with his theoretical knowledge in order to produce the best design to comply with reasonable operating conditions that have to be met.

Due to the scattered nature of the plants and the varying conditions in almost every location with respect to coal characteristics and service requirements unless operating officials co-operate and supply the design engineer with accurate observed data, Canada cannot hope to approximate the thermal performance of comparable size plants in other countries. In other countries they have insisted for some considerable time on dividing their operating staff into skilled technicians and artisans. One group is responsible for obtaining maximum efficiencies from the equipment placed in their charge at lowest costs whereas the other group is required for its manual dexterity and experience in maintaining the equipment in first class operating condition.

It is very seldom that men who start in the second

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category in a plant obtain promotion to the supervisory group unless they already have had, or later obtain, technical experience; until a similar policy is adopted in Canada our plants, with brilliant exceptions, are not likely to compare favourably with those in other countries even though the latest features of design are embodied in the original installation.

It is obvious that progressive modifications in design details must be continually tried and discarded or adopted, based on observed operating data and the theoretical development of the art, if plant extensions or new plants are to show progressive improvement in conformity with local conditions which govern.

The paper presented in June by Mr. Bull on "Experience in Burning Western Canadian Coals," brings out very forcibly results that can be obtained by application of scientifically observed results to the latest theoretical data on design to develop a plant to give minimum operating costs with maximum efficiencies and low capital investment.

When it is fully realized that coal burning is not a manual process but a scientific art and plants reinforce operating staffs with necessary technically trained men, one may expect to see:

(*a*) progressive development in the design features for the scientific burning of the various coals;
(*b*) improvement in overall station efficiencies;
(*c*) a material reduction in capital investment due to co-ordinated and scientific layouts.

R. S. Griffith[10]

In the author's paper in the first paragraph on page four, the remarks contained therein would stand clarification. A new condensing turbine rated at 7,500 kw. 3,600 r.p.m. complete with feed water heating evaporator and condensing equipment supplied with steam at 400 lb. g. 630 deg. total temperature, was placed into operation last April. A few months ago the topping turbine above referred to was placed into operation at the No. 3 power plant. You will doubtless agree that the paragraph referred to does not bring these facts out very clearly.

In view of the author's conclusions as stated on page 8, paragraph 6, the Dominion Steel and Coal Corporation have been requested to supply up-to-date figures regarding the performance of Seaboard Power Plant. There is no doubt that the B.t.u.'s per kilowatt hour in this plant have dropped considerably.

R. G. Edwards[11]

Although this paper does indeed give a history of development and performance, the canvas is so large that for specific information which would be of use to a designer or operator, one would have to go back to the source material.

In discussing the Regina and Edmonton additions, reasons for the choice of the particular units with supporting data would be invaluable.

Steam and power costs, while they are popularly supposed to rest upon a firm engineering and economic foundation, usually contain enough variables to make comparisons useless unless one is familiar with the conditions.

To use Regina as an illustration it is understood that this plant is an outstanding performer. What evidence is there to support this? Was the industrial use of back pressure steam considered? In a city like Regina, where an acute winter heating load exists, district steam heating and air conditioning should indicate a market for exhaust steam at moderate pressures.

With regard to the steam plant at Comeau Bay, a great deal of interest attaches to the combination boiler set up; while the figures given by the author for the fuel value of paper mill refuse are generally accepted, they do not have any real bearing on the situation. It is known in the paper industry that the moisture content of the bark for instance is only one factor. Realization of design figures will depend on the amount of screenings, sawdust and other refuse, and on whether the pulpwood has been in salt or brackish water for any length of time. Specific information on this one operation would be of immense value to members in the pulp and paper industry.

Fuel cost for the various stations are very pertinent figures. It would be interesting to know how the B.t.u. values were arrived at. By this the writer means where and how are the samples taken with respect to the stations in question, and what facilities are used for the analysis.

Minto, N.B., shows a cost of 15.19. This would lead one to believe that the Minto field has inducements to offer well designed plants using this fuel. There are two criticisms of this. Isn't there a doubt as to the available tonnage for steam raising purposes and what are the figures for plants using this fuel at a distance from the mines? At least one plant in Quebec has used this coal for test purposes and plants in New Brunswick were using this fuel on powdered coal installations prior to its use at Minto.

A. D. Harrison, m.e.i.c.[12]

The author's paper on Canada's steam-electric power plants deals very comprehensively with the subject giving mainly the results obtained from central generating stations. A similar summary of the results from by-product steam power plants as installed in the industrial field would be of interest.

Such are mainly associated with paper mills, sugar refineries and textile plants.

By the introduction of modern high pressure boilers this by-product power assumes worth while proportions and combined with the higher efficiency of such boilers remarkable savings can be shown in the cost of steam and power.

A recent installation for instance in a paper mill having a daily output of 500 tons is obtaining an average of 8,600 kw. in by-product power from steam or approximately 64,000,000 kw.h. per annum, which is higher than any central station output in Canada with the exception of the Seaboard plant at Glace Bay.

This by-product power is being obtained at a B.t.u. rate of less than 4,000 as against 19,000 B.t.u. per kw.h. realized at Seaboard.

G. C. Derry[13]

The writer wishes particularly to comment on the section headed "Fly-Ash Handling and Disposal."

The writer cannot agree with the efficiency of collection given for the cyclone type of collectors, unless the percentage of ash is given for each size of ash particle. There is no doubt that the cyclones will collect 70-90 per cent of the larger material, but I am afraid that I cannot agree with the statement that cyclones of newer design will collect "almost 100 per cent of all larger than 325 mesh." This should be broken down into collection efficiency for the various sizes of sieve.

One very interesting way of collecting the finer ash which results from the combustion of powdered coal is that of gas scrubbers. The Boston Edison Company have such an installation in their Kneeland Street central heating steam plant. These scrubbers have been used in connection with their three boilers. Each boiler has a capacity of about 250,000 lb. of steam.

[10] General Manager, Swiss Electric Company of Canada, Montreal.
[11] International Paper Company, Dalhousie, N.B.
[12] Engineer, Ontario Paper Company, Thorold, Ont.
[13] Vice-President, B. F. Sturtevant Company, Boston.

The scrubber consists of a cylindrical shell lined with corrosive proof brick, nozzles are located in a central manifold and the gas is caused to enter the shell tangentially and spiral upward where it is discharged to the fan.

The sludge is removed at the bottom of the cylinder into a rubber lined steel cone where it is syphoned off to receivers in the lower part of the power station.

Such a device has proved to be very efficient and tests show a recovery of 95-98 per cent of the fine ash, most of which will pass through a 325 mesh screen.

The fact that this station is located in the heart of a Boston business district, and has been operating for several years, without a complaint from the neighbouring buildings, shows that it has been a complete commercial success.

Another interesting device is that of a collecting system located inside of the inlet box of the fan. This serves to concentrate the ash in the outer periphery of such an inlet box where it is skimmed off into a collector. While this does not have the same high efficiency as the electric system or the scrubber, yet it has proved to be a very effective means of ash collection and relatively inexpensive.

The writer was impressed with the fact that in the Maritime Provinces they burn coal having a high ash content of 20 to 24 per cent. High ash is a distinct menace to the operation of induced draft fans. A few years ago when the pressures were low this high ash content did not play such an important part. Now that greater capacities are demanded from the boilers, and the fact that higher resistances are imposed upon the system by reason of air heaters, economizers, etc. it requires that the fans run at very much higher rotative speeds which consequently increase the erosion on the blades of the fans at tremendous rates.

This is entirely dependent upon the kind of coal used and the amount of ash resulting from its combustion. Anything in the nature of 20-24 per cent ash being handled by fans that are operating at tip speeds over 8,000 ft. per min. present a very difficult operating problem. There have been found cases where the fan blades have eroded through in less than one month. When coal of this character is used great care is taken in the selection of fans and this feature should be called particularly to the attention of the fan manufacturer so that it can be taken into consideration when the fans are selected.

F. E. M. Thrupp[14]

The author has indicated that dust catchers of the cyclone type are less costly but less efficient than electrostatic precipitators. The difference in the cost is considerable as an electrostatic precipitator normally costs more than one dollar per cubic foot of gases per minute, whereas the cyclone type costs less than one quarter of this figure. The advantage of electrostatic precipitators due to their lower draft loss can be considered to be offset by the complications due to the use of electricity at a very high voltage, but the high efficiency of the electrostatic precipitator is certainly a point in its favour where money is available for the attainment of freedom from the most minute particles of dust in the smoke.

Normally very fine particles, having a low settling velocity, are carried away such distances before reaching the ground that the concentration becomes negligible. It is only the particles larger than 325 mesh which cause a nuisance and practically all these, as stated by the author, can be separated out with a cyclone collector that is designed on aerodynamic principles.

John Blizard[15]

The author has presented some interesting tabulations which show the capacity and performance of steam-electric power plants. But whether he is justified in drawing the conclusion that Canadian power plants compare unfavourably with those of similar size in other countries is dubious.

For the most part the stations in the United States and in England are larger, and larger stations are able to employ more technical men both in planning and in operating the plant. If a power plant is to be efficient it must not only be properly designed but it must be operated by those who have a thorough knowledge of the heat balance and see that this balance is maintained at its peak throughout the year.

It is no simple matter to compare the performance of two plants. For example, two plants may have identical equipment, the same load factor and the same temperature in the cooling water. Yet one plant may have cooling water which rapidly causes the condenser tubes to foul and so materially reduce the vacuum and efficiency, while the other plant may have clean cooling water.

Even the load factors are insufficient criteria of the type of load. One plant, which is on a system with a good load factor, may not know when it will be called on to deliver power and have to operate two turbines with its boilers to be ready for the load, while another plant on the same load factor may be able to rely on receiving ample warning of an anticipated increase in load and so operate only on one turbine instead of two.

Should there be a call in Canada to design and install a power-plant of a size comparable to the larger plants now installed elsewhere, the most efficient and expensive plant may not necessarily be installed but the selection will no doubt fall upon one that serves its purpose with real economy.

The Author

The author wishes to express his appreciation for the contributions which have been made to the discussion by leading authorities in the field of steam power. These contributions are worthy of serious consideration by Canadian engineers who are responsible for the design and operation of steam-electric power plants and co-operation with neighbouring power systems.

Mr. Wright has presented a valuable commentary on present-day practice in Great Britain in regard to power station development, design features, and policy in dealing with industrial aspects, which will be appreciated by Canadian engineers. He refers, in the main, to superstations having a capacity in excess of 50,000 kw. However, experience has shown that the practice in the smaller stations follows the lead given by the developments in the larger stations.

Mr. Elliott has succeeded, with charming brevity, in bringing out the main facts of the paper. His comment, that "in future situations demanding large thermal plants to carry base load, Canada will find it worth while to provide highly efficient steam capacity" is significant. The argument would seem equally good when applied to extensions. New turbines are usually operated at a high capacity factor for the first few years and the older units are relegated to peak load service for which efficiency is of less importance than continuity of service. The prediction that "as larger steam plants are built in Canada, utilizing lignite as fuel, the pulverized coal method of burning will be adopted in larger measure" is well founded in view of the successful experience at the Trinidad and Moose Jaw stations. The manifold advantages of this method of firing have been too well established in recent years to require repetition.

Mr. Powell has adopted a happy phrase in the expression "to give the plant a new lease on life." The reference, of course, is to the application to low pressure plant of a topping turbine and when necessary, due to

[14] Manager for Canada, The Buell Combustion Co. Ltd., Hamilton, Ont.

[15] Consulting Engineer, Foster Wheeler Corporation, New York.

poor efficiency, replacement or reconstruction of old boilers. It has been stated that when the objective is a reliable supply of power at minimum cost, the dollar is always the denominator. The graphical representation of "Load Dispatching on System Duration Curve" provides a fine example of the precision, not too generally realized, with which such studies can be carried out.

Mr. Gaffert has raised a point in regard to comparative performance which the author is glad to clarify. As explained in the note at the bottom of page 9 (which refers to the British stations reported in Table I, page 13), the author's intention was to deal with stations having a capacity of 50,000 kw. and under as distinguished from the larger super stations. Thus, the data set out in graphical form in Fig. 1 is limited to stations of a size comparable with Canadian stations. It will be noted that five of the American stations selected in this class show a better thermal performance than those of other countries.

Mr. Drabelle has reported the successful application of two novel developments in steam-generating plant at Cedar Rapids—the inner water wall, which divides the main furnace into two separate furnaces; and a water-cooled underfeed stoker. Test results from these units will be awaited with interest.

Mr. Spotton has referred to the superposition of reciprocating engines which exhaust into low pressure turbines of small power plants. The application would presumably apply to units of 500 kw. or under, in which reciprocators may compete with turbines, and to low pressures, since even a small quantity of engine lubricant in the condensate presents difficulty in the operation of high pressure steam-generating plant.

Professor Hall's predictions with reference to the co-ordination of hydro with fuel stations are encouraging and augur a brighter future for steam-electric plants in Canada.

The author agrees with Mr. Parker that, when fuller advantage is taken of the present state of the art of station design and operation, improvement in overall station efficiencies may be expected.

The author is indebted to Mr. Griffith for clarification of the text in regard to the turbine units of the Dominion Steel and Coal Corporation. It has been stated that the reducing valve which serves the topping turbine is particularly quiet in operation.

Messrs. Edwards and Harrison have presented a number of interesting engineering problems from the pulp and paper industry which might well serve as a basis for a symposium on thermal problems in this industry. The heat rate of 4,000 B.t.u. per kw.h. for by-product power suggests useful possibilities. Fuel costs are calculated on the basis of heating value of the coal in B.t.u. per lb. and the average cost of coal per ton.

The comments of Messrs. Derry and Thrupp on "Fly-ash Handling and Disposal" provide a welcome addition to the discussion.

A hopeful avenue for improving the situation in Canada would be to encourage the bringing together, into a sort of Prime Movers Committee, of engineers who are concerned with the design of steam power plants to discuss matters among themselves with a view to exposing the operating troubles and generally to exchange ideas as is done successfully elsewhere. The position in Canada seems to be that engineers of municipal stations, commercial stations, and the pulp and paper mills, etc., get together, but in separate associations, and no one group in in a position to expose, by comparison, the whole picture. The proposal would facilitate the interchange of operating data, quicker acceptance of novel developments, impartial consideration of plans for interchange and mutual assistance in emergencies, and bring the thermal performance of our Canadian stations more in line with that of stations of comparable size in other countries.

Joint Dinner of the Councils of The Engineering Institute of Canada and the Association of Professional Engineers of the Province of Ontario Held at Toronto, April 22nd

Head Table, left to right, Prof. R. W. Angus, HON.M.E.I.C., Dr. A. Surveyer, M.E.I.C., Dr. A. H. Harkness, M.E.I.C., Brig.-Gen. C. H. Mitchell, M.E.I.C., J. B. Challies, M.E.I.C., E. P. Muntz, M.E.I.C. (chairman), Dr. J. M. R. Fairbairn, M.E.I.C., A. D. Campbell, M.E.I.C., Dr. O. O. Lefebvre, M.E.I.C.

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."

VOLUME XXI JUNE, 1938 No. 6

The Maritime Visit

The outstanding lesson learned by the delegation from Headquarters which recently had the privilege of conferring with the four most easterly branches of The Institute, is that there is an urgent need for some means of bringing Headquarters into closer and more continuous contact with the management committees of the branches. Theoretically, this should not be difficult because every branch has at least one representative on Council. Unfortunately, however, Council is so widespread, funds for transportation are so limited and distances so great, that the far-away branches are rarely able by personal contact to keep in intimate and immediate touch with Council business. While the situation can be greatly relieved by more detailed Minutes of Council discussions, and particularly by their wider dissemination, an annual visit of a party from Headquarters is perhaps the most acceptable means of meeting the growing demand from the branches for a greater "say" in the shaping of Institute policies and in the carrying out of Institute programmes.

The President and his party, which consisted of Vice-President McCrory, Councillor Newell and the new General Secretary, were surprised and delighted with the marked interest which the members of executive committees, and also the rank and file everywhere exhibited in all the matters which have been and are now being dealt with by Council. Well advised of this deep interest by his immediate predecessor Mr. Desbarats who, during his term of office conferred with practically every one of the 25 branches, President Challies has, wherever possible, acted as host at round-table luncheon conferences with branch officers, their committees and the senior local members of The Institute. At these conferences full opportunity has been afforded interested local members to discuss any matter of Institute business. Not only have these Maritime consultations been informative to the local members, but they have been very illuminating to the delegation from Headquarters. The General Secretary has found them an invaluable aid to a proper understanding of The Institute's problems, and perhaps what is of timely significance, they have indicated many possibilities for a more enhanced usefulness to the general membership, of the Headquarters secretariat.

The one matter which more than all others interested the members everywhere was the progress that is being made in establishing closer co-operation with the Provincial Professional Associations. It was therefore fortunate that the President was able to have with him the Chairman of the Council's Committee on Professional Interests. That Mr. Councillor Newell was able to speak reassuringly of the proposals for an early agreement under the new enabling By-law No. 76 in so many of the provinces gave great satisfaction everywhere.

No account of the Maritime pilgrimage would be complete without reference to the loyal support of the branch officers everywhere, to The Institute, their solicitous interest in the Secretary Emeritus, their encouragingly friendly attitude to the new General Secretary and their whole-hearted desire to do honour to the President and his party. Such experiences are an inspiration to all who are privileged to share them.

Supply and Demand

Attention is directed to a report published in this issue dealing with supply and demand in relationship to engineers. The report has been prepared for Council by Past-President F. P. Shearwood, and since its presentation has been the object of much discussion and favourable comment.

Council felt that the subject was of such importance and that the report was so clear and comprehensive in spite of its brevity, that further publicity should be given to it. Consequently by motion it was decided to place the report before the membership at large, through the medium of The Journal, and to bring it to the attention of universities, Ministers and Deputy Ministers of Education and such others as might be interested in the education and welfare of the young engineer, and to invite comments from all these sources. It is only right that leadership in such matters should come from The Engineering Institute of Canada, and it is hoped that our readers will give the report careful consideration. It deals with a subject that is vital to coming generations of engineers, and points a way which may lead to the solution of the problem of employment for the graduate.

Innovation

Something absolutely new in the affairs of The Institute occurred at the May meeting of Council. For the first time in the history of that body a woman was elected to corporate membership. The new member is Elizabeth Muriel Gregory MacGill, assistant engineer of one of Montreal's aircraft factories. Miss MacGill is a Bachelor of Applied Science of the University of Toronto, and a Master of Science in Engineering of the University of Michigan, and has done two years graduate study at the Massachusetts Institute of Technology towards her Doctorate. She is also an Associate Fellow of the Royal Aeronautical Society.

Her home is in Vancouver where her father is a well known lawyer, and her mother is Judge of the Juvenile Court, holder of an Honorary LL.D. of the University of British Columbia and a Bachelor of Music of the University of Toronto.

Recently Miss MacGill read a paper before the Ottawa Branch on "Simplified Performance Calculations for Aeroplanes," in which she showed by the use of logarithmic curves how to determine in simple manner the ceilings and high speed, climbing speed and the maximum rate of climb at any altitude for any aeroplane. We are informed that the paper reflected great credit on the author and made a definite contribution to the art of flying.

The Journal is pleased to make acknowledgment of Miss MacGill's election to Associate Membership, and to congratulate her on her high academic standing and her practical knowledge in this complicated field. We wish her great success in her future endeavours.

The President and Party's Visit to Sackville

Standing—F. Binns, A.M.E.I.C., C. F. Johns, Jr.E.I.C., H. W. Read, A.M.E.I.C., J. F. MacKenzie, A.M.E.I.C., L. A. Wright, A.M.E.I.C., G. T. Medforth, A.M.E.I.C., Prof. F. L. West, M.E.I.C. Seated—Dr. G. J. Trueman, J. B. Challies, M.E.I.C., Prof. H. W. McKiel, M.E.I.C., F. Newell, M.E.I.C.

Presidential Activities

The President accompanied by Vice-President J. A. McCrory, Councillor Fred Newell and the General Secretary has completed his visit to the Maritime branches. The itinerary included Halifax, Sydney, Sackville, Moncton and Saint John. The party left Montreal on April 29th and arrived back on May 7th, covering in all a distance of two thousand miles. A further reference to the journey will be found on the editorial page.

Some of the highlights are described briefly herewith:

Halifax:—

The unique banquet on April 30th at the Nova Scotian hotel, graced by the presence of ladies, and followed by after-dinner wit and oratory that would have done credit to Ottawa at its best;

The five-hour Maritime meeting of Council on May 1st, including the President's luncheon at which six Councillors and nine invited guests were present;

The delightful Sunday afternoon tea and reception of the President and Mrs. Challies at the Lord Nelson hotel, to which came many members of the Institute and of the Association of Professional Engineers of Nova Scotia and their ladies; also several distinguished guests including the Premier and Mrs. Angus MacDonald, the immediate past president of the Canadian Institute of Mining and Metallurgy, the Hon. Michael and Mrs. Dwyer. Approximately 125 people were in attendance.

Sydney:—

The very friendly informal gathering on the 3rd of the Sydney Branch members in the cozy library quarters which they share with the local members of the Canadian Institute of Mining and Metallurgy.

Sackville:—

The unexpected, but all the more enjoyable luncheon party at Sackville on the 4th, with former Vice-President and Mrs. McKiel and the local members of the Institute.

Moncton:—

The largely attended supper meeting of the Moncton Branch, followed by a frank and profitable discussion of Institute affairs.

Saint John:—

The enthusiastic and well attended annual business meeting of the Saint John Branch on the 5th, which concluded with a banquet and speeches from all the members of the Headquarters delegation; and

Finally, the President's luncheon at the Admiral Beatty hotel on the 6th for the President of the Dominion Council and the Saint John Executive Committee.

On May 13th the Niagara Peninsula Branch held its annual meeting at the General Brock hotel with the President as the guest of honour. The meeting took the form of a dinner function, general business being completed beforehand in order that plenty of time would be available for speeches and discussions.

The following members of the Executive were guests of the President at a luncheon round table conference at which the relationship of the Branch to Headquarters was thoroughly and satisfactorily discussed: L. C. McMurtry, A.M.E.I.C., Chairman; C. G. Moon, A.M.E.I.C., Chairman elect; Geo. E. Griffiths, A.M.E.I.C., Secretary-Treasurer; Councillor W. R. Manock, A.M.E.I.C., Councillor J. A. Vance, A.M.E.I.C., George H. Wood, A.M.E.I.C., Walter Jackson, M.E.I.C., C. G. Cline, A.M.E.I.C., W. D. Bracken, A.M.E.I.C.

The President and General Secretary attended the excellent annual dinner and meeting of the Toronto Branch held at the Military Institute on May 12th. There were many features that made this an unusually interesting gathering, such as the large attendance, the interest in the President's talk about the Institute, the presence of so many representatives of other branches, and the talk on Germany by Wilson Woodside. The out-of-town visitors were Vice-President E. V. Buchanan, Councillors Manock and Vance, Past Vice-President Dobbin, with W. T. Fanjoy, A.M.E.I.C., and A. L. Malby, Jr.E.I.C., secretary and chairman of the Peterborough Branch, and A. L. Killaly, A.M.E.I.C., W. J. W. Reid, M.E.I.C., and A. R. Hannaford, A.M.E.I.C., chairman and secretary respectively of the Hamilton Branch.

The branch executive and certain other prominent members of the Institute were guests of the President for luncheon at the University Club on the same day. Following are the names of those in attendance: A. U. Sanderson, A.M.E.I.C., C. E. Sisson, M.E.I.C., Brig.-Gen. C. H. Mitchell, M.E.I.C., Dr. T. H. Hogg, M.E.I.C., Dr. F. A. Gaby, M.E.I.C., Dr. A. H. Harkness, M.E.I.C., Professor Robert W. Angus, Hon.M.E.I.C., Professor C. R. Young, M.E.I.C., W. E. Bonn, M.E.I.C., Nicol MacNicol, M.E.I.C., W. S. Wilson, A.M.E.I.C., Dr. A. E. Berry, M.E.I.C., H. E. Brandon, A.M.E.I.C., J. J. Spence, A.M.E.I.C., and the General Secretary.

Result of the Ballot for Amendments Proposed to Sections 44 and 51 of the By-laws

We, the undersigned scrutineers, appointed to canvass the ballot for amendments proposed to Sections 44 and 51 of the Institute By-laws, beg to report as follows:

Total Ballots received		1,024
Unsigned Ballots	3	
Members in Arrears	14	
Spoiled Ballots	7	
Total	24	
Ballots Valid		1,000
SECTION 44		
Yes	359	
No	641	1,000
SECTION 51		
Yes	403	
No	589	992

Respectfully submitted,

HUET MASSUE, M.E.I.C.,
M. BALLS, A.M.E.I.C.,
Scrutineers.

Meetings of Council

A meeting of Council was held in Toronto at the Royal York Hotel, on April 22nd, 1938, at two o'clock p.m., with President J. B. Challies in the chair, and sixteen other members of Council present. Four past-presidents and one honorary member were also in attendance by invitation of the President.

The Council noted with regret the sudden death of Dr. Adhemar Mailhiot, M.E.I.C., Dean of the Ecole Polytechnique, Montreal, and Registrar of the Association of Professional Engineers of Quebec. The following resolution was passed, and the Secretary was directed to send copies to Madame Mailhiot, the Ecole Polytechnique and the Corporation of Professional Engineers of Quebec:

> "The Council of The Engineering Institute of Canada, assembled in Toronto at a special meeting, on April 22nd, 1938, was shocked to hear of the sudden death of Dr. Adhemar Mailhiot, Dean of the Ecole Polytechnique of Montreal, and valued Member of The Institute. His wisdom, his broadmindedness and his ready helpfulness, have done much to endear him to his friends and associates and to advance the cause of the professional engineer, not only in Quebec but throughout Canada. His loss will be felt very keenly by the Ecole Polytechnique and by all others who were privileged to know him, but particularly by his family to whom the Council wishes to extend this expression of their profound and sincere sympathy."

Lieut.-Col. L. F. Grant, M.E.I.C., was appointed councillor representing the Kingston Branch, replacing J. E. Goodman, A.M.E.I.C., who had resigned.

Announcement was made that Vice-President E. V. Buchanan would attend the International Engineering Congress in Glasgow as The Institute's representative along with Major James MacGregor, D.S.O., M.E.I.C., of Glasgow. A paper on Gas Engineering, by John Keillor, of Vancouver, has been prepared, at the invitation of the Congress, for presentation.

It was decided to send Past-President Shearwood's report on the supply of and demand for technically trained men to public officials interested in the welfare and education of the young engineer.

The chairman of the Publication Committee reported on the committee's plan to revise The Journal. After discussion of several features, including Transactions, the matter was left with the committee for further action and consideration.

It was announced that Dr. Alfred Stansfield, M.E.I.C., had accepted the chairmanship of the Plummer Medal Committee, and had selected the following members to act with him: Messrs. J. R. Dunbar, M.E.I.C., C. K. McLeod, A.M.E.I.C., G. St. G. Sproule, M.E.I.C., and C. R. Whittemore, A.M.E.I.C.

A letter was read from G. A. Gaherty, M.E.I.C., chairman of the Committee on Western Water Problems, recommending the holding of a general professional meeting to discuss the economic utilization of the prairie water supply for increasing agricultural production, and making certain definite recommendations as to the conduct of this meeting. The President reported that he and Mr. Gaherty had visited Ottawa to discuss this matter with the Minister of Agriculture with the object of securing the co-operation of the Dominion technical officers for the meeting. It was reported that the Minister was very sympathetic to the suggestion and agreed to co-operate in any way that would assist in bringing about a betterment of conditions on the prairies. After considerable discussion, it was unanimously decided that this problem would be the main subject for discussion at the next annual general meeting at Ottawa, and that it would be left with the President, in consultation with Mr. Gaherty and the General Secretary, to arrange for the technical papers.

Council accepted with appreciation the invitation of the Managing Committee of the Ottawa Branch to hold the 1939 annual meeting in Ottawa at the end of January or the beginning of February.

Announcement was made of the results of the ballot for the proposed agreement in Nova Scotia which was practically unanimously approved.

The President explained the present status of negotiations between The Institute and the Association of Professional Engineers of Nova Scotia. After a good deal of discussion it was agreed that no further action should be taken by Council until after the special Maritime meeting of Council which was to take place in Halifax on the first of May.

Approval was given to the policy of Council in holding special meetings away from Headquarters whenever and wherever circumstances permitted. It was decided that the June meeting of Council would be held in Ottawa, the date to be determined later.

It was reported that the Canadian Chamber of Commerce had invited The Institute to appoint a representative to the Chamber's National Board of Directors. Mr. F. S. B. Heward was named for the balance of The Institute year.

Mr. McCrory reported on the financial statement to the end of March, calling attention to the fact that expenditures were running very close to the budgeted amounts.

Mr. McCrory also called attention to the small rebates that were received by some of the smaller branches, explaining that in such conditions the cost of some of the branch activities had been paid for out of the pockets of the officers. He recommended that some minimum amount should be set for such branches, irrespective of the number of their members. Council was very sympathetic, and decided to recommend the principle that there would be a minimum rebate of $100 a year, and that the Finance Committee should consider an additional rebate and the conditions which would be attached to it, if it were recommended.

Eight resignations were accepted; reinstatement was granted to one Student, who is also applying for transfer to Associate Member; Life Memberships were granted to four members who had been recommended by their branches; six special cases were considered, and decisions reached in accordance with their merits.

The President reported on the meeting of the Dominion Council of Professional Engineers that had been held in Montreal early in April, at which time he had had the opportunity of entertaining them at dinner. A very satisfactory round table discussion had followed, at which the subject of closer relationships between the Provincial Associations and The Institute was the theme.

The Secretary read a letter from Mr. Busfield relative to the library and employment services of The Institute. Such portions of this as were considered appropriate were allocated to the House Committee for their consideration, and the portion dealing with the employment service was left in the hands of Mr. Busfield and Mr. Heward for a further report.

Past-President Fairbairn and the General Secretary reported on their recent visit to the Secretaries of the Founder Societies in New York. Mr. Fairbairn recommended that close contact be maintained between these societies and the General Secretary, as such relationship would be greatly to the advantage of The Institute.

A report was presented from Professor Spencer, chairman of The Institute's Committee on Membership and Management. The Secretary was directed to send a copy to all members of Council with a request for comments, the report to be brought up again at the next regular meeting of Council.

New officers were noted for the Calgary and Saskatchewan branches.

A letter was read from Councillor A. J. Taunton of Winnipeg dealing with the method of electing applicants for admission and for transfer to a higher class of membership. After considerable discussion it was agreed that in future, when Council's decision differed from the recommendation of the branch, action would be deferred until the branch had been communicated with and requested to reconsider their decision in the light of full information.

The President reported on the joint dinner which was to follow the Council meeting between the Council of the Ontario Professional Association, and the Council of The Engineering Institute. The Council unanimously expressed appreciation of the arrangements, and recommended that family councils of this character should be held whenever and wherever practicable.

The following elections and transfers were considered and approved:

Elections		*Transfers*	
Member	1	Assoc. Member to Member	2
Assoc. Members	4	Junion to Assoc. Member	4
Juniors	6	Student to Junior	1
Students admitted	22		

One application for admission as Associate Member was approved, subject to the passing of The Institute's examinations. Two special cases were voted upon, and disposed of in accordance with their merits.

It was decided that the next regular meeting of Council would be held at Headquarters on Friday, May 20th, 1938.

The Council rose at six thirty p.m.

Maritime Meeting

A meeting of Council was held in Halifax, Nova Scotia, at the Lord Nelson Hotel, on May 1st, 1938, at ten fifteen a.m., with President J. B. Challies in the chair, and five other members of Council present. The chairmen of the Halifax and Cape Breton branches, the secretary of the Halifax Branch, together with other members of the Halifax executive and senior members of The Institute resident in Halifax were present by invitation.

The President explained that the purpose of a Council meeting in Halifax was to afford the four Maritime branches an opportunity to become well informed regarding the problems of The Institute, and the proposals for their solutions which committees of Council were considering.

The General Secretary announced the result of the recent ballot on the proposed amendments to Sections 44 and 51 of the By-laws. (See p. 299 of this issue.)

The President gave a general outline of the relations with the various Provincial Associations with special regard to the Dominion Council. He also described a very successful joint dinner which had been held on April 22nd in Toronto between the Council and Past-Presidents of The Institute and the Council and Past-Presidents of the Association of Professional Engineers of the Province of Ontario, and mentioned some of the expressions of appreciation which had come from various officers of the Provincial Association and from others interested in the welfare of the engineering profession. He thought that this dinner had prepared the way for further conferences leading to closer co-operation between all organized engineering bodies in Ontario.

Councillor Newell, as chairman of the special Committee on Professional Interests, made a report on the activities of his committee dealing with the Professsional Associations in Nova Scotia, New Brunswick, Manitoba and Saskatchewan. Negotiations with these provinces were proceeding satisfactorily, and he was hopeful that a satisfactory basis of co-operation would be reached in due course. The tremendous majority by which the members of The Institute had approved of the enabling By-law No. 76 was an indication that members were anxious to see a closer relationship brought to pass in all the provinces.

The status of the Nova Scotia negotiations was discussed at great length, and it was unanimously agreed that the present difficulties regarding authority for an appropriate agreement could and would be cleared away. The President emphasized that as far as the Institute was concerned, its policy and its practice was to encourage the closest possible constructive co-operation with the Associations, at the same time to refrain from forcing or pressing negotiations faster or further than might be desired by the respective associations.

Strong representations were made for a widespread dissemination of the proceedings of Council in order that branch executives might be better informed. Council was urged to consider at its next regular meeting the advisability of authorizing the General Secretary to send copies of minutes to all branch chairmen.

Mention was made of the progress report of the Committee on Membership and Management. In view of the pressure of time, it was decided that the report be considered by the local branches, and their comments forwarded to Headquarters.

Many expressions of appreciation were made in reference to Mr. R. J. Durley's services as General Secretary. Great regret at his retirement was indicated.

An intersting discussion took place on the report of Past-President Shearwood dealing with the supply of and demand for technically trained men. The President reported the action of the Toronto meeting, and described what had been done since that time towards capitalizing on the suggestions contained in the report. Professor McKiel commended the report strongly, and stated that this was one of the most important subjects that the Institute could consider.

As the date for the submission of names for the Sir John Kennedy Medal had passed, the President announced the five names which had been sent to Headquarters with branch recommendations. It was agreed that the five names, with a history of their achievements, should be sent to all members of Council.

The President outlined the developments leading up to the World Power Conference which was to take place at Vienna on August 25th, 1938, and stated that council would we glad to accredit any corporate member who desired to attend.

The Council rose at three forty-five p.m., to attend the President's reception, which was held in the main lounge of the hotel.

Annual Meeting in Ottawa 1939

At the Council meeting in Toronto on April 22nd the invitation of the Ottawa Branch was accepted and the annual meeting will be held in that city at a date which is not yet determined. It is expected that it will take place at the end of January or early in February.

One of the principal features of this meeting will be the presentation of papers and discussions on Western Water Problems. G. A. Gaherty, M.E.I.C., is chairman of the committee and has already arranged with several of the outstanding experts for the preparation and presentation of papers on the various phases of this important topic. It is expected that members and public officials from the Prairie Provinces and from Ottawa will take a very active part in this part of the annual meeting. A list of papers and speakers will be published shortly.

OBITUARIES

Frederick William Caldwell, M.E.I.C.

Deep regret is expressed in placing on record the death of Frederick William Caldwell, M.E.I.C., at his home in Schenectady, N.Y., after several months' illness.

Mr. Caldwell was born at Lawrence, Mass., on November 12th, 1875. He was graduated from the Massachusetts Institute of Technology in 1899 with the degree of S.B. Going to Schenectady in 1902, he began a connection with the General Electric Company which lasted twenty-five years. During this time he was in the office of the vice-president of the company, in charge of engineering and manufacturing. His duties were of an executive nature in general engineering. In 1928 he came to Montreal where he remained until 1934, practising as a consulting engineer. He then returned to Schenectady and continued his practice. In 1935 he became a member of the New York State Planning Board.

Mr. Caldwell joined The Institute in 1929 as a Member.

Major John Cormack Craig, D.S.O., O.B.E., M.E.I.C.

From Scotland comes word of the death of Major John Cormack Craig, M.E.I.C., in Edinburgh on April 30th. Major Craig was born at Aberdeen, Scotland, on July 10th, 1874, where he received his early education at Robert Gordon's College. In 1900, after ten years' apprenticeship with Hall Russell and Company, shipbuilders and engineers, and with the city engineer, Aberdeen, Major Craig was appointed assistant resident engineer on the Aberdeen sewage works. Three years later he became engineering assistant to the city engineer of Westminster, London.

In 1905 Major Craig was appointed resident engineer of the Public Works Department of Straits Settlements. During the years from 1905 to 1913 in which he held office, he was in charge of the construction of ferro concrete lighthouse Straits of Malacca and harbour extension works Penang.

In 1914 Major Craig came to Canada and was on the staff of the Pacific Great Eastern Railway at Vancouver. In the fall of that year he received his commission as lieutenant in the 6th Field Company Engineers. In 1915 he became captain of the 1st Canadian Pioneers and in 1916 major chief engineer and 2nd in command of the 9th Canadian Railway Troops until September 1918, when he became assistant director of construction, light railway section. He was awarded the Distinguished Service Order and was mentioned in despatches three times. Following the war he remained in the Old Country until his appointment in 1922 as assistant chief engineer, Gold Coast Harbours, with headquarters at Accra. Later he was located at Seccondee, Gold Coast Colony, West Africa.

In 1927 Major Craig left Aberdeen for British Guiana as director of public works at Georgetown. In 1931 he returned to British Guiana for another term of duty. At the completion of this term he returned to Scotland where he resided until the time of his death.

Major Craig joined The Institute in 1916 as an Associate Member becoming a Member in 1919.

His Grace the Duke of Devonshire, K.G., P.C., G.C.M.G., LL.D., Hon.M.E.I.C.

His Grace the Duke of Devonshire, whose death occurred on May 5th, 1938, was born on May 31st, 1868. He received his education at Eton and Trinity College, Cambridge. From 1891 to 1908 he was a Member of Parliament for Derbyshire West. From 1900 to 1903 he served as Treasurer of H.M. Household and from 1903 to 1905 Financial Secretary to the Treasury. His Grace served as a Civil Lord of the Admiralty from 1915 to 1916. With his fine reputation gained in local affairs and affairs of the state, his appointment as Governor-General of Canada in 1916 was a fortunate one for Canada. His term of office included the last two years of the Great War and continued until 1921. During this eventful period the Duke of Devonshire exerted himself on behalf of every patriotic cause.

In 1917 His Grace shared in the national celebration of the golden jubilee of Confederation and took part in the inaugural ceremonies of the opening of the Quebec bridge. In 1919, as Governor-General, he took a leading part in the ceremonies attending the laying of the foundation stone of the Memorial Tower of the new Parliament Buildings at Ottawa by the Prince of Wales.

The Duke of Devonshire became an Honorary Member of The Institute on March 20, 1917.

David Howard Fleming, M.E.I.C.

Members of The Institute will learn with regret of the death of David Howard Fleming, M.E.I.C., who died April 9th in Toronto. Mr. Fleming was born at Pelee Island, Essex County, Ont., on April 1st, 1888. He received his education at Windsor Collegiate and later at the University of Toronto from which he was graduated in 1913 with the degree of B.A.Sc. After graduation he became assistant to the city engineer at St. Catharines, Ont., and later was connected with the engineering department of the City of Toronto. In 1919 Mr. Fleming became town engineer of Owen Sound, Ont. This position he held until 1924 when he joined the firm of A. W. Connor and Company, consulting engineers, in the capacity of municipal engineer. In 1929 he became consulting engineer for Layne Canadian Water Supply Company, Toronto. From 1931 he was in private practice as consulting engineer in Toronto.

Mr. Fleming joined The Institute in 1912 as a Student, becoming an Associate Member in 1916 and a Member in 1936.

Edwin Albert Forward, M.E.I.C.

Members of The Institute will regret to learn of the death of Edwin Albert Forward, M.E.I.C., in Montreal, on April 30th. Mr. Forward was born at Iroquois, Ont., on October 23rd, 1870. He received his early education there, later attending the School of Practical Science, University of Toronto, from which he was graduated in 1897 with honours. From 1898 to 1904 he was engaged on construction of the 14-foot enlargement of the St. Lawrence canals, at the Galops, Morrisburg, Farrans Point and Cornwall sections.

In 1905 to 1906 he took part in the preparation of survey and estimates for the Georgian Bay ship canal and then took charge of construction of a lock and curtain dam on the Red river, Manitoba, until 1909.

In 1910, Mr. Forward associated himself with Messrs. Quinlan and Robertson of Montreal, general contractors, and for ten years was connected with construction works of importance including, Transcona railway shops, Trent and Welland canals, power dam at High Falls on the Du Lièvre, St. Charles river and harbour improvements at Quebec, the building and outfitting of vessels.

From 1919 to 1921 he was engaged on various valuation cases including the Grand Trunk arbitration case, and in the latter year established a consulting practice. He remained in private practice until 1926 when he entered the firm of Robertson and Janin, Iroquois, Ont. In 1931 he came to Montreal to the firm of Angus Robertson Limited as chief engineer.

Mr. Forward joined The Institute as Associate Member in 1900, transferring to the class of Member in December 1911.

Harry Donald Macaulay, A.M.E.I.C.

The death of Harry Donald Macaulay, A.M.E.I.C., occurred in Montreal on May 14th, 1938. Mr. Macaulay was born in Saint John, N.B., on August 2nd, 1888, and here received his early education. After following a course in civil engineering at the University of New Brunswick, Fredericton, N.B., he began his railway work as rodman on the Boston and Albany Rail Road in 1909. In 1910 he became rodman then instrumentman on construction and valuation work with the Chicago and North-Western Railway. While in the United States Mr. Macaulay continued to study civil engineering and took a post graduate course at the Wisconsin University. Mr. Macaulay entered the employ of the Canadian Northern Railway in 1912 and as resident engineer remained here for a year. From 1913-1914 he acted as transitman on location with the St. John and Quebec Railway.

Mr. Macaulay contributed in no small measure to the development of his native port. In 1914 he became assistant engineer in the Federal Department of Works, Saint John Harbour staff. He worked on the design and construction of the Beacon Bar wharves and on the Courtenay Bay development and later on the harbour-front survey.

When the Saint John Harbour Commission was formed Mr. Macaulay became a member of the staff and afterwards served on the National Harbours Board. He left the latter position in the fall of 1937 to go to Port Alfred, Que., to take the position of resident engineer of the Saguenay Terminals Limited for the Aluminum Company of Canada. He held this position until he became ill and fourteen days later died.

Mr. Macaulay joined The Institute as an Associate Member in 1919.

Joseph Baermann Strauss, M.E.I.C.

The death of Joseph Baermann Strauss, M.E.I.C., occurred on May 16th in Los Angeles. Mr. Strauss was born in Cincinnati, Ohio, on January 9th, 1870, and was graduated from the University of Cincinnati in civil engineering in 1892. He returned to the University two years later as instructor in the College of Engineering. From 1897 to 1899 he was designer in charge of the Sanitary District of Chicago.

In 1904, after two years' practice as consulting engineer in Chicago, Mr. Strauss formed the Strauss Bascule Bridge Company in which we held the positions of president and chief engineer. This company devoted itself to the preparation of plans and specifications for bascule and lift bridges of his design. Between the years 1904 and 1921 approximately 220 of these bridges, representing a money value of $30,000,000, were built in the United States, Canada and various parts of the world. In the designs of these bridges the bascule bridge reached the largest limits in size and weight which had been attempted up to that time. Mr. Strauss was thus the originator of five types of the Strauss trunnion bascule bridge which is standard throughout the world. He also originated two types of lift bridges and invented a type of portable searchlight used by the United States and Russian Governments in the Great War.

Mr. Strauss was also designing engineer for the Arlington Memorial Bridge across the Potomac river at Washington, D.C., and consulting engineer for the Port of New York Authority on the George Washington Memorial Bridge. He will be remembered in Montreal for his work as engineer for the Jacques Cartier Bridge. His reputation was made world-wide by his design of the Golden Gate Bridge at San Francisco. He received the degree of D.Sc. from Cincinnati University.

He joined The Institute as an Associate Member in 1909 becoming a Member in 1921.

PERSONALS

Members will be interested and concerned to hear of the illness of Secretary Emeritus R. J. Durley, M.E.I.C. Mr. Durley underwent a serious operation on May 16th, the outcome of which the doctor reports to be perfectly satisfactory. It will be many weeks, however, before he will be able to leave hospital. Any communications for Mr. Durley addressed to the Institute will be put into his hands without delay.

Members of the Institute everywhere will be pleased to know that recognition of the services of President Challies during the period of his public service at Ottawa, has been made by the Professional Institute of the Civil Service of Canada, in the form of an Honorary Membership. The citation on the certificate reads as follows:

> "In recognition of conspicuous services rendered by him to the Institute in that he was chiefly responsible for proposing that an institute of professional civil servants of Canada be established, took the initiative in its formation and served upon the provisional executive during the organization period; thereafter, he at at all times promoted the interests of the Institute as a member of the Hydraulic-Reclamation Engineers Group until his resignation from the public service in 1925."

(Signed) J. Clement Beauchamp,
President.
C. Sweet,
Hon. Secretary-Treasurer.

G. J. Desbarats, Hon.M.E.I.C., formerly Deputy Minister of National Defence, and Mrs. Desbarats celebrated the fortieth anniversary of their marriage on May 17th. In the evening they held a dinner party when their entire family were present. The Institute joins with their many friends in offering congratulations, and expresses the hope that they may enjoy many more anniversaries together.

Past-President A. J. Grant, M.E.I.C., of St. Catharines, has been visiting throughout the winter in the Barbados. He was present at the dinner given by the Niagara Peninsula Branch to the President on May 13th, looking very fit after his vacation.

J. G. Sullivan, LL.D., M.E.I.C., was honoured by the American Railway Engineering Association at its thirty-ninth annual meeting in Chicago, by his election to honorary membership. Mr. Sullivan is a prominent figure in both The Engineering Institute of Canada and the American Railway Engineers Association, being a past-president of both organizations. His contribution to the science of engineering and to the benefit of the Institute was recognized in the awarding of the Sir John Kennedy Medal to Mr. Sullivan in 1937. This is the highest honour which the Institute can confer.

C. A. Robb, M.E.I.C., Professor of Mechanical Engineering at the University of Alberta, was a very welcome visitor at Headquarters on May 19th.

J. D. Sylvester, S.E.I.C., is another Edmonton member who is spending some time in Montreal. It was an interesting coincidence that Professor Robb and Mr. Sylvester should happen to come to Headquarters at the same time. It is pleasant for the Headquarters staff to see out-of-town members meeting in this way under the Headquarters roof.

John A. Stiles, M.E.I.C., of Ottawa, chief executive commissioner of the Boy Scouts Association in Canada, was awarded the "Silver Buffalo for Disinguished Service to Boyhood" at the National Scout Council's 28th annual meeting May 14th.

Norman B. Wilson, M.E.I.C., a partner in the firm of Wilson and Bunnell, consulting engineers, Toronto, has been retained by the city of Edmonton to prepare a comprehensive survey of the city's transportation set-up.

G. P. Wilbur, A.M.E.I.C., manager of sales, Ontario Division of the Dominion Bridge Company, Toronto, was recently elected president of the Canadian Institute of Steel Construction.

Archibald Cox, A.M.E.I.C., has accepted the position of master mechanic and construction engineer with the Crow's Nest Pass Coal Company, Limited, Michel, B.C.

David Boyd, A.M.E.I.C., who has been with the Canada Car and Foundry Company as welding engineer, has been transferred to Fort William, Ont., as works manager of their plant there.

Robert M. Hardy, M.Sc., A.M.E.I.C., assistant professor of civil engineering at the University of Alberta, was another welcome visitor at Headquarters. He was particularly interested in sounding out the employment situation in the Montreal district in order that he might be in a better position to advise the Edmonton graduates. He has been very active in Institute affairs, serving for some time as Secretary-Treasurer of the Edmonton Branch.

D. C. Tennant, M.E.I.C., has recently been appointed engineer to the Ontario Division of the Dominion Bridge Company and will be located at Toronto. Mr. Tennant has been connected with the Dominion Bridge Company since 1900 having entered the company after his graduation from Toronto University with the degree of B.A.Sc. with honours. He served as Councillor of The Institute from 1931-1933.

L. G. Scott, Jr.E.I.C., who has been located at Winnipeg, has been transferred by the Hudson's Bay Company to Edmonton, Alta.

K. Y. Lochhead, Jr.E.I.C., is now with the Hudson's Bay Company Retail Store in Vancouver, B.C., having been transferred from Winnipeg, Man.

The Council of the Association of Professional Engineers of British Columbia announces the appointment of Mr. J. C. Oliver, B.A., B.A.Sc., as Registrar of the Association. Mr. Oliver graduated from the University of British Columbia in 1927. He took up his duties as Registrar on May 1st.

John T. Dyment, A.M.E.I.C., who for the past year has been with the Department of Transport as aeronautical engineer in the Aeronautical Engineering Branch has accepted a position with the Trans-Canada Air Lines in Winnipeg in the same capacity. Mr. Dyment was graduated from the University of Toronto in 1929 with the degree of B.A.Sc.

J. Donald Rice, S.E.I.C., is now engineer in charge of the geological office of the International Petroleum Company, Limited, Negritos, Peru, S.A. After graduating from McGill University in 1935 with the degree of B.Eng., Mr. Rice was connected with the Foundation Company of Canada, Montreal, for a year. He then entered the Canada Car and Foundry Company Limited, Montreal, remaining with this Company until March of this year.

Edgar T. J. Brandon, A.M.E.I.C., chief electrical engineer of the Hydro-Electric Power Commission of Ontario, on April 25th celebrated thirty years' service with the commission. Mr. Brandon has the distinction of being the second longest service employee on the staff. He began his connection with the Commission in 1908 on design and construction.

George MacLeod, A.M.E.I.C., was recently made district engineer at Salmon Arm, British Columbia, by the Department of Public Works. Mr. MacLeod was formerly general foreman in the Departmental office in New Westminster, B.C.

ELECTIONS AND TRANSFERS

At the meeting of Council held on May 20th, 1938, the following elections and transfers were effected:

Members

HODGSON, Ernest Atkinson, M.A., (Univ. of Toronto), Ph.D., (Univ. of St. Louis), chief, Division of Seismology, Dominion Observatory, Ottawa, Ont.

HORNBACK, Michael Edwin, B.Sc. (Civil), (Univ. of Miss.), 2535 Montclair Ave., Montreal, Que.

THRUPP, Frederick Edward Milan, Dipl. Ing., (Tech. Univ. of Darmstadt, Germany), manager for Canada and Newfoundland for the Buell Combustion Co. Ltd., of London, England, Hamilton, Ont.

Associate Members

CHARLES, Robert Simpson, Jr., B.A., (Amherst College, Mass.), field engr., International Water Supply Ltd., London, Ont.

HUTCHEON, Neil Barron, B.Sc. (Mech.), M.Sc., (Univ. of Sask.), asst. professor in mechanical engineering, University of Saskatchewan, Saskatoon, Sask.

MacGILL, Elizabeth Muriel Gregory, B.A.Sc. (E.E.), (Univ. of Toronto), M.Sc. in Engrg., (Univ. of Mich.), asst. engr., Fairchild Aircraft Ltd., Longueuil, Que.

MUSGRAVE, Arthur Stanley Gordon, B.A., B.Eng. (Civil), (Trinity College, Dublin), municipal engr., Oak Bay, B.C.

Juniors

HARSHAW, Francis Norman, B.Sc. (Civil), (Univ. of Sask.), transmitter operator CFQC, Saskatoon, Sask.

KRENDEL, Conrad John, B.Sc. (Civil), (Univ. of Man.), University of Manitoba, Fort Garry, Man.

MALBY, George Thomas, B.Sc. (Civil), (Univ. of Man.), engr., Saguenay Power Co. Ltd., Arvida, Que.

PIERCY, Walter J., B.Sc. (E.E.), (Univ. of N.B.), underground electrn., McIntyre Gold Mines, Timmins, Ont.

PORTER, LAWSON BARDON, (Univ. of N.B.), asst. engr., National Harbours Board, Saint John, N.B.

*STEAD, Harry G., chief dftsman., E. Leonard & Sons Limited, London, Ont.

WHITEWAY, Lorne Bruce, B.Sc. (E.E.), (N.S. Tech. Coll.), Stellarton, N.S.

Transferred from the class of Associate Member to that of Member

ELDERKIN, Karl O., B.Sc. (Mech.), (McGill Univ.), engr. for John Stadler, M.E.I.C., consltg. engr., Montreal, Que.

KINGSTON, Thomas M.S., B.A.Sc., (Univ. of Toronto), city manager-engineer, Chatham, Ont.

Transferred from the class of Junior to that of Associate Member

*GRANT, Eric, 3645 Jeanne Mance Street, Montreal, Que.

HORTON, Everill Blackwell, B.A.Sc., (Univ. of Toronto), designing engr. and dftsman., Price Bros. & Co. Ltd., Riverbend, Que.

LEBLANC, Jules, B.A.Sc., C.E., (Ecole Polytechnique, Montreal), B.Sc. (Elec.), (Mass. Inst. Tech.), asst. chief engr. for Provincial Relief Work, District of Montreal, Ministry of Labor, Montreal, Que.

*MOFFAT, Alexander Robertson, (Queen's Univ.), chief surveyor of underground workings, Lamaque Gold Mines Ltd., Bourlamaque, Que.

WRIGHT, Noel Nithsdale, B.Sc., (Univ. of Illinois), sales engr., Ferranti Electric Limited, Montreal, Que.

Transferred from the class of Student to that of Associate Member

MACDONALD, John Ernest, B.A.Sc., (Univ. of B.C.), constrn. foreman, West Kootenay Power & Light Co., South Slocan, B.C.

Transferred from the class of Student to that of Junior

BENJAFIELD, John F., B.Sc., (Queen's Univ.), field engr., Foundation Company of Canada, Cornwall, Ont.

JOHNSON, James Richard, B.Eng., (McGill Univ.), asst. chief engr., Dominion Rubber Company, Montreal, Que.

JORDAN, Jack McLean, B.A.Sc., (Univ. of Toronto), 205 Wychwood Ave., Toronto, Ont.

McMANUS, Leslie Harold, B.Sc., (Univ. of Alta.), instructor, University of Alberta, Edmonton, Alta.

McMATH, Andrew A. B., B.Eng., (McGill Univ.), i/c Pulp and Paper Engrg. Dept., Canadian Ingersoll Rand Ltd., Sherbrooke, Que.

Students Admitted

ACKHURST, William Hall, (N.S. Tech. Coll.), 113 Henry St., Halifax, N.S.

BRYDGES, Robert James, B.Sc., (Univ. of Man.), P.O. Box 303, Souris, Man.

BUCHANAN, Arnold Amherst, (McGill Univ.), 3472 Montclair Ave., Montreal, Que.

DEAN, Maurice Ferguson, (Dalhousie Univ.), 142 9th Ave., Lachine, Que.

MEAGHER, Robert Douglas, B.Eng., (McGill Univ.), 571 Island Park Drive, Ottawa, Ont.

SNYDER, Robert Bertrum, B.Sc., (Univ. of Sask.), Lashburn, Sask.

WHITE, Clifford Hubert, B.Sc., (Univ. of Man), 337 Arlington St., Winnipeg, Man.

The following Students were admitted at the meeting of Council held on May 1st, 1938:

HOUGHTON, James Scott, B.Eng., (McGill Univ.), 730 Upper Belmont Ave., Westmount, Que.

RONCARELLI, Joseph Angelo, B.Eng., (McGill Univ.), 1429 Crescent St., Montreal, Que.

*Has passed Institute's examinations.

Elizabeth M. G. McGill, A.M.E.I.C.

Additions to the Library

Proceedings, Transactions, etc.

Association Canadienne-Française pour l'Avancement des Sciences: Annales, vol. 3, Montreal, 1937.

Institution of Mechanical Engineers: List of Members, 1938. Proceedings, vol. 137, 1937; London, 1938.

Reports, etc.

Alberta, Lethbridge Northern Irrigation District: Annual Report, 1937.

American Society of Mechanical Engineers: Rationalization of British Railways, by W. L. Waters. New York, 1938.

Canada Department of Labour: Prices in Canada and Other Countries, 1937; Strikes and Lockouts in Canada and Other Countries 1937; Wages and Hours of Labour in Canada, 1929, 1936 and 1937 (Report No. 21).

Canada Department of Mines and Resources: Report of the Department including Report of Soldier Settlement of Canada for the year ended March 31, 1937.

Canada Department of Mines and Resources Bureau of Mines: Petroleum Fuels in Canada (No. 789).

Canada Department of Mines and Resources Geological Survey: A Reconnaissance of Pelly River Between Macmillan River and Hoole Canyon, Yukon, by J. R. Johnston; Geology and Mineral Deposits of Ville-Marie and Guillet (Mud) Lake Map-areas, Quebec, by J. F. Henderson; Cadillac Area, Quebec, by H. C. Gunning; Gold Deposits of Herb Lake Area, Northern Manitoba, by C. H. Stock well.

Canada Department of Mines and Resources Mines and Geology Branch: Report for the Fiscal Year Ended March 31, 1937, John McLeish, Director.

Canada Department of Mines and Resources Surveys and Engineering Branch: Surface Water Supply of Canada, St. Lawrence and Southern Hudson Bay Drainage Ontario and Quebec Climatic Years 1931-32 and 1932-33 (Water Resources Paper No. 74).

Canadian Engineering Standards Association: Submission to the Royal Commission on Dominion Provincial Relations, Ottawa, 1938.

Canadian Government Purchasing Standards Committee: Specifications for Paint Thinner (Petroleum Spirits), Type I, II; Soap for Salt Water Use (Tentative). May 1938.

Edison Electric Institute: Distribution Transformer Load Characteristics 1938.

McGill University: A Select Bibliography on Location of Industry, References on Industrial Location and Development and Related Conditions in Montreal (Supplement) by Douglas Moore McDonald. (Social Research Bulletin No. 2.)

Ohio State University: Secondary Expansion in Refractory Clays, by J. O. Everhart. (Engineering Experiment Station Bulletin No. 98.)

Society of Naval Architects and Marine Engineers: The Essential Elements of Naval Research, by Dr. Ross Gunn; Non-Destructive Examination of Steel, by Dr. R. H. Canfield.

U.S. Department of Commerce National Bureau of Standards: Handbook H22; Fire Tests of Treated and Untreated Wood Partitions, by Clement R. Brown.

U.S. Department of the Interior Bureau of Mines: Ball-Mill Grinding, by W. H. Coghill and F. D. Devaney (Technical Paper 581).

Reprints

Aluminum in Canada, by E. V. N. Kennedy (University of Toronto Monthly, October 1937).

Bridge Across Lake Maggiore, by Dr. Artemio Ferrario (Italian Technique, October 1937).

Technical Books, etc.

Canadian Trade Index 1938 (*Canadian Manufacturers' Association, Toronto, 1938*).

Fundamentals of Electrical Engineering, by M. B. Reed (*International Textbook Company, Scranton, 1938*).

Klimatechnik, Entwurf, Berechnung und Ausfuhrung von Klima-Anlagen, by K. R. Rybka. (*Oldenbourg, Munchen, 1938.*)

Mechanical Engineers Handbook Design. Shop Practice, by R. T. Kent. (Wiley Engineering Handbook Series Vol. 3.) (*Wiley, New York, 1938.*)

Moncton Branch Dinner to Presidential Party

Standing—C. J. Letterick, Prof. F. L. West, M.E.I.C., A. R. Bennett, V. C. Blackett, A.M.E.I.C., Sec.-Treas., H. A. Fuller, G. E. Smith, A.M.E.I.C., C. W. Milton, N. B. Eagles, S.E.I.C.

Seated—Councillor F. Newell, President J. B. Challies, G. L. Dickson, A.M.E.I.C., General Secretary L. A. Wright, Prof. H. W. McKiel, M.E.I.C., J. A. Godfrey, C. S. G. Rogers, A.M.E.I.C., E. A. Cummings, Murray Wilson, S.E.I.C.

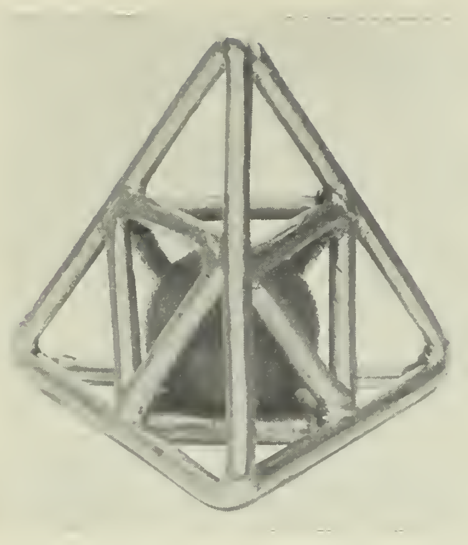
Saint John Branch Entertains the President and His Party

Seated at head table—G. A. FitzRandolph, G. Stead, M.E.I.C., S. Hogg, A.M.E.I.C., President J. B. Challies, Maj. W. H. Blake, A.M.E.I.C., Councillor F. Newell, General Secretary L. A. Wright, C. C. Kirby, M.E.I.C., J. D. Geary.

Standing—G. A. Vandervoort, A.M.E.I.C., V. S. Chesnut, A.M.E.I.C., C. N. Wilson, J. T. Turnbull, A.M.E.I.C., J. P. Mooney, A.M.E.I.C., G. G. Murdoch, M.E.I.C.

E. J. Owens, A.M.E.I.C. is seated at the end of the table to the left with C. T. Nisbitt, W. D. MacDonald, F. P. Vaughan, M.E.I.C., R. T. A. Moore, J. E. Warner, and F. A. Patriquen, JR.E.I.C., to his left and C. D. McAllister, R. E. Beeth, A. R. Crookshank, M.E.I.C., H. R. Logie, G. N. Hatfield, A.M.E.I.C., J. H. McKinney, A.M.E.I.C., and John Reed to his right.

Seated at table to the right—Norman Britain, A.M.E.I.C., H. P. Lingley, JR.E.I.C., Gordon Dow, S.E.I.C., J. R. Freeman, M.E.I.C., T. S. Moffat, A.M.E.I.C., A. A. Turnbull, A.M.E.I.C., and J. N. Flood, A.M.E.I.C.



The New Equilateral Tetrahedron

A photograph of an ingenious paper weight which was used by a past-president of The Engineering Institute of Canada, in his short speech at the memorable joint dinner of the Councils of The Institute and The Association of Professional Engineers of Ontario, held in the Royal York hotel, Toronto, on the evening of Friday, April 22nd, 1938. He appealed to all the various engineering organizations of the country to unite in some kind of all embracing organization, whatever its form might take, to enclose within it the whole engineering profession, loosely knit together with some freedom of internal movement. He likened the twenty triangles of the chromium plated copper framework to The Engineering Institute, the Dominion Council, the Provincial Associations and other organizations, and the loose manganese bronze ball enclosed within, to the profession in its entirety.

CORRESPONDENCE

The Editor,
The Engineering Journal.

Dear Sir:—

I desire to make the following statements in answer to Mr. R. M. Hardy's letter appearing in the issue of May 1938 (p. 253), in criticism of an article by myself entitled "A Statical Determination of the Reactions at Points of Contra-flexure in the Columns of a Steel Mill Building Bent Due to an External Wind Load" which appeared in the February, 1938 issue (p. 109).

The computations necessary to obtain the numerical values of the reactions require only one setting of the slide rule and the values are read off directly, knowing the length of the vector. The scale for all vectors is the resultant load divided by the length N and in this example the value of the right hand reaction is the scale multiplied by the length NB, which equals 9,000 divided by 2.4 and multiplied by 1.1. The value of the left hand reaction $= 9{,}000 \div 2.4 \times 1.5$.

The unit wind loads are for a wind velocity of 100 mi. per hr. The pressures produced on the different parts of the bent are with one exception in accordance with the Fifth Progressive Report of Sub-Committee No. 31, Committee on Steel of the Structural Division of the American Society of Civil Engineers. This report, under the heading "Wind Bracing in Steel Buildings" appeared in Proceedings of the American Society of Civil Engineers, March, 1936. The one exception is the unit load used for the windward slope of roof. A unit load of 5 lb. per sq. ft. pressure was used whereas for this roof — slope 25.5 degrees — and openings assumed the unit load on windward side would be almost zero. This value being so different from present specifications I was afraid of being misunderstood; moreover, a pressure load illustrated the example to better advantage.

The assumption that the windward column takes sixty percent of the total shear is directly in accordance with the distribution of shear in horizontally loaded two post rigid bents as determined by the "Cross" and "Slope Deflection" methods.

The assumed position of the plane of contra-flexure in the columns as located above the column base a distance of one-third the height to the knee brace connection is based on the fact that in actual construction the columns are only partially fixed at the base. This assumption is on the side of safety, for to assume contra-flexure as at half the height to the knee brace connection would be for the condition of a perfectly fixed base.

Yours very truly,
W. J. Smither,
Associate Professor of Structural Engineering, University of Toronto.

Toronto, Ont.,
May 20th, 1938.

The American Society of Mechanical Engineers Alleghenies Student Conference at Toronto, May 2nd and 3rd, 1938

The following report was prepared by Professor W. G. McIntosh in response to a request from the editor. The Journal is always pleased to give publicity to any activity that tends to enlarge the education or improve the welfare of the student engineer.

While the Student Branch organization in the A.S.M.E. is of comparatively recent origin, the present enrolment is about 4,000 at about 110 colleges which are divided into 9 groups for the purpose of holding annual conferences.

The Alleghenies group (Group III) comprises branches at the following colleges—University of Akron, Bucknell University, Carnegie Institute of Technology, Case School of Applied Science, Catholic University of America, University of Cincinnati, George Washington University, Johns Hopkins University, University of Maryland, Ohio Northern University, Ohio State University, Pennsylvania State College, University of Pittsburgh, University of Toronto and West Virginia University.

The meeting at Toronto was the fifth for this group, the previous meetings being held at Pittsburgh, State College Pa., Washington, D.C., and Columbus, Ohio. The Student Branch at the University of Toronto was represented by a large delegation of students at all except the first conference.

The organization work for this conference was carried out by student committees under the general chairmanship of Mr. Vernon M. Parrish, an undergraduate student, who was also chairman of the Student Branch here during the past year.

The most important features of the Conference were the Technical Sessions held on Monday and Tuesday mornings. The first session opened with an address of welcome by President Cody which was very much appreciated by the students and members of staff of the visiting colleges. Nine papers were presented by undergraduates from as many colleges in competition for five prizes of $50, $25, $10, $10 and a pocket slide rule. The judges, Mr. Ellis of the Ontario Research Foundation, Mr. Nagler of the Canadian Allis-Chalmers Co., and Mr. Rude of the British American Oil Co., gave very high praise for the excellence of the papers.

At a banquet Tuesday evening, Dr. Harvey N. Davis, President of Stevens Institute of Technology and President of the A.S.M.E. for 1938, presented the prizes to the winners. Mr. James B. Purdy, Ohio State University, received first prize for his paper on "Air Conditioning for Railway Passenger Cars." Mr. Robert J. Rock, Case School of Applied Science, received second prize for his paper on "The Air Streamlining of Ocean Ships." Following the presentation of the prizes, Dr. Davis addressed the gathering, which numbered about 190, on "Some Phases of the Engineer of the Future," emphasizing the human aspects of the work of the engineer.

The committee arranged for the inspection of the University laboratories and the Ontario Research Foundation by the visitors from other colleges and also for a number of plant visits on Monday and Tuesday afternoons; in the latter they had the co-operation of the industries in the Toronto district.

With a view to creating more and better friendships between the members from the various colleges the social activities were given considerable prominence. Group meals in the Great Hall of Hart House, swims in the pool before breakfast, a smoker and entertainment Monday evening, and a dance at Hart House Tuesday evening as a final wind-up of the conference were arranged by the committee with the co-operation of the staff at Hart House. At the dinner Monday evening, Dean Mitchell, M.E.I.C., and Professor Angus, M.E.I.C., each gave a very interesting coffee talk.

As an indication of the enthusiasm of the student members for these conferences I may be permitted to give a few examples. Two years ago 33 U. of T. students travelled to Washington, a distance of about 550 miles each way. Last year 25 University of Toronto students attended the conference at Columbus, a distance of about 425 miles, and spent the balance of the week visiting the University of Michigan, General Motors Proving Grounds, Chrysler Research Laboratory, the Packard and Ford plants and Greenfield Village. This year Ohio State University had an attendance of 33 students who travelled about 425 miles, Case School of Applied Science 24 students who travelled about 300 miles, and the University of Maryland 13 students who travelled about 550 miles. The travelling in most cases is done in private automobiles and the necessary cost to each student would probably not average more than about $12 to $15. To create additional interest, the Ontario Section donated a "man-miles" cup for annual competition. The cup was presented for the first time this year, the winning college having about 15,000 man-miles to its credit, by Professor F. V. Larkin, Director of Mechanical and Industrial Engineering at Lehigh University and representative of the Committee on Relations with Colleges at the conference.

As a further indication of the interest of the students the attendance at the technical sessions was about 180 and 160 on Monday and Tuesday respectively from a total registration at the conference of 201 of whom 155 were students and staff from colleges to the south.

The conference next year will be held at Case School of Applied Science, Cleveland, Ohio.

While the effects of such conferences are no doubt many, from my observations of the first four of this group, and my intimate connection with this the fifth conference, I believe they can all be summed up under the heading of "training the young engineer for future responsibility in society activities." This training is broad and varied, involving the organizing and carrying out of the many details which go to make a conference successful; financing all functions on a very limited allowance from headquarters and with no reserves upon which to call; the handling of a technical meeting involving the presentation of papers and the discussions of same; experience in presenting papers and meeting the discussion as gained by the speakers; the promotion of social intercourse and the intermingling of delegates; and last, but by no means least, the mixing of students from different colleges, exchange of ideas, the broadening of enlarged acquaintenceship, and the valuable friendships frequently made.

World Power Conference

Notice has been received of the Vienna Sectional Meeting of the World Power Conference to be held from August 25th to September 2nd, 1938, at Vienna. The absorption of Austria by Germany necessitated a few changes in the details of the conference, but the meeting will take place as originally arranged and the technical programme remains unchanged.

Canadian participation is confined to two papers for the Section on Energy for Agriculture.

1. "Agriculture in Canada" by Dr. C. F. Wilson, Dominion Bureau of Statistics.
2. "Electric Energy in Agriculture in the Province of Ontario" by R. T. Jeffery, Hydro-Electric Power Commission of Ontario.

So far we have not been informed of any delegates in Canada who will attend the conference, but if any of our members plan to be there, the Institute will be very pleased to recommend them to the Canadian Management Committee of the conference as accredited delegates.

A few copies of the detailed programme are available and may be secured from the General Secretary.

The International Electrotechnical Commission—Canadian National Committee

Originally formed in 1906, in London, as an outcome of an International Electrical Congress held in the United States in 1904, the I.E.C. has the object of furthering international co-operation in electrotechnical industry, with a view of obtaining uniformity in such matters as nomenclature, methods of testing and rating, and electrical standardization in its broader aspects.

The work is carried on by more than twenty advisory committees each dealing with a specific subject and composed of delegates of the various countries interested therein. These delegates are appointed by the national committees, of which there are now some twenty-two. The Plenary meetings of the Commission are in fact a kind of world parliament of electrical technologists and are held triennially.

The original Canadian Committee of the International Electrotechnical Commission was maintained for years under the Chairmanship of John Murphy, M.E.I.C., of Ottawa, to whom the continuity of this organization is largely due. After some years, during which the Committee was the responsibility of the Department of Trade and Commerce and, later, of the Canadian Engineering Standards Association, it was felt that the function of maintaining this organization and service should come under the direct auspices of the National Research Council. Accordingly, the old Committee wound up its affairs in order that the National Research Council could take over.

Early in 1937 the National Research Council organized its Associate Electrical Committee to function also as the Canadian Committee of the International Electrotechnical Commission. On this Committee are representatives of the Electrical Industries and Utilities, Electrical Departments of the Universities, Government Services and the National Research Council. The Council appointed Dr. R. W. Boyle, M.E.I.C., as Chairman and A. J. Grant, M.E.I.C., as Secretary. Thus far, two Technical Panels have been organized and have begun their work. A Panel on Nomenclature, Symbols, Units, Electrical Measurements and Instruments acts under the Chairmanship of Professor V. G. Smith of the University of Toronto, with Mr. J. S. Johnson of the National Research Council as Secretary, and there is a Panel on Aluminum Conductors, under the Chairmanship of A. S. Runciman, A.M.E.I.C., Shawinigan Water and Power Company, with Mr. A. J. Grant, National Research Council, as Secretary (*pro tem.*). The President of the National Research Council is a member ex officio of the Associate Committee and all subsidiary committees.

The new Canadian Committee will be represented and make its submissions to the International Electrotechnical Commission for the first time at the coming Triennial Plenary Conference to be held in England in June 1938. An invitation has been received for direct representation, and arrangements have been made for the Secretary of the Committee to proceed to England as its representative.

BRANCH NEWS

Edmonton Branch

F. A. Brownie, A.M.E.I.C., Secretary-Treasurer.
J. W. Porteous, Jr.E.I.C., Branch News Editor.

The final dinner meeting of the Edmonton Branch for the 1937-38 season was held at the Macdonald hotel on April 21st, 1938. As the main item of business, a new executive committee was elected for the ensuing year with W. E. Cornish, A.M.E.I.C., as Branch chairman.

Chairman J. D. Baker, M.E.I.C., then introduced the speaker of the evening, A. W. Haddow, A.M.E.I.C., Edmonton City Engineer, who presented a very interesting paper under the title "An Amateur Tries to Understand the Weather."

Mr. Haddow introduced his subject by pointing out that it is only since the development of the telegraph and the radio that weather has been studied on a world-wide basis rather than as a purely local phenomenon. He then outlined the various theories to account for the major movements of air masses on the earth's surface. It can be shown that the forces which act on the atmosphere due to the earth's motions and shape, together with the effect of the sun's energy, produce the prevailing winds as we know them.

Mr. Haddow then described the effects of these air movements and proceeded to a discussion of local weather conditions in Alberta. He concluded by correlating moisture and temperature conditions with the vegetation found in various parts of the world.

The discussion which followed indicated the general interest and timeliness of Mr. Haddow's subject in view of the important problems now being attacked with regard to drought and agriculture in Western Canada.

Hamilton Branch

A. R. Hannaford, A.M.E.I.C., Secretary-Treasurer.
W. W. Preston, S.E.I.C., Branch News Editor.

Why Bridges?

In an address enhanced with humour, R. K. Palmer, M.E.I.C., Chief Engineer of the Hamilton Bridge Company, discussed the question "Why Bridges?" before the Hamilton Branch at its meeting in McMaster University on May 10th, 1938. Mr. Palmer stated that the purpose of bridges was obviously to surmount barriers. He pointed out that bridges and roads were developed about the same time, because gaps along the roads had to be bridged before the roads could be opened for through traffic.

Any bridge, he continued, should possess structural efficiency and beauty of appearance. It is comparatively easy for the engineer to write specifications to guarantee that bridges will have the necessary strength, conveniences and durability, but writing a specification for beauty is exceedingly difficult. Beauty is art and depends on the designer's emotions rather than his mathematics. The surroundings at the bridge-site have considerable influence on the appearance of the bridge.

To make bridges beautiful, the speaker urged designers to select the most suitable materials. Every material has a particular place in a structure and any substitution would offend the spectators. Concrete has a pleasing appearance when it follows curved lines. Its massiveness gives one a feeling that there is great compressive strength in concrete, but when it is used in tension or bending, one is apt to be dissatisfied. On the other hand steel is the proper material where there is tension, and it alone is suitable for long-span bridges. Mr. Palmer then asked for unity of appearance. He deplored the use of both concrete spans and steel spans in the same bridge. He condemned, especially, the use of different materials for the hand-railings, and the use of concrete when fixed up to imitate cut stonework.

Throughout the lecture Mr. Palmer illustrated his remarks by referring to local bridges. His outstanding example was the high level bridge at the western entrance to Hamilton. This structure was awarded the second prize in the annual A.I.S.C. competition for bridges built in North America. Its beauty is increased by four pylons at the ends of the bridge and on each side of the roadway. Without them the motorist would pass over the bridge without knowing it was there, but by their presence he realizes that he is passing over something unusual.

Mr. Palmer was introduced by H. A. Lumsden, M.E.I.C., and at the close of his address called on Major V. S. Thompson, A.M.E.I.C., designing engineer at Hamilton Bridge Co. Mr. Thompson described briefly how recent designs had been influenced by aesthetic considerations. By substituting rocker bents for towers, and curved portals for straight ones, mazes of intersecting lines have given place to graceful curves and beauty.

The concluding part of the programme featured two motion pictures loaned by the Bethlehem Steel Co. and shown by their representatives, W. W. Martin of Hamilton, and W. R. Harris of Toronto. The first reel, entitled "The Manufacture of Structural Steel Shapes," gave the story of steel from the mine to the finished products. The second picture showed the "Erection of the Golden Gate Bridge" at San Francisco.

W. J. W. Reid, M.E.I.C., was chairman and attendance 175. W. L. McFaul, M.E.I.C., moved a vote of thanks to the two speakers, the two projectionists and also to Chancellor Whidden and Dr. Burke of McMaster University for their kindness to the Hamilton Branch. Refreshments were served following the meeting.

Kingston Branch

R. A. Low, A.M.E.I.C., Secretary-Treasurer.

A general dinner meeting of the Kingston Branch was held in the Students Memorial Union, Queens University, on March 1st, 1938.

A short business meeting followed the dinner, with Major H. H. Lawson, M.E.I.C., chairman of the Branch, presiding.

Following the meeting, members made an inspection tour of the new Sanitary and Highway Laboratory, Queens University. Dr. W. L. Malcolm, M.E.I.C., professor of Sanitary Engineering at Queens University, conducted the tour, explaining the operations of the many different methods of sewage and water treatments available in the laboratory, and giving brief outlines of many active or projected research problems. The many discussions throughout the evening showed the keen interest of all those present.

A hearty vote of thanks to Dr. Malcolm for his instructive discourse was moved by E. C. Goodman, A.M.E.I.C.

The second public meeting of the Kingston Branch was held in Sir Arthur Currie Memorial Hall, Royal Military College, on April 17th. In addition to the members of The Institute, many students from both Queens University and the Royal Military College were present.

The speaker of the evening, Mr. Robson Black, Vice-President and Manager of the Canadian Forestry Association, was introduced by the chairman, Major H. H. Lawson, M.E.I.C., of the Kingston Branch.

Conservation: A First Charge on Patriotism

Mr. Black brought forcibly home, by statistics, the vast amount of wastage of this country's forest wealth. He also referred to the wholesale slaughter of wild life, with the resultant disappearing of many valuable species. Such an attitude on the part of Canadians, if pointed in other directions, would result in the practical disappearance of other resources. Unlike the resources of a mine, the resources of a forest was not alone in cubic content of wood but rather in its capacity, under scientific direction to reproduce itself or its most desirable species in maximum volume and with a maximum rate of growth.

The speaker pointed out that 92 per cent of the forest resources of Canada were public-owned. The greater part of these forest lands were unfit permanently for agriculture, but their one highly desired service to the nation was in their valuable contribution of timber. The authority of the state was absolutely essential for the proper regulation of any public-owned natural resource.

Mr. Black presented interesting data on conservation measures adopted in Finland, Switzerland and other European countries, where often the whole of the national estate was under an economic plan and the right to exploit natural resources ended where it failed to coincide with the interests of society. The speaker stressed the fact that large numbers of thoughtful Canadians have become persuaded that the resources of this country were no longer the affairs of learned societies alone, but the immediate and demanding concern of this generation. He closed with an appeal to the younger man to give leadership to the cause of conservation, and urged that immediate action should be taken to awaken Canadians to their duty. A series of films on conservation completed the programme.

A vote of thanks to Mr. Black for his interesting and instructive address was moved by Gentleman Cadet Hyman of Montreal, seconded by K. N. Campbell, Queens University.

Prior to the address, Mr. Black was guest of honour at a dinner held at the Badminton Club, other guests including the Commandant of R.M.C., Brigadier Matthews.

At the conclusion of the lecture, the guests and members were entertained at the R.M.C. Senior Staff Mess by the chairman, Major H. H. Lawson, M.E.I.C., and Lt.-Col. Leroy Grant, M.E.I.C. Members were given a much appreciated opportunity of discussing various aspects of the problems of conservation with Mr. Black.

Lakehead Branch

H. Os, A.M.E.I.C., Secretary-Treasurer.

The regular monthly dinner meeting of the Lakehead Branch was held at the Royal Edward hotel, Fort William, April 13th, 1938.

The chairman, G. R. Duncan, A.M.E.I.C., welcomed the members and guests, and requested those present to introduce themselves by standing in turn giving name and employment.

The following three members, J. M. Fleming, M.E.I.C., P. E. Doncaster, M.E.I.C., and H. P. Sisson, Affil. E.I.C., were elected to act with G. H. Burbidge, M.E.I.C., and H. G. O'Leary, A.M.E.I.C., previously appointed by the Executive, as a Nominating committee to draw up a slate of officers for election at the annual meeting in May. Mr. G. H. Burbidge was elected chairman of the committee.

F. C. Graham, A.M.E.I.C., read a resolution, made by the Executive committee of the Branch and edited by J. M. Fleming, M.E.I.C., recommending Hon. C. D. Howe, Hon.M.E.I.C., Minister of Transport, for the Sir John Kennedy Medal. Mr. Graham moved that the resolution be adopted as read, Mr. O'Leary seconded it and the motion was carried unanimously. J. Antonisen, M.E.I.C., spoke in support of the motion and expressed his pleasure at this effort to give recognition to Mr. Howe for his outstanding services to the engineering profession.

Mr. P. E. Doncaster brought up the question of amendment to By-laws No. 44 and No. 51, and spoke very strongly in favour of changing them as recommended by Council. David Boyd, A.M.E.I.C., urged that the amendments to the by-laws should be approved by the membership. He stated that the elected Executive committee of the Montreal Branch had been powerless for years due to existing by-law No. 51 of The Institute. He lauded the work of the ex-officio members of the Montreal Branch for the work they had done for that Branch and The Institute at large, but stressed the fact that they could, under the present conditions, run Branch affairs and also Institute affairs to suit their own interests without due regard to the opinions and interests of the younger members elected to Council.

S. E. Flook, M.E.I.C., introduced the speaker of the evening, D. B. Armstrong, A.M.E.I.C., of the Dominion Bridge Company. Mr. Armstrong spoke on "Pre-stressing and Erection of the Island of Orleans Bridge," showing slides to illustrate his lecture. Mr. E. Smith moved a vote of thanks to the speaker and Mr. Doncaster seconded the motion. Due to the lateness of the hour, there was no general discussion of the many interesting subjects introduced by the speaker during his lecture.

Forty-one members and guests were present.

Lethbridge Branch

E. A. Lawrence, S.E.I.C., Secretary-Treasurer.

The annual meeting of the Lethbridge Branch was held on Saturday afternoon, March 5th, 1938, at which the Secretary's annual report was read and adopted. The financial statement showed a satisfactory improvement in the Branch's affairs. The retiring chairman, J. M. Campbell, A.M.E.I.C., expressed his appreciation of the Branch Secretary, E. A. Lawrence, S.E.I.C., and thanked the various committees for their efforts. He then vacated the chair in favour of the incoming chairman, R. F. P. Bowman, A.M.E.I.C.

The Lethbridge Branch held a dinner meeting at the Marquis hotel on Saturday evening, March 12th, at which the members entertained their ladies. During the dinner orchestral numbers were rendered by Mr. Geo Brown Sr. and his orchestra, followed by vocal solos by Miss Eastabrook and Mr. Geo Brown Jr.

The speaker of the evening was Pilot-Officer Wilson Donaldson, R.A.F., who addressed the meeting on "Training for the Royal Air Force." Mr. Donaldson described the procedure of applying for a short service commission and the many tests and examinations involved, followed by an interesting description of the methods in vogue in England. His experiences in England and Iraq as a pilot of heavy bombing planes were told in a very interesting and homorous manner.

A hearty vote of thanks was moved by C. S. Clendenning, A.M.E.I.C., for Mr. Donaldson's address.

London Branch

D. S. Scrymgeour, 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 April 26th, 1938, in the Officers' Mess, Richmond Street Armouries, London, Ontario, through the kindness of Lt.-Col. Veitch, A.M.E.I.C. Two talking films, sponsored by the Imperial Oil Company, were shown.

A. O. Wolff, M.E.I.C., chairman of the Branch, presided and in his opening remarks he welcomed those members of military units who were present and said that the thanks of the meeting were due Lt.-Col. Veitch for the use of the officers' quarters.

He also said that a joint meeting would be held between the Grand Valley Group of Registered Professional Engineers and the London Branch of the E.I.C. at Brantford toward the end of May and it was hoped that as many members and others of the Branch as possible would attend. All were heartily welcome.

Mr. Wolff then pointed out that the thanks of those present were due the Imperial Oil Company for the movie exhibition which was now to be shown and introduced Mr. Howard of the Imperial Oil Company.

The first film was called "The Long Road," its object being to show the rapid growth and improvement and use of the motor car and other locomotive traction right from the days of Watt and Stephenson to the present day.

The first locomotives and later the first motor carriages and cars were shown. Amusing scenes were given of the days when all power driven units on the road must be preceded by a man with a red flag and so on through all the stages up to the present day facilities of traction. All modern transportation units were shown in full operation on the railways and highways, in cities and at the race tracks.

The second film was named the "Inside Story," and dealt mostly with lubrication. From the days of the first refining of petroleum in 1859 the industry had never stood still. Scientific research had been going on all the time so that wonderful improvements had been made. If a 1938 car were operated with 1928 gas and oil the results would be found to be very inferior.

This film gave views of various refineries and depicted scientists at work in their laboratories, also showing the elaborate and delicate machinery used. It showed how the "knock" was eventually taken out of the motor which for a long time was thought to be of mechanical origin but was found at last to be in the explosion of the gasoline and was duly corrected.

Many times magnified views of bearings, cylinders, etc., were shown and the action of the lubricant therein. This was particularly the case with the cylinders where the action of the oil and the piston rings was very clearly shown and described. All kinds of gears were shown and the necessity of using the right grade of oil was stressed. Particular attention was also drawn to the proper consideration of temperature and speeds in the selection of the proper oil.

The films throughout were beautifully clear and steady.

A vote of thanks to the representatives of the Imperial Oil Company present was moved by R. S. Charles, seconded by Major Andrewes, A.M.E.I.C., and unanimously carried.

About 31 members and guests were present, and questions were asked and answered by the company's representatives.

Montreal Branch

E. R. Smallhorn, A.M.E.I.C., Secretary-Treasurer.

Trans Island Motor Highway

The Executive committee of the Montreal Branch called a special general meeting on May 9th for the purpose of discussing the location of the western portion of the proposed Trans Island Motor Highway. It was their wish to obtain a general discussion and as much information as possible concerning the proposed routes other than the Metropolitan Commission scheme, and particularly if possible to hear an elaboration of the reasons in favour of a location south of the tracks nearer to the Lake Shore summer resorts. There have been committees appointed by the Executive at various times during the past few years to endeavour to gather and present such information in case the Branch might be put in the position of expressing an opinion on this question. Up to the present it has not been easy to get such data.

For this meeting the Hon. F. J. Leduc co-operated whole-heartedly and delegated Mr. Martineau and Mr. Racicot, two engineers in his department, to explain fully the views of the Provincial Roads Department. This they did very capably and satisfactorily.

Other engineers especially invited included Mr. H. A. Terreault, Chairman of the Town Planning Commission, and all the engineers who were members of the Board appointed by the City of Montreal about ten years ago, to survey and report on this question. Mr. Terreault opened the meeting by explaining very clearly the background and technical investigation which had resulted in the so-called Metropolitan Commission scheme. Mr. Paul A. Beique also contributed a concise and clear resumé of the work of the engineering commission. Mr. Gordon McL. Pitts also spoke generally in favour of the Central Island scheme.

The meeting proved to be one of the largest of the year and evoked such interest that active discussion continued until 11 p.m. when a resolution was adopted by a large majority of those present approving the location of the western access to the city north of the tracks rather than to the south.

Lectures on Economics

A series of lectures on economics has just been concluded. Such a series has been carried on for the past four years under the auspices of the Papers Committee. Each year they have been given by Dr. D. M. Marvin, economist, of the Royal Bank of Canada, Montreal, who has shown a keen interest in the activities of the group and who has devoted a great deal of time to the preparation of the necessary lecture material and to the answering of questions.

In order to obtain proper continuity, the attendance at lectures has been restricted each year to those subscribing to the whole course although the invitation was extended to all members of the Branch. No rigid routine of subject-matter has been adhered to, as the lectures have not been in any way an elementary or technical study of economics itself, but rather discussions of business and business conditions associated with engineering and allied activity and the discussion of such conditions from the economic view point. To provide background, some of the earlier lectures dealt with the fundamentals of economics.

The series during this past winter season consisted of eleven lectures dealing with the present world situation in general; the present irregularities in financial and business stability, etc. One evening was devoted to an informal talk by Miss Aryness Joy who is head of the Statistical Bureau in Washington, who was visiting Montreal in connection with her work.

Dr. Marvin is internationally known as an economist, but it is less well-known that he studied and taught psychology for many years. These qualifications and his keen interest in engineers and engineering have made this activity of the Montreal Branch extremely interesting and the twenty-three members who participated feel that an opportunity of very great value has been afforded to the membership of our Branch.

Typical of the activities of this group is the present arrangement that two lectures will be held during the summer; one at the end of July and one at the end of August to discuss economic developments at that time; it being felt that these few months are a period of pronounced financial and economic change.

Niagara Peninsula Branch

G. E. Griffiths, A.M.E.I.C., Secretary-Treasurer.
J. G. Welsh, S.E.I.C., Branch News Editor.

On May 13th, 1938, the Niagara Peninsula Branch of The Institute terminated another very successful season of activities with a dinner meeting at the Hotel General Brock, Niagara Falls, Ontario, with Chairman L. C. McMurtry, A.M.E.I.C., presiding.

The Branch was highly honoured by the presence of the President of The Institute, J. B. Challies, M.E.I.C., and the General Secretary, L. Austin Wright, A.M.E.I.C. Mr. Challies gave a few words of praise to the Canadian engineers with regard to their hydro-electric achievements which are so splendidly illustrated in the Niagara District. He stated that the European plants excelled the Canadian developments in but one manner, and that was in their aesthetic treatment.

Mr. Wright placed himself high in the respect of the listeners with his few pointed remarks. After a few interesting words from Mr. Anderson, M.P.P. for Welland, the retiring chairman, Mr. McMurtry, thanked the assembly and his executive for the splendid way in which all had co-operated during the past season.

Mr. McMurtry then called upon the chairman elect, C. G. Moon, A.M.E.I.C. The executive for the ensuing year was introduced and the reappointment of Mr. Griffiths as Secretary-Treasurer was heartily endorsed by all those present.

W. R. Manock, A.M.E.I.C., the Niagara District's new Councillor to The Institute, introduced the speaker of the evening, Mr. A. E. Hay, sales manager of the Pratt & Lambert Company. In a very sincere, exceedingly interesting and humorous manner Mr. Hay spoke in his own inimitable way of "The Essentials of Life," pointing out that labour, perseverance and service were the true essentials.

The meeting was taken to a still greater degree of perfection by the achievements of past-chairman G. E. Woods as maker of "Manhattans."

Saturday afternoon a few members of the Branch joined the Buffalo Engineering Society in a luncheon and a trip through the new sewage disposal plant of the City of Buffalo. The plant was in the final stages of completion and with a large number of very competent guides the afternoon was very profitably spent.

Ottawa Branch

R. K. Odell, A.M.E.I.C., Secretary-Treasurer.

Parking in Ottawa

At an evening meeting, held at the lecture hall in the National Research Laboratories on April 12th, 1938, Robert M. Simpson addressed the members on "Parking in Ottawa." Mr. Simpson had been acting as Survey Director of the Citizens Parking Committee of Ottawa, an organization which had recently completed an investigation of the car parking situation in the city, and had prepared a comprehensive report.

The speaker explained some of the findings of the committee. He stated that Ottawa's effort was the first comprehensive parking survey ever made in Canada although one was subsequently completed in Vancouver. To carry out the survey, the assistance of 240 men who were on the relief rolls was utilized to obtain the detailed information required. These men, for an area of about a third of a square mile in the business centre of the city, obtained comprehensive data relating to traffic movement on certain days during the fall of 1937.

One thing which the survey revealed was the large number of people who walked to work in the city of Ottawa. There were, as a matter of fact, about three times as many people walking to work in Ottawa as in any other city of comparable size in America. After 9.30 a.m. also, there were many more motor vehicles in the district than parking spaces provided for. This overloaded condition of the city streets was no doubt largely responsible for the number of violations of parking ordinances noted by the enumerators.

According to the count, at one time over 41 per cent of all the motor cars parked in the downtown section were violating one or more of the traffic ordinances, such as by parking in no parking areas, by overtime, by being too near corners, by double parking, by being close to hydrants or otherwise by improper parking. Incidentally, for 1937, out of the total number of parking infractions noted by the police, less than 6 per cent resulted in prosecutions. No doubt the tendency toward this condition of congestion will be more intensified in the future, as more people are supplied with cars. In 1920, for instance, there was one car for every 22 people in the city whereas in 1937 there was one for every 7 people. By 1950 it is estimated there will be about one car for every 6 people. Another interesting point brought out by the survey was that while the average motor car is travelling over the down town section, 68.93 per cent of the time is taken up in actual motion, 22.08 per cent in waiting for cross traffic, 7.78 per cent for street cars to load and unload, 1.04 per cent in delays due to the improper parking of automobiles and 0.16 per cent of the time in waiting for pedestrians to get out of the way.

A. K. Hay, A.M.E.I.C., in leading off with the discussion, stated that as a result of the survey some recommendations had been brought forward from the advisory committee, one of which was that a straight fine of one dollar be imposed for every traffic law violation, such fine to be without additional costs if paid within 48 hours, otherwise the regular rates would prevail. Such a course would engender a greater respect for traffic regulations and militate against their abuse.

Other discussion followed. One of the recommendations was that parking meters be installed in the downtown area and much of the time of the discussion was taken up with this suggestion.

Seismology

At the noon luncheon April 21st, Dr. E. A. Hodgson of the Dominion Observatory gave an address on "Seismology," which included a short account of the routine and present-day research trends in this science.

The survey of land for oil bearing strata was one of the off-shoots of seismological science of recent years, according to Dr. E. A. Hodgson. Using seismographs it was possible to locate underground oil sources through a study of the records obtained upon the recording instruments. A small party of men can by this means cover from two to three square miles of territory in a day. Equipment costs about $30,000, lasts about two years, and requires an expenditure of from $3,500 to $4,000 per year to operate.

Dr. Hodgson briefly outlined the development of the science of seismology since the establishment all over the world about 43 years ago of a series of stations for the study of earthquakes. Recording instruments may vary in weight from one pound to 20 tons. Nowadays they are more sensitive than formerly and may be electrically controlled instead of mechanically controlled. Although he has been a student of seismology for 25 years, Dr. Hodgson stated, he has actually studied earthquakes themselves and their effects upon the ground only on two different occasions.

Another study bearing upon the science is that of the design and construction of buildings to resist the devastating effects of earthquakes. Scientists have tried to determine just what it is about earthquakes that actually cause devastation and to introduce elements into building design so as to obviate the possibility of such destruction. He instanced the case of a hotel in Tokio where such considerations had been taken into account in its construction with the result that it had survived many earthquakes where even the ornamental parts of the hotel had not suffered. In California much attention has been paid to building construction from this point of view. Specifications can be made up whereby at an additional cost of 10 per cent over usual costs of construction, buildings can be made earthquake free. The additional cost can be saved on reduced insurance premiums in about ten years.

W. F. M. Bryce, A.M.E.I.C., local chairman, presided.

Sunspots

An address on "Sunspots" was given at the noon luncheon, May 5th, by Dr. Ralph E. DeLury, of the Dominion Observatory. Dr. DeLury of late years has devoted an increasing amount of attention to the effects of solar variations on terrestrial phenomena, and his talk dealt largely with fluctuations in physical, organic and economic phenomena as related to the eleven-year sunspot cycle.

Years of research and investigation on the part of physicists and scientists generally have revealed remarkable similarities between the cycles of sunspot activity and other trends, according to the speaker. By the use of graphs and diagrams he showed how the curve of sunspot activity over a period of years was closely approximated by the curve of marriages, of commodity prices, of tree growth, and of many other happenings, even to the number of influenza cases. As Dr. DeLury explained it, whatever type of precipitation follows as a direct result of sunspot activity has a definite bearing upon life itself.

Although the average sunspot cycle is about eleven years, the definite prediction of crops ahead cannot be made as yet but one would expect the prairie crops to be at their best when the solar activity was at a minimum. A very long series of records and much further study would be necessary if one wished to arrive at any definite conclusion in this regard. At the present time the sun has just passed through a period of maximum activity and appears to be going on towards a minimum phase.

By making use of fine grained plates sensitive to violet and blue light, photographs of the sun's disc now reveal much more character than those taken formerly by plates using yellow light. The shape and nature of the spots and large bright faculae themselves are more readily observed, as well as the radial streamers that may be given off indicating their rotating or vortex nature. The spots are, according to the speaker, comparatively stable, and often last longer than a complete rotation of the sun or more than 25 days.

Much can also be learned regarding the sunspots from a study of their spectra. Analyses of these undertaken at the Mount Wilson Observatory revealed that spots are magnets and close pairs are usually of opposite polarity. Variation in the frequency of the Northern Lights appears to follow that of the sunspots, lagging one year behind.

As an indication, also, that the sunspots may have an effect upon other bodies than the earth, there appears to be a relationship between the intensity of the spots and the size of the snow-capped areas on the planet Mars, and the brightness of Encke's comet.

Ultra violet light, emitted strongly by the high-level faculae, ionizes the upper atmosphere of the earth in variable amounts producing electromagnetic fluctuations and inducing variations in haziness and cloudiness with the other meteorological pulsations in the sunspot cycle.

W. F. M. Bryce, A.M.E.I.C., chairman of the local branch, presided.

Peterborough Branch

W. T. Fanjoy, A.M.E.I.C., Secretary-Treasurer.
J. L. McKeever, Jr.E.I.C., Branch News Editor.

At the regular meeting of the Branch held on April 14th, 1938, the guest speaker was Mr. A. G. Scott, chief lubrication engineer of the Imperial Oil Company Limited. Instead of addressing the meeting himself Mr. Scott brought with him two talking films. The first of these was a travel film, being the record of a motorized expedition through Central Africa from French Morocco to Nairobi. This picture gave an interesting account of the customs of the various native tribes through whose territory the expedition passed, and was much appreciated by the Branch.

The second and main film of the evening was called "The Inside Story," and gave a graphic account of the lubrication of various types of mechanism, and by means of animated diagrams showed how the lubrication wedge forms between journal and bearings and how this wedge is affected by load, speed and type of lubricant. After the showing of the picture, Mr. Scott was good enough to answer a number of questions put to him by members of the Branch.

Attendance, 58.

The annual meeting of the Branch was held at the Y.M.C.A. on Thursday, May 5th, commencing with supper at 6.30 p.m. Unfortunately the Branch chairman, V. R. Currie, A.M.E.I.C., was still feeling too badly over the recent loss of an appendix to attend, and his place was taken by the past-chairman, H. R. Sills, A.M.E.I.C., After supper, the ballots were counted by scrutineers W. M. Cruthers, A.M.E.I.C., and V. S. Foster, A.M.E.I.C., and the following were declared elected to the executive for 1938-39: I. F. McRae, A.M.E.I.C., B. I. Burgess, A.M.E.I.C., W. T. Fanjoy, A.M.E.I.C., G. A. Cunningham, A.M.E.I.C., A. L. Malby, Jr.E.I.C., B. Ottewell, A.M.E.I.C., and R. L. Dobbin, M.E.I.C. Councillor A. B. Gates, A.M.E.I.C., and Past-chairman V. R. Currie, are, of course, members ex-officio. Following announcement of the new executive, the usual yearly reports from the various officers were heard. In this connection the Branch were very glad to welcome back after his long illness their Councillor, Mr. Gates, who reported on the activities of the Council, with which he had kept in touch by correspondence. The remainder of the evening was spent in various diversions such as bowling, ping-pong and volley-ball, for which prizes were awarded at the close of the meeting by Mr. Dobbin.

Attendance, 42.

On May 19th the Peterborough Branch held a joint meeting with the Foreman's Association of the Canadian General Electric Company in the Legion Hall, the occasion being the showing of two talking films furnished through the courtesy of the Bethlehem Steel Corporation. The first picture showed the manufacture of structural steel shapes at the various plants of the Corporation, the process being followed from the unloading of the ore to the finished rolled product.

The second picture was a pictorial and verbal description of the building of the great suspension bridge over the Golden Gate narrows at San Francisco, for which the Bethlehem Corporation furnished the steel.

Both pictures were viewed with great interest by a large audience and the representatives of the Steel Company were sincerely thanked for bringing them to Peterborough.

Sault Ste. Marie Branch

N. C. Cowie, Jr.E.I.C., Secretary-Treasurer.

The Sault Ste. Marie Branch of The Engineering Institute of Canada held a dinner meeting in the grill room of the Windsor hotel, Sault Ste. Marie, Ont., on Friday, April 29th, 1938.

Following an appetizing dinner, which was served by the hotel staff and enjoyed by the 29 members and guests in attendance, the chairman of the Sault Branch, J. S. Macleod, A.M.E.I.C., presided at a short business meeting. During this period the secretary was instructed by the meeting, on a motion of John L. Lang, M.E.I.C., seconded by Wm. Seymour, M.E.I.C., to write to R. J. Durley, M.E.I.C., Secretary Emeritus of The Engineering Institute of Canada, and to L. Austin Wright, A.M.E.I.C., General Secretary of The Institute, and to convey to the former the regrets of the meeting on hearing that he had found it necessary to resign from his former position as general secretary and to extend to the latter the welcome of the meeting as he takes over the heavy responsibilities Mr. Durley lays down.

Following this business part of the meeting, the members and guests present were favoured by Mr. R. J. Anderson, service engineer of the Dominion Oxygen Co., Limited, Montreal, with an excellent paper entitled. "The Oxygen-Acetylene Process in Industry." In introducing his talk, Mr. Anderson gave a brief résumé of the founding of the various materials used in this process, and an outline of the present day methods and procedures used to produce these materials. He then mentioned the ways this process can and is being used to the economic advantage of several of the industries with which his listeners were familiar. The discussion which followed brought out several uses of this process which were of more particular interest to some of the members present.

The appreciation of the meeting of Mr. Anderson's talk were extended to him on a motion of F. Smallwood, M.E.I.C.

Toronto Branch

J. J. Spence, A.M.E.I.C., Secretary-Treasurer.
A. E. Berry, M.E.I.C., Branch News Editor.

The annual meeting of the Toronto Branch was held at the Military Institute, University Ave., on Thursday, May 12th, 1938. A. U. Sanderson, A.M.E.I.C., occupied the chair. A number of prominent guests were in attendance, including President Challies, M.E.I.C., General Secretary L. A. Wright, A.M.E.I.C., Past Vice-President R. L. Dobbin, M.E.I.C., Peterborough; Vice-President E. V. Buchanan, M.E.I.C., London; James A. Vance, A.M.E.I.C., London; W. J. W. Reid, M.E.I.C., Hamilton, and others.

The activities of the evening started with a dinner, at which an unusually large number were present. Chairman Sanderson in his opening address reviewed the year's activities of the branch, and emphasized the desirability of having all engineers associated with The Institute.

Committee reports were presented as follows:—Secretary-Treasurer —J. J. Spence; Membership—W. E. P. Duncan, M.E.I.C.; Branch Editor—A. E. Berry; Social Committee—N. MacNicol, M.E.I.C., and Press Relations—D. D. Whitson, A.M.E.I.C.

The scrutineers' report on the election of officers resulted in the following executive for 1938-39:

Chairman:	C. E. Sisson, M.E.I.C.	
Vice-Chairman:	A. E. Berry, M.E.I.C.	
Sec.-Treasurer:	J. J. Spence, A.M.E.I.C.	
Committee:	Nicol MacNicol, M.E.I.C.,	H. E. Brandon, A.M.E.I.C.,
	D. D. Whitson, A.M.E.I.C.,	W. E. P. Duncan, M.E.I.C.,
	G. H. Rogers, A.M.E.I.C.,	M. Barry Watson, A.M.E.I.C.
Councillors:	W. E. Bonn, M.E.I.C.,	O. Holden, A.M.E.I.C.
Ex-officio:	A. U. Sanderson, A.M.E.I.C.	

President Challies addressed the meeting and in a most interesting manner discussed the various problems which are now before The Institute, and also reviewed the more recent activities of the executive. The address dealt in vivid manner with the arguments for recognition by all engineers of this national Institute. It was indeed a stimulus and an inspiration to greater attainments by The Engineering Institute.

The guest speaker of the evening was Wilson Woodside, who gave a most enlightening discourse on his observations in Germany, particularly on that country's living conditions and preparations for war.

Presidential Party's Visit to the Cape Breton Branch

Standing—S. C. Mifflen, M.E.I.C., W. C. Risley, M.E.I.C., Y. C. Barrington, A.M.E.I.C., J. H. Fraser, C. M. Anson, A.M.E.I.C., R. F. McAlpine, JR.E.I.C., S. G. Naish, A.M.E.I.C., J. A. MacLeod, A.M.E.I.C., A. B. Blanchard, M.E.I.C.

Seated—L. A. Wright, A.M.E.I.C., A. P. Theuerkauf, M.E.I.C., J. B. Challies, M.E.I.C., F. Newell, M.E.I.C., I. W. Buckley, A.M.E.I.C., F. W. Gray, M.E.I.C., M. F. Cossitt, A.M.E.I.C.

Canadian Living Costs Favourable on Comparison

Rising living costs since 1934 in most important countries add significance to a comparison of recent indices. In 1937, the average cost of living index for Canada was 131; for the United States 147; and for Great Britain 159; according to figures based on government statistics. The average for Canada over a 25-year period to the end of 1937 was 8 per cent below that of the United States and about 20 per cent below that of Great Britain.

James Watt International Medal

The Council of the Institution of Mechanical Engineers awarded the second James Watt International Medal to Mr. Henry Ford on April 22nd. This award, established in 1936 on the centenary of Watt's birth, is made biennially for outstanding achievements in the field of mechanical engineering.

Erratum

The price of "Engineering Law" by R. E. Laidlaw and C. R. Young reviewed in the Engineering Journal, May 1938, page 252, was incorrectly stated as $5.00. The price is $4.00 a copy.

The Empire Exhibition at Glasgow

The British Empire is a group of nations bound together by the ties of sentiment and common interest, and including units of the most diversified races, languages and creeds, all in very widely varying stages of industrial development. The task of bringing the characters, interests and industries of all these nations into focus by the holding of an Empire exhibition is therefore a formidable one, and has not been attempted since the British Empire Exhibition at Wembley in 1924. With improving trade, however, manufacturers are looking for new markets, and the potentialities of the Empire are of particular significance in this connection in view of the unfortunate restrictions which hamper developments in so many foreign markets. The decision to hold a further Empire exhibition in Glasgow this year is, therefore, particularly timely, and it may be hoped that the opportunities which it will afford for an interchange of views and information between those representing the various units of the Empire, in combination with the improved prospects of extra-imperial trade arising from negotiations with foreign nations, will give a marked fillip not only to our home manufacturers, but to those of other Empire countries. It is clearly essential that to be successful, an exhibition of the type visualized must be on an extensive scale, and the Glasgow exhibition, which opened on May 3rd and will remain open until October 29, covers an area little less than that at Wembley, of which the great extent will be remembered by a large proportion of our readers. Actually, the area covered by the Glasgow exhibition is 175 acres, against 216 acres for Wembley, but the chief effect of this difference is to make the present exhibition slightly more compact. It may be said that while full advantage has been taken of the developments in exhibition technique since 1924 to display the exhibits in a more attractive manner, and particularly to utilize the experience recently gained in the construction, lighting and heating of buildings, the two exhibitions are closely comparable in their manner of demonstrating the art, culture and products of the Empire. In view of the progress that has been made in so many directions since the Wembley exhibition, that at Glasgow should prove of even greater interest.

—*Engineering.*

Institute of Metals Award Medal

Sir William H. Bragg, O.M., F.R.S., noted crystallographer and physical chemist, has been awarded the platinum medal which has been established by the Institute of Metals, a leading British scientific organization, in recognition of his outstanding services to non-ferrous metallurgy.

The medal was conferred on Sir William for his achievements in the x-ray examination of metals. He has been a pioneer in the study of the crystalline structure of metals by the refractory method; his findings have been an important factor in the development of modern alloys. He is an Australian by birth and is an honorary member of The Institute.

The medal is a disc of pure platinum, two inches in diameter and weighing 4½ ounces. It is donated by the Mond Nickel Company, Limited, subsidiary of International Nickel, the company which in 1933, in commemoration of the 50th anniversary of the Canadian nickel industry, established a platinum medal for award by the Canadian Institute of Mining and Metallurgy for distinguished contribution to the mining and metallurgical industries of the Dominion.

In recent years Canada has become the world's largest producer of the platinum metals, its output being recovered and refined in the precious metals refinery of the Mond Nickel Company at Acton, a suburb of London. The source of this platinum is the copper-nickel ore of the Sudbury district.

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.

Notices appearing in the Situations Wanted column will be discontinued after three insertions, and will be re-inserted after a lapse of one month, upon request.

All correspondence should be addressed to

The Employment Service Bureau, The Engineering Institute of Canada
2050 Mansfield Street, Montreal

Situations Wanted

ENGINEER, A.M.E.I.C., Combustion specialist heat balance. Steam, Mechanical. Refrigeration. Office routine. Correspondence. Plant layout. Apply to Box No. 5-W.

PAPER MILL ENGINEER: B.A., B.A.Sc. Married. Age 34. A.M.E.I.C. Ten years experience in paper mill costs, maintenance, design and construction. Now employed as cost engineer in Southern States. Hard worker with excellent references. Available immediately. Apply to Box No. 150-W.

PAPER MILL ENGINEER. If you are willing to pay around $5,000 per year for the services of an engineer, age 36, with twelve years experience in paper mill design, construction and operation, apply to Box No. 482-W.

CIVIL ENGINEER, B.A.Sc., A.M.E.I.C. Married. Experienced in engineering and architechtural design and in supervision, office management, etc., wants to round out experience in the contracting field. Ten years experience since graduation. Present location Toronto. Address Box No. 576-W.

ELECTRICAL ENGINEER, B.Sc. E.E., Age 39. Married. Seven years experience in operation, maintenance and construction of hydro-electric plants, and sub-stations. Five years maintenance and installation of pulp and paper mill electric equipment. Reliable and sober, with ability to handle men. Best references. Any location, at once. Apply to Box No. 636-W.

ELECTRICAL ENGINEER, B.Sc. '28. Two years student apprenticeship at Can. Westinghouse Co., including test and electrical machine design. Also about two years experience in operating dept. of large electrical power organization. Available on short notice. Apply to Box No. 660-W.

ELECTRICAL AND CIVIL ENGINEER. B.Sc. Elec. '29, B.Sc. Civil '33. JR.E.I.C. Age 32. Experience includes four months with Can. Gen. Elec. Co., approximately three years in engineering office of large electrical manufacturing company in Montreal, the last six months of which were spent as commercial engineer, also experience in surveying and highway work. Year and a half employed in electrical repair. Best of references. Apply to Box No. 693-W.

CIVIL ENGINEER, B.A.Sc. (Toronto '27), age 34, married. Five years railway and construction work as building inspector and instrumentman. Level engineer and on construction of a long timber flume for a pulp and paper mill. Field engineer for a sulphite company, in charge of the following mill buildings, acid, digester, blow pit, barker room, chip storage and acid towers. Available immediately. Apply to Box No. 714-W.

MECHANICAL ENGINEER, JR.E.I.C. Technical Graduate. Bilingual. Married. Experience includes five years with firm of consulting engineers, design of steam boiler plants, mechanical equipment of buildings, heating, ventilating, air conditioning, plumbing, writing specifications, etc. Six years with large company on sales and design of power plant, steam specialties and heating equipment. Available on short notice. Apply to Box No. 850-W.

CONSTRUCTION ENGINEER, Grad. Toronto '07. Experience as resident engineer and superintendent on railroad, municipal, hydro-electric and industrial construction. Intimate with organizing, layout, survey, estimates and costs. Available immediately. Apply to Box No. 886-W.

CIVIL ENGINEER, B.Sc. '29, JR.E.I.C., R.P.E.M. Age 31. Married. Experience includes railway and highway surveys and construction, land and mineral claim surveys, 4 years draughting, structural and hydraulic design, preparation of plans and estimates for hydro-electric development, sewage disposal project, water treatment plant, subway construction, buildings, etc. Experienced in reinforced concrete design including statically indeterminate frames. Also capable of preparing designs in steel and timber. Desire permanent employment, preferably in structural design. Available immediately. Apply to Box No. 1023-W.

ELECTRICAL ENGINEER, B.Sc. '29, age 30. Single. Eight and a half years experience on maintenance, on construction, floorman and operator on hydro-electric system. Desires construction, service, sales or research work. Any location. Excellent references. Apply to Box No. 1062-W.

ELECTRICAL ENGINEER AND GEOPHYSICIST. Age 36. 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.

TECHNICALLY TRAINED EXECUTIVE. General experience administrative, organization and management in business and industrial fields, including; business, plant, property and estate management; plant maintenance, modernization, production and personnel; economic studies, company reorganizations and amalgamations, valuations; railroad, highway, hydro, pulp, newsprint, housing, industrial surveys, investigations and construction; B.Sc. degree in engineering, age 49, married, Canadian. Apply to Box No. 1175-W.

CHEMICAL ENGINEER, grad. McGill '34, experienced in meter repairs, control work; and also chemical laboratory experience. Apply to Box No. 1222-W.

CIVIL ENGINEER, B.A.Sc. (Toronto '33), S.E.I.C., age 27. Married. Five years experience includes highway surveys, bituminous and concrete paving, steel and reinforced concrete building construction, instrument work, draughting, cost accounting and estimating and some experience as foreman. Available immediately. Apply to Box No. 1265-W.

ENGINEER SUPERINTENDENT, A.M.E.I.C., R.P.E., Que. and Atla. Age 47. Twenty years experience as engineer and superintendent in charge of hydro-electric, industrial, railroad, and irrigation construction. Specialized in rock excavation and suction dredging. Intimate knowledge of costs, estimating and organizing. Available immediately. Apply to Box No. 1411-W.

CIVIL ENGINEER, graduate 1927, age 34 years, desires position as town engineer. Eight years municipal experience. Location immaterial. Apply to Box No. 1628-W.

CIVIL AND ELECTRICAL ENGINEER, JR.E.I.C. (Univ of Man.). Married. Age 25. Good draughtsman. Four months draughting, one year instrumentman on highway location and construction, inspection and miscellaneous surveying and estimating. Six months as field engineer on pulp and paper mill construction. Prefer electrical or structural design. Available at once. Apply to Box No. 1633-W.

ELECTRICAL ENGINEER, B.Sc. E.E. (Univ. of Man. '37). Age 24. Single. Experience in highway construction as inspector. Also experience in sales work and petroleum refining. Available on short notice. Apply to Box No. 1703-W.

CIVIL ENGINEER, B.Sc. in C.E. '34. S.E.I.C. Age 27. Five years experience, including harbour construction, highway paving, one and a half years paper mill construction, instrument work, draughting, estimating, interested in design. Available on short notice. Apply to Box No. 1737-W.

CIVIL ENGINEER, B.A.Sc. '33. O.L.S. Age 27. Married. One year and a half in charge of power plant construction. Four summers on land surveys and one summer on mine survey work. Also experience in draughting, electrical wiring, and highway engineering. Apply to Box No. 1757-W.

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The Outlook in Constructional and General Engineering

There was again a very considerable expansion in activity in constructional engineering in 1937. Employment at July rose from 31,733 in 1936 to 36,025 in 1937. The latter being an increase of 87.6 per cent compared with the low level of 19,198 reached both in 1932 and 1933. Both the number insured and number in employment are very substantially in advance of pre-depression levels, but the figure for the number unemployed at 4,038 is also considerably above the minimum of 1,857 recorded in 1927. By December, 1937, the number unemployed had fallen to 3,834, but this was followed by an increase in January, 1938, to 4,063.

In spite of a substantially increased production of structural steel, most constructional engineers complained of the difficulty of obtaining adequate supplies of raw material. According to the Building Industries Survey, issued by the Building Industries National Council, the output of structural steel in 1937 amounted to 3,330,000 tons, compared with 3,042,000 tons in 1936 and 2,153,000 tons in 1929. This substantially increased demand was brought about by the combined incidence of rearmament requirements and the considerable recovery in normal activity. The problem of delivery dates was further accentuated by the fact that rearmament work was of a particularly urgent nature, consisting in the construction of new factories and of factory extensions as a preliminary to the actual production of armaments and equipment for the defence services. Specific examples are provided by the shadow aircraft factories and the new munitions factory at Chorley. In connection with the latter, Sir Lindsay Parkinson and Company, to whom the contract was allotted, recently announced that work was being carried out to the value of £300,000 per month.

Some idea of the importance of rearmament work can be obtained from the statement of Sir Thomas Inskip in November, 1937, that fourteen shadow factories had then been erected at a total cost of £8,368,000, including machinery. In addition, over 900 engineering firms had been visited and allocated to the War Office, Admiralty or Air Ministry, in accordance with their qualifications and the ease with which they could take up the manufacture of any particular product. In many cases extensions to capacity were financed by the Government and expenditure on extensions to factories amounted to £8,162,552. These figures do not include factory construction and extensions other than those financed by the Government, nor do they include direct Government expenditure on aerodrome and munition and other factories managed by the Government; the value of the contract for the munitions factory at Chorley, for example, alone amounted to approximately £4,000,000.

The development of flat construction which has been such a feature of recent years continued in 1937. Though most marked in London and the Southern counties, this development is by no means confined to these areas and there has been considerable activity in the construction of working-class flats in several of the Northern industrial centres. There has also been a good deal of flat construction in the seaside towns on the South Coast.

Turning to future prospects on the industrial side, it has already been stated that new factory construction has shown signs of falling off in recent months. This has been attributed to the incidence of N.D.C. and to general uncertainty regarding the future trade outlook. In certain individual categories, demand has been well maintained, and coke-oven construction, for example, continued at a high level.

There is, however, growing support for deferring public works schemes and for drawing up a long-term programme of such projects to be put in hand when industrial activity begins to decline.—*Engineering.*

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THE ENGINEERING JOURNAL

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The Island of Orleans Suspension Bridge; Prestressing and Erection

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Designing Engineer, Dominion Bridge Company Limited, Montreal.

Presented before the Montreal Branch of the Engineering Institute of Canada, October 21st, 1937.

SUMMARY.—An outline of the principles involved, and the methods employed in prestressing the cable strands and suspender ropes for the Island of Orleans bridge; followed by a description of the principal erection features.

Foreword

Construction of the Island of Orleans bridge, across the north channel of the St. Lawrence river some six miles below the City of Quebec, was undertaken by the Provincial Government as an unemployment relief project and the work was spread over a four year period, from 1931 to July 1935.

The bridge measures 5,840 ft. between abutments and the long north and south approaches, each consisting of a series of reinforced concrete girder spans followed by a number of steel deck-truss spans of conventional type, were built under the direct supervision of the Department of Public Works, Quebec. The central portion, 2,370 ft. long, contains a suspension span which, with the two adjoining approach spans, was designed by Messrs. Monsarrat and Pratley of Montreal, consulting engineers, who also supervised the construction of this portion throughout.

Owing to the special purpose of the work it was specified that, as far as possible, all labour and materials must be of Canadian and preferably of provincial origin. This stipulation was largely responsible for the contractor's decision to construct a modern plant for prestressing the long cable strands and suspender ropes, the first plant of the kind to be established in Canada.

Cables and Suspenders

The compositions of the main cable, cable strand and suspender rope are shown in Fig. 1.

The main cable, 10 in. in external diameter, is composed of thirty-seven 1⅜ in. dia. parallel prestressed galvanized wire strands and is built up in hexagonal form, rounded out by cedar filler strips and wrapped with a continuous serving of No. 9 gauge soft galvanized wire. Each strand contains 37 main wires and six filler wires, having a specified gross area (including galvanizing) of 1.12994 sq. in., but the actual area is more nearly 1.17 sq. in. due to a slight over-run in the wire sizes. The pitch of the outer gallery, or layer, of wires was made of opposite hand to those of the core section, in order to neutralize torsional twisting. The strands of successive layers are alternatively of right and left hand lay; the purpose being to create line bearing, instead of point contact, between the wires of adjacent layers.

The suspenders are 1⅜ in. dia. galvanized wire ropes of Warrington construction (i.e., 6 strands of 19 wires each, surrounding an independent wire rope centre composed of 7 strands of 7 wires each), and having a gross area of .9229 sq. in.

Prestressing

The 74 bridge strands were manufactured in a rope closing machine, of sufficient capacity to contain the 43 spools of wire required to make a 2,500 ft. strand, and were stranded in a single closing operation. They were wound on individual wooden reels, having an external diameter of 5½ ft. and a drum diameter of 4 ft. and were delivered to the prestressing plant with sockets attached.

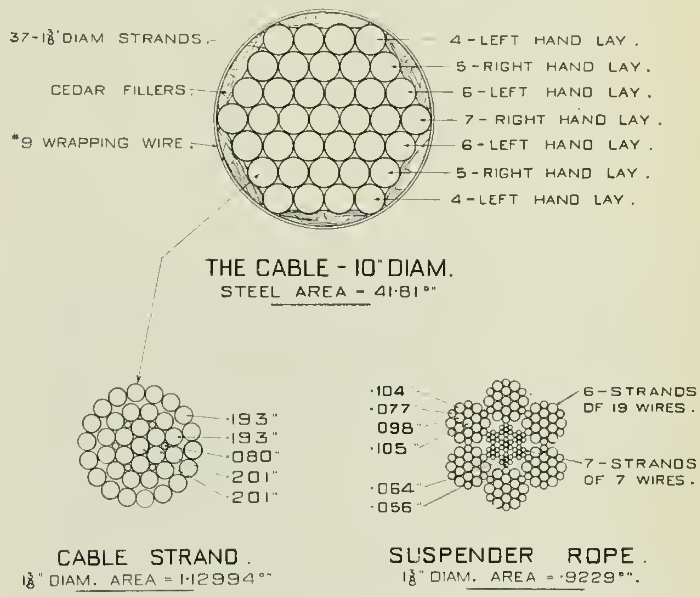

Fig. 1—Cross-sections of Cable, Cable Strand and Suspender Rope.

The prestressing tension, generally specified as 50 per cent of the ultimate strength, is considerably higher than the maximum designed working load but is well under the yield point of the strand. For the Orleans bridge the designed working stress was 83,400 lb., the prestressing load was 120,000 lb. and the minimum allowable yield point was 167,000 lb. per strand.

Measurement of the strands for finished length, and the application of intermediate marks corresponding to the locations of the cable saddles and suspender attachments in the finished bridge, is done immediately following the prestressing. This supplementary operation calls for the exercise of extreme care to attain the required precision, such as in this case, where the extreme tolerance was one inch in 2,468 ft. or approximately 1 in 30,000.

Prestressing Plant

The prestressing plant, a general view of which appears in Fig. 2, is situated on the contractor's property at Longueuil, Quebec, where sufficient land was available to

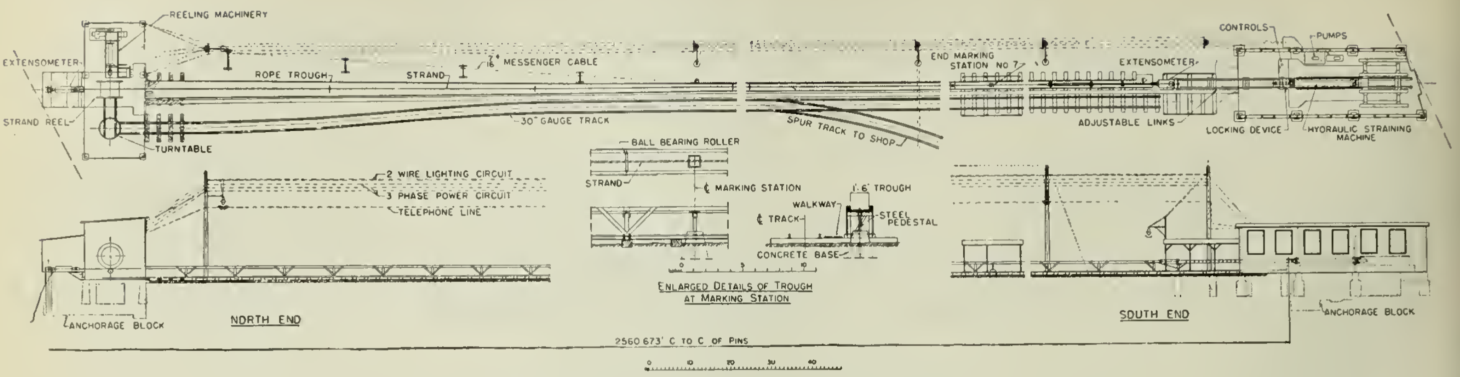

Fig. 2—Prestressing Plant; General Layout.

prestress the strands in a straight length. Adjacent shop buildings, with overhead crane facilities, provided suitable space for the socketing and storage of strands.

At points 2,540 ft. apart, massive concrete anchorages were built, one to serve as a "dead" end anchorage and the other as a base for the hydraulic straining machine.

Between these anchorages the strand was supported, at 50 ft. intervals, on ball-bearing rollers mounted in a continuous shallow wooden through, 18 in. wide. Since the ground was not perfectly level, the trough was built on a slight vertical curve having a maximum offset of 4 ft. from a straight line. At intermediate points where the strand was to be marked, steel marking pedestals, set in concrete footings, were installed in the trough. Paralleling the trough were a walkway, a narrow gauge railway with connecting spur to the shop, and a pole line carrying power, telephone and lighting circuits between the buildings at either end. The entire runway was illuminated by lights spaced at 120 ft. intervals, since the operations could only be carried out at night under favourable temperature conditions.

The strand reel, weighing $5\frac{1}{2}$ tons, was first fitted with an 8 in. dia. shaft, equipped with keyed face plates which were securely bolted to the reel heads. It was then mounted on the special truck and shunted by a yard locomotive to the north end of the plant. Here the truck was turned through 90 deg. on a turntable, and moved into position over a structural steel base located in the line of the trough. The truck was jacked clear of the rails, by operating 4 corner screws, then shimmed and bolted to the base.

Next, the outer strand socket was detached from the reel and connected to a small two-wheeled rubber-tired buggy, carried on the end of a $\frac{7}{16}$ in. dia. messenger cable. This cable, used for unreeling the strand, led up the trough to a sheave located at the far end whence it returned, through idler sheaves mounted on the side of the trough, to a winding drum in the north end building. The drum was operated through a 15 hp. electric motor at an unreeling speed of 100 ft. per min. The reverse operation of reeling the strand was done through the same motor, by disengaging the winding drum and engaging the chain and sprocket driving mechanism on the reel truck. During the unreeling operation it was necessary to apply a slight braking force to the reel shaft, to prevent the strand from overwinding and to counteract a surging action induced by a combination of friction on the trough and elasticity in the 5,000 ft. messenger cable. When the strand was fully unreeled, the sockets were coupled up to 2 load-measuring extensometers, permanently attached to the fixed anchorage girder and hydraulic straining machine, respectively.

Hydraulic Straining Machine

The straining machine is essentially a hydraulic ram with a 12 ft. stroke (Fig. 3). The ram is retractable by means of a push-back piston, and a set of telescoping side bars permits the overall travel of the tail block to be increased to 22 ft.

The ram cylinder is a steel casting 15 ft. 3 in. long, $18\frac{3}{4}$ in. in dia. and $1\frac{3}{4}$ in. thick, mounted on a steel base which is in turn anchored to a concrete block containing 60 cu. yd. The ram is a hollow cast iron cylinder, 16 ft. long, machined to $11\frac{7}{8}$ in. outside and $7\frac{3}{8}$ in. internal diameters. Attached to its head is a trunnion, mounted on wheels that travel on machined rails; its rear end is supported and guided on the push-back piston, a 4 in. dia. shelby steel tube 15 ft. 6 in. long with $2\frac{1}{4}$ in. bore. One end of this piston is affixed to the cylinder head and the other end carries a bronze piston head upon which the ram slides.

The telescopic side bars that connect the ram trunnion to the tail block are bored at one foot intervals to permit free adjustment of the overall length, and for locking purposes. The tail block is mounted on wheels which travel on a machined track set in the rear of the straining machine, and carries the south extensometer on cantilevered supports. An important feature of the straining machine is a device for locking the side bars to the machine base at any position of the ram travel thus making it possible to release the pressure, either to retract the ram for a second stroke or to relieve the pumps during the relatively long prestressing and marking periods. Fluid pressure is applied through two electrically driven triplex pumps, operated singly or in tandem as desired. A needle control valve provides for fine regulation of the ram stroke and a relief valve limits the overall travel.

The machine has a capacity of 165,000 lb. at a working pressure of 1,500 lb. per sq. in. and was subjected to a test pressure of 2,000 lb. per sq. in. A load of 1,000 lb. produced an elongation of about 1 in. in the 2,500 ft. strand, hence it was considered essential to have instruments that would record the load accurately within 200 lb., and for this purpose the extensometers were developed.

Extensometer

Fundamentally, the extensometer simply consists of a steel rod, equipped with sensitive indicators for measuring the axial strains when the rod is subjected to tension.

The rod is composed of a nickel alloy steel, heat treated to give a high elastic limit, without appreciably affecting the ductility. Test coupons which underwent the same heat treatment showed a yield point of 114,500 lb., an ultimate strength of 135,500 lb. per sq. in., with 22 per cent elongation and 62 per cent reduction of area.

The body of the rod which is 56 in. long, was ground to a uniform diameter of 1.595 in., corresponding to 2 sq. in. in cross-sectional area. Its ends were upset before heat treatment, and threaded for the necessary attachments.

Two crosshead blocks are mounted on the bar, at 30 in. centres, by means of adjustable hardened steel points, bearing precisely on the horizontal axis of the rod. Two side bars, 1½ in. deep and ¾ in. thick, pass through vertical slots in these crossheads, being supported in the one on vertical steel points and in the other on small brass rollers, centred in longitudinal grooves cut in the underside of the bars. Dial indicators, reading directly to 1/10000 part of an inch, are mounted horizontally on the outer ends of the side bars, with their spindles located in the plane of the horizontal axis of the bar and bearing against the polished ends of micrometer screws mounted in the rear crosshead.

When the extensometers are not in use the micrometer screws can be disengaged from the spindles to protect the indicator mechanism against inadvertent shocks.

When the rod is under tension the mean of the two indicator readings represents the true axial strain, since the influence of vertical bending is avoided by taking the measurements on the horizontal axis, and horizontal bending strains are nullified by averaging the two dial readings.

The extensometers were calibrated for loads up to 160,000 lb., in an Olsen tensile testing machine, and showed remarkable consistency under repeated loadings. The calibration also served to eliminate possible inconsistencies in the individual characteristics of the indicators. An elongation of .0001 of an inch in the bar is equivalent to 203 lb. tension and it is possible to read loads to within 50 lb., by interpolation, if desired.

The north extensometer was attached directly to the fixed anchorage loading girder by means of a yoke plate provided with vertical and horizontal pins designed to eliminate bending strains. The south extensometer engaged the tail block of the straining machine through a spherical nut, bearing on a spherical seat, to allow correct alignment of the extensometer and strand.

A set of adjustable plate links, carried on 10 in. dia. roller-bearing wheels, were inserted between the south extensometer and strand socket to accommodate small variations in the manufactured lengths of the strands.

Preliminary Studies

Before any bridge strands were actually prestressed, a study was made of the various influences that might affect their finished lengths, and a number of preliminary experiments were conducted. For these experiments four strands, identical in construction to the bridge strands and utilized later as erection footwalk cables, were used.

The several factors which had a bearing, in greater or lesser degree, on the finished strand lengths were as follows: base line chainage, anchorage movement, tension, friction, temperature, reeling, twisting, socketing.

Chainage

The distances between the anchorage blocks and marking stations were chained at night, using a 500 ft. tape that had been previously checked and calibrated by the Department of Standards at Ottawa. Several chainages were made until the probable overall error was reduced to less than $\frac{1}{16}$ in. Incidentally the same engineers using the same tape, made the chainage of the bridge piers, thus personal errors were largely avoided.

Anchorage Movement

Before any strands were prestressed, reference targets were established on each anchorage block. The locations of these targets, under no load and under the full prestressing load of 120,000 lb., were observed by means of transits set at right angles to the line of stress, but no movement whatsoever could be detected.

Tension and Friction

The average tension in the strand was assumed to be the mean between the readings of the two extensometers. This would only be true if the friction on the trough, represented by the difference between extensometer readings, were applied uniformly throughout its entire length and an experiment was therefore conducted to determine if this were so. At that time the strand was supported directly by the wooden trough; the ball-bearing rollers being added later as a result of this experiment.

The strand was first loaded to the specified marking tension of 59,000 lb. and, based on the difference between the extensometer readings, corrections for a uniformly applied friction were computed and applied to the strand at each station. Next, the load was increased about 10,000 lb. then lowered to bring the end mark back to its former position; this operation being done to reverse the direction of the friction. When proportional friction corrections had been computed and applied as before, it was found that these marks, instead of coinciding with the original set, as they should have for a uniform distribution of friction, varied erratically, by as much as one-half inch. It was also found that the quantity of friction varied considerably, being greatest (about 5,000 lb.) when the trough was thoroughly wet, less on a perfectly dry trough and almost nothing when the trough was heavy with dew.

These phenomena led to the introduction of ball-bearing rollers, at 50 ft. intervals, for supporting the strand clear of the trough when under marking tension. The overall friction was reduced thereby to about 2,000 lb. and was found to be very uniformly distributed throughout the length of the trough.

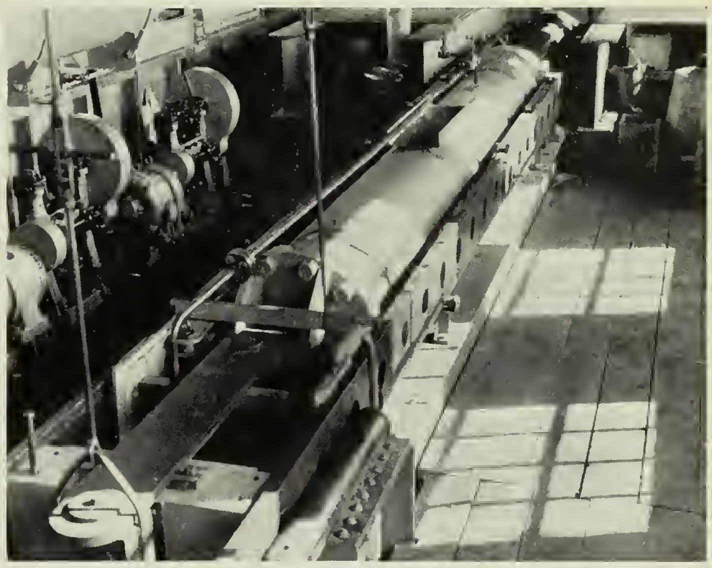

Fig. 3—Prestressing; Hydraulic Straining Machine.

Temperature

All prestressing and marking operations were, of necessity, done at night and work was not commenced until well after sundown, to allow equalization of the strand and trough temperatures. Automatic recording thermometers were installed at intermediate points for determining the general trend of temperatures.

Sensitive thermometers, calibrated to $^1/_{10}$ deg. C., were clamped on the strand near each end and a complete record of temperatures was kept during the prestressing period so that not only the actual temperature, but the rate of change would be known at the time of marking. Temperature fluctuations were generally slight but, when any rapid change occurred, sufficient time was allowed for the strand to absorb the full effect before any marks were applied.

A somewhat interesting experiment was made to determine the relationship existing between the true strand temperatures and the thermometer readings, under various conditions. A strand was stressed and left in the trough for a period of 20 hours commencing at 4 a.m. and ending at midnight, during which time the thermometers and extensometers were read at short intervals. Changes in the strand tension were translated into corresponding temperature changes, through the common relationship that

$$\delta = \frac{PL}{AE} = WTL, \text{ whence } t = \frac{P}{AEW}$$

(t = temperature, P = pull, A = strand area, E = modulus of elasticity and W = coefficient of expansion).

The results of this study are shown in Fig. 4 and led to the conclusions that:—

1. It would be utterly impracticable to measure and mark the strands accurately in sunlight.
2. Measurements should not be made in hot weather until two hours after sundown.
3. Under normal night conditions, the strand would absorb temperature changes fully within 30 min.

Reeling

Several strands were unreeled a second time and were re-measured to determine the influence of reeling after prestressing. The strands in every case were found to have shortened, but by variable amounts ranging from 3/8 in. to 2 3/8 in. It was also found that the modulus of elasticity remained unaffected when the strand was reloaded, up to 80,000 lb., but beyond this point the modulus fell off and by the time the full prestressing load of 120,000 lb. was reached the strand had stretched to its original prestressed length. As the normal bridge design stress was only 75,000 lb., an arbitrary amount of 2 in. was added to all standard strands to compensate for reel shortening.

Two special strands, however, that were to be used as guides for erecting the cables, and four others, marked for locating the suspender ropes in the bridge, were reeled in after being prestressed and then unreeled for marking so that errors from reeling would be eliminated. Further investigation showed that the strand lengths were not affected by a second reeling operation.

Twisting

In some former instances, fabricators and erectors have found it difficult, if not impossible, to prevent strands from twisting during and after prestressing, thus altering their length. The Orleans strands were so constructed that the torsions of the inner and outer galleries were almost perfectly balanced and no trouble from twisting occurred.

From the time the outer socket was removed from the reel until it was re-attached after prestressing, the sockets were positively restrained and this procedure was also followed during erection so that not a single twist occurred in any of the 74 strands.

Socketing

When delivered for prestressing, the strands were equipped with permanent sockets on one end and temporary sockets on the other. As tension was applied, the zinc cones bedded down in the socket baskets and by the time the marking tension of 59,000 lb., i.e. the average dead load stress in the bridge, was reached the total slip amounted to 1/8 in. An allowance of this amount was therefore made for subsequent slip under load, when the strand was cut and re-socketed to exact length.

Prestressing Strands

The sequence of operations in prestressing a bridge strand is as follows:—

After being connected up, the strand was subjected to an initial load of 10,000 lb., a reference mark was established on the strand at the end station (No. 7) and the thermometers were attached. The tension was then increased to slightly more than the minimum specified prestressing load of 120,000 lb., where the strand was locked up for 30 min. For about 10 min. the load fell off slowly, indicating a readjustment of the wires, or structural stretching, but after decreasing about 1,500 lb., no further change occurred. The strand was then unlocked and the tension reduced by 10,000 lb. stages until all load was off, changes in the strand length being recorded at each stage for the calculation of the modulus.

Tension approximating the marking load of 59,000 lb. was next applied and the strand was again locked. Corrections for differences between the normal and actual temperatures, and tensions, were calculated with the aid of ready reference tables, and the strand was marked accordingly with pencil, at each marking station. The tension was then increased some 10,000 lb. and lowered again to about the marking load, this operation being done to reverse the direction of the friction. Temperature and pull corrections were again computed and applied to the strand. The mean between the first and second set of marks at each station was deemed to be the correct location, with friction eliminated, of the permanent mark.

The permanent marks consisted of fine black lacquer lines around the strands with heavy black bands painted on either side for ease in location in the field. A series of red marks were also applied, at about 6 ft. intervals, to the upper face of the strand throughout its entire length, in order that any subsequent twisting could be detected and rectified. The strand was then re-reeled and returned to the shop for cutting and socketing.

The 1 3/8 in. diameter suspender ropes were fabricated by the manufacturer in a single length of 11,600 ft. and then cut into five suitable lengths for prestressing. In prestressing them it was found necessary to maintain the specified prestressing load of 75,000 lb. for at least three hours before all stretching ceased. The suspenders were measured off under a marking tension of 24,000 lb., using a steel tape standardized at the normal design temperature of 60 deg F., hence only corrections for pull and socketing allowance had to be provided. Friction and reeling corrections were disregarded since their influences on the suspenders, the longest of which was 236 ft., were negligible.

Cutting points were established by notching the wires with a hack-saw, and each length was painted with its identification number and an intermittent red stripe in the same manner as the strands.

Cutting and Socketing

The strand was firmly seized with wire at three points on either side of the cutting mark, and was then cut by means of a power driven hack-saw, equipped with a tungsten steel blade, since the high carbon steel wires were of almost tool steel hardness.

Sockets were clamped in a special stand, located 16 ft. above the shop floor, designed to ensure a straight lead and to maintain the strand and socket in perfect alignment. The strand was secured in long vertical clamps, adjustable by a rack and pinion device for locating the strand correctly with respect to the socket. Every care was taken in brooming and cleaning the end of the strand, the socket was preheated to about 300 deg. F. by blow torches and was then filled with molten zinc poured at the carefully controlled temperature of 850 deg. F. During the pouring process, the sockets were vibrated by hammers to dislodge air pockets and were then left to cool undisturbed for 20 minutes.

Tests

The engineer's specifications called for laboratory tests to determine the modulus of elasticity, yield point and ultimate strength of both the strands and suspender ropes, the ultimate strength of sockets and the adequacy of the socketing methods.

Twelve prestressed strand specimens were tested for modulus, yield and ultimate strength, and twelve others for ultimate strength only. Readings were made over a specified length of 100 in. by means of sliding extensometers with scales graduated to 1/100 of an inch. The 24 strand

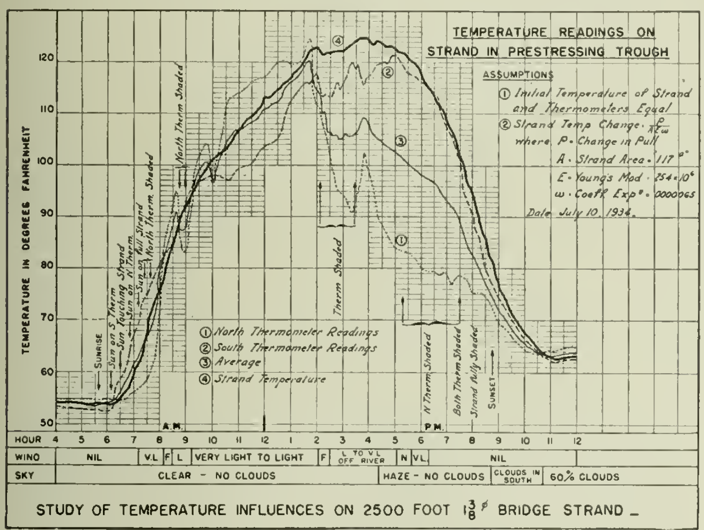

Fig. 4—Temperature Study on 2,500 ft. Bridge Strand.

tests indicated a remarkably close range of uniformity and a much higher strength than specified.

In one of these tests an interesting demonstration was had of the intimate bond that exists between the layers of wires in a strand. It was found that a single internal wire (slightly defective due to piping) broke at three separate points and at different stages of loading, before the strand failed as a whole; which would indicate that despite the initial breakages, the wire was prevented from slipping by the clamping action of the outer wires.

Four suspender specimens were also tested around a sheave of 12¼ in. inside diameter. When a load of 300,000 lb., the limiting capacity of the local testing machine, failed to produce ultimate failure, two specimens were broken at Toronto, in the one million pounds capacity machine of the Department of Mines. Failures occurred at 324,800 lb., and 325,600 lb., respectively, about 82 per cent of the value of the two parts of rope in direct tension.

Two suspender sockets were attached to short pieces of bridge strand, linked together, and tested to destruction. Failure occurred at 203,700 lb., through one pinhole at a point approximately 120 deg. from the back of the pinhole. The sockets had a guaranteed strength of 90 tons and the failure was undoubtedly accelerated by pronounced bending in the 1⅞ in. dia. connecting pins, which had a permanent central deflection of ¼ in.

Strand specimens were also socketed and tested to destruction, and in every case the socketing proved adequate, the only effect being that the zinc cones bedded down about ½ in. under the ultimate load.

PART II. ERECTION

The anchorage steel was erected during the course of the anchorage pier construction, early in the summer of 1934.

The main programme, however, commenced with the setting of the north tower bases on September 20th, 1934, and continued with only minor interruptions due to bad weather, throughout the winter and into mid-summer of the following year.

Cold and blustery weather severely hampered the cable erection, but this disadvantage was ultimately offset by the ease with which the suspended span steelwork was handled from the ice, with the result that the total erection costs were probably no greater than if all work had been done during the summer months.

Chainage

The absence of any suitable locations for establishing triangulation stations and a base line close to the site made it necessary to measure the central span by direct chainage.

This was done by means of a piano wire stretched over the ice, in the early spring of 1934, before any of the six central piers had been built. The measurement was therefore made between the last approach span piers, a distance of 2,670 ft., or practically one-half mile.

The piano wire was fixed at one pier, supported on four intermediate trestles set on the ice, and passed over a bicycle wheel (a practically frictionless sheave) on the far pier, with a 20 lb. weight suspended from the end to maintain a constant tension in the wire. When weather conditions became favourable, and the supports were brought level by the rising tide, reference points were established on each end of the wire.

The wire was later set up over level ground with all governing conditions duplicated, and the distance between the end reference marks was chained and corrected for temperature differences. This measurement was used for locating the six central piers and was proved by subsequent observations to be extremely accurate.

Anchorages, Cable Bents and Towers

The anchorage steel was transported on scows, directly from the contractor's dock in Lachine, to the site where a floating derrick was used to erect it in the partially built anchor piers. Each anchorage unit was assembled to its previously located centre lines, brought to correct elevation by means of special adjustment screws provided in the base plates, concreted in, and its position re-checked to assure that no displacement had occurred.

The cable bents were erected by deck travellers, after the latter had completed erecting the 238 ft. approach spans. After being assembled, the bents were tilted shorewards on their pins to bring the saddles 10 in. back of their normal locations, where they were securely shored and tied to the ends of the approach spans.

The tops of the main piers were bush-hammered and ground to provide perfectly level seats for the tower bases, the accuracy of this work being checked with a 12 ft. straight-edge and a sensitive hand level, containing the bubble from a surveyor's level, and made especially for the purpose.

The tower steel arrived at the site on scows and the first section, comprising bases, posts and bracing, was erected by the Quebec Harbour Commission's 50 ton capacity floating crane. This crane also placed the frame of the creeper traveller in its first position, attached to the tower, after which a smaller derrick scow was utilized for assembling the traveller derrick and mounting its hoisting engines on the pier.

The creeper traveller shown in Fig. 5 consisted of a structural steel frame, 47 ft. by 27 ft. in plan and 18 ft. deep, surmounted by a 20 ton capacity stiff-leg derrick, with 60 ft. boom. The frame was suspended by long pin-connected link plates, bolted to the tower splices, and was held in contact with the tower by means of adjustable yokes that encircled each tower post. The traveller weighed

42 tons and, when boomed up, its centre of gravity lay 3 ft. beyond the tower face, but when making the heaviest lifts from a scow on the far side of the pier, the combined load was practically centralized on the tower, so that at all times its overturning influence was small. The traveller was "jumped" from one splice to the next by means of nine part hoisting tackles, hung from outrigger brackets, bolted to the topmost splice holes. Two 9 by 10 hoisting engines were installed on the pier for operating the derrick and for raising the traveller, respectively, but it was found advisable to substitute a larger 10 by 12 engine for the latter operation owing to the large amount of sliding friction developed.

During erection the post splices tended to remain open on the outside faces, due to the inward inclination of the posts, and the fact that the post sections were fabricated slightly longer than normal to compensate for dead load compression, whereas the bracing members were of true geometric length. This difficulty was overcome by the use of temporary splice bars, having groups of holes, matching those in the two sections to be connected but spaced ¼ in. closer together than normal. Drift pins brought the joints perfectly tight and after the surrounding rivets were driven the temporary bars were replaced by permanent splice plates. Riveting scaffolds were suspended below the traveller frame and all riveting followed closely behind the assembly.

After completing the tower erection, the traveller placed the main cable saddles in their initial positions, offset 21 in. towards the shore, and mounted a 5 ton capacity guy derrick, with 20 ft. mast and 30 ft. boom, on the centre of the top strut. The derrick was guyed to the ends of the strut and to outrigger timbers, bolted across the strut and anchored down to the tower bracing. The traveller was then lowered to the pier and dismantled.

Catwalks

Temporary light wooden walkways or "catwalks" were installed immediately after the completion of the second tower (Fig. 6). These catwalks were located about 3 ft. below the initial position of the main cables and extended from pier to pier, each being carried on two 1⅜ in. dia. strands that were, in turn, supported in temporary saddles attached to the sides of the main tower and cable bent posts.

The strands were anchored to rods embedded in the anchor pier, by turnbuckles having a 30 in. runout, so that later the catwalks could be slackened off as the main cables deflected under the weight of the suspended structure, a deflection that amounted to 11 ft. in the central span.

The reels containing the catwalk strands were first mounted on a scow and after the strand sockets had been connected at one anchorage the scow was towed across the river at slack water, and the strands unreeled. As each pier was passed, slings were attached to the strands and when the far anchorage had been reached and the sockets at that end connected, the strands were hoisted by the tower derricks, placed to their designated marks in the saddles and clamped to prevent displacement.

Next, a light timber and steel cross-bridge was hoisted at one tower, attached to the four strands by hookbolts, and lowered by tag lines as far as it would slide towards the centre of the main span.

The wooden walkway sections, which were prefabricated in units 10 ft. long, and stored on the main piers in early December before the river ice formed, were then hoisted to the tower tops, hook bolted to the catwalk cables and lowered concurrently in the central and side spans and on the back stays. As soon as the cross-bridge became accessible it was worked down to the centre of the main span, where it served as a combined strut and crossover between the catwalks. Additional timber cross-struts were installed at the quarter points of the main span and at the middle of the side spans.

The posts and braces provided on each walkway section, and attached to them by single bolted connections, were next upended and made ready to receive the hand lines. The latter were ⅝ in. dia. ropes, hung from tower to tower under their own weight to provide initial tension, and then hook bolted to the walkway posts.

Storm cables, single ¾ in. dia. ropes in the form of inverted catenaries directly below each catwalk and bridled to the catwalk cables, were provided in the central span only. Their ends were fixed to the base of one tower and were connected to the other by means of running tackles, to allow free movement under temperature changes, but counterweighted to maintain a constant tension of 5,000 lb., in the rope.

Shortly after the catwalks were erected they were subjected to a strong gale, during which their behaviour became a matter of much interest. Under the action of the wind, which blew diagonally from the south east, the main span catwalks drifted approximately 8 ft. laterally, accompanied by a very slight and slow vertical motion. In the north side span, however, they swung rapidly to and fro through an arc of nearly 180 deg., midway between the end- and mid-supports. The oscillations were of a periodic nature, delivered severe longitudinal impulses to the cable bent and in turn appeared to be amplified by the spring in the lashings that tied the cable bent to the approach span.

Fig. 5—Creeper Traveller Erecting Tower.

The turnbuckles on the lashings were tightened as much as possible in an endeavour to dampen the oscillations and, whether due to this action or not, the catwalks steadied down within 20 min. and additional cross-struts were immediately installed at the quarter points of each side span. No further trouble of this sort was experienced during the many periods of high wind that followed.

Main Cables

The 74 strand reels were delivered by scow before winter set in, and were stored on the base of the north anchor pier until required. Unreeling stands were set up on the pier and the strands were hauled across in pairs, one to each catwalk, by means of ¾ in. dia. lines operated from a hoisting engine located on the south anchor pier. The leading socket was carried in a light sheet-steel "torpedo" which was guided by a man to prevent fouling or twisting. Signal men, stationed at telephones on the tower tops and at both anchor piers, were in direct communication with the engine runner so that when necessary the operations could be stopped instantly.

The first two strands to be erected were the special guide strands. After being unreeled and connected to the anchorages, the strands were lifted by means of the tower derricks, assisted by gin poles at the cable bents, and placed in the saddles with their marks carefully adjusted to the scribed centre lines on the saddles. As previously stated, the saddles were all offset definite amounts towards the shores, their temporary positions being the predetermined points at which the unloaded strands should be supported in order to have balanced horizontal components at the towers and equal tensions on either side of the cable bents, under a temperature of +15 deg. F.

Checking of the guide strand setting involved a rather elaborate series of field observations which, on account of the unfavourable weather, took nearly three weeks to complete. It was necessary to determine the true positions of the four tower saddles, the four cable bent saddles and the elevations of the five sag points for each strand and, to be of any value, the observations had to be made when the structure was not exposed to sun or wind, and when the temperature was steady.

From a comparison of the results of this survey with a set of prepared charts, showing the correct sag elevations for a wide range of temperatures combined with variations in span lengths, the required adjustments of the strand were found.

The sag elevations in the central span were read by means of a level, mounted on one tower, which was first lined in on a target set at the same elevation on the far tower and then rotated to read on a level rod projected downwards from the strand, through the catwalk. Transits were set up at fixed points, and elevations, on the outer ends of the approach spans for reading the side span sags. The telescope was first sighted on a target at a known elevation on the tower, to fix the vertical angle, and was then rotated horizontally to read on a vertical rod held on the strand at the middle of the side span. The elevation of the line of sight at this point having been calculated in advance, the sag elevation was quickly determined from the rod reading. The backstay sags were taped directly from timbers, set at a fixed elevation above the strand and cantilevered from the approach span trusses.

Mining transits were used for locating the positions of the tower saddles, the transits being set on the main piers, at points, offset from the tower axis, on the centre line of bridge. After sighting on a central target on the far pier, the telescope was rotated horizontally through 90 deg. then transited to read on horizontal target rods clamped to the top strut of the tower. The cable bent saddles were located directly by means of plumb bobs.

A complete set of observations took about 2½ hr. for a party of six men, and on more than one occasion the work was rendered useless by the sun's appearance before all readings could be completed. It is interesting to note in this connection that, after the strands were finally adjusted, an examination of the original marks applied at the prestressing plant indicated that just as satisfactory results would have been obtained by setting the strands to these marks and then equalizing for any small differences in sags. This procedure would undoubtedly have saved much time, and should be entirely practicable on future

Fig. 6—General View of Catwalks.

occasions where due care has been taken with the preliminary preparations.

After the two guide strands were finally adjusted and re-checked, erection of the remaining strands got underway. Each layer of strands was set slightly high in all spans and the individual strands were then slackened down to their final positions by means of clamps and adjusting turnbuckles, attached temporarily to the saddles, and by easing off the end adjustment bolts. To prevent the strands from slipping in the saddles, the partially completed cables were clamped down to the saddles by wooden blocks, excepting while strands were actually being placed, and, to preserve them in their proper relative positions, light wooden frames were lashed around the strands at intervals of 200 ft. These frames were replaced by heavier wooden template frames as soon as the cable acquired sufficient mass to support them without causing appreciable local deflections.

On several occasions, for short periods, operations had to be suspended when the combination of wind and sub-zero temperatures became unbearable and once, following an unseasonable thaw, thick ice formed on the strands, and had to be removed by scraping and beating with hardwood sticks, before additional strands could be erected. The cables were finally completed on January 28th, seven weeks after having been started, and strangely enough the weather immediately moderated and was ideal for all later work.

The caps were firmly bolted on the cable bent saddles and all lashings and shores were then removed from the bents. The cable bands were assembled on the cables, being located by the marks placed on the suspender guide strands during prestressing.

The bands were found to be slightly large for the finished cable, due to the facts that their internal dimensions overran slightly and that an allowance of $\frac{1}{16}$ in. had been made for "build up" of the cable, which did not occur. The bands were therefore removed and the ¼ in. clearance between the two halves was increased to ⅝ in.

by machining off the adjoining faces. All cable band bolts were tightened to not less than the specified tension of 33,000 lb., the required turning moment being determined experimentally as the force that two average men could exert on the end of a 4 ft. wrench.

The coils of suspender rope were hoisted to the tower tops, uncoiled on the catwalks, and after their two ends had been brought together they were lowered through slots cut in the planking, being slid over cross timbers to protect the galvanizing, and kept under control by a tag line, snubbed around the cable. The ropes were then carefully centred on the cable bands with the red guide lines always located on top.

Suspended Steelwork

During the preliminary office studies of the erection procedure, two alternative methods for erecting the stiffener trusses and floor steel were investigated, and a small scale model was constructed to determine the respective cable distortions. The model was built to a scale of 1:48, and the substitute for a cable was a small chain, weighing .0768 lb. per ft., from which paper cups were suspended by wires at each panel point. The cable supports were made immoveable, it being assumed that the sequence of erection in the central and side spans would be regulated so as to keep the towers plumb. It was also assumed that the individual truss sections would hang freely and would not be inter-connected until after all were erected.

The relation of the chain weight to that of the actual cable was first established and equivalent weights were then computed, in the same ratio, for the suspended structure. The loads representing successive erection stages were applied to the cable, in the form of B.B. shot, and the resultant deflections were measured by means of a surveyor's level, reading on paper scales attached to the hangers.

The first method considered was based on simultaneous erection, working in opposite directions from each tower, which would necessitate the provision of four light-weight deck travellers and erection of considerable floor steel to carry the travellers and supply tracks. The resultant deflections were considered to be so large as to seriously affect the operation of traveller derricks and make difficult the framing of the floor steel. Another objection to the method was that all material would have to be hoisted at the towers and re-handled to the point of erection.

The alternative, which was finally adopted, was to hoist the steel from directly below its permanent location, by means of tackles suspended from the cables, commencing at the middle of the main span and the shore ends of the side spans. This method permitted all truss sections to be erected in advance of the floor steel, resulted in much smaller cable distortions, and did away with the requirements for travellers, tracks, special derricks at the towers and expensive re-handling of materials. The steel was unloaded from a railway siding on shore and hauled about ½ mi. across the ice, on sleighs pulled by a small caterpillar tractor.

Four-part hoisting tackles were provided, operated from engines on the main piers, and as each truss section (the heaviest of which weighed nine tons) was raised, it was permanently connected to its suspender and connected by a pair of bolts to the adjoining section. In the initial stages, due to the cable distortions, only the top chord joints could be so connected but as the curvature in the spans gradually reversed, the bottom joints closed and were bolted; at the same time some of the top chord splices were released to prevent overstraining of the trusses.

The two deck travellers used in erecting the approach spans and cable bents were started off erecting steel in the side spans and, it had been contemplated, would continue right out to the towers. However, the more direct method proved so satisfactory in the central span that the travellers were stopped after erecting six panels and their hoisting lines were reeved to operate tackles hung from the side span cables.

Erection of the truss sections immediately altered the cable stresses and the first two sections, hung in the central span, 16 tons on each cable, caused deflections of 5½ inches in the tower tops. The saddles being still offset

Fig. 7—Erection of Stiffening Trusses.

21 inches on the tower posts, it was necessary to jack them onto centre as soon as possible before their reactions became excessive, but this could not be done until the cable reactions had been built up sufficiently to eliminate all danger of slipping on the saddles.

The saddles were first moved an amount of 9 in. after five truss sections of the central span were up and the towers were leaning 8½ in. out of plumb. The saddle bases had been coated with paraffin wax to decrease friction and when the holding bolts were removed, the saddles slid forward approximately 3 in. without being forced and were then jacked a further 6 in. with two 25 ton capacity mechanical jacks, bearing against temporary brackets attached to the tower. The saddles were jacked the final 12 in. after nine central span truss sections were in place and when the towers were again leaning inwards about 3½ in. Heavy jacking became necessary as the towers were actually sprung 6¼ in. in the opposite direction, but the saddles were centered without real difficulty and the permanent connecting bolts were installed.

Erection of the stiffener trusses (Fig. 7) with floorbeams at every sixth panel to act as struts, proceeded until all sections were in place.

The hoisting tackles were then shifted back to their first positions and the remaining floorbeams, together with laterals, stringers and floor grids were raised in a similar manner. The efficiency of this erection procedure was exemplified by the fact that the entire suspended structure, weighing 1,900 tons, was completely assembled in 19 working days.

Riveting of the floorsteel, bottom chord joints and those top chord joints that were tight, was next completed, but due to the excess camber still remaining in the spans some of the latter joints were still open and were left to be driven after the floor concrete was placed. Welders followed along behind the riveters, welding the roadway and sidewalk grids to the stringers, and the fence panels to the stiffener trusses.

One week sufficed for the roadway contractor to fill the floor grids with high strength vibrated concrete which was screeded flush with the tops of the grids. Riveting of the top chord joints was then completed, most of the joints being closed easily by means of draw-bars, and those near the ends of the spans by jacking the extreme ends of the trusses, with the final result that every splice in the bridge trusses was brought to full bearing.

Up to this stage the ends of the stiffener trusses had been left free and unsupported, so that adjustment for any slight discrepancies in their final elevations could be made by shimming under the rocker posts that supported them at the towers. It was found, however, that the ends of the spans were so close to their theoretical elevations that no re-adjustment was necessary and the connecting pins were driven as for the normal setting.

Cable Wrapping

Wrapping of the cables was commenced soon after the full dead load had been placed. The strands were first painted with a heavy red lead paste after which the cedar filler strips were wired in position, ready to receive the continuous serving of No. 9 gauge galvanized wire, which was applied under tension by a motor-driven wrapping machine. The machine (Fig. 8) was built by the contractors to drawings supplied by the patentee, Dr. H. S. Robinson, and was the more or less standard type developed for this purpose.

It comprised a cast steel ring, carrying three spools of wire, which was revolved about the cable by means of a compressed air motor, through a pinion and rack gear. The motor base was rigidly affixed to a segmental bearing that rested on the cable and supported the revolving ring, and was itself prevented from rotating by vertical guides that engaged an overhead pipe frame, clamped to the cable. As the ring rotated, the three wires were fed tangentially onto the cable, passing under three case-hardened guide shoes that were shouldered so as to bear against the sides of the wires and consequently to force the machine to travel along the cable.

All wrapping was done uphill with the result that the wires were firmly compressed downwards by the weight of the machine and formed a practically waterproof covering even before the application of any paint. The machine weighed about 1,000 lb. and was designed to wrap 18 in. of cable per minute, but in practice the actual speed rarely exceeded half of this amount. The steel ring was built up of three segments, one of which was hinged in order to pass the suspenders, and the whole machine could be raised on a screw device for moving it over the cable bands.

The first and last few inches of wrapping in each panel could not be wound by the machine and was therefore done by hand and soldered in place to prevent unravelling. All crevices where water might enter the strand were caulked with oakum topped off with lead wool. Finally, the cables were painted with one coat of red lead paste, followed by two coats of the standard field paint.

Cable wrapping, necessarily a slow job with only one wrapping machine, extended over three months but did not interfere in any way with the traffic, which was admitted to the bridge on July 15th, ten months after erection of the towers had commenced.

Final Survey

On September 26th, 1935, a final survey was made to check the accuracy of the field work and to obtain a measure of the spans stiffness. The date chosen for the observations was most opportune, weather conditions being extremely favourable and the prevailing temperature being exactly 60 deg. F., the precise normal temperature for which the bridge was designed. The results of this survey proved very gratifying to all those whose privilege it had been to be associated with the enterprise.

Conclusion

The total weight of steel in the central portion of the bridge is 3,615 tons, including 420 tons of cable strands, 25 tons of suspender ropes and 520 tons of welded floor grids.

As contractors for the superstructure, the Dominion Bridge Company Limited prestressed the cable strands and suspenders, fabricated all steelwork with the following exceptions, and did all erection.

Fabrication of the 238 ft. approach spans (463 tons) was sub-let to the MacKinnon Steel Corporation of Sherbrooke, Quebec.

The welded floor grids were fabricated by the Eastern Canada Steel and Iron Works Limited, Quebec City, under arrangement with Truscon Steel Company of Canada Limited, the sub-contractors for this item.

Fig. 8—Wrapping the Cable.

The cable strands and suspender ropes were manufactured by the Dominion Wire Rope Company Limited, from wire supplied by the American Steel and Wire Company and the Steel Company of Canada Limited., respectively.

The contractors, having had no previous experience in the construction of suspension bridges, consulted the well-known engineering firm of Robinson and Steinman, principally with regard to erection problems, and acknowledgement is made of the invaluable assistance and advice rendered by Dr. H. S. Robinson, personally, and by his engineering staff. Particularly useful was the method developed by them for computing and plotting the necessary data for setting and checking the cable strands in the field.

DISCUSSION

S. R. Banks, A.M.E.I.C.[1]

Dealing with the latter part of the paper, the writer wishes to draw attention to the way in which the main towers, which were 220 ft. in height, had been erected. On account of the necessarily eccentric loading imposed during erection by the creeper-derrick, it had been impracticable to make any check measurements on the verticality of the towers until their erection had been completed and the creeper dismantled. That appears to have been a very bold procedure since, in such tall and slender structures, any faults in the dressing of the concrete pier-tops and any discrepancies in the splices of the steel columns during fabrication or assembly in the field would have been greatly magnified when they appeared as errors in the location of the cable-saddles relative to the pedestals of the towers. The contractor had evidently placed great

[1] Assistant Engineer, Monsarrat and Pratley, Consulting Engineers, Montreal.

reliance in the accuracy of both shop and field-work, and the results have entirely vindicated his confidence.

With regard to the prestressing of the cable strands and suspender-ropes, the writer points out that the plant at Longueuil, besides being the first and only one in the country, was apparently the first such plant to have been installed and operated by a structural-steel fabricating company. The Dominion Bridge Company have been pioneers in this field, and have dealt successfully with a process that has hitherto been tacitly regarded as being beyond the scope of others than wire-rope manufacturers.

In considering the accuracy of the measuring of the strands, it is observed that the loading of the strand was controllable to within 200 lb. which was equivalent to a temperature variation of approximately 1 deg. F. The mean recorded temperature, however, could not, except under very favourable circumstances, be relied upon to be equally close to the actual mean temperature of the strand. This was due to the long length of strand exposed to the weather, the impracticability of having a large number of thermometers to be read simultaneously, and the fact that the thermometers were more susceptible to local variations of temperature than was the strand itself. The only means of obviating the possibility of errors from this source seems to be recourse to the costly expedient of enclosing the whole plant inside a building. Such errors, though, were small compared with those introduced by the assumption of the two inch correction which had been applied to offset the uncertain amount by which a strand shortened when it was reeled up after it had been prestressed.

Specifications for prestressing strands usually called for the application of the prestressing load "for at least 30 minutes or until stretching has ceased," and for a longer period in the case of suspender-ropes. Prestressing was a comparatively new branch of engineering (having been used perhaps for the first time for the strands of the Grand'Mère suspension bridge), and it appears that there was still scope for study of the behaviour of strands and ropes during the process. For instance, there might be some doubt as to the benefits to be derived from maintaining the load for very long periods such as were necessary, according to the conventional specification, for ropes of larger diameters. The writer remembers reading (in connection with some experimental work carried out on rope to be used for the tie-backs of the Sydney arch during construction) that a 40 ft. length of 2¾ in. dia. rope had been subjected to a load of 100 tons for 22 days, at the end of which period stretching had been found to be still taking place. The results of prestressing the suspender-ropes of the Island of Orleans bridge were of interest in this connection. For some reason, the two ropes that had received the longest periods of prestressing exhibited the lowest resulting moduli. These five lengths of rope had been manufactured in one continuous operation, so that the variation did not appear to be due to the manufacture; but, in any case, the results suggested that the length of the prestressing period could vary considerably without significant alteration to the final modulus of the rope.

In the writer's opinion, any time that could be given to experimental work during prestressing would be well spent, and might yield information of considerable value.

F. H. Hopkins[2]

The author's able paper has been very interesting. His full description and the illustrations leave very little to be added by the writer other than to refer to the actual manufacture of the suspender strands and suspender ropes. The writer's company was entrusted with the manufacture of 185,000 ft. of 1⅜ in. galvanized special openhearth steel bridge strand, wound on special reels in 74 lengths each 2,500 ft. These strands were composed of 37 continuous main wires with 6 fillers, making in all 43 wires in the completed construction. The inside 25 wires for half the quantity being laid from left to right with 18 covering wires laid in the reverse direction. This same process was carried out for the remaining half, only with the inside wires being laid from right to left and the covering wires from left to right. The object of this being to make as near as possible a perfectly dead strand, non-twisting.

Geo. H. Atkinson[3]

First of all reference should be made to the statement made by Mr. Banks to the effect that some British made wire ropes, which were supposed to be prestressed and which were used on the Sydney bridge, continued to stretch after they were put into service. There is no doubt that this is correct, but it should be borne in mind that the cable strands referred to were exceedingly large, some of them being in the neighbourhood of 4½ in. dia. Naturally it would take a tremendous prestressing plant to fully prestress cable strand of this diameter.

Mr. Banks took issue with the author as to how much wire rope would lengthen when the socket was turned over. The author mentioned about 3 in. after one turn of the socket, whereas Mr. Banks said he had experimented and three turns of the socket only changed the length of the rope approximately 1½ in. The author was discussing at

Fig. 9—The Completed Bridge.

[2] F. H. Hopkins, President and Managing Director, Dominion Wire Rope and Cable Company Limited, Montreal.

[3] General Manager, Anglo-Canadian Wire Rope Company Limited, Montreal.

the time suspender rope which is made six strands 19 wires over independent wire rope core, whereas Mr. Banks had in mind cable strand. These are two very different types of rope and therefore both the author and Mr. Banks were correct.

There is another thing the author might have explained to the meeting which might have proved interesting and that is as to why they laid these cable strands into a hexagon rather than into a round strand. It is of course quite plain to most as to why it is laid hexagon but the writer has in mind a recent suspension main cable put up by the John A. Roebling's Sons Company at Maysville, Kentucky, in which the main cable was laid perfectly circular. This was done by using smaller strands in the corner of the hexagon laid strand and owing to the filler being less they could use aluminum as against wood without going to any extra high cost. In the case now referred to, the cable strand was only 12⅞ in. dia. whereas laid up into a hexagon it would have been at least 13¼ in.

Fred Newell, m.e.i.c.[4]

On account of the comprehensive description of this work by the author, it is rather difficult to discuss the subject without following the path which he has already taken. The writer would, however, like to stress some phases from the point of view of accuracy of the work.

During preliminary considerations of the work it was decided that absolute accuracy was necessary to get correct results with a minimum of cost and time, and with this idea in mind it might be well to run over some of the points on which great care was taken to obtain these results, even though in doing so the writer will probably mention a number of features which have already been referred to by the author in his paper.

This method of obtaining measurements between piers has been fully described and the writer will proceed to the next consideration, which is that of measuring the prestressing and marking loads. It was first of all decided that the ram pressure of the pulling machine could be used as an indication of load on the rope. On experimenting however, it was found that the pressure could be varied at least plus or minus 8,000 lb. without changing the length of rope. This was thought, first of all, to be due to friction between the wood trough and the strand. However, it was finally determined that a great deal of friction was in the ram itself, and that some other means would have to be obtained to accurately measure the load applied to the strand. It was also decided at the same time that as much of the friction as possible between the trough and strand should be eliminated. These considerations resulted in the idea of using an extensometer for measuring the load on the rope, and that if two extensometers were used—one at each end—it would be known definitely the amount of friction between the rope and the trough and that the average reading of these extensometers would give the average load on the strand. It was, however, decided that, in order to guard against eccentricity of pull on the extensometers, two micrometer clocks should be used on each extensometer, and the average reading on these clocks would be taken as the exact pull. Micrometer clocks were obtained reading to 1/1000 in. which equalled 200 lb. pull on the rope and interpolations could easily be made for reading to about one-quarter of this amount.

The ropes were also striped intermittently along their entire length so as to detect twisting during reeling and unreeling, and the engineers are confident that as a result of these precautions correct lengths are obtained within plus or minus 1 in., which, as stated in the author's paper, is equal to plus or minus 1/30000.

In the design of the anchorage arrangements considerable thought was also given to the question of accuracy, and partly with this end in view it was decided to terminate the ropes in a spherical anchorage whose radius is equal to the distance from the splay point to the anchorage. This meant that all strands could be made exactly the same length, so that one set of measurements, only, was necessary at the prestressing plant and apart from the lay of the strand any strand could be placed into any position in the cable.

Great care was also taken with the tower fabrication and while each section of the tower was assembled to the mating section in the shop the tower was never assembled complete until it was erected in place. All work in the shop was done to centrelines placed on the tower plates at the beginning of the layout work and this centreline was worked to for all operations. Squaring lines were placed at right angles to these centrelines as checking lines for end facing. The rotary planer was very carefully checked for accuracy and for its ability to machine a true plane surface.

The setting of the tower base members at the site was made to an absolute level by a spirit level. The result of this work was very gratifying as when the tops of the tower were checked by instruments it was found that they were only out by between ¾ in. and 1¼ in. from their true position in a height of 220 ft.

In conclusion it is perhaps well to realize that the final location of the centre of the span was plus ½ in. on one side and 1⅛ in. on the other side above the theoretical position, which the writer feels is a good indication of the accuracy of the work throughout the job.

J. B. D'Aeth, m.e.i.c.[5]

This paper has been of great interest but the bridge was not the first of its kind to have been constructed in Canada. In 1929 the first long span suspension bridge ever constructed with steel cable rope strands was built across the St. Maurice river at Grand'Mère. The bridge which has been described is a somewhat larger edition of the Grand'Mère one. They compare about as follows:

	Grand'Mère	Ile d'Orleans
Central span	948 ft. 10 in.	1,059 ft.
Height of steel tower piers to cable	128 ft.	220 ft.
Width c. to c. stiffening trusses	26 ft. 0 in.	31 ft. 8 in.
Total length cables—anchorage to anchorage	1,681 ft.	2,468 ft.
Clearance above high water	19 ft. 0 in.	106 ft.

Most of the steel erection on the Grand'Mère bridge was carried out during the winter months, December to March. The cables strands were pulled across the frozen river by horses. The rope strands were then lifted onto a set of trestle horses to get them up out of the snow and ice, and from there they were hoisted into position on main towers.

The stiffening trusses were also hoisted into position off the ice. By using the ice as a working platform the necessity of building a cat walk was eliminated.

The rope strands were supplied by John A. Roebling's Sons Company and were prestressed, marked and socketed at their plant before shipment to the site. The strands were stressed to about 60,000 lb. per sq. in. and then slackened to 20,000 lb. for marking and measuring.

The main cables were made up of 37 strands of acid open-hearth cold-drawn bridge wire rope, each strand containing 35 wires of various selected diameters, built up to a 1¼ in. dia. with a metal area of 0.956 sq. in. The minimum ultimate strength of each strand was specified at 180,000 lb. and showed 199,000 lb. in tests. The minimum guaranteed modulus of elasticity was specified at 21,000,000 lb. per sq. in.; tests yielded values exceeding 25,000,000 and the design was based on a modulus of 24,000,000.

[4] Chief Engineer, Dominion Bridge Company Limited, Montreal.

[5] Engineer, Fraser Brace Engineer Company Limited, Montrea (now with the Dufresne Construction Company, Montreal).

The Use of Hydrogenation in the Production of Aviation Fuels*

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Presented before the Ottawa Branch of the Royal Aeronautical Society, and the Aeronautical Section of the Engineering Institute of Canada, March 3rd, 1938.

SUMMARY—Because of the nature of the meeting at which it was delivered, this paper makes specific mention of hydrogenation in relation to aviation fuels, but the developments which it describes are equally related to the whole field of fuels for internal combustion engines. It deals with the processes for making motor fuel from coal and describes the suitability of the various fuels for the different types of engines.

Two of the many uses to which hydrogenation has been put are especially worthy of the attention of aeronautical engineers. One of these is the liquefaction of coal. Already a considerable quantity of motor fuel is being made from coal and it is probable that ultimately the greater part of the world's supply will come from this source. For this reason the methods of manufacture and the limitations inherent in them are of interest to those concerned with the trend of development of internal combustion engines. The second important use of hydrogenation from the point of view of aeronautical engineers is the production of motor fuels having a very high anti-knock rating. These fuels have had an important influence on aviation in recent years and the processes employed in their production as well as the reserve and distribution of the required raw materials are matters of immediate interest.

PRODUCTION OF MOTOR FUEL FROM COAL

There are three general methods for producing motor fuel from coal, all of which are in use at present and will probably continue to be used in the future. The most important of these is the addition of hydrogen directly to coal under such conditions of temperature and pressure that the coal is largely converted to liquid. In a subsequent similar step the primary liquid is converted to motor fuel. This process is called direct hydrogenation. The second method comprises the production of carbon monoxide and hydrogen from coal and the synthesis from these gases of an oil containing a large proportion of motor fuel. This is called indirect hydrogenation. The third method is to heat coal so that a fraction distils off as tar. This tar may then be redistilled to give a small yield of motor fuel or it may be cracked or hydrogenated to give higher yields. Distillation is the basis of the various carbonization processes. However coke is the principal product of carbonization and motor fuel is only a relatively unimportant by-product. Accordingly the scope of the descriptions which follow is confined to direct and indirect hydrogenation.

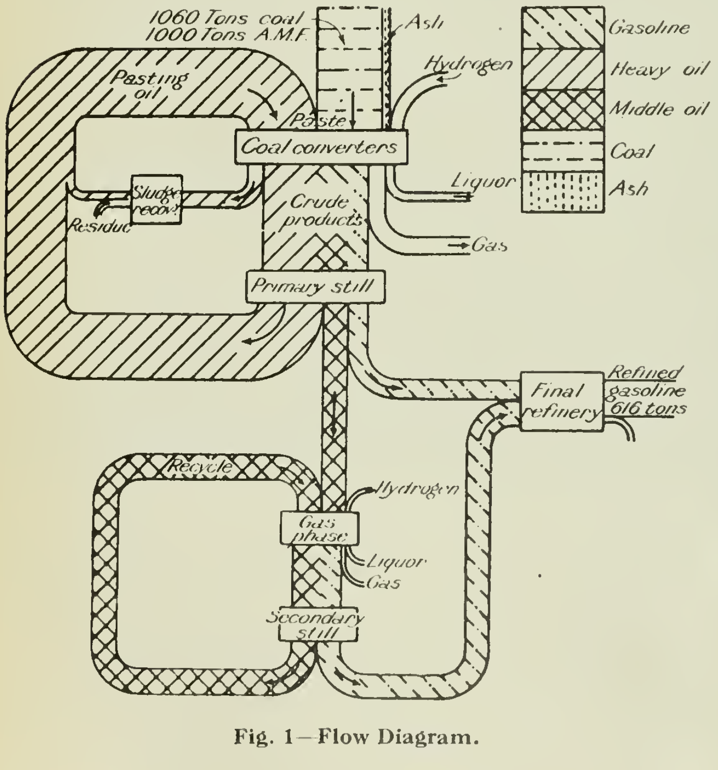

Fig. 1—Flow Diagram.

Direct Hydrogenation

Both gasoline and coal are composed to a large extent of carbon in chemical combination with hydrogen but they differ in three respects: gasoline has about 14 per cent of hydrogen and coal about 5 per cent; the average molecular weight of gasoline is about 100 while that of coal is much greater; gasoline is composed almost entirely of compounds of carbon and hydrogen whereas coal contains substantial quantities of chemically combined nitrogen, oxygen and sulphur.

It is evident, therefore, that to convert coal to gasoline three changes must be made: hydrogen must be added, the molecular size reduced and nitrogen oxygen and sulphur removed.

The hydrogenation process employs only one kind of treatment to accomplish all three changes. This treatment is to dissolve the coal in oil and heat it with hydrogen at high pressure. Under these conditions the large coal molecules break into smaller ones. Hydrogen unites with these to form a series of stable hydrocarbons including gasoline. It also reacts with the nitrogen, oxygen and sulphur in the coal to form ammonia, water and hydrogen sulphide.

As shown in Fig. 1† the process does not accomplish the entire change from coal to gasoline in one operation. It is necessary to remove the gasoline formed in the first cycle and to treat the higher boiling oils again. The heavy oil fraction is mixed with a fresh charge of coal. Enough is available for this purpose so that it is not necessary to introduce oil from an outside source. The oil of intermediate boiling range is hydrogenated further in the vapour phase.

Figure 2 is a simplified diagram illustrating the plant and flow of materials.‡ The coal is ground with heavy oil and catalyst to a fluid paste which is injected through a heating system into the converter. Compressed hydrogen is also heated and passed into the converter where the temperature is about 842 deg. F. (450 deg. C.) and the pressure is 3,000 lb. per sq. in. or more. Liquid is withdrawn from the system in order to remove the accumulation of solids consisting of ash, catalyst and combustible material. The oil is extracted from this suspension and used for pasting. The vaporized product is cooled and condensed from the excess of hydrogen. It is then separated into three fractions by distillation. The heavy oil fraction is

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† Figures 1-5 are from Imperial Chemical Industries, Ltd. Fuel, X, 481 (1931).

‡ For a description of the flow sheet of the Billingham plant of Imperial Chemical Industries, see K. Gordon, Journal of the Institute of Fuel, December 1935.

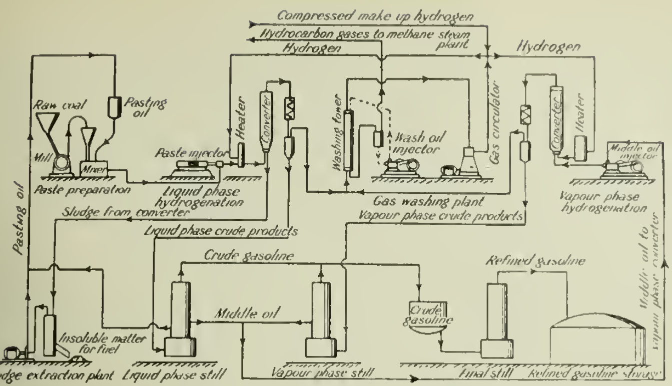

Fig. 2—Hydrogenation Plant.

used for pasting. The gasoline is sent to the refinery. The middle oil passes through the vapour phase converter. The temperature in the vapour phase converter is about 932 deg. F. (500 deg. C.) and the pressure is again 3,000 lb. per sq. in. or more. The catalyst used in the vapour phase is in the form of solid lumps and remains in the converter. The product from the vapour phase converter is separated from excess hydrogen as before and is divided into two fractions by distillation. The gasoline is sent to the refinery and the middle oil is re-cycled through the vapour phase converter. The excess of hydrogen from both phases is scrubbed with oil to remove hydrocarbon gases and is then circulated back into the system. The hydrocarbon gases are sent to the hydrogen producing plant.

Figure 3 is a diagram of the hydrogen producing plant. The hydrocarbon gases are heated with steam to yield a mixture of carbon monoxide and hydrogen. This mixture is heated with more steam at a lower temperature to convert the carbon monoxide to carbon dioxide and at the same time give a further yield of hydrogen. The carbon dioxide is scrubbed from the mixture with water under pressure and the remaining gas, which is nearly pure hydrogen, is compressed and used in the plant as shown in Fig. 2. If a sufficient quantity of hydrocarbon gas is not available, as is the case when operation is being started, the mixture of carbon monoxide and hydrogen can be made from coke and steam.

Considering the hydrogen producing plant and the hydrogenation plant as a single unit it is to be noticed that coal is the only raw material of value which is required. With minor exceptions it may be said that only coal and water are consumed and only gasoline and carbon dioxide are produced.

The efficiency of the process is illustrated in Figs. 4 and 5. The distribution of the reacting coal and hydrogen among the various products is shown in Fig. 4. One hundred tons of ash free coal plus 11 tons of hydrogen yield 62 tons of gasoline. It has been reported that even higher yields are now obtained at the Billingham plant of Imperial Chemical Industries. However the coal actually treated is only about half the total requirement because an equal quantity is used for generation of the steam and producer gas needed in the process. The thermal efficiency of the process is demonstrated in Fig. 5. The overall efficiency is about 43 per cent; that is 43 per cent of the heating value of the total coal required, including that used for steam raising, is recovered in the gasoline.

The quality of the finished gasoline can be varied considerably by changes in the operating conditions which involve no alteration of the equipment. The distillation characteristics and vapour pressure can be adjusted by the final distillation. The anti-knock rating is largely a function of the proportion of aromatics in the fuel. This proportion can be increased by raising the temperature of the vapour phase reaction. However high temperature favours gas formation and consequently a low yield of gasoline. It is therefore necessary to make an economic balance with regard to knock rating.

The properties of the gasoline produced from coal at Billingham are shown in the following table*: I is gasoline obtained directly from coal, II is a vapour phase gasoline containing lead and III is an aviation gasoline made up to 87 octane number presumably with lead.

	I	II	III
Specific gravity	0.740–0.745	0.734–0.738	0.730
Initial boiling point	95° F. (35° C.)	95° F. (35° C.)	95° F. (35° C.)
90% volume recovered at	316° F. (158° C.)	320° F. (160° C.)	302° F. (150° C.)
Final boiling point	338° F. (170° C.)	338° F. (170° C.)	329° F. (165° C)
Residue	1.0%	1.0%	1.0%
Loss	1.0%	1.0%	1.0%
Per cent distillation + loss at			
158° F. (70° C.)	20	19	21
212° F. (100° C.)	40	40	50
284° F. (140° C.)	75	75	87
Reid vapour pressure, at 100°F.	9 lb. per sq. in.	9 lb. per sq. in.	7 lb. per sq. in.
Octane No. C.F.R. (motor)	71–73	80	—
Octane No. C.F.R. (aviation)	—	—	87
Colour	+ 25 Saybolt	Red	Blue
Odour	Marketable	Marketable	Marketable
Sulphur per cent by weight	0.05	0.01–0.02	0.01–0.02
Doctor test	Negative	Negative	Negative
A.S.T.M. copper strip	"	"	"
Gum pyrex dish without air jet (mg. per 100 c.c.)	2.0	up to 3.0	up to 3.0

One important limitation of the direct hydrogenation process is that it is not applicable to all coals. Anthracitic coals invariably give very small yields of oil. In the bituminous class the low and medium volatile groups also usually give unsatisfactory yields. The best coals for commercial use are found in the high volatile bituminous group. The lower ranks of coal are also to be considered for commercial use whenever they have especial advantages in price or location. There is, however, a considerable variation in the oil yields from coals classified in the same group by chemical analysis so that it is necessary to test each coal under conditions closely parallel to those of commercial hydrogenation before deciding on its merits.

Another limitation is that the final product is not entirely independent of the chemical characteristics of the original coal. While the properties of the product can be widely varied it is not possible to produce high yields of paraffinic oils. For this reason it has not yet been found possible to produce a first rate Diesel fuel by direct hydrogenation of coal.

Indirect Hydrogenation

The principal reaction of indirect hydrogenation can be expressed by the following equation.

$$CO + 2H_2 = —CH_2— + H_2O$$

The $—CH_2—$ radicals probably have a separate existence only for a very short time on the surface of the catalyst and then unite to form hydrocarbon chains of various lengths. The product has a smooth distillation curve and contains hydrocarbons varying from methane to paraffin wax and including about 60 per cent which boils within the gasoline range.

The first technical problem in the process is that of producing a mixture of carbon monoxide and hydrogen in the proportion of 1 to 2 as indicated by the equation. Ordinary water gas produced from coke and steam is largely composed of these gases in equal amounts and, after the addition of the required amount of hydrogen,

*K. Gordon, *loc. cit.*

is commonly used for the synthesis. One means of doubling the proportion of hydrogen is to divert about one third of the water gas and treat it with steam to yield hydrogen and carbon dioxide. The carbon dioxide is removed and the hydrogen is added to the remaining two thirds of the water gas to give a synthesis gas of the correct composition. The equipment used for the production of hydrogen is identical with that used for the same operation in the direct hydrogenation process.

The synthesis gas requires careful purification. Sulphur must be reduced to a value less than 0.087 grains per 100 cu. ft. (0.2 grams per 100 cu. metres). This is necessary to prevent poisoning the sensitive catalyst which, unlike those used for direct hydrogenation, quickly deteriorates in the presence of sulphur. The purification is carried out in two steps, the first to remove hydrogen sulphide and the second to remove organic sulphur.

After purification the gas is passed to the chamber containing the catalyst. The catalysts which can be used for the synthesis are basically iron, cobalt or nickel. These are usually mixed with a second metal which may be copper, manganese or thorium and are supported on a non-metallic carrier. A catalyst of cobalt and thorium supported on kieselguhr and formed by the precipitation of the nitrates with soda is stated to be the best for the commercial process, particularly with regard to its period of activity which is about 60 days.*

The temperature in the reaction chamber must be maintained at an optimum corresponding to the catalyst used. This temperature is usually between 356 deg. F. (180 deg. C.) and 392 deg. F. (200 deg. C.). Since the reaction is strongly exothermic considerable ingenuity is required in the construction of the catalyst chamber to prevent local overheating and to maintain a constant temperature. One means is to circulate hot water through tubes in the catalyst bed and to control the pressure on the circulating water so that the correct temperature is maintained. The pressure of the reacting gases in the catalyst chamber is of the order of one atmosphere.

The products are in part condensed and in part absorbed on charcoal. One product, paraffin wax, has so high a boiling point that it remains on the catalyst and has to be removed periodically. A sample of the liquid product examined by the Universal Oil Products, Company had the following properties†:

Gravity, deg. A.P.I.	63.0
Specific gravity at 60 deg. F.	0.7275
Sulphur per cent	0.01
Octane number (C.F.R. motor)	20

Engler distillation (100 c.c.)

	Deg. F.		Deg. C.
Initial boiling point	113		45
5 per cent over	148		64
10 " "	170		77
20 " "	205		96
30 " "	245		118
40 " "	286		141
50 " "	323		162
60 " "	368		187
70 " "	420		216
80 " "	487		253
90 " "	657		347
End point	702		372
Per cent over		97.5	
Per cent bottoms		1.0	
Per cent loss		1.5	

The gasoline distilled from the total product has an octane number of only 40. The total oil can be fractionated and subjected to selective cracking conditions and the olefines in the cracked gas polymerized to give a yield of 84 per cent of gasoline having an octane number of 66. An aviation gasoline can be produced by blending a low boiling straight-run fraction with the polymer gasoline produced from the gases formed in cracking the higher fractions. However, the yield of aviation gasoline obtained in this way is only 27.4 per cent by volume of the original total product. It has the following properties:

Gravity, deg. A.P.I.	80.3
Specific gravity at 60 deg. F.	0.6681
Colour, deg. Saybolt	30
Doctor test	Negative
Gum, mg. per 100 c.c.	
Copper dish	0
A.S.T.M. glass dish	0
Octane number A.S.T.M.	77

Distillation 100 c.c. A.S.T.M.

	Deg. F.		Deg. C.
Initial boiling point	92		33
5 per cent over	105		41
10 " "	113		45
20 " "	122		50
30 " "	131		55
40 " "	141		61
50 " "	150		66
60 " "	162		(72)
70 " "	175		(79)
80 " "	190		(88)
90 " "	213		(101)
95 " "	239		(115)
End point	291		(144)
Per cent over		97.0	
Per cent bottoms		1.0	
Per cent loss		2.0	

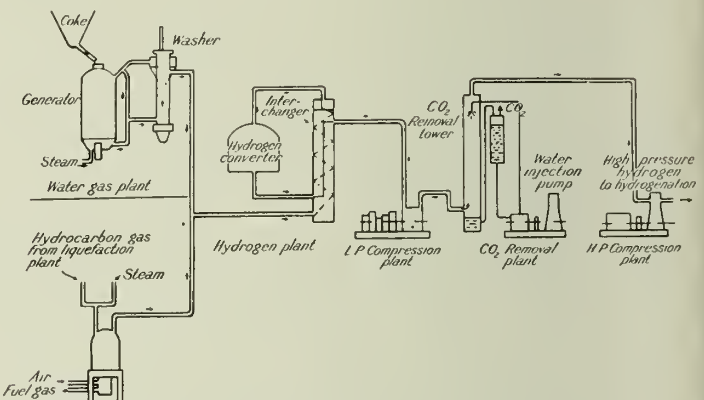

Fig. 3—Hydrogen Producing Plant.

The low knock rating of the product is the principal limitation of indirect hydrogenation. It is due to the fact that the product is largely composed of straight chain paraffin hydrocarbons.

On the other hand the ignition properties required of a Diesel fuel are the opposite of those required of a spark ignition fuel and accordingly the straight chain paraffinic product of indirect hydrogenation is an excellent Diesel fuel. In this respect direct and indirect hydrogenation are supplementary rather than competitive.

A valuable feature of indirect hydrogenation is that it can be applied to any material from which water gas can be made. The range from which the raw materials can be selected is therefore much greater than that for direct hydrogenation and includes all ranks of coal. Further the products from different raw materials are identical and the process varies only in the means adopted for the production and purification of water gas.

PRODUCTION OF ANTI-KNOCK FUELS

Two series of hydrocarbons have outstanding anti-knock values; these are the aromatics and the branched-chain paraffins. Of the latter, iso-octane is the most

*Koppers Review, Vol. 2 No. 3, 1937, p. 106. The Koppers Coke Oven Co. Ltd., Sheffield.

†Egloff, Nelson and Morrell, Ind. Eng. Chem., Vol. 29 No. 5, May 1937.

important individual and it is now being prepared commercially as a blending agent for the manufacture of 100-octane fuels. Hydrogenation is used in the production of both aromatics and iso-octane.

Aromatization

Liquid hydrocarbons are largely composed of four series of compounds namely paraffins, olefins, naphthenes and aromatics. The most resistant to heat of these are the aromatics and to increase their proportion in a mixture it is sufficient to heat it strongly, in which case the less refractory molecules are broken down to gas and coke and the aromatics remain. There is, moreover, a tendency for the other groups to be converted into aromatics under the influence of heat. An example is the conversion of cyclohexane to benzene. The reaction is expressed by the following equation

$$C_6H_{12} = C_6H_6 + 3H_2$$

This reaction is obviously the opposite of hydrogenation and by applying hydrogen under pressure can be made to go in the reverse direction. By selecting conditions of temperature and pressure it is possible to control this reaction at will.

However another reaction involving loss of hydrogen produces an undesirable result. This is the conversion of paraffins to olefins. When strongly heated olefins tend to polymerize and crack repeatedly, forming at each step more complex compounds which are more deficient in hydrogen, until the final product is tar or coke. It is important therefore to reduce the concentration of olefins in the reacting oil to a minimum. A typical example of olefin formation is the dehydrogenation of octane to octene which is shown in the following equation

$$C_8H_{18} = C_8H_{16} + H_2$$

This reaction is also reversible and can be made to go in either direction by adjusting the pressure of hydrogen.

A very important fact is that the pressure of hydrogen required to reverse the paraffin-olefin reaction is less than that required to reverse the naphthene-aromatic reaction. This is the basis of the process of aromatization which is to apply to a hydrocarbon mixture a temperature and pressure of hydrogen such that aromatics are formed while at the same time the production of olefins is prevented. The equipment in which this process is carried out is similar to that used for the vapour phase stage of coal hydrogenation.

This means of producing aromatic hydrocarbons is especially applicable to the primary product of coal liquifaction which is already rich in aromatics. For example the neutral oil fraction boiling up to 572 deg. F. (300 deg. C.) from a primary oil made from Nova Scotia coal contained 74 per cent of aromatics. Although experimental data are lacking it is probable that a 100-octane fuel could be made from such a stock.

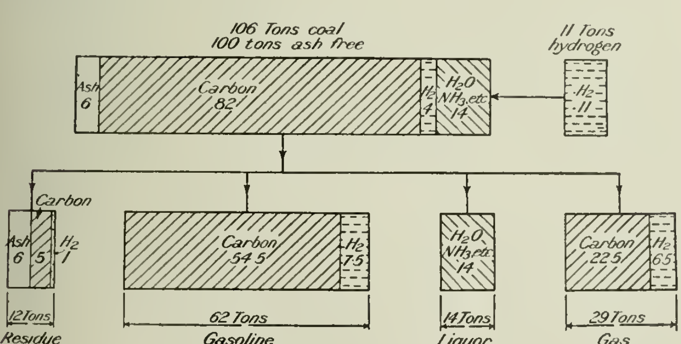

Fig. 4—Material Balance.

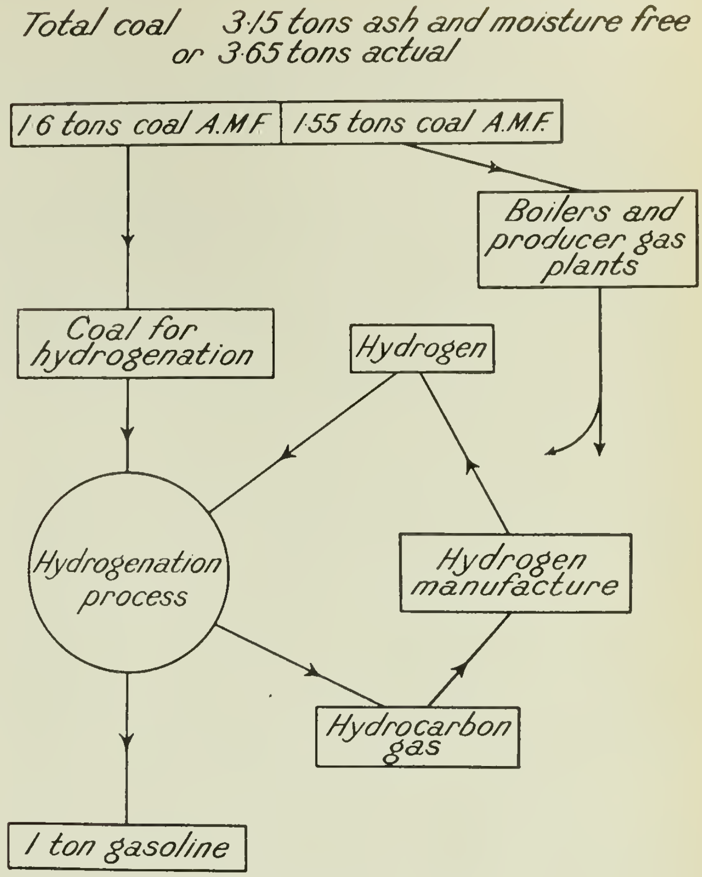

Fig. 5—Thermal Balance.

The aromatizing process is also applicable to petroleum stocks.* Ordinarily, aviation gasoline is made by distilling crudes which have been carefully selected for their high anti-knock properties. Tetra ethyl lead is added to bring the octane rating up from about 75 to the desired value. However it is rarely possible to reach an octane rating of 90 by the addition of 3 c.c. of lead per gal. Moreover the supply of suitable base stocks is not great. However by hydrogenating aromatic stocks it is possible to produce a fuel with satisfactory volatility and having an octane number of 75 to 78 which can be raised to above 90 by the addition of 3 c.c. of lead per gal.

Another use of aromatization is the production of aviation safety fuel.† This is a hydrocarbon fraction boiling between 310 deg. F. and 410 deg. F. Because of its high initial boiling point it has a high flash point and is less apt to ignite accidentally than gasoline. A fraction of untreated petroleum boiling within the required range could not be used for this purpose because of its low anti-knock value. However by aromatizing a suitable petroleum stock a safety fuel having an octane number above 100 can be made without the addition of any lead. Such a fuel obviously lacks the low-boiling fraction necessary for use with an ordinary carburettor. One of the best means of introducing the fuel into the cylinders appears to be direct injection although this problem at present has not been satisfactorily solved.

Synthesis of Iso-octane

Hydrogenation is also used in the commercial preparation of iso-octane. This process takes place in two steps as shown by the following equations:

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*Brown and Gohr, World Petroleum, Vol. VIII No. 11, Page 49, October 1937.

† Howard, Oil Gas J., 30, No. 46, 90 (1932).

(1) $$\underset{\text{isobutylene}}{2C_4H_8} = \underset{\text{di-isobutylene}}{C_8H_{16}}$$

(2) $$C_8H_{16} + H_2 = C_8H_{18}$$

In the first step isobutylene is polymerized to di-isobutylene. In the second the di-isobutylene so formed is hydrogenated to iso-octane.

The present source of isobutylene is the gas produced in the cracking of petroleum. Isobutylene can also be made from isobutane which occurs in natural gas. The supply of isobutylene is adequate for any demand which is likely to arise in the near future. Estimates of the potential supply of iso-octane from this source in the United States vary between one billion gallons and 155 million gallons per year.* The higher figure is more than 15 times the total consumption of aircraft fuel in the United States in 1934.

The process of production of iso-octane begins with the removal of the butane-butylene fraction from the gas by distillation. This fraction comprises four hydrocarbons, namely butane, butylene, isobutane and isobutylene. Of these, isobutylene, which has the desired branched chain structure, polymerizes most readily.

Advantage is taken of the activity of isobutylene in the three major processes of catalytic polymerization.† All three use a strong acid to catalyse the reaction shown in equation (1). The so-called cold acid process uses 60 to 70 per cent sulphuric acid at 68 to 95 deg. F. to selectively absorb isobutylene from the butane-butylene mixture. The acid containing the isobutylene is then heated to 212 deg. F. which causes the absorbed isobutylene to polymerize to di-isobutylene. The other two processes employ hot sulphuric acid and hot solid phosphoric acid respectively as catalytic agents. Selective absorption and polymerization proceed simultaneously in the presence of the hot acids. The hot acid processes have the advantage of a higher yield but the disadvantage of an impure product. This is because their selectivity is not so exact and some of the butylene reacts along with the isobutylene.

The di-isobutylene produced by any of these processes is not suitable as an aviation blending fuel because its anti-knock rating is only about 84. However on combining hydrogen with it, iso-octane is formed, which of course has an octane number of 100. Hydrogenation of di-isobutylene can be carried out in equipment similar to that used for the vapour phase step of coal hydrogenation.‡ Either high or low pressure can be employed. High pressure has the advantage that a less active but more durable catalyst can be used.

*Hubner, Egloff and Murphy, National Pet. News, July 28, 1937.
†McAllister, Paper to American Pet. Inst., Nov. 12, 1937.

CONCLUSIONS

In the foregoing outlines it has been shown that where coal only is available as the raw material, it is possible to make a highly aromatic gasoline by direct hydrogenation or a good Diesel fuel by indirect hydrogenation. It is also conceivably possible to utilize the isobutane in the gas produced by direct hydrogenation to make iso-octane. This however will not be commercially feasible until a hydrogenation industry of very large proportions has been built up. At present, therefore, there is no satisfactory method of producing iso-octane from coal.

On the other hand, where a variety of petroleum stocks is available and there is a large supply of cracked or natural gas, it is possible to make not only aromatic gasoline and Diesel fuel but also iso-octane and similar branched-chain paraffins.

Comparing branched-chain paraffins with aromatics it is to be noticed that the latter have certain disadvantages. One of these is that some of the aromatics, notably benzene and para-xylene have high freezing points and therefore cannot be used in high concentration in aviation fuels. Another disadvantage of the aromatics is that they have lower calorific values than the paraffins. For example the gross heat of combustion of toluene is about 11 per cent less than that of octane.§ High calorific values are of course essential to long distance non-stop flying. The relative anti-knock ratings of aromatic and branched chain paraffins depend to a great extent on the type of engine employed. Water cooled engines favour aromatics and air cooled engines favour paraffins.

It would appear, therefore, that where coal is to be used as the source of motor fuel the trend of development will be towards water-cooled spark ignition engines for short distances and Diesel engines for longer distances. Where iso-octane is available it should be possible to combine the advantages of both to a large extent in a single engine.

‡Brown and Gohr, *loc. cit.*
§Nash and Howes, The Principles of Motor Fuel Preparation and Application, Vol. 2, paragraph 825, Chapman and Hall, London.

Welded Steel Pipe for the City of Toronto Water Works Extension

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Paper presented before the Toronto Branch of The Engineering Institute of Canada on November 4th, 1937, and before the Montreal Branch on February 10th, 1938.

SUMMARY. This paper describes a pipe making process which never before has been done in Canada. It deals with design, manufacture and installation of 48 in. internal diameter concrete lined, welded steel pipe for the city of Toronto, and outlines the methods and equipment for the automatic welding process, the centrifugally placed concrete lining, the hydrostatic tests and the field assembly.

A vital factor in the life of mankind is an abundant supply of pure and fresh water which must be conveyed by some means to the points of consumption. The term "aqueduct" embraces all types of artificial works designed for the purpose of conveying water from one place to another. Generally the term is applied only to works of considerable magnitude.

In ancient times, wells were dug to underground waters. In the cities the populations were dependent on the water carrier, who filled his bags of skin from the wells and springs. These conditions exposed the inhabitants to the danger of an insufficient water supply during a long drought or a siege, so, with the advance of civilization, measures were taken to provide an adequate supply at all times.

The oldest inscription known—that upon the Moabite Stone in the tenth century, B.C.—records an aqueduct for carrying water to supply the cisterns of Kancha. Early forms of conduit found at Jerusalem and dating from the time of the Judean kings were pierced stones and tunnels. One of these consists of limestone blocks, each pierced by a hole, fifteen inches in diameter, chiseled out by hand. The blocks were covered by masonry. The other is the 1,700 ft. tunnel connecting the Virgino Pool with the upper Pool of Saloam. Other forms of early conduit are pipe made of wood, lead and potters clay.

In Egypt, Babylonia and Assyria water was supplied by means of open canals and large basins. In relation to the achievements of Greece and Rome, the Phoenicians were the most important among the engineers of their day. Their most noted water works was the well of Ras-el Ain near Tyre, comprising four octagonal towers in which water rises to a height of 18 to 20 ft. from four deep artesian wells. The accumulated water was carried off in conduits.

The earliest attempts in Europe to solve the problem of water supply were made by the Greeks. Examples of Greek work are the tunnels draining Lake Copais in Boeotia.

The Romans built aqueducts across valleys as a matter of economy, in preference to carrying pipes underground. Pipes had to be made of lead which was weak, or of bronze, which was expensive; and the Romans were not sufficiently expert in the casting of large pipes of these materials which would stand a moderate pressure.

The first known superintendent of water works was Frontinus, appointed curator aquaruum for the city of Rome by the Emperor Nerva, in 97 A.D. In his treatise on the aqueducts of the City of Rome he mentions nine aqueducts the substructures of which were in masonry while the water channels were brick-lined and faced with concrete.

During the Mediaeval Ages small lead pipes were used for water distribution in such cities as London and Paris. In England, water was conveyed across valleys in wooden troughs. These were lined with lead and supported on wooden arches. One of England's oldest water works, where the supply was taken from a river, was installed in London in 1582. Later two types of aqueduct were used, the one being built of brick, concrete, stone, etc., the other of cast iron.

The first experiments in the manufacture and use of cast iron pipe were made at Versailles in 1664 but it was not until 1738 that economical production was attained. The joints of all the earlier lines were of the bolted types, with lead gaskets, and gave trouble through the rusting of the bolts. This difficulty was overcome by Thomas Simpson, of London, who, in 1785, invented the bell and spigot joint that has been used so extensively ever since.

In 1775, at Bethlehem, Pennsylvania, there was installed one of the first public water supplies in the United States. It consisted of a pipe system of bored logs which carried the water to points of consumption. In 1800, in New York city, a company was granted permission to dig wells at various points and to lay to a number of houses wooden water mains, bored from pine logs. In 1830 the first cast iron water mains were installed.

Cast iron water mains have been and continue to be widely used throughout the world with varying degrees of success, depending upon the nature of the soil and the character of the water conveyed. In recent years the following economical limitations have been placed upon cast iron pipe:

(1) A maximum diameter of 36 in.
(2) Pressures not in excess of 180 lb. per sq. in.
(3) Uncertain resistance to pulsations caused by water-hammer and stress of "street conditions."
(4) Decrease of carrying capacity with age due to tuberculation and incrustation.

At Hartford, Conn., a flow test on a 30 in. main showed a coefficient of 61 by the Hazen and Williams formula. The age of the pipe was 30 years but its condition gave an equivalent age of 70 years, indicating a reduction of 28 per cent in carrying capacity in 15 years. The coefficient required in the call for tenders was $C = 80$.

To prevent tuberculation in cast iron pipe and the pitting and corrosion of steel pipe it was found over a hundred years ago that a cement lining was most effective. An investigation of pipe corrosion by the French Academy of Science in 1836 states that "hydraulic cement, applied 1/10 in. thick, is of all compositions, combining facility of application and cheapness, the most indestructible, and prevents most effectively all oxidation and consequent formation of tuberculation or incrustation of the pipe."

In America, experience with cement lined pipe covers a period of about ninety years. An early type of cement lined pipe was the Phipps Patent Pipe. It consisted of a thin sheet of iron (about 1/16 in. thick) riveted into pipe form and then lined inside and covered outside with one-half to three-quarters of an inch of cement. The exterior cement was held in place by an outer sheet iron shell, which in corrosive soils, rusted away. This type of pipe removed after forty to sixty years service has always shown the lining to be in good condition and free from tuberculation and incrustation.

Following the cement lined pipe, reinforced concrete pipe was first developed in France between 1895 and

1900 and introduced into America in 1905. It was developed to meet the main requirements of pressure pipe lines, namely, ability to withstand internal and external pressures, a sustained minimum coefficient of friction, minimum leakage, minimum maintenance, permanency of construction and low construction costs without sacrificing these requirements.

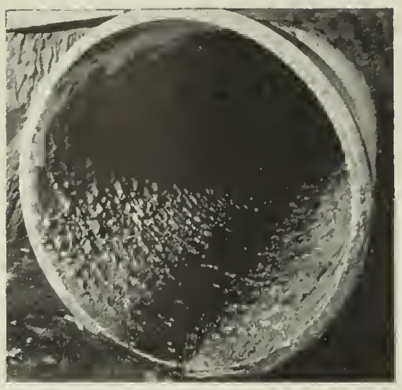


Fig. 1—Tuberculation and Incrustation of Cast Iron Pipe.

Reinforced concrete pipe, correctly designed, will resist internal and external pressures and will work within safe limits up to a water pressure of 150 ft. head. Pipes for higher pressures with the attendant benefits of efficiency and durability comprise a steel shell, lined centrifugally with concrete and protected on the outside with a covering of concrete, a fabric, wrapped and impregnated with a bitumastic composition, or coated with a bitumastic composition.

This type of pipe, for main water supply lines, has been in successful use in the United States and Canada since 1919. Its widest use has been in Europe, Africa, Australia, the Malay States and parts of India. All installations show a uniformly successful record as to carrying capacity, water-tightness and permanence, with negligible cost of maintenance.

In recent years, particularly in active water areas, the use of cement or concrete lined pipe has increased due to the appreciation of the fact that what is really being purchased is water carrying capacity. The composite steel concrete lined pipe permits more economical laying than either the reinforced concrete or cast iron pipe since lengths up to 36 ft. are readily fabricated.

Fabrication of 48-inch Internal Diameter Pipe

The design, fabrication and installation of approximately 38,380 lin. ft. of 48 in. internal diameter steel-cylinder reinforced concrete pipe comprises part of the Toronto water works system as originally decided upon in general principle in 1926 under the direction of R. C. Harris, Commissioner of Works. This scheme selected Victoria Park as the proper location for a raw water intake and the above pipe line comprises the distribution main from this point to the existing system at Dupont Street and Davenport Road, which supplies the St. Clair Avenue-Spadina Road reservoir.

In December, 1936, the Corporation of the City of Toronto called for tenders for riveted steel pipe, or alternatively electrically-welded steel pipe, concrete lined and when laid, encased in concrete. The general contract for supplying and laying the pipe was awarded to the Atlas Construction Company who called for tenders for fabrication of the pipe and joining of the pipe lengths in the field. This portion of the work was awarded to the Dominion Bridge Company, Toronto, in March, 1937, who tendered on a shop welded steel pipe centrifugally concrete lined and welded field joints. All welding was to be in accordance with the American Society of Mechanical Engineer's Welding Code for Unfired Pressure Vessels, paragraph U-69 (formerly Class 2).

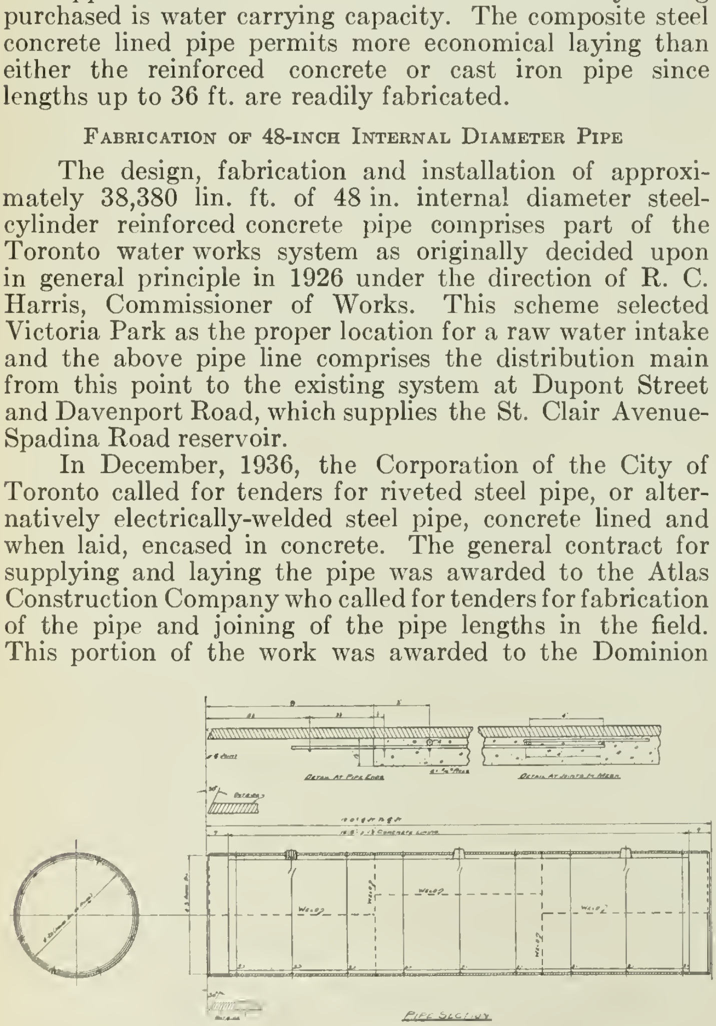


Fig. 2—An 18 ft. Pipe Length Illustrative of the Design.

In manufacture and installation three general types of pipe are recognized: standards, specials and bends. Standards are made in 12, 18 and 30 ft. lengths. The 12 and 18 ft. lengths for the tunnels and shafts are made of 9/16 in. plate, six feet wide, thereby requiring one and two circumferential joints, respectively. The 30 ft. lengths for open trench work comprise the majority of the pipe lengths and are made of ½ in. plate, 6 ft. wide, thus requiring four circumferential joints. Specials comprise closing sections, tees, straight sections jointed at an angle, reducing sections, etc.

All standard pipe lengths are automatically metallic arc welded. Straight pipe sections are centrifugally concrete lined whilst all others and the field joints are lined with gunite.

Training and Qualifying Welding Operators

Upon the decision to electric arc weld the field joints it was fully appreciated that competent welding operators would not be available and that training would be necessary. It was therefore decided to form a welding school to specifically train men for hand welding the specials, bends and field joints.

The company advertised first for experienced welders and received many applications, none of which were considered acceptable without further training in vertical welding. Many could not pass the necessary test on the flat. In answer to the advertisement that a welding school was to be started some 400 applications were received and from these 25 men were selected.

Each man was accepted on the understanding that he would serve a probational period of about two weeks, for the purpose of ascertaining his adaptability to and interest in welding. This avoided undue waste of the individual's time and unremunerative outlay of equipment and time by the company.

The proper training of welders usually presents many difficulties on account of the varied classes of work to be done but in this case the ultimate aim was that the student or "improver" should be capable of passing specific tests in accordance with the A.S.M.E. Welding Code for Unfired Pressure Vessels, paragraph U-69. In order to fulfil the specifications of the Code the "improver" was required to undergo a practical shop training period, approximately 400 hours, covering general welding as set forth in the Dominion Bridge Company Welding Manual. Upon the completion of these lessons, instruction was concentrated on the welding of ½ in. plate in the flat and vertical positions.

Instruction

Instruction consisted of twenty-five lessons. The first nineteen lessons were on bare wire welding and the remainder on covered electrode welding. It is advisable to start with bare wire welding because a higher degree of skill is required in its manipulation than with covered wire and the fundamentals of good fusion, penetration, arc length, etc., are more readily emphasized. A number of suitable lectures on welding hazards, the theory of welding, and the care and operation of welding machines were also included in the course.

The "improvers" were divided into two classes, each being continually supervised by a practical instructor who in turn was responsible to the engineer in charge of welding. The work week was forty-two hours and to assist the individual financially he was paid a small hourly rate for the training period. Towards the end of the training period the "improver" was given a certain amount of simple welding, such as tacking, and was paid the wage that such work commanded.

The qualifying of welders and poor quality welding in production work are naturally costly operations. To ensure satisfactory welding, each welder was thorughly instructed in the so-called "trifling defects" which result in failure of the test plate and increase the cost of testing. In production they result in inferior work. As illustrative of the factors which contribute to inferior welding, consider the causes of failure of a test plate made to fulfil the A.S.M.E. Code requirements, paragraph U-69.

Failure in most cases is due to porosity or poor fusion, causing rejection of the nick-break and free-bend specimens. These defects are usually attributable to one of the following:—

(*a*) Nervousness of the welder.
(*b*) Improper current and arc voltage.
(*c*) Improper rate of travel.
(*d*) Joint design.

(*a*) Although the welder must realize the difficulties in making a weld conforming to Code requirements this realization sometimes causes the welder to experience something like "stage fright" from trying too hard. This condition is best overcome by welding sufficient preliminary test plates to give him confidence.

(*b*) For a given size of electrode a wide current range is recommended by the manufacturer but for best results on a given plate thickness the range of adjustment is fairly narrow. Too high a current produces undercutting at the surface of each layer and if not chipped out, slag inclusions will result when the next layer is deposited. It also causes excessive boiling of the deposited metal and the formation of gas pockets. Too low a current results in poor fusion, entrapped slag and gas pockets, and is the most frequent cause of failure. Too long an arc or a high arc voltage also causes undercutting and too short an arc will cause porosity.

All noticeable gas pockets and slag inclusions in any deposited layer must be removed as they will cause defects in subsequent layers. The arc craters must be clean, shallow and free from porosity.

(*c*) The rate of travel of the electrode if too slow will give a heavy deposit of metal which tends to porosity due to entrapment of the gas by rapid solidification. Subsequent layers will not completely re-crystallize and alternate coarse and fine structures will result. Deposited layers should not be over one-eighth inch in thickness.

(*d*) The joint design must be such that all points of fusion are nearly equi-distant from the electrode tip so as to remove an equal amount of heat to give uniform fusion. The electrode size selected must be suitable for the type of groove.

The above mentioned factors which affect weld quality and joint efficiency must be thoroughly understood by the welding supervisor and frequently impressed upon the welder.

From the class twenty-two men were qualified, in accordance with the Code, in the flat position and ten of these in the vertical position. In no case was there a failure of an individual test in the flat position and no complete failure in the vertical position.

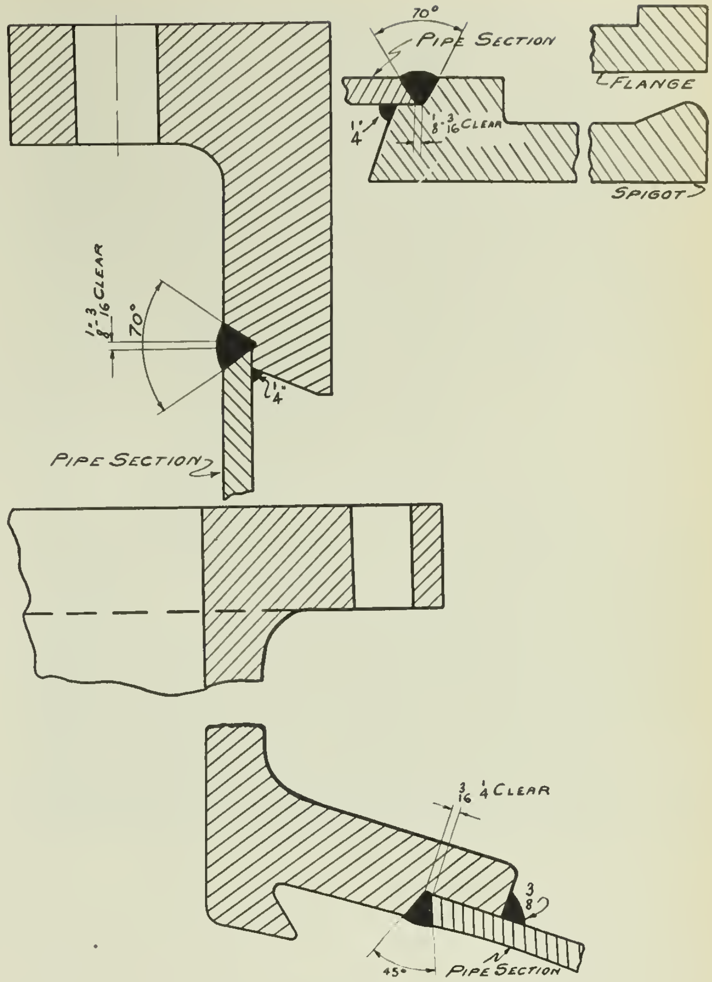


Fig. 3—Joint Details for Fittings.

With the careful selection of the welding personnel, thorough training and qualified supervision at all times, the "human factor" element was reduced to a minimum.

At no time should a welder be employed merely upon his claim of years of experience in arc welding. While the welder's claim may be quite correct for one class of work he might be unable to perform the work required. Each man should be given a suitable preliminary test to ascertain his ability to weld on the flat and in the vertical position.

Fabrication of Steel Shell

Material

Steel plate

Steel plates ½ in. and 9/16 in. in thickness were purchased to specification A.S.T.M. A78-33, grade B, covering plates of structural quality for forge welding, except that a tensile strength of 55,000 lb. per sq. in. minimum was required. The average chemical composition was—carbon 0.20 per cent, manganese 0.43 per cent, phosphorus 0.014 per cent, sulphur 0.043 per cent. Physical properties averaged 36,690 lb. per sq. in. yield point, 60,750 lb. per sq. in. tensile strength, 29.0 per cent elongation in 8 in.

Wire Mesh Reinforcing

A galvanized and welded wire mesh 4 by 4 in. square, 10 gauge was purchased in sheets 82 in. long by 13 ft. 10 in. to C.E.S.A. Specification A-9-C, 1923, for cold drawn wire for concrete reinforcement.

Spacing Wire

Steel wire, 5/16 in. dia., was used for spacing the wire mesh away from the shell of the pipe. The wire was purchased in coils, rolled to the required diameter and cut to length.

Piezometers and Pitot Tube Nozzles

Round bar material for the piezometers and pitot tube nozzles was of chrome-nickel-iron containing 18 per cent chromium, 8 per cent nickel, 0.15 per cent carbon, 0.50 per cent of manganese and 3.0 per cent molybdenum.

Bolts and Nuts

The eye bolts for the 36 in. dia. pressure manhole covers, the bolts and eye bolts for the ladders and gratings were chrome-nickel-iron containing 18.0 per cent chromium, 2.0 per cent nickel, 0.10 per cent carbon and 0.50 per cent manganese. All other bolts and nuts conform to A.S.T.M. Specification A-50-33 for Quenched Carbon Steel Track Bolts. The minimum physical requirements were 70,000 lb. per sq. in. yield point, 100,000 lb. per sq. in. tensile strength and 12 per cent in 2 in. elongation.

Steel Castings

Steel castings conform to A.S.T.M. Specification A27-24, Class B, Medium Grade. The minimum physical requirements were 31,500 lb. per sq. in. yield point, 70,000 lb. per sq. in. tensile strength, 20 per cent elongation in 2 in. and 30 per cent reduction of area.

Design

The steel cylinder, 51 in. internal dia. is designed and fabricated to withstand all stresses due to internal pressure whilst the concrete lining with wire mesh reinforcing provides permanent protection and maintenance of high water carrying capacity. Figure 2 shows an 18 ft. pipe length which is illustrative of the design.

The pipe lengths in the open trench are fabricated of ½ in. steel plate which at 195 lb. per sq. in. test pressure produce a unit stress of 10,000 lb. per sq. in.

The pipe lengths for the tunnel and shaft sections, specials and bends are fabricated of 9/16 in. steel plate which at 255 lb. per sq. in. test pressure produce a unit stress of 12,500 lb. per sq. in.

Air valve connections, drain nozzles, the ends of the steel pipe and pipe specials requiring connections by Victaulic couplings, manholes and flanges are of cast steel and designed for butt welding to the steel shell as illustrated in Fig. 3.

The use of steel plate insures convenience and adaptability in meeting almost any condition of construction required in the field. Therefore, all bends, both horizontal and vertical, are of the welded segmental type, and fabricated in the shop for all angles over one degree. They are made symmetrical, with each deflection an even degree, to simplify manufacture; that is, a 90 deg. bend would be made up of deflections as follows:—8 at 5 deg., 1 at 4 deg., 1 at 2 deg., 1 at 4 deg., and 8 at 5 deg.

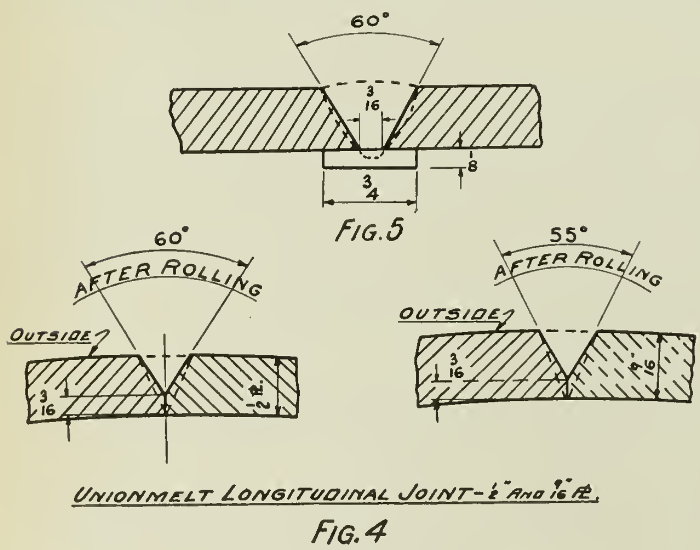


Fig. 5—Joint Design.

Joints

The edges of plates ½ in. and 9/16 in. in thickness, which are to be automatically welded by the Unionmelt Process, are bevelled to form a 60 and 55 deg. vee respectively with a 3/16 in. lip as illustrated in Fig. 4.

The plate edges forming the field joints of all horizontal pipe are fully bevelled, inside for the lower half and outside for the upper half of the circumference, at an angle of 30 deg. Figures 2 and 5 show the joint design.

The pipe lengths for the shafts require that the field joint be fully welded from the inside. One end of each pipe length is 90 deg. to the vertical axis whilst the opposite end is fully bevelled to an angle of 45 deg. with the vertical axis. Two pipe lengths are assembled to form a joint as illustrated in Fig. 6.

All specials and bends are made up of segmental sections, manually metallic arc welded. The edges of the adjoining sections are fully bevelled to form a 60 deg. vee, as shown in Fig. 7, for both circumferential and horizontal joints.

Plate Edge Preparation

The edges of the plate are prepared for automatic or hand welding by planing and by machine gas cutting. The plate as received from the mill is squared from one long side and end, then marked to length. The sides of the plate are next prepared by two Niles Bement Pond plate planers. The plate is not planed to a given width since closing pieces are used in the pipe line wherever required.

After the sides are prepared the plate is set up to stops on a table and one end cut and bevelled in the same operation using a special gas cutting machine (Fig. 8). The plate is then turned around, cut to length and bevelled, also, in one operation.

The machine is essentially a standard cutting machine with plate edge bevelling attachments which permit a uniform bevel cut since the guide wheel follows the contour of the plate. The commercial success of simultaneous cutting and bevelling depends primarily on the condition of the slag formed and its ease of removal. The control of the slag is governed by the velocity of the cutting oxygen stream and the bevel cutting reaction temperature. The smoothness of the gas cut edge is influenced by the preheat flames of both blowpipe nozzles.

The edges of the plate are next ground by an electric hand grinding wheel for a distance of about one inch from the edge for the purpose of removing mill scale which would contaminate the weld metal.

Rolling

The plates are rolled on a ten foot Bertsch Roll, equipped with a hydraulic drop housing which permits quick removal of the rolled plate. As the plate must be formed accurately, no flat spots at the joint being permitted, the first operation is to break one plate edge for a distance of six to seven inches by entering the plate at the rear of the rolls. The plate is then removed by reversing the rolls, the formed edge entered from the front of the machine and the plate rolled to the required diameter in two or three passes. This gives a true circular pipe.

Assembly for Longitudinal Welding

The plate edges of a six foot can section are placed in alignment and tacked together at 12 to 18 in. intervals. At either end of the section a steel tab, 8 in. wide by 4 in. long by the thickness of the shell and curved to its radius, is solidly welded for the starting and finishing of the electrode and to prevent the weld from cracking longitudinally at the finish.

Figure 9 shows the clamps for lining up the plate edges and taking out any twist due to rolling. The plate edges are made flush on the underside by jacking the edges into position and tacking on the groove side. The assembled can section is now ready for automatic welding.

Trueing

The operations of trueing and assembly for circumferential welding which follow the longitudinal welding are now considered in order to maintain continuity in describing the automatic welding process.

The longitudinal welding tends to peak the can section along the welded joint. In order to obtain proper joints for circumferential welding it is necessary to make the can section truely circular by passing the welded seam between top and bottom dies radiused to the outside and inside diameters, respectively, of the pipe.

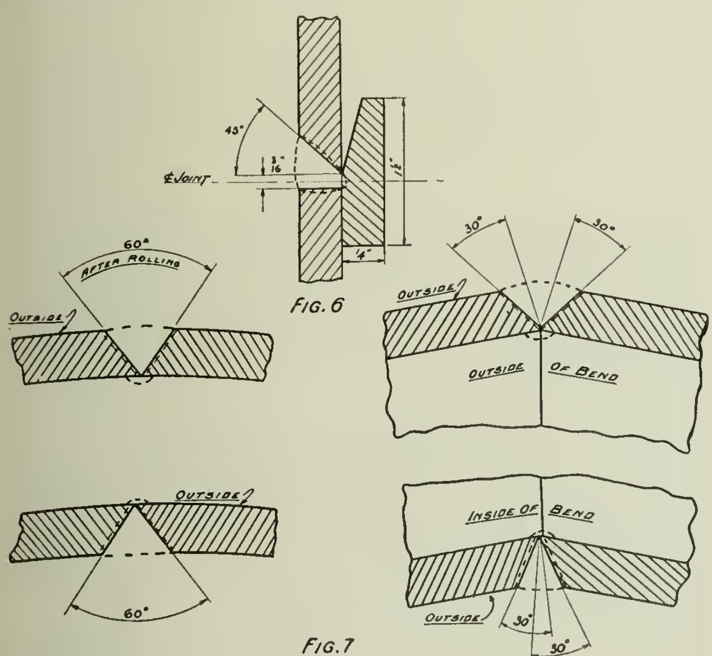
Assembly for Circumferential Welding.

The six-foot can sections are assembled end to end on a roller bed to form 12, 18 and 30 ft. pipe lengths as required.

Assembly rings are placed in one section of the pipe, the next section of pipe is slipped over the ring with the longitudinal seam offset six inches from that of the previous section. The next ring is similarly placed on and the longitudinal weld placed in line with the first pipe section. When the required number of sections are placed together they are drawn tight by means of clamps and the joints tack welded at intervals of about 18 in. The pipe is now ready for the circumferential welder.

Automatic Welding

Before describing in detail the automatic process used in welding the steel pipe shell, it will be instructive to consider automatic welding generally.



Horizontal Joint **Circumferential Joint**

Fig. 6—Two Pipe Lengths forming Joint.

Automatic welding is of great value in fabrication when the work involves large numbers of similar articles. It has the advantage of showing a saving in time and labour charges in conjunction with a greater degree of reliability in the finished product.

To obtain the full advantage of automatic welding it is essential that the following operations be properly balanced.

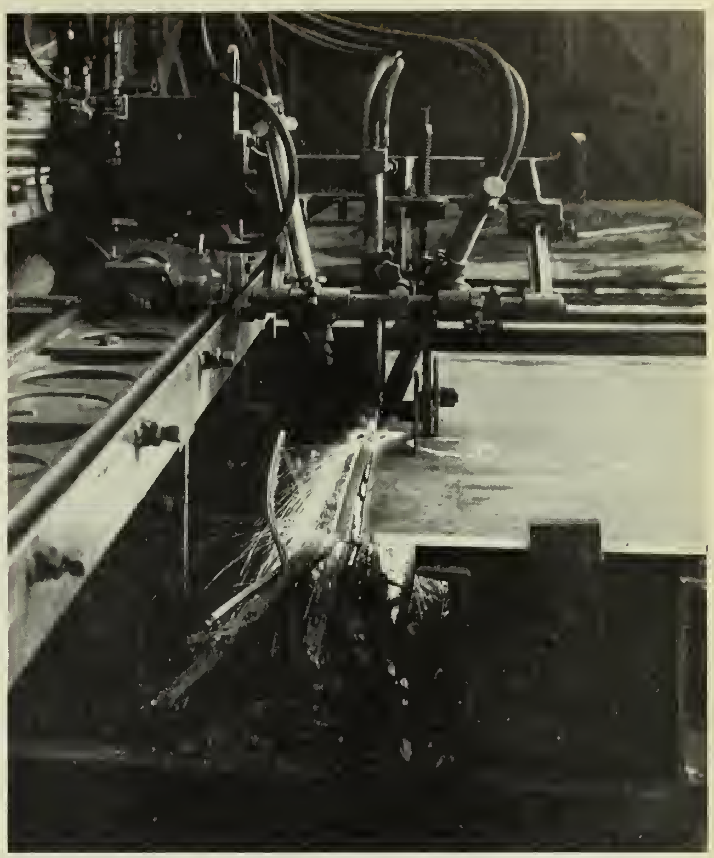


Fig. 8—Special Gas Cutting Machine which Cuts and Bevels at the Same Time.

(1) That care in preparation be no more than that necessary for hand welding.
(2) That the loading and unloading of the machine be in proportion to the welding time which necessitates that the former be less than the latter.
(3) That the output of the welding machine is not in excess of the capacity of the equipment following, so that the machine is not idle part of the time.

In hand welding with an experienced welder the arc length is controlled by eye and ear, and skill is required in the control and movement of the electrode. These factors, therefore, are not the same from day to day and the quality of work cannot be consistently uniform.

Automatic welding enables the maintenance of constant arc conditions and uniform speed. Thermal conditions are therefore constant with the result that uniform penetration, appearance and quality of weld are obtained. Higher welding speeds are obtainable as the current input to the electrode is only a few inches from the point of consumption which enables the current to be three to four times as great, for a given size of electrode, as used in hand welding. Also there is no loss of time due to changing electrodes and practically no wire wastage as compared to approximately 15 per cent from stub ends of hand welding wire.

From the foregoing one would consider that automatic welding was the solution to the welding engineers' problems and wonder why automatic welding has not been used more extensively. Unfortunately, it is beyond the scope of this paper to discuss the various types of automatic equipment developed to date, but two of the chief difficulties have been their complicated mechanical and electrical designs and the feeding of covered electrode. This latter requirement has been the major cause of complicated design as the units for feeding bare wire are now quite simple. Un-

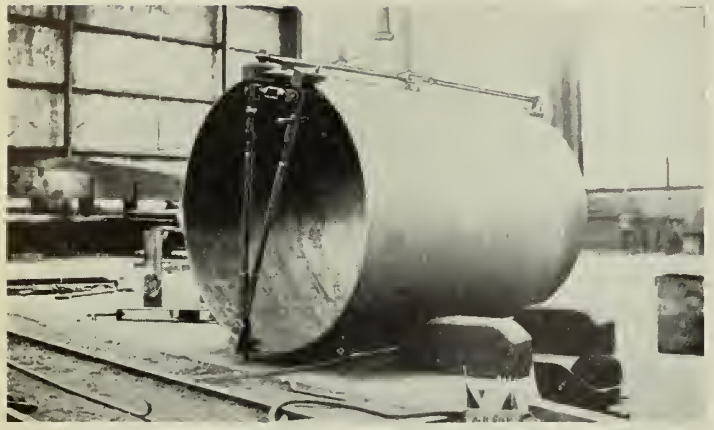


Fig. 9—Clamps for Lining up Plate Edges.

fortunately, the metallurgical and physical properties of bare wire weld metal, as is well known, are no longer satisfactory for the majority of applications.

Another means of providing protection to the metal being deposited is to cover the seam to be welded with finely divided flux material and to feed by conventional means a bare wire electrode, striking the arc under the powdered flux. Although this method has been known for several years it has not, until recently, met with much success owing to the variable porosity resulting from the type of flux and comparatively low currents used.

Realizing that the principle of such a method would be of great economic importance if welded joints conforming to the A.S.M.E. Code for power boilers and unfired pressure vessels could be made, the Union Carbide and Carbon Corporation investigated the method and over a development period of four to five years succeeded in meeting Code requirements and in welding greater plate thicknesses in a single pass than formerly, viz. above ½ in. This process will hereinafter be referred to as the Unionmelt Process.

The Unionmelt Process is undoubtedly the most unique and fundamentally sound automatic welding process evolved to date. It provides a process by which plates up to and including two inches can be welded in a single pass at speeds greater than any other automatic process. Plates over two inches are welded in a plurality of passes. The welds thus produced are equal in density and physical properties to the parent material. The process also eliminates arc blow and avoids the necessity for flux covering the electrode.

The above results are accomplished by the use of high currents and a flux or welding composition which forms a high resistance melt providing heating means, controlling the welding speed, the penetration, the quality of weld and protecting the molten metal.

The properties of a welding composition capable of producing quality welds must fulfil the following requirements:

(*a*) Complete the chemical reactions between the components of the melt, otherwise porosity will result.
(*b*) Must be capable of controlling the penetration and width of weld.
(*c*) Fluidity at welding temperatures must be such that it will not be entrapped in the molten metal.
(*d*) Chemical elements must not be detrimental to the weld metal.
(*e*) Resulting slag must be readily removable from the finished weld.

The above requirements are fully embodied in the Unionmelt welding composition. A process so different to other automatic processes naturally requires innovations in the design of equipment, joints and operating technique.

Equipment and Materials

Welding Head

The source of welding current may be either direct current or alternating current. The former is used by Dominion Bridge Company Limited and is supplied by two standard 600 ampere Lincoln welding machines connected in parallel.

The welding head is designed to feed the electrode automatically, and to conduct current to the "bare" wire electrode. The welding head and flux hopper are mounted on a travelling carriage.

Welding Flux

The flux, which at all times covers and surrounds the electrode, is fed down through a tube from the hopper. The amount fed is regulated by a small adjustable valve at the end of the tube and distributed to an even height and width during welding. Immediately behind the completed weld a suction tube picks up the unused flux and returns it to the top of the hopper in which a screen is inserted for the removal of partially fused particles. Ahead of the completed weld and running in the joint are two guide rollers which keep the electrode in the proper relative location to the seam being welded. These rollers operate integrally with the welding head.

Electrode

The electrode is a "bare" metal electrode, ¼ in. in dia., with a copper finish for protection from rusting. The chemical composition is carbon 0.12 per cent, manganese 0.97 per cent, silicon 0.30 per cent, sulphur 0.0266 per cent. The electrode is furnished in coils of 150-170 lb.

Fixture for Longitudinal Seam

The welding fixture for the longitudinal seam comprises a welding head and flux hopper suitably mounted on a track over an air operated clamping fixture designed to accommodate a six foot pipe section (Fig. 10).

The joint to be welded is backed up by a water-cooled copper backing bar which is attached by means of an arm to the travelling welding head and centred directly under the electrode.

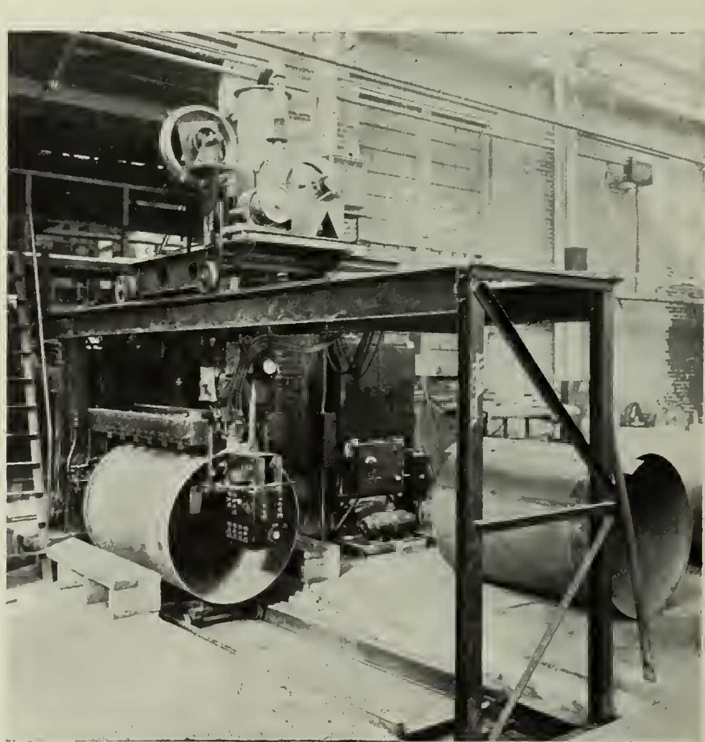


Fig. 10—Welding Fixture for Longitudinal Seam.

In the welding of the longitudinal seam the pipe section remains stationary and the welding mechanism automatically traverses at a predetermined speed along the seam.

Welding Fixture for Circumferential Seams

The fixture for welding the circumferential seams accommodates a 30 ft. pipe length and comprises a rotating mechanism over which is mounted a steel framework carrying the welding head and flux hopper (Fig. 11). In this welding operation the head, having been previously set in the proper position over the seam to be welded, remains stationary, whilst the pipe revolves at the predetermined welding speed. When the electrode feed is started, power is simultaneously applied to the rotating mechanism and the pipe revolves.

Welding Technique

It is essential that the plate edges, prepared as shown in Fig. 4, be tight throughout their entire length and flush on the underside, this being obtained as described under Assembly for Longitudinal Welding.

The flux composition when cold is non-conductive and to provide a conductive path for the current the gap between the electrode and the work is bridged by a ball of steel wool about ½ in. in dia. Flux is then fed around the electrode and the power applied. The flux is locally heated until it fuses and becomes conductive, forming a subsurface pool and immediately thereafter the end of the electrode fuses and the molten metal begins to deposit in the groove, displacing the subsurface pool of fused flux. At the same time the plate edges fuse and coalesce with the metal deposited as the electrode continues to feed under a protective layer of flux. About one minute after completion of the weld the fused slag covering lifts away from the weld exposing a clean and uniform surface.

The weld quality is influenced by the voltage difference between the electrode and the work, by the current, the size of electrode, the rate of feeding the electrode and the speed of travel along the seam. Keeping the welding speed constant, the arc voltage and current vary with the plate thickness, each being a function thereof. The proper welding current for a given plate thickness is a function of the diameter of the electrode, the degree of penetration, rate of deposition of metal, welding speed and the composition of the flux.

Welding conditions for ½ in. and $\frac{9}{16}$ in. plate are as follows:—

Plate Thickness—inches	Current Amperes	Arc Voltage	Speed in. per min.
½	900	32	14
$\frac{9}{16}$	920	32	13
	900	32	12

These conditions in conjunction with the proper design of backing-up bar produce full penetration with a slight reinforcement on the underside. If at any point in the weld length penetration is lacking the unfused portion is chipped out and rewelded by hand.

With sufficient welding generator capacity the welding currents and speeds may be increased to 1,075 to 1,175 amperes and 20 to 23 in. per min. for ½ in. plate, and 1,150 to 1,200 amperes and 16 to 19 in. per min. for $\frac{9}{16}$ in. plate without affecting weld quality.

Metallurgical Examination of Unionmelt Welded Joint

The chemical and physical properties of the plate material conforming to A.S.T.M. Specification A78-33, the weld metal and the welded joint are as follows:—

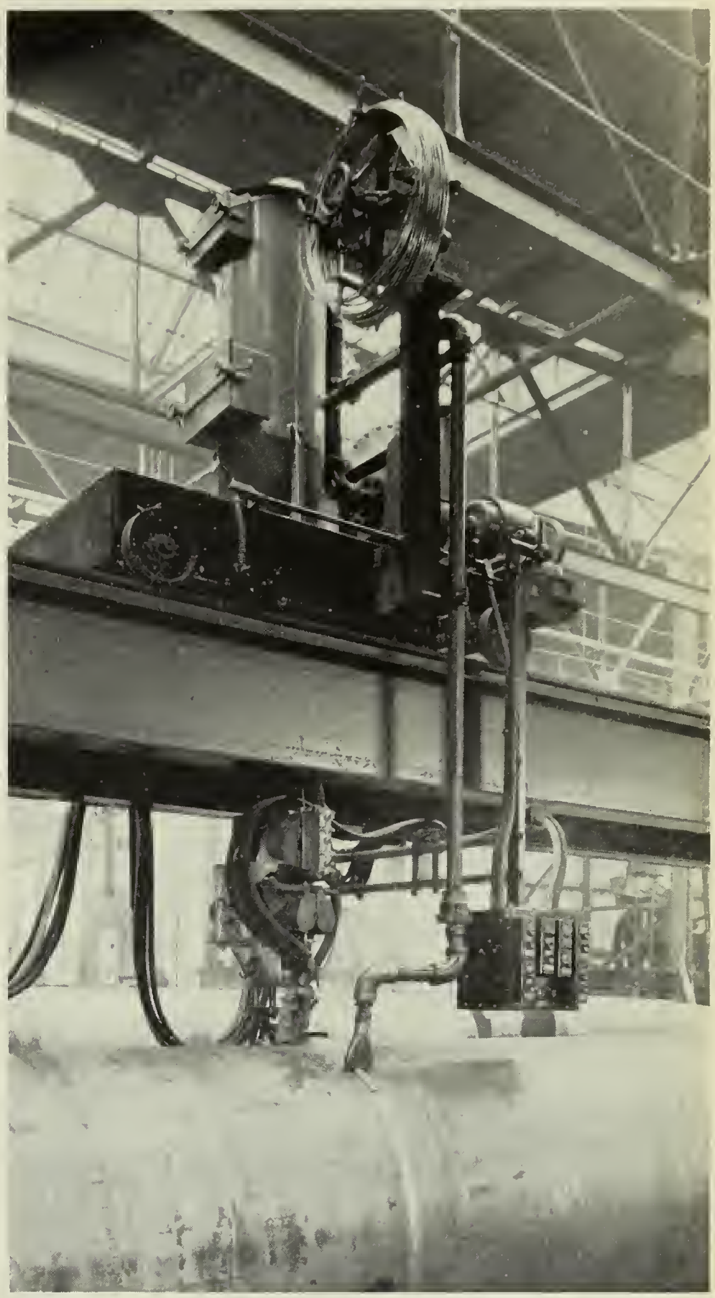


Fig. 11—Welding Fixture for Circumferential Seams.

One-half inch Welded Plate

Plate Material

Chemical Composition		Physical Properties	
Carbon	0.18%	Yield point	37,140 lb. per sq. in.
Manganese	0.44%	Ultimate strength	60,920 lb. per sq. in.
Phosphorus	0.016%	Per cent elong. in 8 in.	29.0
Sulphur	0.04%		

Weld Metal

Chemical Composition		Physical Properties—as welded	
Carbon	0.15%	Yield point	42,600 lb. per sq. in.
Manganese	0.37%	Ultimate strength	70,600 lb. per sq. in.
Silicon	0.14%	Per cent elong. in 1½ in.	22.0
Sulphur	0.033%	Per cent reduction of area	29.4
		Impact — Charpy	
		Transverse	29 and 33 ft. lb.
		Longitudinal	17 and 22 ft. lb.

Welded Joint

The following physical tests, non stress-relieved, in accordance with paragraph U-69 A.S.M.E. Code requirements are representative of those made during progress of fabrication:—

Reduced Tensile

No.	Ultimate Strength lb. per sq. in.	Remarks
1	62,389	Fracture in plate 1¼ in. from weld
2	60,824	" " " 1¼ " " "
3	59,452	" " " 1⅜ " " "
4	59,685	" " " 1¼ " " "

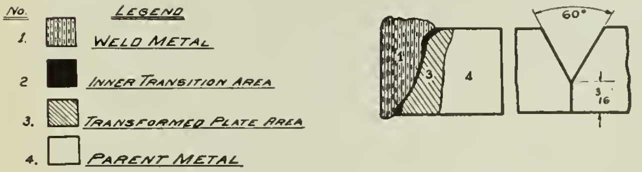


Fig. 12—Transformation Zones on $\frac{9}{16}$ in. Pipe.

Free Bend

No.	Per cent elongation of outside fibres	Remarks
1	60.5	No failure, no fracture, 180 deg. bend
2	62.5	No failure, no fracture, 180 deg. bend
3	51.2	No failure, no fracture
4	43.9	No failure, no fracture

$\frac{9}{16}$ in. Welded Plate

Plate Material

Chemical composition – Per cent		Physical properties
Carbon	0.20	Yield point—39,220 lb. per sq. in.
Manganese	0.54	Ultimate strength—63,150 lb. per sq. in.
Phosphorus	0.03	Per cent elongation in 8 in.—27.5
Sulphur	0.04	
Silicon	0.02	

Weld Metal

Chemical composition—Per cent		Physical properties—as welded
Carbon	0.17	Yield point—62,000 lb. per sq. in.
Manganese	0.70	Ultimate strength—78,000 lb. per sq. in.
Silicon	0.34	Per cent elongation in 2 in.—21.0

Welded Joint

Forward bend	48.5 per cent elongation of the outside fibres, no failure, no fracture, no porosity.
Back bend	180 deg. without evidence of fracture, porosity, or slag inclusion.
Nick break	Uniform crystalline structure—no slag—no porosity.
Exograph	The exographs show no porosity, no slag and no lack of fusion.

Hardness

Seleroscope hardness readings taken across the welded joint indicate only 1 to 2.5 points of hardness increase in the weld above that of the plate.

Microstructure of Welded Joint in $\frac{9}{16}$ in. Plate

The Unionmelt weld being a single pass weld for plate thicknesses up to and including two inches has certain distinguishing characteristics.

Microscopic examination of a cross-section of the welds of different plate thicknesses shows that the planes defining the zone of fusion at the sides of the weld and the zone boundary of the transformed plate are approximately parallel. The microstructure of these zones throughout the cross-sectional area are very uniform, indicating that the heat conditions from the top to the bottom of the weld do not differ greatly. Such a condition materially decreases the unequal stresses and lessens the distortion of the plate.

The following microstructures are typical of welds made by the Unionmelt Process on $\frac{9}{16}$ in. and ½ in. plate.

Figure 12 shows diagrammatically, to twice full size, the extent of the transformation zones on $\frac{9}{16}$ in. plate.

Figure 13 shows the microstructure at a magnification of 100 times of the weld metal. It is a fine cast structure composed of pearlite and ferrite uniformly distributed.

Figure 14 represents the microstructure at a magnification of 100 times of the transition zone adjacent to the weld metal.

Figure 15 represents the microstructure at a magnification of 100 times of the transition zone adjacent to the plate. The structure has been refined at a temperature of 1,500 deg.-1,550 deg. F. within the thermocritical range.

Figure 16 shows the microstructure at a magnification of 100 times of the parent plate. The structure is typical of low carbon plate comprising ferrite and pearlite (dark).

Pipe Testing

The welded pipe length from the circumferential welding machine is inspected for visible defects inside and out, and the necessary repairs made. Small outlets, if required, are then welded in and the pipe made ready for the insertion of gaskets at either end for the hydraulic test.

The pipe is rolled into the press and the moveable head set up to with $\frac{1}{16}$ in. of the pipe. The low pressure filling pump is started and the air release valve opened permitting the air to be displaced by the filling water. When the pipe is full of water as shown by the escape of water from the air valve, the filler pump is stopped, the valve closed and the triplex pressure pump started. The pump is set to by-pass

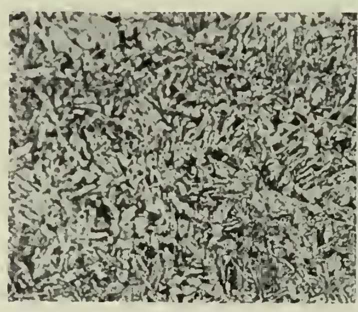


Fig. 13

Fig. 14

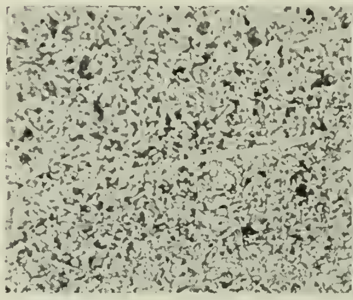


Fig. 15

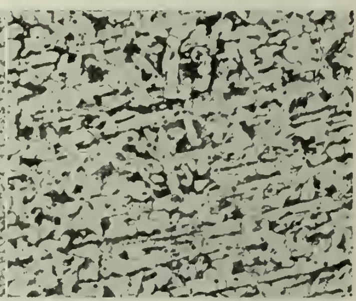


Fig. 16

Figs. 13, 14, 15 and 16—Microstructure of Weld Metal Transition Zone and Parent Plate.

at the test pressure so that it can operate whilst the pipe under test is inspected for leaks. Pipes having a ½ in. wall thickness are tested at 195 lb. per sq. in. pressure and those having a $\frac{9}{16}$ in. wall thickness at 225 lb. per sq. in.

The hydrostatic testing of the specials and bends presented a problem as regards evolving a quick and economical method. This was satisfactorily solved by clamping a wide band onto either end of the special or bend. The band is notched out at eight points equally spaced around the circumference and sixteen one and one quarter inch bolts welded to the band for attachment of a two-inch steel plate head with gasket. The clamp is firmly held by tabs welded onto the steel shell into which the notches fit. Upon completion of the test the head and clamp are unbolted and lifted off. The tabs are left on the pipe.

Placing of Wire Mesh for Concrete

The sheets of wire mesh are rolled to a diameter of 49⅞ in. and the $\frac{5}{16}$ in. dia. spacing wire rolled to 50⅛ in. dia. The wire hoop spacers, starting one foot from each end, are tack welded at intervals of two feet leaving about 1/10 in. gap between the spacer and the shell. The wire mesh is placed on top of the spacers to within 9 in. from either end of the pipe. The mesh is fastened to the spacers by means of spring steel clips.

Centrifugal Placing of Concrete Lining

The outstanding properties of centrifugally spun concrete are its smooth finish, high compressive strength, and high density which give excellent resistance to wear and erosion. It has been shown that wear is inversely proportional to the strength of the concrete; the wear for 6,000 lb. concrete being one half of that for 3,000 lb., one third that for 2,000 lb., and one fifth that for 1,200 lb. concrete.

Apart from the compacting by centrifugal force, the factors which produce concrete of high strength are:—

1—High cement content.
2—Minimum quantity of mixing water.
3—Correct grading of aggregate.
4—Proper curing of the concrete.
5—Control of mixing time.
6—Age: the older the concrete, the greater its strength.

Details of the equipment and the procedure followed in centrifugally placing a 1½ in. concrete lining in the steel pipe follow:—

Equipment

(a) *Retainer Rings*

The retainer rings determine the thickness of lining and are placed nine inches from each end of the pipe.

(b) *Spinning Cage*

The spinning cage is a reinforced steel shell made in two halves which are clamped around the pipe and bolted together. Steel tires are then placed at either end and the whole unit placed on the spinning machine.

(c) *Spinning Equipment*

The spinner is a four trunnion machine driven by a direct current motor with rheostat control for obtaining any required speed.

The concrete loading is accomplished by means of a filling trough travelling on a track and operated for dumping by an electric motor.

Figure 17 shows the concrete mixing, loading and spinning equipment.

Materials

Cement

Portland cement was purchased to Canadian Engineering Standards Association Specification A5-1927.

Stone

Stone was obtained to fulfil the following specification:

The crushed stone shall be clean and free from shale, slate or other soft friable material.

The crushed stone shall range in size from fine to coarse within the following limits:—

Size	Percentage retained
⅜	3.0
4	40.5
8	93.5
14	97.0
28	99.5
48	100.0
100	100.0
	F.M. 5.38

The fineness modulus shall be kept within the range 5.2 to 6.0 in. In other respects the material shall conform to the C.E.S.A. A23-1929 Specification.

Sand

Sand was purchased to the following specifications:—

The sand shall consist of clean, uncoated grains of strong durable minerals.

The sand shall be free from organic matter especially tannic acid and shall not contain soft friable laminated particles totalling more than 2.5 per cent or fines passing a 100 mesh sieve in excess of 3.0 per cent.

Fig. 17—Concrete Mixing, Loading and Spinning Equipment.

The sand shall range in size, closely to the following screen analysis:

Sieve No.	Percentage retained
⅜	....
4	1.00
8	9.00
14	28.00
28	70.00
48	93.00
100	99.00
	F.M. 3.0

The fineness modulus of the sand may vary from 2.8 to 3.2. In other respects the material must conform to the C.E.S.A. Specification A23-1929 for fine aggregate.

Concrete Mix

The concrete mix consisted of 1 part of Portland cement, 1.93 of sand and 1.36 of stone, measured by volume, loose and uncompacted. The amount of water per bag of cement is about 4.0 gal. per bag of cement being regulated to give approximately a 3.5 in. slump.

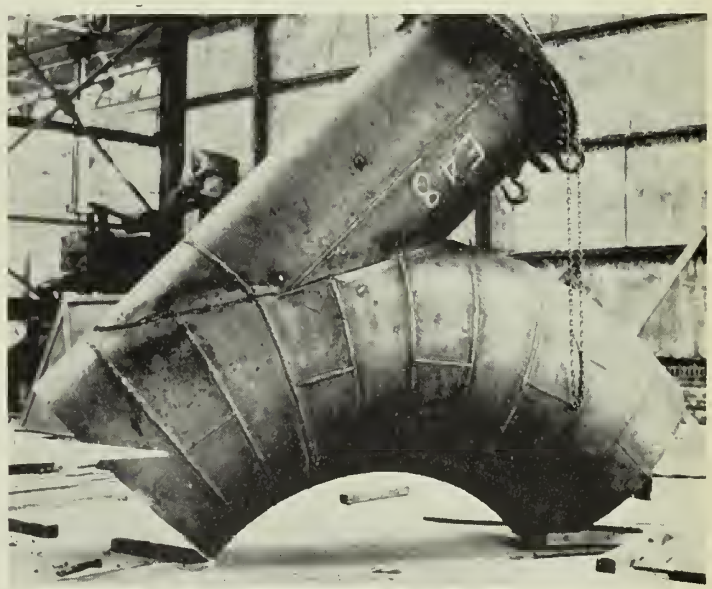


Fig. 18—A typical Bend.

The total mix for the pipe is made in two batches, the first being sufficient to completely cover the wire mesh and the second to give the proper thickness of lining. Each batch is mixed for a period of three minutes then discharged into the loading trough.

Representative tests of the concrete mix previous to spinning are shown in Table I. The centrifugal compacting was observed by spinning concrete cylinders 2 in. dia. by 4 in. high simultaneously with the pipe. The test results at the end of 28 days are as follows:

Date	Compression strength lb. per sq. in.
Oct. 7	6,462
8	6,541
13	6,334
27	6,048
28	7,735

Table I

Concrete Compression Tests

Mix for 1½ inch Centrifugally Spun Lining—1.0 Cement, 1.93 Sand, 136 Stone

Date	Serial No.	Lb. per sq. in.		Slump in.
		7-day	28-day	
Sept. 3	104	3,320	3,770	2.75
" 15	148	3,690	3,720	2.25
" 28	214	3,990	4,330	4.00
Oct. 1	246	4,140	4,250	3.00
" 12	301	4,050	4,520	3.50
" 14	318	3,510	4,340	4.50
" 21	361	4,290	4,900	3.50
" 28	403	3,650	4,740	3.00
Nov. 1	421	4,280	5,480	3.50

Spinning Lining

The spinning operation consists of rotating the pipe at a relatively low speed while introducing the concrete mix and then rotating the pipe at a relatively high speed to compact the lining and remove excess water. In general, the placing speed must be a little greater than that necessary to overcome gravity, and the length of time at this speed being sufficient to permit uniform distribution. The final spinning speed is high enough to throw out all excess water and of sufficient duration to give the concrete an initial set. For the 52 in. outside diameter pipe the filling speed is 800 ft. per min. and the final speed 2,400 ft. per min.

When the lining is placed in two stages it is necessary that the first stage be spun till initial set occurs and the spinning stopped for draining off the expelled water.

Curing

Upon completion of the lining the pipe is placed on the curing bed and the ends of the pipe covered. Six hours later moist steam is introduced, and the lining cured at a temperature ranging between 80-90 deg. for a period of six hours. Twelve hours later the lining is moistened by sprinkling with clean water after which the pipes are kept continuously moist for a period of ten days.

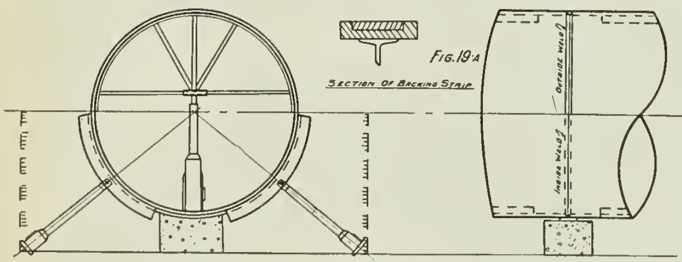


Fig. 19 and 19a—Backing Base for Field Welding.

Pipe Bends

The segments forming the bend are laid out to template on flat plate, cut to shape and bevelled by machine gas cutting. The segments are rolled to the proper diameter and assembled in units which are easily turned by hand. These units are welded and then assembled to form the completed piece which is turned by crane so that welding may be done in a downhand position. The ends of the pipe bend are held circular by welding struts two inches from either end. The bracing is left in until the bend is assembled in the field, then removed by gas cutting.

The design of the joint is shown in Fig. 7. The horizontal welds are first made, then the circumferential welds. A 5/32 in. dia. covered electrode is used for the first pass and a $\frac{3}{16}$ in. dia. covered electrode for the subsequent three passes. Each deposited layer of weld metal is thoroughly cleaned by a Pneumatic Weld-Flux Chipper and wire brushed. The back of the weld is chipped out and a single pass weld made with $\frac{3}{16}$ in. dia. electrode.

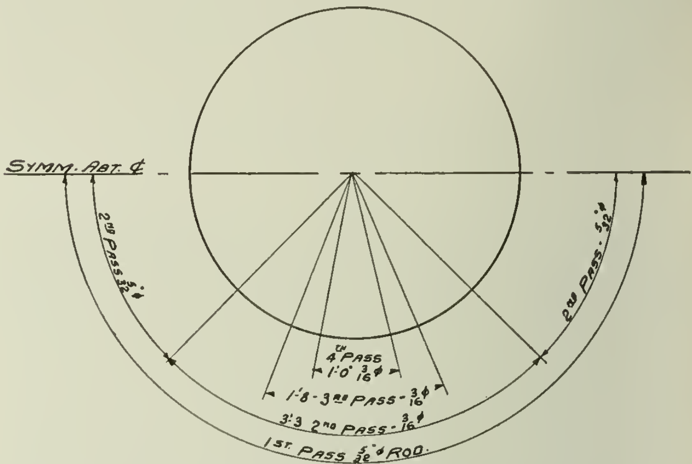


Fig. 20—Weld Metal Deposition Diagram for Circumferential Weld, Specials and Field Welding.

Nozzle outlets or branches are then welded in place and the bend subjected to a hydrostatic test pressure of 255 lb. per sq. in. A typical bend is illustrated in Fig. 18.

After testing, wire mesh reinforcing is placed inside of the bend to within four or five inches of the ends and then lined with gunite to within nine inches of the ends. The mix used is 1 part of cement to 3.26 parts of sand by volume. This gives in place a mix of approximately 1 to 2.75. The compressive strength at the end of 28 days is approximately 5,500 lb. per sq. in.

Hauling and Laying Pipe

After curing, and as required, the pipe is loaded on a truck equipped with cushioned bunks so as to minimize any shock occurring in transit, and hauled to the trench side. One pipe is carried at a time and upon delivery at the site the pipe is carefully unloaded from the truck by a caterpillar tractor crane. The unloading of the pipe at the site, the placing for jointing by welding, the encasing in concrete and backfilling was carried out by the general contractor.

The horizontal pipe lengths are placed on concrete blocks set to grade. At each field joint a steel plate 3 in. by $\frac{3}{16}$ in. by 14 in. formed to the contour of the pipe, is placed between the pipe and concrete block, central with the joint. The ends of the pipe are placed to within about $\frac{3}{16}$ of an in. and then jacked in or out as required to give a uniform gap of $\frac{3}{16}$ in. throughout the circumference. The joint is next backed up by inside and outside steel backing bars tightly jacked against the shell (Fig. 19). A steel strip three quarter inch by one eighth inch is inserted in the backing-up bars (Fig. 19A) and is welded to the joint, thus providing complete fusion throughout the entire plate thickness. The joint is welded on the outside of the top half and on the inside of the bottom half simultaneously using $\frac{5}{32}$ and $\frac{3}{16}$ in. dia. covered electrodes. The sequence of deposition of weld metal is shown in Fig. 20. Upon completion of the welds the backing bars are removed and the junctions of the inside and outside welds gouged out. The joint is rewelded to ensure good weld metal.

It is of interest to note that the field welding was satisfactorily carried out during the winter months by enclosing each joint with a canvas canopy, pre-heating the joint and allowing it to cool slowly after welding.

Welding current is supplied by 300 ampere gasoline driven welding units. The fumes from welding are exhausted by a fan electrically driven by power supplied from the welding unit. The fan is located a few inches from the joint being welded.

The welded joint is next prepared for concrete covering with gunite. As previously noted the concrete lining stops within nine inches of the end of the pipe (Fig. 2) thus leaving a width of eighteen inches to be covered. Wire mesh reinforcing is placed so as to overlap the edges of the reinforcing wire protruding from the lined section. Gunite is then applied. The gunite coating was applied by Gunite and Waterproofing Limited of Toronto.

The pipe line is next encased in concrete, the minimum thickness being four inches, and after setting the trench is backfilled. The pipe line is then subjected to a hydrostatic test between valves.

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Self Preservation in the Northern Wilds

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SUMMARY.—This paper outlines ingenious but practical methods of meeting the challenges of the northern wilds. It lists and describes supplies and equipment that are necessary, such as food, heat, utensils, tools, firing arms, nets (fish and mosquito), clothing, bedding, and tells what to do with frost bite, wet clothing, snow blindness—how to make a camp, catch fish and game—in short, how to live off the land in winter and summer, in storm or fair weather. It is a short text book on a subject of importance to many engineers, and of interest to all.

In that part of Canada lying between the northerly boundaries of the organized Provinces and the Arctic sea is a vast stretch of country known as the North West Territories, sparsely settled by Indians, Esquimaux, white trappers, fur traders, prospectors and mining men, missionaries, government employees and Mounted Police. The total population is around 10,000; the total area more than a million square miles; so it can readily be seen that it can truthfully be described as 'The Wilds.' It is a country of extremes; of forbidding cold and deep snow during the long winter months; of heat and maddening flies during the summer; of thick bush and barren wastes; of no roads except such as are afforded in summer by the waterways, or in winter by the snow. The only means of transportation are dog sleighs, boats or aeroplanes. It is proposed to deal in this paper with the problems that arise in this country, if one is cast on his own resources.

Perhaps the most important thing before setting out on a journey in the wilds is to obtain maps of the country to be traversed. Fairly accurate topographical maps can now be obtained. These should be carefully studied, especially as regards the water routes, settlements, radio stations and trappers' cabins. One can also nearly always get reliable information from men knowing the country. The best safeguard of all is to obtain the services of a local native Indian or Esquimau, in fact if one does this one's problems are practically solved. A long winter journey should never be attempted, especially in the farthest north, without a native guide, except perhaps by aeroplane.

Very careful consideration should be given to planning an emergency supply of food, clothing and equipment. Conditions across the whole of the northern parts of Canada are very different after passing the northern timber limit. Lakes are much more numerous within the timber belt and along the northern boundaries of the provinces than in the barren lands. There is a great difference in the texture of the barren lands snow, which is fine and drifted hard by the prevailing winds, as compared with the deep, soft snow of the timber country. Hunting and travelling in the timber country in the winter is practically impossible without snowshoes, while many Esquimaux further north have never even seen snowshoes. The hard drifted snow makes excellent material for constructing snow shelters. Even an inexperienced man may easily cut snow blocks and build a shelter, over which a tarpaulin may be placed and weighed down with snow blocks, which provides much more warmth and security than a tent against the Arctic winds.

Below is an outline of the emergency supplies which should be carried on any extended patrols in the Arctic, where food values and the conservation of weight and space mean so much.

Fig. 1—Pangnirtung Fiord, N.W.T.

Provisions

Pemmican

Pemmican is a preparation which contains no ingredients other than meat and tallow. The water content of the meat is removed by a drying process. The meat is then ground or pounded and mixed with rendered tallow. It provides a very high food value for its weight, will keep indefinitely and can be eaten without cooking in extremely cold weather. It is approximately 60 per cent meat, 40 per cent tallow, and sometimes contains raisins. The best substitute for pemmican is dried or pounded moose or caribou meat. This may be obtained at some of the northern trading posts or from northern natives.

Bacon

The high percentage of fat in bacon makes it a very useful northern food, as it is generally used in conjunction with the cooking and eating of bannock. Many northern men prefer their bacon raw on the trail. It is not unpalatable when frozen.

Corned Beef or other Canned Meats

If neither pemmican or dried meats are obtainable one would have to fall back on canned meats. Of these, 'bully beef' (in 12 oz. tins) is undoubtedly the best. Many canned meats have a large water content, which only adds to the weight and forms ice in the winter.

Concentrated Soups

Soup powders, such as pea flour, are light in weight and nourishing.

Evaporated Vegetables

Riced or flaked evaporated potatoes are perhaps the most important under this heading. Almost any vetegable can be obtained in evaporated form. Onions are put up in compressed blocks, which have the appearance of plug tobacco.

Biscuits, Flour, Bannock, Salt

Hardtack as used with bully beef for army 'iron rations' is recommended. Flour saves excessive bulk. Bannock is a food known all over the north, and can be made over open fires in the timber, or over a primus lamp in the barren lands.

Doughnuts

This form of food has been used with much success by winter sledging parties in the far north. They are not a very compact form of food, but if made with a generous proportion of milk powder and sugar, mixed with the flour, baking powder and shortening, they are a very nourishing ration. Doughnuts should be fried in deep fat, which helps to give them a good fat content, and makes it easy to thaw them so that they can be eaten in extremely cold weather.

Beans

Another very nourishing food, and one which is used as a staple ration throughout the north. Beans are boiled before starting and frozen separately on a board.

Chocolate

This has an excellent food value, and provides energy more quickly than any other food. As very sweet chocolate induces thirst, bitter-sweet or milk chocolate, in quarter pound sizes to facilitate rationing, should be used.

Rice and Raisins

These are both good foods. For its food value, rice takes up very little space, and requires considerable water to cook.

Beverages, Tea, Coffee, Milk

This is a matter of personal choice, but it should be remembered that cocoa is the most nourishing, and that tea will go much further than coffee. Spirituous liquors are not generally considered as emergency rations. In cases of extreme urgency, liquor may provide the necessary stimulant, but it is not recommended for a person who is undernourished or suffering from the cold.

Fig. 2—Esquimau Camp—Baffin Island, N.W.T.

Sugar

This is an essential part of any emergency ration.

Milk

Milk would best be carried in powder form, such as whole "Klim," and mixed with water as needed. It may also be mixed dry with granulated sugar and carried in this way ready to be put into hot beverages.

Tobacco

While this is not an indispensable item, it is a thing that depends upon the individual. Those who are accustomed to smoking would find it a great comfort—and to a certain extent it helps to tide the accustomed smoker over the bad times when one is inclined to worry. Fine cut tobacco and cigarette papers and plug tobacco will go further than cigarettes and cut tobacco.

Emergency Equipment

Tent

An A-shaped tent, with or without wall, 8 ft. by 10 ft. with 3 light poles will accommodate 3 or 4 men. On the barren lands, it may be pitched with rocks or by making loop-holes in the sea-ice to anchor it.

Primus Lamps

Primus lamps are used in the barren lands, where no fuel is available. These are pressure lamps (sometimes known as "Optimus" primus stoves). They are generally adapted to burn coal-oil, but gasoline may be used. A spare burner and cleaning needles should be carried, also a small quantity of solidified alcohol for starting.

Cooking Utensils

A frying pan for bacon and bannock, and some aluminum pots for hot beverages, meat and soups. This supply depends upon the size of the party.

Butcher Knife

A knife 10 or 12 in. in length, with a pointed blade, for general purposes, and for cutting loop-holes in the ice.

Sleeping Bags

Eiderdown sleeping robes are recommended.

Rifles and Ammunition

For hunting big game, a .303, or similar gauge rifle, with 200 rounds of ammunition, should be taken. For small game (including seal) two or three .22 repeating rifles (depending on the size of the party) should be included, with 2,000 rounds of ammunition (longs).

Fish Nets

One net (1½ in. mesh), 30 meshes deep and 25 to 30 ft. long, for small trout, grayling and other small fish found in freshwater lakes and rivers. One net (2½ in. mesh) 30 meshes deep and about 60 ft. long, for larger fish, such as white fish, salmon trout, and lake trout, found in lakes, rivers and salt water bays of the Arctic. Fish nets should be hung on backing twine and string arranged to tie on wood for floats, and small rocks for sinkers. A spare hank of No. 9 backing twine should also be taken.

Ice-tester

This is a useful tool. A six foot length of cold rolled steel, ½ in. in diameter, with a blunt point, it is very useful for testing the thickness of ice, or the texture of snow-drifts, for shelter blocks. It will be found very useful on many other occasions.

Fish-hooks and Lines

A small quantity of assorted common fish-hooks for bait fishing and a few swivel spoon baits with the necessary line might prove useful.

Hand-saw and Axe

A hand rip-saw is recommended for cutting snow-blocks for building a shelter.

Tarpaulin

A small tarpaulin, 8 ft. by 10 ft., can be used as a ground sheet, as a roof for a snow shelter, and for many other purposes.

Carborundum Stone

A small stone for sharpening knives and axes is indispensable.

Sleigh Material

Two common boards about 5 ft. in length and 7 or 8 in. wide, and about 1¼ in. thick, for runners. If designed to run *with the grain*, shoeing would not be essential. Quarter inch holes should be bored in the runners to lash on the cross-pieces (of cedar, which would save weight). These pieces should be approximately 2 ft. 6 in. in length, 4 in. wide, and one inch thick. About 6 or 7 pieces are required for this purpose. These might, if necessary, be utilized as floats for the fish nets, and the runners for other purposes, if it is found to be impracticable to build a sledge for any purpose. In many sections of the north it is not possible to find even a small stick of wood.

Mosquitoes

In many districts of the north, the mosquito pest and other types of annoying insects, such as sand flies, bull-dogs, etc., are a great drawback in the summer months, and would add greatly to the discomfort of a party in distress. A net large enough for each person to sleep under is recommended, as well as single veils to cover the head and neck. A light weight mosquito-proof tent would take the place of individual nets for sleeping. In the timbered area, camp fire smoke and certain lotions, most of which contain citronella, are used. In choosing a camp site in the summer, it is always advisable to select a place in the open where there are air currents. Generally speaking, sites along the coast line in the Arctic, particularly when a breeze is coming from the sea, will be free from mosquitoes.

Clothing

The following clothing is suggested for each member of a party journeying in the north. It should be remembered that proper clothing will go a long way towards preservation of life in the fall and winter, because without warm clothing, and particularly good warm foot-wear, one cannot travel or hunt or sleep comfortably.

Parka

A parka is a windproof pullover with headpiece (hood) attached. Under this is worn an inner parka made of Hudson's Bay duffle or blanket material, also with attached hood. This is the best combination for warmth in timber country.

Sweater

Under the parka wear a heavy, wool pullover.

Footwear

Good footwear is most important of all. For the timbered areas, take two pairs of Indian tanned moccasins and at least two pairs of snowshoes for any party. For the barren lands, wear shoe-packs, knee or three-quarter length, or three-quarter length gum rubber boots. *All footwear for the north should be a size larger than is usually worn* to allow room for extra socks and also because of the fact that all footwear, whether imported or native made, will contract with the frost after being damp, however slight.

Winter Clothing

If it is possible to obtain it, clothing of native manufacture is preferable for winter. An artiki, or capote, of deer or seal skin will keep out the wind better than anything. These garments are made of the tanned caribou hides, or seal, with the hair left on, and with hoods attached. They are trimmed around the edge of the hood with wol-

Fig. 3—Dog Team—Western Arctic.

verine, if it can be obtained, as the moisture of the breath does not freeze and form ice on this wolverine fur. The capote is a long garment which opens in front like an overcoat, and is an Indian style worn in the wooded country. The artiki is a pull-over garment, and the natives wear two in very cold weather; the inner one with the hair next to the body, and the outer one with the hair out. There are two kinds of hoods on artikis, the Western Esquimaux fashion, which fits closely to the head and does not come far forward, or the Eastern Esquimaux style, which is pointed and comes far in front of the face so as to give it shelter from the wind. The latter type is better for white people.

Indian moccasins made of wood caribou or moose skins are the best footwear for winter time; the Esquimaux seal skin waterproof boot is excellent for summer wear when one is travelling near water or near the coast. Duffle should be worn inside this footwear. Duffles are usually now made like bed-room slippers, and of Hudson's Bay blanket, or duffle cloth; untanned rabbit skin with the hair next to the foot is also sometimes used; these latter are very warm. Indian moccasins are of several patterns, but for white men the pattern known as a 'mitt' moccasin is the best; this moccasin is wider than the usual Indian type. All moccasins should be made so as to fit loosely when the duffle and two pairs of socks are worn. As many pairs of socks should be taken as can be carried, also several pairs of duffles. It will be found that after a days travel in most cases the footwear is wet, and it will have to be dried out each night.

Socks

Each member should be equipped with at least three pairs of heavy wool socks.

Insoles

These add warmth and protect the soles of the feet when walking over rough ice, etc. Felt or duffle insoles are recommended. Like socks, they should be kept as dry as possible.

Mitts

One pair of outer skin mitts and two pairs of inner wool mitts. Fur mitts are not recommended. They are apt to gather snow and are usually clumsy.

Underwear

One change of heavy woollen underwear with long sleeves and legs.

Winter Cap

A winter cap with ear flaps or a fur cap should be carried.

Extras

Each member would be well advised to carry a small waterproof matchbox, and one member should have a compass and a pair of binoculars.

Frost Bites

One of the chief reasons for frost bites is moisture. Wet feet or hands are usually the result of perspiration, which should be avoided as far as possible. Inner mitts and footwear should never be allowed to come into contact with snow. Northern Indians and Esquimaux are most particular in this respect. When there is no available heat to dry socks and mitts overnight, a good plan is to lie on them in the sleeping bag. In cases of severe frost bites, the affected part should not be exposed to the heat of a fire. A badly frozen hand, foot or even an ear is much better when placed in cold coal oil or cold water, not below freezing point, which will aid in drawing the frost out, whereas excessive heat will tend to drive the frost inward.

Game and Fish North of the Timber Limits

One does not find a great variety of game north of the timber, and it should be remembered that weather conditions often prevent hunting. Blizzards blow up very quickly in the barren lands and the Arctic islands, which makes hunting conditions more difficult there. During the fall of the year there is the ever shortening period of daylight as a further hindrance. Individual members of small parties should not hunt alone for more than a few miles from their camp.

Importance of Reaching Coastline in Barren Lands

If a party should be stranded in the Arctic anywhere near the coastline, when there is no indication of game near, they move towards the coast. This is even more important in the fall and winter, unless caribou or fish are easily obtainable. One would be much more likely to find small game along the shores in the Arctic, especially sea birds, eider duck, seal, and Arctic hare. This would also be the best method of trying to get into touch with Esquimaux, as they are usually to be found on the coast; also, by hunting along the shoreline there would be much less chance of becoming lost. A small party following the shoreline would stand a good chance of obtaining small game on which they could at least exist, or they might meet a party of Esquimaux hunters, providing that there were any Esquimaux living in that district. A glance at the map of the North West Territories will show that all trading and police posts are located on waterways, and in the Arctic proper they are all on the coastline.

Esquimaux

If a party in these circumstances should be so fortunate as to come across an Esquimau, they would find him most friendly, and willing to help at hunting or as a guide, but there would be the language difficulty in trying to make known one's situation. The average Esquimau is quite intelligent, but would probably be very bashful at first. The best way for a party to make known their wants would be for one member to converse with him through the use of sign language. If the party did not know its location, the average Esquimau man could, with a pencil and paper, make a rough sketch of the surrounding district. In any case, he would be sure to know the nearest trading post, or perhaps a white trapper, which he could indicate. The Esquimau term for 'white man's house' is '*kod-loo-nah igloo*.' These words would be readily understood by the Esquimaux in any part of the far north. A more or less intelligent conversation would be carried on in regard to hunting, etc., by making sketches of fish, birds and animals. In speaking of distances, an Esquimau uses the term 'so many *sleeps*'; the Indian '*nights*.' If an Esquimau says that '*kod-loo-nah igloo*' is 'one sleep away,' it can be taken for granted that it is two days travel.

Mooring an Aircraft on Ice

The following Esquimau system of fixing anchors in flat ice would be suitable for mooring an aircraft, pitching a tent, or for any purpose where a snubbing post is necessary. The method is to make a 'loop hole' or bridge in the ice. First, carefully chip two parallel lines in the ice, not less than six inches apart. Then gouge holes downwards from these lines at an angle of 45 deg., towards each other, until they meet about six inches under the surface of the ice, thus forming a bridge under which a rope may be passed. Special care should be taken to ensure that there are no cracks in the 'bridge.' This type of anchor will withstand a tremendous horizontal pull, and can be made with a pointed knife with a 10 or 12 in. blade. Three such loops should safely hold an aircraft on the sea ice, or on a barren land lake, against a very high wind. This system is used by the North Greenland Esquimaux in handling heavily loaded sledges on steep glaciers, and in hauling heavy walrus up to the shore ice from the sea. Making a loop hole in sea ice is not a difficult matter, but in fresh water ice, which is more brittle, greater patience is required.

Barren Land Lakes

An interesting observation which has been made in flying over the barren lands in winter, is that it is extremely difficult in some cases to tell a lake from the land. Sometimes the lake ice may be seen in bare patches, where the snow has been blown away, but there is often nothing whatever to indicate the flat shores of lakes where snow or ice covered boulders might be encountered in landing.

Open Patches of Water in Sea Ice

Another point which will be of interest to northern flyers, particularly in the Eastern Arctic, is open patches of water in the sea ice. These open patches, sometimes a mile or more in length, which appear as placid lakes from the air, would make dangerous landing places. Aircraft should not be landed on or near such places. These open patches are caused at intervals during the winter by the fast tidal currents, particularly during high tides, wearing the ice away from beneath. It therefore stands to reason that these open places would not occur were it not for the very fast currents, usually in the vicinity of narrow channels, or near prominent capes. Large pans of ice weighing hundreds of tons will break from one end of an open patch of water to be carried by the tide to the opposite end where the terrific pressure either pushes it up on the main pack or forces it to turn on end and go under the pack. One wonders how long an aeroplane would last under such conditions.

Seasonal Conditions in the Arctic Archipelago

The weather averages fine and warm in May, June and July, all over the Arctic Archipelago. As evidence of this, many species of wild flowers grow in June and July in North Greenland and Ellesmere Island, which is approximately five hundred miles from the North Pole. Lake Hazen, on Ellesmere Island, the most northerly lake in Canada, is surrounded by ice-capped mountains, but it thaws during the short summer months, and is a well-known breeding ground for geese.

Care of the Eyes

Be very careful with your eyes, as without sight one is indeed in a serious plight in the wilds. Snow-blindness is brought on by strain and glare. A person is more likely to go snow-blind on what is termed a 'white day,' than on a bright clear day. A 'white day' is one which is inclined to be foggy or misty, with the sun not visible, but casting a glare through the mist which fails to throw shadows. On a day such as described it is very hard to tell the difference between a snow-bank and a depression, and, if travelling, there is a continuous strain on the eyes. Snow-glasses are very useful on a day such as this, as they act as a filter on a camera bringing out objects such as snow-drifts, depressions and such like, and relieving the eyes of much strain. If, for some reason one's glasses become broken, an improvised pair could be made, such as used by the more primitive Esquimaux. You cut out a piece of wood in the shape of an arc, hollow out part fitting over the bridge of the nose, for it to fit up close to the cheek bones. Next hollow out the part in front of each eye, but not all the way through, leave a thin film of wood on the outside surface into which a very narrow horizontal slit is made in front of each eye.

A good treatment to ease the pain should your eyes become affected, is to insert a little murine or boracic acid solution, and apply cold moist tea-leaves.

How to Make a Camp

In the timber country pick out a location for the camp near a stand of dry timber if possible, also keeping in view sufficient evergreen trees to obtain boughs. As the snow is usually two feet or more in depth, scoop it away down close to the ground for an area of about 6 by 8 ft., this of course will depend on the number of persons camping. Leave the walls formed by cutting away the snow intact, and arrange to have the back wall to the wind. A snowshoe will be found very useful to use as a shovel. Fill in with boughs the area cleared of snow, placing them well up about the sides and walls to prevent bedding from coming in contact with the snow. The sticks from which the boughs have been trimmed, may be placed about the walls and back of camp to help as a wind-breaker. If the weather is inclined to be stormy, cut extra, small evergreen trees and place the butts in the snow at the back so as the tops overhang the camp. This may be done about the sides also, but is not necessary in good weather. Cut fire-wood in long lengths, placing them end to end in such a manner so that they overlap where the fire is to be built in front of the camp. In this way fire-wood may be pulled in together as it burns off without leaving the camp, and this also saves much work in cutting up the wood. A camp built in this manner will take but very little time, and will be found quite comfortable, if no tent is available.

Making a camp in the Arctic you have to resort to snow, and the best camp in cold weather is the snow-igloo, but the art of building an igloo can only come by experience and much practice. However, a good camp can be made by means of snow-blocks, cut about 26 by 18 in. and about 6 in. thick. Place in a circle or oval shape having a diameter about 7 or 8 ft. at bottom, blocks to be placed so that they slant slightly inwards at top. Build the walls about three blocks high, having each row slanting a little more inwards, and build in the form of a spiral if possible, as one block will help to hold the next. Cover the top with a canvas or sled wrapper and chink up the holes.

If this type of shelter is built on a good deep snow-bank, the diameter of the first row of blocks need not be so great, and possibly two blocks high would be sufficient. Then cut out the snow in blocks from the inside and work down, making the inside larger as you work down until you have sufficient room inside. Cut out the door at the bottom making it just large enough to crawl in through, a snow-block will be used as a door. Two large caribou skins to sleep on will be enough for each person. Place the hair of one skin next to the snow, and the other skin on top of this with the hair upwards; the eiderdown or sleeping-bag is then placed on top. Be sure to brush off all snow and frost from bedding and clothing, as this will prevent dampness when the primus stove is lighted. Leave an air hole near the top above where the primus is to be placed, and a small hole near the bottom of the door for air, for if your camp is tight the primus stove will soon use up all the oxygen, and this will be noticed by the candle going low. As holes form about the top of the camp due to heat, cut off small lumps of snow and place in the holes, and when the snow becomes soft enough press gently into place. Do not leave the primus burning any longer than necessary after cooking meal, get into your eiderdown and take your mitts and socks with you to dry them out.

Living Off the Country

If called upon to live entirely off the country, remember that it has been accomplished, and a little knowledge along these lines will be of great assistance to one in case of emergency. Practically all our larger lakes, and many of the smaller ones, in the north country contain fish, which may be caught by means of a net, and some by hook and line. The former is more dependable. The best place to make a set as a rule, if in rivers, is in a small eddy or backwater, where the current will not affect the net to any great extent, and where the fish are most likely to be found. If making a set in a lake, do not get in too deep water. At or near the mouth of a small river or stream is an ideal location.

Nets may also be set in the winter under the ice. This is accomplished by making a series of small holes where the net is to be placed. The distance the holes will be apart, will depend on the length of the pole used to pass the rope under the ice. The rope or line is attached to the pole, and the pole pushed under the ice towards the next hole. It is guided along to the end hole by means of a stick with a fork in the end. After the rope has been passed under the ice, you are ready to attach the net which is pulled under. After the set has been made bank up the end holes well with snow, as this will prevent the ice forming to any great extent over the holes which will be required to pull out the net. When pulling out the net, if it is to be reset, keep it as straight as possible, as it will freeze very quickly in the open.

In cases of starvation, the Esquimaux along the Arctic coast will invariably resort to jigging tom-cod as a means of existence. In many of the bays and inlets along the coast tom-cod are quite plentiful, and as there are many pressure ridges and cracks in these bays it eliminates the necessity of cutting holes. The type of hook used for this purpose is made of ivory, cut in the shape of a small fish with a hook protruding from the end. An empty cartridge shell can be used with good results, by attaching a hook to the end and filling the shell with lead to make it sink easily. The hook is lowered to the bottom and then pulled up about four feet, when the jigging operations will commence. No bait is used, but a small white ribbon or other white object should be attached to the line near the hook. A place should be picked out where the water is not too deep, to obtain the best results.

Snares for Rabbits

In many places in the bush country rabbits are plentiful, and as practically everyone knows how to set a snare in a rabbit's runway, snare line, or wire, should always be included in emergency equipment.

Game

There are many kinds of game in the north, both big and small, which may be procured by means of a rifle, shotgun, or other small arms such as a .22 calibre. Big game is plentiful in many parts, but it is possible to travel, or hunt, for days without seeing any. In practically all parts smaller game may be secured, and it is for this reason that it is recommended that a shotgun or .22 rifle should be included in equipment. However, should a party be travelling together and it is necessary to eliminate extra weight, at least one of the party could carry a shotgun or .22 in place of a heavier rifle. Never lose sight of the fact that practically every kind of animal, such as Arctic lemming, muskrat, fox, beaver, seal, squirrel, and every kind of fowl, may be used for food in cases of emergency. It would require far too much detail to begin to explain the methods used in hunting the different kinds of game. However, one should know at least one method of hunting seal; that is if Arctic travel is contemplated, as seals are very plentiful in all the Arctic waters.

In the spring and early summer when the seals come up on the ice, they may be obtained without much difficulty. It is possible to crawl up very near to a seal lying on the ice, providing one does the crawling during the time the seal has its head down sleeping. Lie flat on the ice with your head down during the time the seal's head is up and looking about, for even if it does see you it will probably take you for another seal and not become suspicious. Crawl up near enough to see the head distinctly before taking a shot, and remember to shoot for the head. The seal has to be knocked outright, as they sleep very near the hole and with but a wiggle they are gone. The best method of approach is to have the seal's head towards you, for when you shoot, should you miss the head, the bullet may penetrate the neck or chest. But this cannot always be accomplished, for you have to approach up wind, as the seal has a keen sense of smell. You can walk towards the seal until you are near enough to distinguish its head, when you will begin to crawl. After shooting, should you hit the seal, run and pull it away from the hole or crack, as it may only be temporarily paralyzed.

Seals may also be obtained near the floe-edge during the winter months, during which time they will float after being shot. Should you be without a boat, wait for the seal to approach near the floe-edge before shooting. It may be retrieved by means of a bobbin (i.e. a round piece of wood with hooks, attached to one end, and a long line to the other), which may be whirled and then cast out over the seal. They may be thrown for a remarkable distance, and if successful in casting directly over it, pull in gently until it is hooked.

Seals are very curious animals, and if seen in the water far out from the floe-edge they may be enticed in by making certain noises, such as knocking two pieces of wood together, whistling, and similar other noises. Remain out of sight behind a piece of ice or snow, or sit near the edge without making any movement. Keep a continual watch, as they will sometimes break water very quietly, and one has to take aim without making much movement.

A seal may be pulled to camp very easily by attaching a line to its nose. When cutting it up, strip off the fat with the skin; this will leave the flesh part of the seal exposed which will not be found greasy.

The common 'Hair Seal' is to be found almost anywhere in the Arctic in salt water, and often near the shores. It should be remembered that seals do not always float. That depends on the amount of blubber they have under the hide, and to a certain extent, whether there is any air in the lungs when killed. In the cold months a seal has a thicker layer of blubber and will float, but in July, August, and September, they are more likely to sink. It is very disappointing when one is desperate for meat to lose a seal in this way. There would not be much object in killing a seal when the tide is going out, without some means of going after it, whereas, on an incoming tide, a seal might float long enough to reach the shore, or the shore ice, when it could be lifted from the water. The common seal weight is from 50 to 200 lb. All the red meat is edible. Contrary to general belief, Esquimaux do not eat seal blubber (the two or more inches of fat which lies between the skin and the red meat) unless they are starving. It is then eaten with some roughage, such as caribou hair. When blubber is consumed it immediately turns to oil and if a newcomer tried to make a meal of blubber it would, in all probability, act as a severe purgative. The meat, ribs and flippers are very nourishing and are usually eaten in a stew, or just boiled in chunks. Most experienced northern men consider fried seal liver with bacon a very good dish.

General

If travelling in the winter, when the weather is very cold, take every precaution against getting over-heated, as this will cause moisture to form on the inside of skin clothing, which will freeze and turn into ice. If likely to perspire, remove skin clothing and put on a canvas parka, or similar garment.

Never travel or try to make a certain point with wet feet, as one's feet will freeze very quickly if in a wet condition, and with frozen feet one cannot hope to travel very far. If in the Arctic, where extra footwear and mitts should always be carried, stop immediately and change. If in the bush country in winter and clothing becomes wet, stop, build a fire and dry out, even though extra clothing is carried; for as it sometimes happens one will get into over-flow soon after changing.

Avoid over-flow, which is usually found near the shores of lakes and rivers, and is sometimes hard to see owing to deep snow.

There have been many cases in the north where men have gone into over-flow, perhaps only a few miles from their cabins and have not bothered to stop and change or dry out, thinking that they could reach their shelters before freezing; the result in many instances has been frozen feet.

Bear in mind that snow is a good absorber of moisture, and if one can get into snow soon enough after breaking through into water, you will find that the snow will take up a great deal of the moisture which otherwise would penetrate into your clothing.

Do not venture on black or dark looking ice without first testing, as new ice appears dark in colour. If on the sea-ice near the vicinity of open water, be careful in crossing cracks, stop and watch the crack for awhile to see if it is widening, as sometimes, especially in the eastern Arctic, near large bays or sounds, fields of ice will break off from the main pack and be carried very rapidly out to sea by wind or current.

Never try to travel in a blizzard, as you will only use up your energy and accomplish very little; this applies more or less to Arctic travel where there is little or no shelter. If overtaken by a storm prepare to make a shelter at once. A few blocks of snow arranged in the proper order will afford an effective windbreak.

If travelling by dog sled or hand-sled, arrange loads so that each sled will have a supply of necessary articles to maintain existence of the persons travelling with that sled, such as axe, rifle, matches, food, bedding and cooking utensils, in the bush country; in the Arctic, snow-knife, rifle, primus stove, coal-oil, matches, food, bedding and cooking utensils. This precaution should be taken in event of parties becoming separated, or outfits getting wet. This also would apply if travelling by canoe during the summer months.

As to firearms, if intended for use during the winter months, you should be very careful to clean off all particles of grease from the working parts. It may be necessary to boil the bolt to accomplish this, as in very cold weather the grease will harden and possibly prevent the rifle from firing. If in constant use, leave firearms in a cold place, for if brought into a heated camp they will sweat, and every part will have to be thoroughly dried out. There is very little need to clean the barrel even though it has been fired a few times, for during very cold weather corrosion will not take place to any extent.

The above has been a necessarily brief summary of suggestions for self preservation in the wilds. It has been impossible to deal fully with this matter as the subject would fill a book. But the most important matters have been dealt with, and this paper may serve a useful purpose to those who find themselves thrown on their own resources in the Arctic.

Council Meets in Ottawa

Local Branch Has Veritable Field Day in Honour of Occasion

Friday, June 24th, was a busy day in Ottawa. In the morning there were group meetings of councillors in the President's suite. At noon there was the luncheon meeting of the Ottawa Branch. All afternoon there was a meeting of Council. At 6.30 p.m. we had the special E.I.C. concert from the Peace Tower by the Carillonneur, and at seven o'clock there was the President's dinner at the Rideau Club. We repeat—it was a busy day.

The Ottawa Branch has built up a reputation for doing things well, and on this occasion they certainly added to their laurels. The noon meeting of the branch at the Chateau Laurier had an attendance of a hundred, with all the out of town councillors as guests of the branch. Chairman W. F. M. Bryce presided, with President Challies on his right and Dr. T. H. Hogg on his left. Other head table guests were Past-Presidents Dr. Charles Camsell, C.M.G., Dr. F. A. Gaby, and G. J. Desbarats, C.M.G.; Vice-President J. A. McCrory, and the following members of Council: W. E. Bonn, Dr. R. W. Boyle, J. L. Busfield, R. H. Findlay, A. B. Gates, Lieut.-Col. L. F. Grant, F. S. B. Heward, H. A. Lumsden, W. R. Manock, F. Newell, J. A. Vance, E. Viens; Treasurer deGaspe Beaubien, and General Secretary L. Austin Wright.

The President traced the development of the status of the engineer from the time of Confederation (when there wasn't any) up to the present when a standing at least the equal of the other professions, is enjoyed. He complimented the Canadian universities on their excellent engineering equipment, and competent staffs, and expressed the opinion that they were second to none in the world. He touched on the Provincial Professional Associations and the splendid work they were doing in protecting the engineer and the public.

The General Secretary, Austin Wright, thanked the officers of the Ottawa Branch for the opportunity of making his first appearance before the branch, under such favourable circumstances, and spoke briefly on changes that were proposed for The Journal.

Immediately after the luncheon meeting, Council convened at 2.15 p.m. for one of the best attended regular meetings of its history. Thirty-five councillors and guests sat down for an interesting and important session that lasted until six o'clock. All past councillors resident in Ottawa, and the officers of the local branch, were especially invited to attend, so that they might have a more intimate knowledge of the problems and developments of The Institute, and give Council the benefit of their opinions and advice.

Many important matters were discussed, all of which will be described in the next issue of The Journal. The proposed agreement with the Association of Professional Engineers of Saskatchewan, which has had the approval of the executives of both organizations in Saskatchewan, was examined very carefully, and was finally approved by every councillor at the meeting. The full context of this important document will be disclosed in the next number of The Journal, and every member will be able to see for himself the simple but solid basis upon which this desirable co-operation can be achieved.

A very enthusiastic outburst of applause greeted Past-President Gaby's announcement that a Doctorate of Engineering would be conferred on President Challies by the University of Toronto at the October Convocation.

The carillon concert was arranged specially for the occasion through the kind offices of Mr. J. B. Hunter, the Senior Deputy Minister of the Federal Public Works. It was a very pleasant experience to be able to stand out on the upper balcony of the Rideau Club in the cooling air of the evening with the beautiful buildings and grounds of the House of Parliament right in the foreground, and listen to the lovely music of the bells.

The President's dinner was a great success. Almost fifty guests joined him in the lounge and on the balcony, and with him shared the comfort and hospitality of this grand old institution. The special guests of the evening were the Hon. C. D. Howe, Minister of Transport, and the Hon. Grote Stirling, both Honorary Members of The Institute, Mr. J. B. Hunter, the Deputy Minister of Public Works, and Mr. J. C. Beauchamp, the President of the Dominion Institute of Professional Civil Servants.

Mr. Challies is very much at home in Ottawa, and it is doubtful if he could be happier than he appeared on this occasion as chairman of his own dinner, surrounded by old Ottawa friends and councillors of The Institute. The head table, arranged from right to left, was deGaspe Beaubien, J. A. McCrory, J. B. Hunter, Dr. F. A. Gaby, Hon. C. D. Howe, Hon. Grote Stirling, J. B. Challies, G. J. Desbarats, J. Clement Beauchamp, Dr. Charles Camsell, L. Austin Wright. Four smaller tables, each under the sub-chairmanship of a councillor selected by the President as his representative, provided for the balance of the party. These sub-chairmen were—F. Newell, J. L. Busfield, J. A. Vance and Dr. R. W. Boyle, and the guests were—W. E. Bonn, W. F. M. Bryce, K. M. Cameron, E. V. Caton, Hon. George H. Challies, T. H. Dunn, Lieut.-Commdr. C. P. Edwards, O.B.E., R. H. Findlay, O. S. Finnie, G. A. Gaherty, A. B. Gates, F. G. Goodspeed, Lieut.-Col. L. F. Grant, A. K. Hay, F. S. B. Heward, Dr. T. H. Hogg, J. T. Johnston, H. A. Lumsden, F. C. C. Lynch, J. G. Macphail, W. R. Manock, W. H. Munro, John Murphy, John McLeish, Major-General A. G. L. McNaughton, C.M.G., F. H. Peters, J. L. Rannie, Group-Capt. E. W. Stedman, O.B.E., and E. Viens.

Hon. Mr. Howe spoke in a very pleasant vein. He referred to the pleasure that it had given him last year to be awarded an Honorary Membership. He said he had never received any honour that he prized so highly as he did this. He humorously referred to parliamentary life for an engineer, and indicated that the usual hard work and long hours that were the experience of all engineers were nothing compared to the task of being a Minister of the Crown. In conclusion he offered his services to The Institute if at any time there should be need of them.

Hon. Mr. Stirling followed, and gave an excellent exposition of one of those talents for which he is famous—after dinner speaking. He, too, referred to the life of an engineer in Parliament, and in a very amusing manner described his experiences as an engineer, both in and out of the House. It is a great treat to hear such a charming speaker in such an informal mood.

The President is such a leader in demonstration of appreciation for other people, that it was rather amusing to see his discomfiture when the entire gathering stood up and sang with an enthusiasm that made up for their lack of musical ability "For He's a Jolly Good Fellow." It was on this note that the party adjourned to the balcony for the balance of the evening.

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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Saskatchewan Takes the Lead

Such progress is being made in the negotiations for a co-operative agreement between the Association of Professional Engineers of Saskatchewan and The Institute, that it now appears that such an agreement will be consummated early this Fall. An account of a recent joint meeting between the two bodies appearing in this issue in the branch news for Regina, gives some indication of how these negotiations have been conducted.

Books—A New Service

Attention is called to a new feature of The Journal. It has always been acknowledged that news of technical books is of real value to the engineer, but many difficulties have made it impossible for The Journal to give its readers a comprehensive picture of the field of new technical literature. It is, therefore, with a great deal of pleasure and satisfaction that we are able to announce that arrangements have been completed with the Director of The Engineering Societies Library of New York, Dr. Harrison W. Craver, to permit us to use the same list of books, and his notes on them, that he prepares for the publications of the four Founder Societies—Civil Engineering, Mechanical Engineering, Electrical Engineering, and Mining and Metallurgy. This list is probably the most complete of its type that is published anywhere, and it is very gratifying to The Journal to know that it is the intermediary that makes it possible for members of The Institute to have such complete information at their disposal.

Please bear in mind that these books are not necessarily in The Institute library. If readers are interested in securing copies for study or for their library, inquiries will be welcomed at Headquarters, or communications may be sent direct to the publisher whose identity is given with each book listed. It will enhance our position with the publishers if The Journal is mentioned in such inquiries.

It is an exceedingly helpful and friendly gesture on the part of the Founder Societies to permit us this privilege. It is another indication of the splendid relationships that exist between The Institute and the four great sister societies to the south. We are very grateful to Dr. Craver and to his societies.

Engineer versus Politician

Engineers throughout Canada will have been interested in following the accounts of a recent governmental power inquiry. Usually in such inquiries the main issues are obscured by a flood of irrelevant questions, charges, accusations and recriminations, and this one seems to be no exception to the custom. To have in mind the purpose of the inquiry, and to attempt to tie into it the evidence as it appears at this distance, is to put a great strain on one's mental equipment. Perhaps if one's training is political rather than logical, the relationship can be more easily discovered.

The one simple, clear and conclusive lesson that can be learned from all this discussion, debate, and disclosure over the power problems of central Canada, is that there is an imperative need of sound engineering leadership in such matters and less political meddling with any industry so technically complicated and so basically important to every citizen, as the electrical services of a great province.

Work to Do

Opportunities for service are always present, but it is doubtful if The Institute has ever been in a position where it can do more for the profession than that in which it now finds itself. There are so many things presenting themselves for attention, some new, some old, but all important and all strictly of real concern to The Institute and to the membership. None of the problems is impossible of solution, yet none of them will be answered without great effort—not the effort of one or two, but the effort of many. Wisdom will be required, patience, perseverance, and we repeat—effort.

Such a situation should not frighten us. Look back at what has been accomplished—the mountains which have been crossed—and we should find encouragement for the future. The presence of problems is a natural condition. In a recent number of Engineering News-Record, Colonel William Chevalier refers to the visitor to New York who said "New York will be a great city if they ever get it finished." But they never will, because there is no finish to the problems of living things. The ability to see these problems as opportunities to accomplish something worth while is one of the things which make a person or a nation great.

* * *

What are these problems that afford us these opportunities? At the moment space does not permit of a sufficient description or discussion, but we can attempt a sketchy outline that may serve to recall them to mind. In later issues, we plan to deal with each one separately in the hope that such a discussion will concentrate the attention of the membership on it, which is the first step towards finding the solution.

MEMBERSHIP is always of paramount importance. The situation to-day, in the light of past records, is excellent, but the desire for more members is based on an appreciation of two things. First, such an increase means increased opportunities for service. Second, increased membership means increased revenue, which in turn makes possible an improvement in existing services and the establishment of additional ones.

EMPLOYMENT for members who from time to time find themselves out of work is one of The Institute's real concerns. Great things have been done in the past, but with the recent increased call for positions greater demands have been placed on this department. Certain handicaps, principally of finance, make it difficult to enlarge the activities sufficiently to be equal to the new opportunities. The field of usefulness for this phase of our activities is very broad, and of itself is almost sufficient to justify the existence of The Institute.

CO-OPERATION with other engineering societies has been a long-time ambition of The Institute. All these bodies have similar objectives. It is therefore reasonable that they should work together to accomplish them. Great progress to this end has been made, but the big work is still ahead. Beyond a doubt, co-operation is "just around the corner," but the remaining distance cannot be covered by coasting.

THE ENGINEERING STUDENT and the recent graduate seemed to present a great opportunity to render a real service that cannot come from any other source. How just to go about this is a large and complicated problem, but the desire of senior practising engineers to pass on to these embryos the benefits of their experience, is genuine. The problem for The Institute is to make this possible. Much thought has already been given to it by senior officers and it is expected that some genuine progress will be indicated before long.

* * *

These are all activities with an "outward look"—things which The Institute can do for others. Surely for a time we have had enough of introspection. Many changes in by-laws have been suggested and voted upon. Some have been approved—others rejected, but the great needs of our membership, the great opportunities of The Institute are not going to be met by tinkering with the constitution. At the moment there are no controversial issues, no outcries for legislative reform. Is this not an excellent time to concern ourselves more deeply with the welfare of our profession and the usefulness of The Institute in promoting such development?

Honours for the President

At the last minute before going to press word has been received from the Registrar of the University of Toronto that at a special convocation to be called on October 14th, the degree of Doctor of Engineering will be conferred on J. B. Challies, C.E., M.E.I.C. Time does not permit now of making proper acknowledgment of this well deserved honour, but the news will be welcomed by our entire membership and by members of the profession everywhere. Subsequently more time and space will be given to this very important announcement.

A Registrar is Appointed

Dr. A. R. Decary, M.E.I.C., President of the Corporation of Professional Engineers of Quebec, announces the appointment of C. Leroux Dufort as registrar of that body, the appointment having been made necessary by the much regretted death of Dr. Adhemar Mailhiot, the former incumbent of that office.

Mr. Dufort was born and educated in Montreal, obtaining his B.A.Sc. and C.E. from the Ecole Polytechnique. From 1905 to 1919 he was engaged in private practice in structural, municipal and general engineering and land surveying. To April 1938 he was with the Department of Colonization of the Province of Quebec as engineer, and for the latter six years as chief engineer. At the time of his appointment he was city engineer of Drummondville, Que.

The Institute congratulates Mr. Dufort on his appointment, and wishes him success and happiness in his new work. At the same time we wish to offer to him, and through him to the Corporation, any assistance that we may be able to give that will help him in his endeavours to promote the welfare of the profession in the Province of Quebec.

A Romance in Engineering

The recent election of W. D. Black, M.E.I.C., to the Presidency of the Canadian Manufacturers Association, brings to light other features of his interesting career. Here is a story that breathes of inspiration to the young engineer and brings satisfaction to the older members of the calling—the story of a man who was determined to complete his education, even to post graduate studies, in spite of severe difficulties; who all his life accepted responsibility both in and out of his professional field—who steadily year by year mastered the industry in which he was interested, and correspondingly year by year stepped in steady measure from labourer to President in the same company.

It is a saga such as novelists invent to entertain their public, and yet it is given to our readers herewith just as a chronological series of actual events. The steady climb from obscurity to national reputation and national service is plainly told. The strength of the story is not reduced by the simplicity of the telling.

William Duncan Black (better known as "Dolly"), born in Toronto, was educated at Dufferin School, Technical High School and the University of Toronto. Attended night classes at technical school four years, working day time as street car conductor; labourer and later foreman, on elevator installation for Fensom Elevator Works. He entered S.P.S. University of Toronto 1906, graduated B.A.Sc. 1910; President, Engineering Society 1909; joined Otis-Fensom Elevator Company 1910 as Superintendent, Montreal and Eastern district; 1913, Manager, same district; 1918, in charge of munitions manufacture for company at Hamilton; General Construction Manager 1919, Works Manager 1921, General Manager 1925, Vice-President 1927, President 1935; Commissioner, Hamilton Hydro-Electric Commission 1933, chairman 1934 to 1936; President, Engineering Alumni Association, University of Toronto, 1936; Canadian Employers representative, Geneva Labour Conference 1934; Director, Bank of Canada, 1936 to date; member, Advisory Board, Canadian Construction Association, and now President Canadian Manufacturers Association 1938.

He has four children, three girls and one boy; owns a three hundred acre farm near Hamilton on which he has one hundred pure bred Ayrshires; belongs to many clubs and has many recreations.

He has been a member of The Engineering Institute of Canada since 1908 when he joined as a Student.

An Appreciation

The following article appeared in the May number of Mechanical Engineering under the heading "Durley." It is reprinted here as it is thought that members will be interested in knowing that Secretary Emeritus R. J. Durley is held in the same high regard in the United States as he is in Canada.

"On March 18 the President and Council of The Engineering Institute of Canada announced the retirement as secretary of the Institute of Richard John Durley, member since 1899 of The American Society of Mechanical Engineers. Captain Durley becomes secretary-emeritus. The duties of the secretaryship were taken over on April 1 by Leslie Austin Wright.

"Captain Durley became secretary of The Institute in April 1925, and in June of that year assumed editorship of The Engineering Journal, official publication of the Institute. Educated in England at the University College, London, he acquired by apprenticeship and engineering practice a background of experience that lent authority to a teaching career begun at Hull, England, in 1894 and continued at McGill University, Montreal, when he went to Canada in 1897. Through his teaching, his consulting practice, his service during the war as officer in charge of the Division of Gauges and Standards, Imperial Ministry of Munitions, Inspection Department (Canada), and his work as secretary of the Canadian Engineering Standards Association he became favorably known to Canadian engineers and added to his professional qualifications those personal characteristics that made his selection, in 1925, as secretary of The Engineering Institute of Canada a fortunate choice.

"Spread out over a narrow strip of territory extending from ocean to ocean in a country where great pioneering works of engineering construction and development are going on simultaneously with highly progressive manufacturing establishments of the most modern type, a country rich in agricultural, mineral, and natural power resources, members of the Institute represent every phase of engineering practice. It has been Captain Durley's task to co-ordinate these diverse professional interests during a period of economic stress and in the face of difficulties inherent in the wide separation of industrial centers and the even more extensive scattering of the districts that make up the engineering frontier. As editor of the Journal of the Institute he produced an engineering magazine of high quality, recording the best developments in technology in Canada. Fortunately his services are not lost to the Institute and the Journal for, as his health permits, he will continue to be active in both."

Presidential Activities

The President and the General Secretary were the guests of the Grand Valley Group of Professional Engineers at the Group's Annual Banquet, at Brantford, Ontario, on Friday, May 27th. Nearly one hundred engineers participated in this extremely enthusiastic engineering function. Other guests included the President of the Ontario Association of Professional Engineers, two members of the Ontario Government, the Speaker of the Ontario Legislature, local members of Parliament, and the Mayor of Brantford. The President was accompanied by Vice-President Buchanan, Councillors Vance and Manock, the chairmen of the London, Toronto, Hamilton and the Niagara Peninsula branches, Fraser S. Keith M.E.I.C., of Montreal, W. J. Johnston, A.M.E.I.C., of Winnipeg, Dr. Charles A. Robb, M.E.I.C., of Edmonton, and the General Secretary.

As the principal speaker of the evening, the President took as his theme "The Engineer in Public Service," and congratulated the Grand Valley Group on their unique service to the public through a "better light better sight" campaign in the schools, for their promotion of a reforestry programme in the surrounding district, and for the advocacy of the conservation of the Grand River waters. He recounted similar notable services by such early leaders of the profession who left their imprint on that part of the Dominion, as Sir Casimir Gzowski, Sir Sandford Fleming, Sir John Kennedy, the two Keefers, and Dr. John Galbraith, all prominent pioneer members of The Institute. He called attention to the progress of the profession as evidenced by the growth of engineering education in all the provinces, by the progress of The Engineering Institute, and the widespread acceptance of provincial registration and licensing, and by the key positions now held by engineers in political life, in the public service, and in big business throughout the Dominion.

The annual banquet of the Grand Valley Group of Professional Engineers is a unique event among engineers in Western Ontario. This year The Institute was privileged to take a leading part in it.

The President, the Ontario Vice-President, and the General Secretary, spent the afternoon and evening of Saturday, May 28th, with members of the Border Cities Branch. Most of the afternoon was devoted to discussions of Institute affairs with Councillor Chambers, Branch Chairman Krebser, and the local executive committee. In the evening, following a well attended supper in the Prince Edward hotel, the President informally discussed the status of the profession, spoke of the co-operative movement which is now progressing satisfactorily in the form of active negotiations for closer relationships between The Institute and the Provincial Professional Associations pursuant to the new enabling By-law No. 76. There followed an hour and a half of spirited and helpful round-the-table debate on engineering matters, which indicates a very active and informed professional personnel in the Border Cities Branch. An interesting feature of the evening meeting was the presentation by the President, on behalf of the Branch, of a suitably engraved gift to W. H. Baltzell, M.E.I.C., one of the oldest members in The Institute, who is retiring from active professional work.

As part of the symposium on "Natural Resources of Canada, and Their Development through Chemical Research," the President delivered a paper on "Water Power and the Electrochemical Industry" at the Fifty-Seventh Annual Meeting of the Society of Chemical Industry in Ottawa on June 21st.

Vice-President E. V. Buchanan arrived in Montreal on the morning of June 10th on his way to the Old Country on vacation. The President, accompanied by Mrs. Challies, Past-President J. M. R. Fairbairn, the General Secretary and Mrs. Wright, was at the station to greet him. The entire party breakfasted with Mr. Challies, after which the visitors enjoyed a short sightseeing trip with the President before embarking on the *Duchess of Richmond.*

The Engineering Institute of Canada Prize Awards 1938

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 1938:—

University of Alberta	LeRoy Allan Thorssen, S.E.I.C.
University of British Columbia	Arthur Leslie Sutton
University of Manitoba	Aaron Gusen
McGill University	William Hartley MacGowan
Ecole Polytechnique	André Dufresne
University of New Brunswick	Cyril J. Gray
Queen's University	Norman Salisbury Edgar
Royal Military College	Lindsay Hugh Brown, S.E.I.C.
University of Toronto	Paul C. Anderson
University of Saskatchewan	Joseph Louis de Stein
Nova Scotia Technical College	James Philip Dumaresq

PERSONALS

Dr. William Lindsay Malcolm, M.E.I.C., professor of municipal engineering in Queens University, Kingston, Ont., has been appointed director of the School of Civil Engineering, Cornell University, it was announced recently by President Edmund E. Day. The appointment was recommended by Dean S. C. Hollister of the College of Engineering and approved by the Board of Trustees at the June meeting.

Charles G. Williams, B.A.Sc., has been appointed Professor of Mining Engineering at the University of Toronto in succession to Professor H. E. T. Haultain, C.E., M.E.I.C., who has resigned. Professor Williams is a graduate of S.P.S. in 1903 and has spent all the intervening years in practical mining work in Northern Ontario. For fifteen years he was with Hollinger Consolidated Gold Mines, and most of that time as General Superintendent. Latterly he has been in private practice in Toronto.

E. V. Buchanan, M.E.I.C., Vice-President for Ontario, passed through Montreal on June 10th on his way to the Old Country, where he will represent The Institute at the International Engineering Congress to be held in Glasgow on June 21st to 24th. Mr. Buchanan was accompanied by Mrs. Buchanan and his son William and daughter Mary. He will also attend the meeting of the International Electrotechnical Commission in London on June 22nd to July 1st. He returns to Canada at the end of July.

R. J. Durley, Secretary Emeritus, at the time of going to press, is still in hospital, but his condition is so greatly improved that it is expected he will be home in ten days' time. A second operation has been performed and with very successful results.

Charles A. Robb, M.E.I.C., Professor of Mechanical Engineering at the University of Alberta, has received the degree of Doctor of Engineering from the Johns Hopkins University, Baltimore. His investigations and report on "Recompression Phenomena in Steam Nozzles" was the basis of the award.

Dr. Robb is a graduate of McGill University in mechanical engineering, and a Master of Science of the Massachusetts Institute of Technology. In 1931-2 he was in residence at Johns Hopkins University doing graduate study under Professor A. G. Christie and Professor D. H. Andrews, leading to the doctorate degree. In May of the year he returned to Baltimore and completed the requirements. He is active in Institute affairs, and has delivered excellent papers at important meetings such as the Semi-centennial meeting of June 1937 and the Annual Meeting in February last, in London, Ont.

Julian C. Smith, LL.D., M.E.I.C., President of the Shawinigan Water and Power Company, has been elected for a second year of office a Member of Council, resident in Canada, of the Institution of Civil Engineers.

Robert F. Legget, A.M.E.I.C., who for the past two sessions has been a lecturer in the Department of Civil Engineering at Queen's University, Kingston, has been appointed assistant professor of civil engineering at the University of Toronto. Mr. Legget received the degree of M.Eng. from the University of Liverpool, England, in 1927 and has been engaged in professional work in Canada since 1929. He has always taken an active interest in Institute affairs.

Fraser S. Keith, M.E.I.C., was elected chairman of the Board of Management of the Presbyterian College of Montreal at the annual meeting of that body. Mr. Keith was re-elected chairman for the fourth consecutive year.

OBITUARY

Alexander Ritchie Dufresne, M.E.I.C.

Members of The Institute will learn with regret of the death of Alexander Ritchie Dufresne, M.E.I.C., which occurred in Montreal, on June 2nd, 1938.

Mr. Dufresne was born in Ottawa, Ont., on December 18th, 1872. He graduated at McGill University with the degree of B.Sc. in 1896 and was placed in charge of work dredging a channel in Lake St. Louis. The following year he became assistant engineer on construction of the Soulanges Canal. From 1900 to 1902 he was assistant engineer of the Hydrographic Survey of the St. Lawrence river from Kingston to Prescott. In 1902 he went to Red River, Man., in charge of construction of the St. Andrews lock and dam. In 1905 he joined the staff of the Dominion Public Works Department for Manitoba. In 1910 he was appointed assistant chief engineer of the Department. He remained in this position until 1918 when he resigned to become manager of the Saint John Dry Dock and Shipbuilding Company, Saint John, N.B. From 1931 until December last, Mr. Dufresne was chief engineer and director of the Canadian Dredge and Dock Company, Montreal.

He joined The Institute in 1894 as a Student, becoming an Associate Member in 1902 and a full Member in 1911.

Gerald N. Martin, Jr.E.I.C., who for the past four years has been with the Dominion Bridge Company Limited as designer in their Structural and Boiler Departments, is being granted two years leave of absence to obtain added experience and to study modern combustion engineering under the Central Electricity Board in London, England, and also with some of the large combustion firms in that country. Mr. Martin is a graduate of Mont Saint-Louis and Ecole Polytechnique. At the latter institution he obtained a Diploma in Civil Engineering, the Degree of Bachelor of Applied Science (U. of M.) and Gold Medal 1934.

Mr. Martin is a member of the executive of the Junior Section of the Montreal Branch of the E.I.C., and in 1937 was awarded the Phelps Johnston prize for his paper on "The Elements of Modern Combustion Engineering." He will again take up his work in the Combustion Engineering Department of the Dominion Bridge Company Limited on his return to Canada.

C. R. Whittemore, A.M.E.I.C., has been made vice-chairman of the Montreal Chapter of the American Society of Metals. He is metallurgist with the Dominion Bridge Company, and is the author of a paper appearing elsewhere in this number of The Journal.

F. R. Park, S.E.I.C., who has been with the Northern Electric Company, Montreal, has now been transferred by that company to Calgary.

R. H. Findlater, F.I.C., M.E.I.C., has recently taken charge of the Montreal and Eastern Canada business of Bruce Ross Limited, Montreal, importers and exporters of chemical supplies. Mr. Findlater began his professional career with the Broxburn Oil Company, Broxburn, Scotland, but in 1911 went to Newcastle, N.S.W., as chief chemist and refinery manager, British Australian Oil Company Limited. In 1916 he returned to Scotland to the Broxburn Oil Company, remaining with them until 1921 when he accepted the position of refinery manager of the Egyptian Government Refinery, Suez, Egypt. This latter position he held until 1925, when he came to Moncton, N.B., as petroleum chemist and assistant manager, New Brunswick Gas Oil Fields Limited.

W. A. Logie, S.E.I.C., has recently come to Montreal, having accepted a position with the Montreal Light, Heat and Power Consolidated.

W. W. H. Dean, S.E.I.C., has accepted a position with the Trans-Canada Airlines, and is now located at the Stevenson Airport, Winnipeg, Manitoba. Mr. Dean graduated at McGill University in 1937 with the degree of B.Eng. in electrical.

Clifford G. Wallman, S.E.I.C., is now with the Canada Starch Company at their plant in Cardinal, Ont. Mr. Wallman graduated at McGill University with the degree of B.Eng. in mechanical engineering, this spring.

J. W. Stafford, S.E.I.C., who has been located at Arvida, Quebec, with the Saguenay Power Company Limited as junior engineer has been transferred to the company's Isle Maligne Station as plant engineer. Mr. Stafford was graduated from the University of Alberta in 1937 with the degree of B.Sc. in electrical engineering.

E. L. Cousins, M.E.I.C., Manager of the Toronto Harbour Commission, was recently bereaved by the loss of his father, E. J. Cousins, who died in his 84th year, after a short illness. He was President of Wilson and Cousins Limited, manufacturers of machinery and supplies in Toronto.

Alex T. Cairncross, B.Sc., A.M.E.I.C., sends us interesting letters from China. The latest word is that he is on his way home to Canada from Shanghai on vacation. He is employed by the Shanghai Municipal Council. During the general melee he has lost all his personal belongings, but is glad he still has his life. He regrets that the lack of "freedom of speech" prevents him expressing himself properly in his letters. We are looking forward to seeing him at Headquarters in August, and getting the whole story.

Frederick G. Goodspeed, M.A., B.Sc., M.E.I.C., District Engineer of the Department of Public Works at Winnipeg, has been moved by the department to Ottawa as Supervising Engineer. Mr. Goodspeed has always taken an active interest in the affairs in The Institute and his move will be good news to the Ottawa Branch. He was a member of Council in 1934 and 1935.

John Murphy, M.E.I.C., senior electrical engineer with the Department of Transport and Board of Railway Commissioners at Ottawa, is now on six months leave of absence, and retires on his seventieth birthday, December 17th, 1938. An account of Mr. Murphy's career will be given in the August issue.

W. Chase Thomson, M.E.I.C., has accepted a position on the engineering staff of the Department of Public Works of the Province of Quebec. Mr. Thomson has now moved to Quebec City from Montreal, where he has been resident for some time.

Guy Beaudet, S.E.I.C., a graduate in engineering from the Ecole Polytechnique in 1938, has been appointed city engineer of Thetford Mines, Que. Mr. Beaudet was awarded the Médaille de Bronze de l'Association des anciens Elèves at his graduation.

W. E. Sprague and H. A. Cooch have been elected to the vice-presidency of the Canadian Westinghouse Company Limited. Mr. Sprague started with the company in Pittsburgh in 1899 and Mr. Couch who is a graduate in engineering of the University of Toronto joined the organization in 1910.

Miss Ellen L. Boyden, accountant of Headquarters Staff, celebrated the twentieth anniversary of her employment with The Institute, on June 15th. She was the recipient of many congratulations and good wishes for the future.

Recent Graduates in Engineering

Congratulations are in order to the following Associate Members, Juniors and Students of The Institute who have completed their course at the various universities:—

Nova Scotia Technical College

Degree of Bachelor of Engineering

Forster, Alfred Manning, Halifax, N.S.—B.E. (Elec.).
MacDonald, Arthur Lamond, Glace Bay, N.S.—B.E. (Elec.).
Martin, Clifford Davison, Amherst, N.S.—B.E. (Elec.).
Rees, Frederick, Bell Island, Nfld.—B.E. (Mi.).

The University of New Brunswick

Medal Awards

Dunphy, Kenneth Rae, Fort William, Ont.—B.Sc. (Elec.); City of Fredericton Gold Medal for Highest Standing in Fourth Year Hydraulics; Brydone-Jack Memorial Scholarship for Highest Standing in Electrical Engineering of the Fourth Year.

Degree of Bachelor of Science

Campbell, Gerald Arthur, Fredericton, N.B.—B.Sc. (Ci.).
Connell, Edwin Allison, Woodstock, N.B.—B.Sc. (Elec.).
Davis, Samuel, Saint John, N.B.—B.Sc. (Ci.).
Leger, John Arthur Kennedy, Newcastle, N.B.—B.Sc. (Elec.).
Logie, William Alexander, Belleville, Ont.—B.Sc. (Elec.).
Sutherland, Donald Henry, Borden, P.E.I.—B.Sc. (Ci.).

University of Manitoba

Medals and Prizes Awards

Bowering, Reginald, Winnipeg, Man.—B.Sc. (Ci.); University Gold Medal; Travelling Fellowship of $400.
Harland, Robert Thompson, Winnipeg, Man.—B.Sc. (Elec.); University Gold Medal.

Degree of Bachelor of Science

Athey, Francis Allan Powell, Dysart, Sask.—B.Sc. (Elec.).
Brydges, Robert James, Souris, Man.—B.Sc. (Elec.).
Douglas, Lloyd Robert, Franklin, Man.—B.Sc. (Elec.).
Duncan, George Patterson, Winnipeg, Man.—B.Sc. (Ci.).
Gershfield, Max, Winnipeg, Man.—B.Sc. (Elec.).
Harvey, Ernest Allan, Winnipeg, Man.—B.Sc. (Elec.).
Krendel, Conrad John, Winnipeg, Man.—B.Sc. (Ci.).
Law, Ernest Gerald, Calgary, Alta.—B.Sc. (Elec.).
MacKay, William Brydon Fraser, Winnipeg, Man.—B.Sc. (Elec.).
MacKenzie, John James, St. Vital, Man.—B.Sc. (Elec.).
McBride, James Wallace, Winnipeg, Man.—B.Sc. (Elec.).
Phomin, Barney Louis, Winnipeg, Man.—B.Sc. (Ci.).
Stevenson, Herbert Irving, Winnipeg, Man.—B.Sc. (Ci.).
Swain, Douglas Smith, Winnipeg, Man.—B.Sc. (Elec.).
Taylor, William Irwin, Winnipeg, Man.—B.Sc. (Ci.).
White, Clifford Hubert, Winnipeg, Man.—B.Sc. (Elec.).

University of Saskatchewan

Degree of Bachelor of Science

McCallum, Francis, Saskatoon, Sask.—B.Sc. (Ci.).
Snyder, Robert Bertrum, Lashburn, Sask.—B.Sc. (Ci.).

J. S. Cooper, Jr.E.I.C., of the engineering staff of the Wabi Iron Works Limited, New Liskeard, Ont., has recently been appointed chief draughtsman of that company. Mr. Cooper graduated at the University of Toronto in 1934 with the degree of B.A.Sc. in civil engineering.

E. P. Fetherstonhaugh, M.E.I.C., Dean of the Faculty of Engineering and Architecture at the University of Manitoba, was a visitor to Headquarters on May 28th.

C. H. Davis, Jr.E.I.C., chief engineer of the Robb Wave Organ Company, Belleville, Ont., was a visitor to Headquarters on June 6th. Prior to accepting his present position in October 1937, he had been connected with the Northern Electric Company for three years.

Paul MacNeil, Jr.E.I.C., who is with the Dominion Coal Company, at Glace Bay, Nova Scotia, was a visitor to Montreal recently while on his vacation.

S. J. Hayes, A.M.E.I.C., Assistant Professor of Engineering at the Memorial University College, St. John's, Newfoundland, visited Headquarters on June 16th.

K. L. Dawson, M.E.I.C., superintendent of the Nova Scotia Light, Heat and Power Company Limited, Halifax, was a recent visitor to Headquarters.

Queen's University

Honours and Medal Awards

McGinnis, Arthur David, Kingston, Ont.—B.Sc. (Ci.); Honours in Civil Engineering; Departmental Medal.
McKibbin, Kenneth Holdsworth, Kingston, Ont.—B.Sc. (Mech.); Honours in Mechanical Engineering; Departmental Medal.

Degree of Master of Science

Katz, Leon, Toronto, Ont., B.Sc. (Queen's '34); M.Sc. (Physics).

Degree of Bachelor of Science

Allan, Robert Gage, Toronto, Ont.—B.Sc. (Ci.).
Brown, Donald Whidden, Ottawa, Ont.—B.Sc. (Mech.).
Callum, John Park, Sarnia, Ont.—B.Sc. (Mech.).
Campbell, Albert Murray, St. Thomas, Ont.—B.Sc. (Mech.).
Campbell, Kenneth William, St. Thomas, Ont.—B.Sc. (Mech.).
Craig, Clarence Edward, Kirkland Lake, Ont.—B.Sc. (Mech.).
Morazain, Jules Fernand, Quebec, Que.—B.Sc. (Ci.).
Neal, Eugene Laurence, Quebec, Que.—B.Sc. (Mech.).
Ramsay, Robert Drummond, Sarnia, Ont.—B.Sc. (Mech.).
Reynolds, George Gilbert, Winnipeg, Man.—B.Sc. (Ci.).
Williams, John Thomas, Clandeboye, Ont.—B.Sc. (Mech.).
Wilson, John Pye, McGregor, Ont.—B.Sc. (Elec.).

University of Alberta

Honours and Prize Awards

Davis, Edgar Hawkins, Edmonton, Alta.—B.Sc. (Ci.); The Association of Professional Engineers of Alberta Prize; Honours in Civil Engineering.
Hayward, Vernon Arthur, Edmonton, Alta.—B.Sc. (Elec.); Honours in Electrical Engineering.
Heath, Frederick Johnston, Edmonton, Alta.—B.Sc. (Elec.); The Association of Professional Engineers of Alberta Prize; First Class General Standing; Honours in Electrical Engineering.
Kobylnyk, Demetrius Frederick, Edmonton, Alta.—B.Sc. (Elec.); Honours in Electrical Engineering.

Degree of Bachelor of Science

Adamson, William Blackwood, Edmonton, Alta.—B.Sc. (Elec.).
Elliott, Clarence Wilbert, Edmonton, Alta.—B.Sc. (Elec.).
Hole, Jack Henry, Edmonton, Alta.—B.Sc. (Elec.).
Parsons, Ronald Albert, Edmonton, Alta.—B.Sc. (Ci.).
Ross, George, Edmonton, Alta.—B.Sc. (Ci.).
Sylvester, Jack Douglas, Edmonton, Alta.—B.Sc. (Elec.).

University of Toronto

Degree of Master of Applied Science

Hogg, Allan Douglas, Toronto, Ont.—B.Sc. (Sask.); M.A.Sc.
Lauchland, Lyman Stuart, Toronto, Ont.—B.A.Sc. (Tor.); M.A.Sc.

Degree of Civil Engineer

Laughlin, William Howard Mountjoy, Toronto, Ont.—M.A.Sc.; C.E.

Degree of Electrical Engineer

Burbank, Jerome Douglas, Buffalo, N.Y.—B.A.Sc. (Tor.); E.E.

Degree of Bachelor of Applied Science

Honours

Rubin, Leon Julius, Toronto, Ont.—B.A.Sc. (Chem.); Honours in Chemical Engineering.

Degree of Bachelor of Applied Science

Loutit, John Alexander, Toronto, Ont.—B.A.Sc. (Elec.).

Ecole Polytechnique

Beaudet, Guy, Montréal, Qué.—B.A.Sc. (Ci.); Médaille de Bronze de l'Association des Anciens Elèves.
Belle-Isle, Jacques, Montréal, Qué.—B.A.Sc. (Ci.); Médaille d'Argent de l'Association des Anciens Elèves.
DeLamirande, Paul, Montréal, Qué.—B.A.Sc. (Ci.); avec Distinction.
Flahault, Jean, Montréal, Qué.—B.A.Sc. (Ci.); avec Distinction.
Gervais, Aimé, Montréal, Qué.—B.A.Sc. (Ci.); avec Distinction.
Halle, Paul-Emile, Montréal, Que.—B.A.Sc. (Ci.); avec Distinction.
Laurence, Jacques, Montréal, Qué.—B.A.Sc. (Ci.); avec Très Grande Distinction; Médaille d'Argent de S.E. le Lieutenant-Gouverneur de la Province; Médaille d'Or de l'Association des Anciens Elèves.
Leblanc, Raymond F., Montréal, Qué.—B.A.Sc. (Chem.); avec Grande Distinction.
Thibaudeau, Guy, Montréal, Qué.—B.A.Sc. (Ci.); Prix d'Architecture Ernest Cormier.

Ingénieurs Civils

Aird, Andre, Montréal, Qué.—B.A.Sc. (Ci.).
Cartier, Léonard, Montréal, Qué.—B.A.Sc. (Ci.).
Crépeau, Marcel, Montréal, Qué.—B.A.Sc. (Ci.).
Dussault, Jean, Montréal, Qué.—B.A.Sc. (Ci.).
Gauthier, René, Montréal, Qué.—B.A.Sc. (Ci.).
Lapointe, Gérard A., Montréal, Qué.—B.A.Sc. (Ci.).
Laurence, Jacques, Montréal, Qué.—B.A.Sc. (Ci.).
Normandeau, Paul D., Montréal, Qué.—B.A.Sc. (Ci.).
Ostiguy, Maurice, Montréal, Qué.—B.A.Sc. (Ci.).
Rioux, René, Montréal, Qué.—B.A.Sc. (Ci.).

McGill University

Honours, Medals and Prizes Awards

Duchastel de Montrouge, Pierre Arthur, Outremont, Que.—B.Eng. (Elec.); Honours in Electrical Engineering; Montreal Light, Heat and Power Consolidated Prize.
Lochhead, Stuart George, Montreal West, Que.—B.Eng. (Ci.); Undergraduate Society's First Prize for Summer Essay; *The Shearwood Prize for Summer Essay in Civil Engineering.
Schwartz, Harry H., Montreal, Que.—B.Eng. (Elec.); Honours in Electrical Engineering; Montreal Light, Heat and Power Consolidated Prize.
Thomlinson, Walter Leonard, Edmonton, Alta.—B.Eng. (Mech.); Honours in Mechanical Engineering; The Anglin Bursary 1937-38.

Degree of Master of Science

Cleveland, Courtney, Ernest, Vancouver, B.C.—B.A.Sc. (British Columbia '34); M.Sc. (Geol.).
MacDonald, Murray Vickers, Toronto, Ont.—B.Sc. (Sask. '31); M.Sc. (Geol.).
Ross, Henry Urquhart, Ottawa, Ont.—B.Eng. (McGill '36); M.Sc. (Met.).

Degree of Master of Engineering

Griffiths, George Henry Rickard, Winnipeg, Man.—B.Sc. (Man. '35); M.Eng. (Ci.).

Scholarship in the Faculty of Graduate Studies and Research

Lichty, Lyall J., Dupuy, Que.—B.A.Sc. (Toronto '33); Siscoe Gold Mines Scholarship.

Degree of Bachelor of Engineering

Alexander, John Andrew, Montreal West, Que.—B.Eng. (Chem.).
Asplin, Albert Grant, Lethbridge, Alta.—B.Eng. (Ci.).
Becker, Sidney John, Montreal, Que.—B.Eng. (Mech.).
Bubbis, Morris Israel, Winnipeg, Man.—B.Eng. (Mech.).
Cameron, Adam Kirkland, Regina, Sask.—B.Eng. (Mech.).
Cheng, Roger Kee, Lillooet, B.C.—B.Eng. (Elec.).
Cook, Kenneth Gilbert, Westmount, Que.—B.Eng. (Mech.).
Coutts, Erskine, Montreal, Que.—B.Eng. (Mi.).
Dupuy, Harry Edward Glen, Montreal, Que.—B.Eng. (Mech.).
Fromson, Sam, Old Kildonan, Man.—B.Eng. (Mech.).
Houghton, James Scott, Westmount, Que.—B.Eng. (Mech.).
Jones, Stuart Percival, Montreal West, Que.—B.Eng. (Mech.).
Kayser, James Nicholas, Mount Vernon, N.Y.—B.Eng. (Mech.).
Kosnar, Vincent George, Saskatoon, Sask.—B.Eng. (Elec.).
MacCallum, Donald Charles, Westmount, Que.—B.Eng. (Mech.).
Meagher, Robert Douglas, Ottawa, Ont.—B.Eng. (Chem.).
Motherwell, Charles Gordon, Westmount, Que.—B.Eng. (Mi.).
Roncarelli, Joseph Angelo, Montreal, Que.—B.Eng. (Mech.).
Snyder, William Garrett, Edmonton, Alta.—B.Eng. (Mech.).
Stanley, James Paul, Westmount, Que.—B.Eng. (Mech.).
Wallman, Clifford George, Winnipeg, Man.—B.Eng. (Mech.).

*This prize donated by F. P. Shearwood, M.E.I.C., Past-President of The Institute.

Results of May Examinations of The Institute

The report of the Board of Examiners, presented at the meeting of Council held on May 20th, 1938, 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 "B"—For admission as Junior:
Harry G. Stead, London, Ont.

Schedule "C"—For admission as Associate Member:
Eric Grant, Jr.E.I.C., Montreal, Que.
A. R. Moffat, Jr.E.I.C., Bourlamaque, Que.

Leonard Medal Presentation

On June 21st, at Sydney, N.S., Vice-President R. L. Dunsmore, on behalf of The Institute, presented the Leonard Gold Medal to T. L. McCall, M.E.I.C. Mr. McCall was awarded this prize for his paper on "Coal Mining Practices of the Dominion Steel and Coal Corporation Limited," of which corporation he is Chief Engineer.

The Leonard Medal was established by the late Lt.-Col. R. W. Leonard, and is an annual award for an outstanding paper on a mining subject by one who is a member of The Engineering Institute of Canada or the Canadian Institute of Mining and Metallurgy. This year the winner is a member of both organizations.

ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

Canadian Institute of Mining and Metallurgy and the Mining Society of Nova Scotia: Transactions, Vol. XI, 1937.
Engineering Society of Detroit: Membership Directory, 1938.
Engineering Society of the University of Toronto: Transactions and Year Book, 1938.
Nova Scotian Institute of Science: Proceedings, Vol. 19, pt. 3. Halifax, 1938.

Reports, etc.

American Telephone and Telegraph Company and the Edison Electric Institute: Inductive Co-ordination of Rural Power and Telephone Systems (Engineering Report No. 40, January 1938).
Alberta Department of Lands and Mines: Annual report, 1937; Dramatic Change in Canada's Position in 1937, by J. L. Irwin.
British Rubber Publicity Association: Report on Pneumatic Tyred Carts and Other Equipment, by Prof. Robert Rae.
Canada National Employment Commission: Final Report, January 1938.
Canada Department of Mines and Resources Bureau of Mines: Limestones of Canada, their Occurrence and Characteristics, Pt. 4, Ontario, by M. F. Goudge.
Canadian Government Purchasing Standards Committee: Tentative Specifications: Putty for Glazing, Types I and II; Enamel, Exterior and Marine, Signal Red; Paste Colours in Oil; Cellulose Finishes for Aircraft Fabric; Conversion Table for Colorimetric Instruments and Solutions; Unbleached Cotton Sheeting for Bedding.
Electrochemical Society: Preprints 73-30—73-35. Mechanism of Cellulose Reactions; Preventing Corrosion in the Sulfate Pulp Mill; The Cathode Ray Oscillograph Applied to the Dropping Mercury Electrode; Applications of Electrophoresis and Electro-osmosis in the Ceramic Industries; The Anodic Corrosion of Commercial Manganese During Electrolysis; The Physical Chemistry of Clay as Related to Paper Filling.
Franklin Institute: Dedication of the Benjamin Franklin Memorial, May 1938.
Institution of Civil Engineers: Report of the Research Committee, 1935-36 and 1936-37.
International Tin Research and Development Council: Second General Report 1937.
Lancashire Industrial Development Council: Lancashire Builds, a Survey of New Industries and Factories since 1930.
Purdue University: Testing Procedure Motor Vehicle Directional Signals, J. H. Karr; Promotion of Safety on the Highways, Hallie Myers; Personnel and Industrial Relations, Proceedings of the Industrial Personnel Institute. (Engineering Bulletin Nos. 1-3.)
Quebec Department of Mines and Fisheries Bureau of Mines: Annual Report for 1936, Pt. A, Mining Operations and Statistics.
Quebec Department of Municipal Affairs, Trade and Commerce: Statistical Year Book, 1937.
U.S. Department of the Interior: Geology and Ground-Water Resources of South-Central Nebraska (Geological Survey Water-Supply Paper 779); Geology and Ore Deposits of Bayhorse Region Custer County, Idaho; Geology and Mineral Deposits of Snowmass Mountain Area Gunnison County, Colorado, Spirit Leveling in Kansas 1896-1935, Geophysical Abstracts 89 April-June 1937 Spirit Leveling in Missouri, Pt. 1 Southeastern Missouri 1896-1937 (Geological Survey Bulletin, 877, 884, 889, 895-B, 898-A).

Technical Books, etc.

Airplane Structures. By Alfred S. Niles and Joseph S. Newell. 2nd ed. N.Y., Wiley, 1938. 2 vols., figs., tables, charts, 9¼ by 6 in., cloth, $7.75.

A Practical Treatise on **Chimney Design.** By D. A. Molitor. Detroit, Mich., Peters Co., 243 W. Congress St., 1938. 123 pp., diagrs., tab., charts, 9 by 7 in., paper, mimeographed, $2.50.

A comprehensive treatise on the structural stability and practical design of chimneys. General factors relating to selection of types and materials, theoretical stress analysis, and chimney foundations are covered in the first few chapters. Then follow three chapters treating respectively of brick, reinforced concrete, and steel types. Comparative design data and costs are given for corresponding chimneys in the three materials. Chimney builders are listed.

Elements of Structural Engineering. By Edward S. Sheiry. Scranton, International Textbook Co., 1938. 326 pp., illus., diagrs., tab., charts, 5½ by 8½ in., lea., $4.00.

Fundamentals of Electrical Engineering. By M. B. Reed. Scranton, International Textbook Co., 1938. 326 pp., illus., diagrs., charts, tab., 9 by 5 in., lea., $3.00.

An elementary textbook covering the customary electrical quantities and phenomena, including chapters on transients and conduction through gases. In the treatment of electric circuits the double-subscript method now in use for a.c. circuits is applied to d.c. Explanatory problems are given.

Simplified Engineering for Architects and Builders. By Harry Parker. N.Y., Wiley, 1938. 214 pp., $2.75.

BOOK REVIEWS

Boulder Canyon Project Final Reports Part VI: Hydraulic Investigations

Bulletin 1. Model Studies of Spillways. U.S. Bureau of Reclamation, Denver and Washington. 190 pp., 9¼ by 6¼ inches; Cloth $1.50, paper $1.00, post free.

Bulletin 2. Model Studies of Penstocks and Outlet Works. U.S. Bureau of Reclamation, Denver and Washington. 165 pp., 9¼ by 6¼ inches; Cloth $1.50, paper $1.00, post free.

Reviewed by J. B. Macphail, A.M.E.I.C.*

The United States Bureau of Reclamation is preparing for publication a series of bulletins on the Boulder Canyon Project, to record the history of the development, the results of technical studies and experimental investigations and the more unusual features of design and construction. There will be some forty in all, and these two are the first to appear.

In designing the spillways, a flood of 400,000 cu. ft. per sec. had to be taken past a dam 500 ft. high. The bulletin first mentioned describes various methods which were found to be unsatisfactory, and the various steps leading to the final design of two spillways, each discharging into a deep trapezoidal side channel only 40 ft. wide at the bottom, and then into tunnels. The present theory of design was found to be satisfactory, except for flows near critical depth, and little was added to it, but the great use of the models was in developing refinements in details, to eliminate undesirable eddies and turbulence. Without these experiments, according to the authors, the same degree of security could have been attained only by the expenditure of several million dollars more. Much of the space in the bulletin is devoted to a description of the effects of the various changes in details, and it appears likely to be of use to those who have similar problems to face.

Model tests at different scale ratios of 1/100, 1/60 and 1/20 gave satisfactorily consistent results even in wave forms, and their extension up to full size is therefore partly justified. The final proof, a comparison of photographs of model and prototype for similar flows, is difficult to get because of the infrequency of high flows, but it is to be hoped that something will be done in this direction. There is a reference to some comparisons of this kind wherein the prototype flow was rougher than the model flow, with more foam and mist, a thing which, incidentally, has been found elsewhere in other circumstances. There is a good discussion of the effects of entrained air, leading to the conclusion that allowance for it is most needed only at low and unimportant flows.

Some experiments on a Stoney gate 60 ft. wide by 80 ft. high were made in one scheme, and the discharge was found to agree well with theory but the water surfaces did not. Lack of time prevented further enquiry. Some observations of flow in the model tunnels are reported; and some experiments with jets show that velocities of 175 ft. per sec. may safely be used on the concrete lining.

The second of the bulletins describes some model tests of other elements. The loss of head at pipe junctions was very thoroughly investigated, with the conclusion that a short conical section in the branch at the junction with the main reduces the junction loss by two-thirds, and that full scale losses are probably less than model losses.

Tests were also made on models of the intake towers and penstocks, on the use of needle valves for discharging surplus water and the effect of the outlet works on the topography of the tailrace. Many results, useful both in construction and operation were obtained.

Both bulletins accomplish very successfully their purpose of describing the experimental methods used in investigating specific problems, and in giving sufficient extracts from a large mass of test data to support the conclusions which were reached. References to theory, and to other experimental work, are intentionally confined to separate bibliographies for the various subjects.

**Shawinigan Engineering Company, Montreal, Que.*

Transactions and Year Book

The Engineering Society of the University of Toronto, 1938

An interesting publication in the form of Transactions and Year Book has recently been issued by the Engineering Society of the University of Toronto. There are in all one hundred and eight pages containing messages from University officials, transactions of the Society, and the year's record of general activities. It is beautifully printed and bound, and is a great credit to this undergraduate society.

The balance sheet accompanies the book as supplement, and is perhaps the most interesting feature of it all. It shows assets of almost $10,000 with a portfolio of investments that is steadily growing from year to year. Sales of supplies to students amounted to almost $13,000, from an inventoried stock of nearly $2,000. Any organization that can turn over its merchandise six and a half times in an operating year of only six months has something to show to business in general. Our congratulations to the Engineering Society.

Thermal Conductivity of Building Materials

By Frank B. Rowley and Axel B. Algren, Engineering Experiment Station Bulletin No. 12, University of Minnesota, Minneapolis, 1937. 134 pp., 9 by 12 inches. $1.00 (cloth $1.50).

Reviewed by Professor E. A. Allcut, m.e.i.c.*

This bulletin is a summary of the work done by Professor Rowley and his associates at the University of Minnesota on the transmission of heat through building materials and walls. Most of it has been published in the Transactions of the American Society of Heating and Ventilating Engineers, and a list of the papers is given in the bulletin, but it is very convenient to have the material collected together in this form.

The first part consists of descriptions and illustrations of the apparatus used in making the tests. The materials were tested in a guarded hot plate apparatus 12 in. sq. This indicates that the experiments were confined to thicknesses not greatly exceeding one inch. Thicker specimens and wall sections were tested in the guarded hot box which is approximately 5 ft. cube and has a test surface 3 ft. sq.

An interesting piece of test apparatus is that used for measuring surface coefficients or the effect of wind direction and velocity on heat losses. The curves indicate that the relationships between the surface conductance and the mean temperature and air velocity, respectively, are practically represented by straight lines, so that simple formulae may be derived for them. The influence of the character of the surface and that of different angles of incidence are also indicated, so that corrections may be made for winds of different speeds and blowing from different directions.

A large number of test results and curves are given for air spaces, and these indicate that no increased thermal resistance is obtained by increasing the thickness of an air space beyond ⅞ in. Test results, obtained by the reviewer, do not agree with this general conclusion. The influence of bright surfaces such as aluminum foil, on the heat transmission across an air space is also discussed in some detail.

Considerable space is given to test results on timber in the dry and moist states, but there does not appear to be any indication of the thickness of the samples tested. This will probably have some influence on the results, particularly as the moisture tends to migrate from the hot to the cold side of the specimen. The general impression that the heat transmission increases in direct proportion to the moisture content, is confirmed by these tests.

The bulletin ends with a large number of test results on walls of frame, brick, hollow tile and monolithic construction, and these tables are very useful for reference purposes. While the whole of this work is very valuable, test apparatus and procedure are still insufficiently standardized and therefore the figures given should be regarded as relative only and should be applied with discrimination.

*Professor of Mechanical Engineering, University of Toronto, Toronto, Ont.

Trade Literature*

Floodlighting.—The Northern Electric Company Limited, Montreal, have published an 8-page bulletin on this subject, illustrating their different types of floodlights and the uses to which they may be put.

Refrigeration.—A 36-page catalogue has been received from Canadian Ingersoll-Rand Company Limited, New Birks Bldg., Montreal, Que., reviewing the development, perfection and advantages of their centrifugal water-vapour refrigeration system.

Roofing and Siding.—The Canadian Johns-Manville Company Limited, Laird Drive (Leaside), Toronto, have issued a 12-page booklet on industrial roofing and siding. Typical installations of their corrugated transite are illustrated.

Motors.—A 4-page leaflet, which has been received from the General Electric Company Limited, Montreal, Que., describes motors for every running-speed condition.

Motor Testing.—A 4-page booklet has been received from the Canadian General Electric Company Limited, Montreal, Que., on the selecting of portable electric instruments for motor testing.

Prospecting.—The Geophysical Instrument Company, Washington, D.C., have issued a 4-page bulletin on their seismic prospecting apparatus, refraction type, for mineral and oil prospecting, engineering and geological sub-surface investigation, solution of foundation problems and study of vibration problems.

Friction Materials.—An 8-page brochure recently received from the Canadian Johns-Manville Company Limited, Laird Drive (Leaside), Toronto, presents data on the lines of industrial brake linings and blocks and clutch facings for all types of industrial equipment. Illustrations and tables accompany the next.

British Manufactures.—The British Engineers' Association, 32 Victoria Street, Westminster, London S.W.1, England, have issued the 1938 edition of their Classified Handbook of Members and their Manufactures.

*Copies of the above publications may be obtained by writing to the companies mentioned.

BOOK NOTES

The following notes on new books appear here through the courtesy of the Engineering Societies Library of New York. As yet, the books are not in The Institute library, but inquiries will be welcomed at Headquarters, or may be sent direct to the publishers:

Analytical Chemistry of Tantalum and Niobium. By W. R. Schoeller. London, Chapman & Hall; New York, Nordemann Publishing Co., 1937. 198 pp., tables, 9 x 6 in., cloth, $5.50.

A practical manual for the quantitative analysis of their pentoxides and the separation of tantalum and niobium from each other and from the rare metals and the earth oxides. Brief historical material is included and special attention is given to the application of tannin in gravimetric analysis of the various rare metals and earths.

Army Engineering. By W. A. Mitchell. 5 ed. Washington, D.C., Society of American Military Engineers, 1938. 329 pp., illus., diagrs., charts, tables, 7 x 4 in., lea., $3.00.

"Army engineering" designates that portion of military engineering not included in fortification. As a consequence this United States Military Academy textbook covers mapping, roads, railways, bridges, camouflage, explosives, gasoline engines, power plants, chemicals, and river and harbour engineering from the point of view of military operations. There is also brief information on fortification, although there is a separate text on that subject.

British Non-Ferrous Metals Research Association Series No. 473. **Elastic Properties of Non-Ferrous Metals and Alloys: Collected Data.** By J. McKeown and E. D. Ward. London, British Non-Ferrous Metals Research Association, Regnart Bldgs., Euston St., 1938. 35 pp., charts, tables, 12 x 10 in., linen, 6s.

The data presented in this report have been selected after a critical survey of a large mass of published information. Copper, nickel, aluminum, magnesium, gold, silver, the platinum group metals, and their alloys are included. The elastic properties are presented in tables or graphically, with information on the ultimate tensile strength and elongation of the materials in many cases. A list of sources of the data is included.

Chinese Bridges. By H. Fugl-Meyer. Shanghai, Hong Kong, Singapore, Kelly and Walsh, Ltd., 1937. 138 pp., illus., diagrs., 9 x 6 in., cloth, $5.00. (Also K. Paul, London, 9s.)

Descriptive information concerning old Chinese bridges, including stone and wooden trusses, stone and brick arches, wooden cantilevers, and rope and chain suspension bridges. Historical notes, superstitions, and the results of some bending tests on stone beams are also included.

Einführung in die Technische Schwingungslehre, Bd. 1, Einfache Schwinger. By K. Klotter. Berlin, Julius Springer, 1938. 206 pp., diagrs., charts, tables, 10 x 7 in., cloth, 19.80 rm.; paper, 18 rm.

This is the first part of a three-volume introduction to vibration in engineering. In the present work the characteristics of simple oscillating bodies and mechanisms are considered theoretically. An introductory section on the general theory of vibration is followed by a discussion of the kinetics of simple oscillators under varying conditions of free or forced, damped or undamped vibration, including material on starting effects and maintained vibrations.

Elasticity Structure and Strength, Philosophy Natural versus Sophistical for Problems of Astronomy and Physics, Promotion of Progress in Engineering and Chemical Mechanics and Analysis of the Structure of Matter: Electronics and Organic Functions, Part 2. By C. A. P. Turner. Columbus, Ohio, 964 North High St., the author, 1938. 82 pp., charts, 12 x 9 in., paper, manifold copy, apply.

Chemical mechanics is conceived as a science through which the physical properties of matter may be determined quantitatively from chemical structure. The postulation of this structure as triunal, consisting of a group of atoms enclosing an atmosphere of pulsation and enclosed by an atmosphere of vibration of a fundamental aether, and of an inherent relation between atomic weights and various chemical, electrical and mechanical properties, permits the calculations produced.

Electric Welding. By M. H. Potter. Chicago, American Technical Society, 1938. 77 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $1.25.

A practical book for the inexperienced welder, describing processes and equipment, methods for various metals, shapes and types of work, the weldability of different metals, and certain special jobs. The last chapter covers power tube rectifiers and their utilization in welding equipment.

Elements of Physics. By A. W. Smith. 4 ed. New York and London, McGraw-Hill Book Co., 1938. 790 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $3.75.

A further revision of a standard textbook on physics, covering under the headings: mechanics, wave motion and sound, heat, magnetism and electricity, electronics, physical and geometrical optics, radiation and atomic structure, the manifold phases of the modern subject. Two new chapters are devoted to nuclear physics and astrophysics.

Elements of Steam and Gas Power Engineering. By A. A. Potter and J. P. Calderwood. 4 ed. New York and London, McGraw-Hill Book Co., 1938. 374 pp., illus., diagrs., charts, tables, 8 x 6 in., cloth, $2.75.

The beginning chapters cover the fundamentals of thermodynamics, fuels and combustion. Succeeding chapters cover steam power-plant machinery, auxiliaries and accessories, and internal-combustion engines, fuels and auxiliaries. The final chapter treats of the application of steam and gas power to locomotives, automobiles and airplanes. Problems are included.

Elements of Thermodynamics. By E. M. Fernald. 2 ed. New York and London, McGraw-Hill Book Co., 1938. 330 pp., diagrs., charts, tables, 9 x 6 in., cloth, $3.50.

A textbook presenting the subject with special reference to its applications in engineering. The customary topics of general phases and states, steam cycles, refrigeration cycles, gas mixtures, compressed air, flow phenomena, combustion and available energy are included. The last chapter, however, represents an endeavour to present the essential structure of thermodynamics from the viewpoint of pure energy relations.

Engineering Electronics. By D. G. Fink. New York and London, McGraw-Hill Book Co., 1938. 358 pp., illus., diagrs., charts, tables, 6 x 9 in., lea., $3.50.

A practical volume for engineers who wish to take up or review electronic principles and their application in typical engineering problems of tube use and circuit design. Covers the fundamentals of electron physics and electron tube structures, the engineering characteristics of a wide variety of tubes, and a demonstration of the application of tubes in a variety of electrical and industrial problems.

From Plan to Reality, Two, ed. by the Staff of the Regional Plan Association, April 1938. New York, Regional Plan Association, 400 Madison Ave. 95 pp., illus., diagrs., maps, charts, tables, 12 x 9 in., cloth, $2.00.

Describes the developments carried out according to the "Regional Plan of New York and Its Environs," particularly during the last four years, with a general summary of the last eight years. Highways and parkways, rail and air transportation and other public services, parks and reservations, and the organization for future planning are covered. Maps, diagrams and photographs illustrate the text.

Great Britain. Dept. of Scientific and Industrial Research. **Building Research** Technical Paper No. 20. London, His Majesty's Stationery Office, 1938. 111 pp., illus., diagrs., charts, tables, 10 x 6 in., paper, 3s. [obtainable from British Library of Information, 270 Madison Ave., New York, $0.95].

For a number of years the Department, with the co-operation of the Institution of Civil Engineers, has been studying these stresses. The outcome of these investigations has been the formulation of a theory that explains the phenomena observed and which has made it possible to construct charts for the guidance of engineers in safeguarding the pile from excessive stresses. The theory will also assist in diagnosing the cause of failure. The theory is presented in this pamphlet, together with recommendations concerning the manufacture, handling and driving of reinforced concrete piles, based upon the investigations.

Great Britain. Dept. of Scientific and Industrial Research. **Fuel Research,** Physical and Chemical Survey of the National Coal Resources No. 43. The **Leicestershire and South Derbyshire Coalfield, South Derbyshire Area,** the **Stockings Seam.** London, His Majesty's Stationery Office, 1938. 59 pp., illus., tables, 10 x 6 in., paper, 2s. [obtainable from British Library of Information, 270 Madison Ave., New York, $0.65].

Results of a comprehensive and detailed examination, from floor to roof, of eight pillar sections taken from points distributed over the area of the important coal seam in question. The results of the various analyses are given in tabular form with a summary for the whole seam.

Great Britain. Dept. of Scientific and Industrial Research. **Water Pollution Research** Technical Paper No. 7. **Estuary of the River Mersey.** London. His Majesty's Stationery Office, 1938. 337 pp., diagrs., charts, maps, tables, 13 x 8 in., cloth, £1 10s. [obtainable from British Library of Information, 270 Madison Ave., New York, $7.75].

In 1932 the Department of Scientific and Industrial Research undertook an investigation of the possible effects of the discharge of untreated sewage into the estuary of the River Mersey upon the amount and hardness of the deposit in the estuary. The investigation was completed in 1937 and the methods and conclusions are now available in this report which is of interest to students of sedimentation generally. So far as this case was concerned, the sewage discharge was found to have no appreciable effect.

Great Britain. Dept. of Scientific and Industrial Research. **Fuel Research** Technical Paper No. 44. **The Action of Hydrogen upon Coal,** Pt. 3. The Development of a Small-Scale Liquid-Phase Continuous Plant, by N. Booth, F. A. Williams and J. G. King. London, His Majesty's Stationery Office, 1938. 27 pp., illus., diagrs., charts, tables, 10 x 6 in., paper [obtainable from British Library of Information, 270 Madison Ave., New York, $0.30].

Continuing a research on the action of hydrogen upon coal, this part describes the layout and development of a small-scale plant for the continuous hydrogenation of coal in the liquid phase. There is also information concerning the influence of coal composition on the process.

Great Britain. Dept. of Scientific and Industrial Research. **Investigation of Atmospheric Pollution,** Report on Observations in the Year ended 31st March, 1937. 23rd Report. London, His Majesty's Stationery Office, 1938. 161 pp., charts, maps, tables, 11 x 9 in., paper [obtainable from British Library of Information, 270 Madison Ave., New York, $2.15].

Tabular and explanatory data regarding observations made with deposit gauges and automatic filters, measurements of sulphur pollution, daylight, and ultra-violet radiation, including the effect of the site of the station upon recorded observations.

Great Britain. Mines Dept. **Report of the Committee on the Firedamp Detector Regulations.** London, His Majesty's Stationery Office, 1938. 55 pp., charts, tables, 10 x 6 in., paper, 1s. [obtainable from British Library of Information, 270 Madison Ave., New York, $0.35].

The report includes the working of the regulations (the text of which appears in Appendix I), a comparison of flame lamps and automatic detectors, a consideration of the Ringrose alarm (tests of which appear in Appendix II), recommendations and reservations as to the use of automatic firedamp detectors in mines.

History of the Gas Industry. By L. Stotz in collaboration with A. Jamison. New York, American Gas Association, 420 Lexington Ave., 1938. 534 pp., illus., maps, tables, 9 x 6 in., cloth, $3.50 ($3.00 each for 10 or more copies).

A non-technical story of the gas business in the United States, covering the period from its introduction in Baltimore in 1816 to the present day and including developments, expansion of uses, financial and business activities, rates, etc., with a section on natural gas.

Household Electric Refrigeration. By J. F. Wostrel and J. G. Praetz. New York and London, McGraw-Hill Book Co., 1938. 406 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $4.00.

A practical manual for refrigeration service men, electricians, salesmen and others interested in the operation, construction, adjustment and servicing of household refrigerators and their control devices. In non-technical language it covers refrigeration fundamentals and the various types of household machines and systems, and gives facts and instructions for trouble-shooting, service shop equipment, etc.

Introduction to College Physics. By C. M. Kilby. 2 ed. New York, D. Van Nostrand Co., 1938. 398 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $3.25.

This text book is intended to present a brief course in the fundamentals of physics. The arrangement of material is orthodox, there being five main sections on mechanics, sound, heat, magnetism and electricity, and light. There are many worked-out problems in the text material and lists of review problems with each chapter.

Introduction to Yacht Design. By A. A. Symonds. London, Edward Arnold & Co.; New York, Longmans, Green & Co., 1938. 142 pp., diagrs., charts, tables, 9 x 6 in., cloth, $3.50.

This introduction is intended for the amateur, and presents the elementary theoretical and practical principles in simple language. The physical principles involved in floating and sailing are discussed in the first part, and accommodation and draft requirements and their bearing upon design are considered. The second part deals with the practice of design, following the practice, step by step.

Introductory Economic Geology. By W. A. Tarr, 2 ed. New York and London, McGraw-Hill Book Co., 1938. 645 pp., illus., diagrs., charts, maps, tables, 9 x 6 in., cloth, $5.00.

A comprehensive general survey of the earth materials used by man. Historical material and the principles of the formation of mineral deposits appear in Part I. Parts II and III cover respectively metallic and non-metallic (coal, petroleum, minerals) materials, including the occurrence, geographic distribution, mining, treatment, applications, and production statistics of the various materials of economic importance.

Isaac Newton 1642-1727. By J. W. N. Sullivan, with a memoir of the author by C. Singer. New York, Macmillan Co., 1938. 275 pp., 9 x 6 in., cloth, $2.50.

A new biography in which the purpose has been to paint a clear picture of Newton, the man, stressing the events which influenced his career and throw light on his character. His scientific achievements are discussed particularly with reference to their relation to the contemporary scene and subsequent developments.

A Manual of Porcelain Enameling. Ed. by J. E. Hansen; published for the Ferro Enamel Corporation by The Enamelist Publishing Company, Cleveland, Ohio, 1937. 513 pp., illus., diagrs., charts, tables, 9 x 6 in., lea., $5.00.

A collection of articles upon the application of wet-process enamels to sheet iron and cast iron. A diversity of subjects is covered, including design and fabrication of sheet-iron parts, equipment and methods for preparing and applying enamels, inspection and decorative effects. Short bibliographies and a glossary add to the value of the book.

National Physical Laboratory Report for the Year 1937. London, His Majesty's Stationery Office, 1938. 150 pp., tables, 10 x 6 in., paper, 2s. 6d. [obtainable from British Library of Information, 270 Madison Ave., New York, $0.80].

In addition to general information concerning the laboratory and its work, this publication presents the reports of the William Froude Naval Laboratory and the departments of physics, electricity, radio, metrology, engineering, metallurgy and aerodynamics, indicating the state of the current researches.

Newfoundland Geological Survey, Information Circular No. 4. **Mines and Mineral Resources of Newfoundland.** By A. K. Snelgrove. St. John's, Newfoundland, Geological Survey, 1938. 162 pp., illus., maps, diagrs., charts, tables, 9 x 6 in., paper, free upon application.

Aims to give an authoritative account of the past and present mining industry and to eall attention to opportunities for further development. The geology of the eountry and the conditions affecting mine development are discussed briefly. The active mines and quarries are described and about one-half the report is devoted to inactive mines and projects. A number of maps accompany the report.

On the **Edeleanu Process.** By J. C. L. Defize. Amsterdam, D. B. Centen's Uitgevers-Nastschappij N.V., 1938. 310 pp., illus., diagrs., charts, tables, 10 x 6 in., cloth, $7.50.

A full description of the process for the selective extraction of mineral oils with liquid sulphur dioxide. The plant is described with the aid of flowsheets and photographs, the purpose and nature of the process are explained and the basic theoretical considerations are stated in the early chapters. The major part of the book is devoted to experimental work on kerosenes, lubricating oils, petrols, etc. References and a patent list are given.

Radio-Frequency Electrical Measurements. By H. A. Brown. 2 ed. New York, McGraw-Hill Book Co., 1938. 384 pp., diagrs., charts, tables, 9 x 6 in., cloth, $4.00.

A guide for radio engineering laboratory instruction. Within each chapter, covering a particular group of measurements of circuit constants, frequency, electron-tube coefficients, etc., the principles are explained, the laboratory equipment and procedure are described, and the precision attainable, the necessary precautions and the merits of the methods are discussed.

Sand, Gravel and Other Aggregates. Methods of Testing. By J. Watson. New York, Chemical Publishing Co., 1938. 48 pp., illus., 9 x 6 in., cloth, $1.75.

Testing methods for sand, gravel and other aggregates for use as construction materials, in moulding practice, and as refractories. The importance, evaluation, procedure, and equipment of the tests are discussed.

A Short History of Naval and Marine Engineering. By E. C. Smith. Cambridge, England, University Press; New York, The Macmillan Co., 1938. 376 pp., illus., diagrs., charts, tables, 10 x 6 in., cloth, $6.00.

This book, it is claimed, is the first to give a consecutive account of the whole progress of marine engineering. Its author, an Engineer Captain of the British Navy, has devoted many years to collecting the material which is here presented in pleasant, readable form. A large amount of information is presented upon the development of screw propellers, marine boilers and engines, steam turbines, auxiliary machinery and internal-combustion engines, as well as about the men responsible for this development.

Then Came Oil. By C. B. Glasscock. Indianapolis and New York, Bobbs-Merrill Co., 1938. 349 pp., illus., 9 x 6 in., cloth, $3.00.

Oklahoma history from the time of the Indian Territory to the present day, written around the development of the oil industry. Indian troubles, settlement rushes, gushers, oil pools, bad men, financial and promotional personalities, fortunes made and lost, and the final solid accomplishments are presented in this picture of the wiping out of the last frontier.

Trane Air Conditioning Manual. 2 ed. La Crosse, Wisconsin, The Trane Co., 1938. 333 pp., illus., diagrs., charts, tables, 11 x 8 in., cloth, $5.00.

Primarily concerned with the application of the fundamental faets of engineering to the design of air conditioning systems, this publication touches on all phases of the field. Heat and its transmission, physical comfort, air properties and supply, psychrometry, refrigeration and ventilation processes, and the functions of water in air conditioning, all these, with numerous diagrams, tables, problems and numerical examples, comprise a comprehensive practical treatment of the subject.

Journal Cover Competition

The Publications Committee has been pleasantly surprised at the number of designs that have been submitted. The suggestions are all excellent and the task of choosing one as being more meritorious than the others is not going to be an easy one. The competition closed at the end of June, but that was too late for any announcement to be made in this number. Definite word should be available for the next issue.

BRANCH NEWS

C. E. Sisson, M.E.I.C.
Newly Elected Chairman of the Toronto Branch

Halifax Branch

R. R. Murray, M.E.I.C., Secretary-Treasurer.
A. D. Nickerson, A.M.E.I.C., Branch News Editor.

On the evening of April 30th, 1938, the Halifax Branch E.I.C. tendered a reception to a visiting party from Montreal consisting of President J. B. Challies and Mrs. Challies, General Secretary L. Austin Wright, Vice-President J. A. McCrory and Councillor F. Newell.

President Challies was the principal speaker of the evening. He referred to the high regard with which the Canadian engineers had been held at the first World Power Conference in London in 1924. Speaking of the work done by the 1924, 1930 and 1936 Power Conferences, Mr. Challies discussed the national policies of various countries in providing a network system of primary electric energy. Canada was now recognized as one of the most advanced countries in the world in respect to hydro-electric development.

Other speakers included L. Austin Wright, A.M.E.I.C., J. A. McCrory, M.E.I.C., F. Newell, M.E.I.C., and Hon. Michael Dwyer, A.M.E.I.C., Minister of Public Works and Mines for Nova Scotia.

Following the banquet the party adjourned to the hotel ball room where dancing was enjoyed.

On Sunday, May 1st, Mr. and Mrs. J. B. Challies entertained the members and wives of the Halifax Branch at afternoon tea at the Lord Nelson hotel. About 150 guests were present at this very enjoyable affair.

London Branch

D. S. Scrymgeour, A.M.E.I.C., Secretary-Treasurer.
Jno. R. Rostron, A.M.E.I.C., Branch News Editor.

A very successful joint meeting was held at Brantford on May 27th, 1938 (taking the place of the regular monthly meeting of the Branch), when the Grand Valley Group of Professional Engineers under the chairmanship of E. C. Caton, M.E.I.C., acted as host to members of Niagara Falls, Hamilton and London Branches of the E.I.C.

Approximately 100 members and guests sat down to a delightful dinner served at the Kerby House.

A large number of distinguished guests were there including President J. B. Challies and Vice-President E. V. Buchanan, E. P. Muntz, M.E.I.C., Chairman of the Association of Professional Engineers of Ontario, the Honourable M. McBride, Minister of Labour (whom we note with deep regret has passed away since this meeting was held), the Honourable Duncan Campbell, Minister of Public Works, Honourable H. E. Hipel, Speaker of the House, and J. R. McAllister, Deputy Minister of Public Works.

Among the visitors we were especially happy to see Professor C. A. Robb, M.E.I.C., of the University of Alberta, Edmonton, who, we understand, has again recently added distinction to himself and honour to the profession. We were also particularly glad to note the presence of W. J. Johnstone, A.M.E.I.C., District Engineer, Department of Public Works, Winnipeg, who with others were able to renew old friendships.

A representative number attended from the various Branches of the E.I.C. headed by W. J. Reid, M.E.I.C., chairman of the Hamilton Branch, and our own chairman, A. O. Wolff, M.E.I.C.

During the afternoon golf, skeet and trap shooting were indulged in by devotees of those sports.

Our General Secretary, L. Austin Wright, made his first appearance in these parts and left a good impression.

A civic welcome was tendered by the Mayor of Brantford after the dinner, following him the Honourable Duncan Campbell paid a warm tribute to the engineers for always having held up the standard of their profession but he stressed the need for leadership in the country's affairs today which he felt the engineering profession was so well qualified to meet if, as individuals, they would take a more active part in public affairs.

Mr. Muntz, in speaking about the Professional Associations' influence, pointed out the enabling legislation that now existed for the benefit of the profession in Ontario and in fact all over the Dominion. He expressed the opinion that the real groundwork had been provided for the engineer to make himself a little more constructively prominent in community and general public welfare.

Following him George D. Leacock, President of Moloney Electric Company, Toronto, and a brother of the exceptionally fine Canadian Stephen Leacock, gave a very humorous and entertaining address.

President Challies gave the main address of the evening paying a glowing tribute to those outstanding engineers, many of whom had been born and raised in this part of Ontario and who had in the past given so much of their personality, training and ability, not alone to engineering developments and great projects but had contributed in equal measure to the building and progress of our country. He pointed with pride to the magnificent achievements that had been made and are still being accomplished through the individual and collective efforts of members of our profession. The complexity of our problems, engineering, as well as social, contains an ever fresh challenge to us all. Their solving is one well within the confines of our training and one worthy of our attention.

E. T. Sterne of Brantford, in his own inimitable and admirable way, extended thanks and appreciation to the distinguished guest speakers.

The meeting was voted one of the most successful and worth while that had been held for some time.

Nine members from London were able to be there.

Moncton Branch

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

The annual meeting of the Branch was held on May 31st, 1938. Chairman E. B. Martin, A.M.E.I.C., presided. The annual report and financial statement was presented, and approved, on motion of G. L. Dickson, A.M.E.I.C., seconded by R. H. Emmerson, A.M.E.I.C. At a meeting held on May 19th for the nomination of Branch officers for next season, no more than the number required were nominated and an election had, therefore, been unnecessary. The chairman announced that the following would constitute the Branch executive for 1938-39: Chairman, B. E. Bayne, A.M.E.I.C.; Vice-Chairman, F. L. West, M.E.I.C.; Secretary-Treasurer, V. C. Blackett, A.M.E.I.C.; Committee, F. O. Condon, M.E.I.C., G. L. Dickson, A.M.E.I.C., R. H. Emmerson, A.M.E.I.C., A. S. Gunn, A.M.E.I.C., C. S. G. Rogers, A.M.E.I.C., G. E. Smith, A.M.E.I.C.; Ex-officio, E. B. Martin, A.M.E.I.C.

A vote of thanks moved by T. H. Dickson, A.M.E.I.C., was extended the retiring officers.

Ottawa Branch

R. K. Odell, A.M.E.I.C., Secretary-Treasurer.

Roads in the Sky

The last regular noon luncheon of the season for the Ottawa Branch was held at the Chateau Laurier, at which Professor R. DeL. French, professor of Highway and Municipal Engineering of McGill University, spoke upon the subject of "Roads in the Sky."

Safety on the highways has a definite economic value, declared Professor French. He foresaw the day when many drivers of today would be told they were not fit to drive and if they wanted to travel on the highways it would have to be with a driver who met the qualifications. Statistics show that four per cent of accidents on the highways are due to defects in the vehicle, while five per cent are due to defects in the highway. The remaining 91 per cent are due to defects in the drivers and because of this he said licensing would become more strict and penalties for breaches of the traffic laws more stringent.

When engineers design roads on which it would be easier to drive safely than recklessly they will have accomplished something. Wide shoulders on roads, shallow ditches with a physical division between traffic lanes were desirable features for highways. Islands at intersecting highways force motorists to slow down and reduce accidents. He also advocated the greater use of traffic circles and said he did not know why there were not more of them in Canada. On heavily travelled roads he advocated grade intersections with one road passing above the other and "clover leaf" traffic circles with only right turns to change from one road to another. Provisions for parking off the travelled part of the roads also was necessary.

"It was surprising that in Canada, where efforts are made to attract tourists and where roads travel through beautiful country, the tourists cannot see the country because they have no place to pull up and park," Professor French said. Highway authorities should pay attention to this feature. The problem of bicyclists also was becoming greater and provision for cyclists on highways would be demanded.

Touching on illuminated highways, Professor French spoke of different methods of lighting roads and said the time would come when country roads would be illuminated. Lighting costs about $6,000 a mile, but this was not a high price for the safety which lighting brings by elimination of accidents.

In Canada there were 3,000 deaths and 40,000 to 50,000 accidents from motoring last year, while in the United States 39,000 were killed and there were 400,000 accidents in which there was lost time. The value of a man killed between the ages of 35 and 50 years, on an actuarial basis, Professor French said, had been set at $50,000, the amount necessary to invest in an annuity to provide the income that a man between these ages would earn had he not died. Then there were the medical, hospital, and other charges for accidents to be considered. In view of this, Professor French said the cost of improving highways to promote safety had a definite relationship to the economic value of such work.

W. F. M. Bryce, chairman of the Branch, presided.

Saguenay Branch

C. Miller, A.M.E.I.C., Secretary-Treasurer.
J. W. Ward, A.M.E.I.C., Branch News Editor.

At the regular monthly meeting of the Saguenay Branch held in Arvida on March 25th, 1938, some 30 members and guests were present. M. G. Saunders, A.M.E.I.C., vice-chairman, presided.

The first speaker of the evening, N. D. Paine, A.M.E.I.C., general electrical superintendent, Price Brothers and Company Limited, gave an illustrated address on "Operating Experience with Wood-Pole Transmission Lines in Saguenay District." Mr. Paine pointed out the economy and great adaptability of wood poles in transmission-line structures, discussed preservation practices and inspection routine. The great value of wood as an insulating medium was thoroughly presented, and experience data quoted.

One of the illustrations shown by Mr. Paine was most unusual, being a photograph of white-hot telephone line wires on a power-line telephone circuit carried on the same poles as a transmission line, the conductor of which had been struck by lighting about two miles from a large generating station.

The second speaker was F. L. Lawton, M.E.I.C., chief engineer of Saguenay Power Company, Limited, who spoke on "Operating Experience with Steel-Tower Transmission Lines in the Saguenay District." His address, illustrated with a number of slides, covered general features and insulation levels of three double-circuit steel-tower lines in the Saguenay district. The important part played in subsequent operating troubles by defects overlooked at the time of construction was noted, defects discussed being improper sagging of ground wires, kinking of cables, poorly-made joints or splices in cables, etc.

Failures encountered with certain component members of the steel towers, excellent performance of line insulation, relative freedom from conductor fatigue troubles, remedial measures available for vibration difficulties, data on sleet storms, etc., were touched on during Mr. Lawton's talk.

Exposure to lightning storms and operating records were analyzed. Lightning was shown to be the only important cause of service interruptions where good design, good construction practice and careful inspection were applied.

Following the two papers a most instructive discussion took place.

The regular monthly meeting of the Saguenay Branch of The Engineering Institute of Canada was held on May 4th; G. E. LaMothe, A.M.E.I.C., logging division engineer, Price Bros. and Company Limited, delivered an address on "Wood Preservation," before about 60 members and guests.

Wood Preservation

Mr. LaMothe said it was his intention to discuss wood preservation from the point of view of the engineer in Eastern Canada who often uses wood for minor construction where treated lumber is too expensive or in places where transportation is difficult or where it is economically prohibitive to employ pressure treated lumber.

Decay results from an organic process caused by low forms of plant life called fungi—whether the rot be wet or dry. Damage done by insects is not of any magnitude in the Saguenay district. Unseasoned sapwood contains food for fungi whilst the heartwood of many trees holds gum and other substances toxic in nature. Growth of fungi is dependent on the moisture content of the wood the limits between which life exists, being 25 to 150 per cent moisture by weight. Fungi thrive at temperatures between 75 deg. and 90 deg. F., are dormant below 40 deg. F. but cannot be frozen out. Moist heat above 100 deg. F. will kill them and this method of sterilization is sometimes used in completed structures. Air is required for fungus life.

Decay may be combatted by proper seasoning which will reduce moisture content to the safe figure of 12 to 15 per cent whereas green lumber contains 35 to 150 per cent. The use of wood where saturation is continuous or away from air removes the possibility of decay. Design of joints to shed moisture, use of a preservative coating where two surfaces meet, provision for air circulation and protection from the elements are also effective. Where timber roofs are used on heated buildings condensation should be guarded against.

Tree form timber is generally cut in summer. It should be thoroughly barked as this part is impervious to moisture, and, if possible should be skidded into well aired covered piles until hauling season. Cutting and hauling in winter and barking in spring followed by two years seasoning in the yards is the best method for this size timber but is costly.

Preservatives are even detrimental if applied to green lumber but are beneficial when used on seasoned wood. They consist chiefly of coal tar derivatives or water borne salts. The former are not fireproof while the latter are non-inflammable. Points containing hygroscopics help fungus growth due to their moisture attraction. Paint protects against weathering and changes in moisture content with consequent volume changes but is not a preservative. Aluminum paint is more effective as a moisture stop than ordinary paints or varnishes. A lime whitewash is fire retardant and appears to be toxic to fungi.

Of the Eastern Canadian trees within his experience the topic qualities of the heartwood contents decrease in the following order: cedar, pine, jackpine, yellow and black spruce, balsam and common white spruce. The sapwood of these trees is in about the same order for its resistance to fungi. Cedar is an excellent timber for sills and posts though pressure treated wood competition has reduced its popularity. Pressure treatment is the only really reliable method of preservation and should it become economically feasible in the Saguenay district would render many hardwoods useful that are at present weeds.

After this meeting two talkies, "Structural Shapes" and "Golden Gate Bridge," were shown through the courtesy of the Bethlehem Steel Export Corporation.

A meeting of the executive of the Saguenay Branch was held immediately after the general meeting of May 4th. The following members were present:—F. L. Lawton, M.E.I.C., chairman, M. G. Saunders, A.M.E.I.C., vice-chairman, J. S. Fisher, M.E.I.C., A. B. Sinclair, A.M.E.I.C., R. Rimmer, A.M.E.I.C., J. F. Layne, A.M.E.I.C., G. E. LaMothe, A.M.E.I.C., A. C. Johnston, A.M.E.I.C., Charles Miller, A.M.E.I.C., secretary-treasurer.

The following applications were recommended for admission:—

Mr. Omer Chaput as Junior, moved by Mr. Fisher and seconded by Mr. Layne.

Mr. Walter Dow as Junior, moved by Mr. Johnston and seconded by Mr. Rimmer.

The following applications were recommended for transfer:—

Mr. K. A. Booth, Student to Junior, moved by Mr. Johnston and seconded by Mr. Saunders.

Mr. W. P. LeBoutilier, Junior to Associate, moved by Mr. Layne and seconded by Mr. Sinclair.

Mr. Fisher moved and Mr. Johnston seconded the motion that the Saguenay Branch recommend that Julian C. Smith, M.E.I.C., be awarded the Sir John Kennedy Medal for 1938 and that the Secretary advise the St. Maurice Valley Branch accordingly.

Subjects for the Past President's prizes were then discussed. Mr. Saunders moved and Mr. Fisher seconded the motion that the following subjects be submitted.

(1) Use of Canadian Woods in Engineering Structures.
(2) Lack of Engineering Control in Public Work Expenditure.

The Secretary read a letter from the District Vice-President, Mr. Keay, requesting that the Branch Executive appoint members to the Papers Committee. Mr. Layne moved and Mr. LaMothe seconded the motion that the Chairman and the Secretary be appointed members.

The following members were appointed to the Nominating Committee:—

N. McCaghey, A.M.E.I.C., moved by Mr. Layne and seconded by Mr. Sinclair; R. Belanger, A.M.E.I.C., by Mr. LaMothe and Mr. Fisher.

The plans for the annual dinner were next discussed. Moved by Mr. Saunders and seconded by Mr. Layne that a sub-committee of Messrs. Fisher, Rimmer and LaMothe be appointed to investigate the arrangements at Port Alfred.

At a meeting of the Saguenay Branch in Arvida on May 13th, 1938, some 40 members and guests had the pleasure of hearing Dipl.-Eng. A. Leuthold, of Brown-Boveri Company, Baden, Switzerland, give a very interesting illustrated address on:

LATEST APPLICATION OF GRID CONTROL MUTATORS

Mr. Leuthold referred briefly to the origin of the term "mutator" for what we more commonly call "mercury-arc rectifier," and touched on the mutator plant just completed for the Aluminum Company of Canada Limited, at Arvida, Que., where there are 18 high-current mutators with complete static grid control of latest design. This plant constitutes one of the world's largest.

The mutator is an electronic valve, the arc of which burns from the anodes to the cathode in a partial vacuum containing mercury vapour. A fine mesh metal or carbon screen, known as the grid, is placed between each anode and the cathode. Control of anode firing is obtained by applying a potential to grids so that the polarity can be altered as desired. If a negative charge is applied to the grids, no anode current can flow from the anode to the cathode, even if the anode is at high positive potential. As soon as the grid of an anode is positively charged, the anode to the cathode, provided, of course, that the anode is still at positive potential.

By means of oscillograms, Mr. Leuthold demonstrated how shifting the ignition or firing point of the anodes permitted operation of the mutator for rectification with d.c. output or inversion with a.c. output. The limit to voltage regulation by means of grid control was shown to be the permissible power factor in the a.c. supply lines and smoothness of the d.c. voltage.

An additional very important function of the controlled grids is the suppression of backfires in mutators and clearing of short circuits on the d.c. side. A quick-acting grid relay is operated from a current transformer on the mutator transformer primary side, and cuts off the periodic positive charge to the grid as soon as a backfire in the mutator or a short-circuit on the d.c. side occurs. By leaving a negative charge continually on the grids a negative space charge is produced which acts as a brake upon the electrons and prevents the arc from being ignited even during the positive half-wave. The anode which is just firing at this moment extinguishes at the end of its respective half-wave and cannot strike again. In this manner the heaviest short-circuit may be interrupted within one cycle.

Controlled grids make possible the use of mutators for conversion of direct current into three-phase a.c. This development is utilized by the South African Railways at Van Reenen and Colworth substations where mutators for recuperation by regenerative braking have proved entirely satisfactory. The line served has grades of 3 per cent in places.

Another application is the conversion of three-phase current at 50 cycles into single-phase current at $16\frac{2}{3}$ cycles, for single-phase railway systems. The three-phase single-phase mutator loads the three-phase power supply system symmetrically. An adjustable amount of power can be exchanged between the two networks independently of variations in the frequency ratio and without distortion of the voltage curves in either network.

The speaker mentioned the possibility of using grid-controlled mutators in connection with commutatorless d.c. and single-phase motors, for speed regulation and, finally, the use of single-pole grid-controlled mutators as high-voltage direct-current breakers or switches, with a tripping time of 1/1000 to 2/1000 of a second.

In discussing d.c. high-voltage power transmission, Mr. Leuthold noted a mutator has been developed with an output of 2,000 kw. at 50,000 volts d.c.

A most interesting and instructive discussion was brought to a close by A. B. Sinclair, A.M.E.I.C., in expressing the thanks of the meeting.

Saskatchewan Branch

J. J. White, M.E.I.C., Secretary-Treasurer.

The last meeting of the season was held on April 22nd, 1938, under the joint auspices of the Saskatchewan Branch of The Engineering Institute of Canada, the Association of Professional Engineers of Saskatchewan and the Saskatchewan Section of the American Institute of Electrical Engineers. It was held in the King's hotel, Regina, in the form of a dinner meeting.

R. W. Jickling, A.M.E.I.C., the new President of the Saskatchewan Section of the American Institute of Electrical Engineers, was in the chair and the attendance was good for an April meeting, namely seventy.

The speaker, L. M. Howe, M.Sc., District Superintendent of the Saskatchewan Power Commission at Saskatoon, delivered a very unusual and instructive address on "Photographic Registration of Lightning Discharges." The subject matter had been prepared by the speaker from actual experiments under his personal supervision, he had developed his own equipment which was set up for inspection, and he explained in both technical and non-technical language the operation of the equipment and how it photographically recorded the various types of lightning discharges.

Following the technical paper by Mr. Howe the audience viewed some excellent coloured moving pictures of travel through the British Isles and British Columbia. These views were exceedingly well edited by their producer, Professor A. L. C. Atkinson, of the College of Engineering, University of Saskatchewan, Saskatoon. Although the films were designed to be of general interest rather than of special interest to engineers they were greatly enjoyed by the large audience.

During the winter months the executive of the Saskatchewan Branch appointed a committee with Professor R. A. Spencer, M.E.I.C., as Chairman and Messrs. Young, McCannel and Lovell, to prepare an agreement that might be negotiated with the Professional Association for some form of local co-operation. The agreement is now in draft form having been tentatively approved by Headquarters.

In a recent meeting the joint executives of the Saskatchewan Branch of The Engineering Institute of Canada and the Association of Professional Engineers of Saskatchewan gave the draft some further study and with the minimum of amendments approved of it. The draft will now be forwarded to Headquarters for Council approval.

The joint executives were rather proud of the draft agreement and thought that through the columns of The Journal appreciation should be extended to Mr. Spencer and all the members of his committee.

The Benjamin Franklin Memorial

On May 19th, the Franklin Institute of the State of Pennsylvania held dedicatory exercises for the unveiling of a new memorial to that remarkable man Benjamin Franklin. The ceremony occupied three days of stately ceremonies, including the unveiling of the heroic Fraser statue of Benjamin Franklin, lectures on pure and applied science, a two million dollar philatelic exhibition, military and naval displays, and exhibits contrasting the science of Franklin's time with that of to-day. The Journal is pleased to be able to give herewith a sketch of the events, which has been written for us by Dr. T. Kennard Thomson, M.E.I.C., the official representative of The Institute on that occasion.

"It was a great privilege to be the official representative of The Engineering Institute of Canada at the very interesting and impressive Dedication of the Benjamin Franklin Memorial of the Franklin Institute, at Philadelphia on May 19th, 20th and 21st, 1938.

The Government opened a temporary post office in the Franklin Institute and issued for the first time the new Benjamin Franklin half cent stamp.

May 19th—Roll call of the official representatives, over two hundred from all over the world. They were called in chronological order—some dating back over eight hundred years. When waiting to hear 'Our Institute' called I was wondering whether they would use the date of the E.I.C. or that of the Canadian Society of Civil Engineers, and was therefore glad to hear The Institute and my name called as of 1887.

General Charles H. Mitchell responded for the University of Toronto. It is always pleasant to see that University take rank with the first group in age of the universities of this continent.

The American Society of Civil Engineers was represented by Benjamin Franklin of Philadelphia, a consulting engineer and a direct descendant of the original Benjamin Franklin.

During the afternoon the huge and magnificent statue of Benjamin Franklin, by James Earle Fraser, was unveiled in one of the impressive halls of the building.

On Thursday evening the Poor Richard Dinner was held in Franklin Hall with Hon. Daniel C. Roper, Minister of Commerce, as chief guest, making an excellent speech.

On Friday and Saturday, a series of very interesting lectures were given. All were well delivered and on schedule time.

On Friday we were lunched by the Institute; heard the French Ambassador gracefully confer a Medal on the President of the Institute. From four to six o'clock Count Rene Moynel de Saint Quentin, the French Ambassador, gave us a very fine reception and tea at The Barclay, where we met many old friends and made new ones.

Friday evening—Awards of medals by the Franklin Institute and the conferring of degrees by the University of Pennsylvania (University was founded by Franklin). We all marched in wearing our academic gowns and hoods.

The final event was the Dedication Dinner held at Hotel Bellevue-Stratford, with former President Hon. Herbert Clark Hoover as guest of honour. He made an exceptionally interesting speech.

I wish space permitted a description of the magnificent new building and its contents which would require several weeks to carefully examine.

The Franklin Institute was founded in 1824 and is the oldest in the U.S.A. devoted to mechanics, arts and applied science.

Benjamin Franklin (1706-1794) left school to work for his father when he was ten years old. Two years later he was apprenticed to one of his brothers who paid him no wages but paid for his board. Young Benjamin, one of seventeen children and the youngest son of the youngest son for five generations, suggested that his brother give him in cash half the amount that he was paying for his board. This being done, he divided it into two parts, one-half of which he used to buy books. Small wonder he made a fortune, was the best educated, broadest and most inventive minded man of his time, if not of all time. He founded the *Montreal Gazette*; guaranteed the debts of the British Army under General Braddock, which was a great financial strain on him. Franklin probably saved Canada for the British Empire. It would take many books to cover his career, as a "Master of all Trades," he was a printer, author, patriot, diplomat, logician, resourceful in every sense, lucid in expression, past master of reasoning, statesman, scientist, humanitarian, philosopher and lucid debater. Never egotistical, but a Democrat in spite of all honours.

His sterling honesty and thrift are well known. In 1740 he founded the University of Pennsylvania, and in 1787 gave the land and laid the cornerstone for the Franklin and Marshall College, Lancaster, Pa.

The first letter postmarked in the Colonies was addressed to Col. George Washington, c/o Benj. Franklin, Phila., and delivered to Washington by the Weekly Post Rider Service established by Benjamin Franklin.

Franklin was deeply interested in and wrote clearly on aeronautics, agriculture, silkworms, astronomy, botany, chemistry, education, fire protection, geology, hydrostatics, hygiene, mathematics, medicine, lead poisoning, the Gulf Stream, tides, optics, musical tones, infection from dead bodies, meteorology, origin of the north east storms, natural history, navigation and magnetism of metals. He invented a flexible catheter to show circulation of blood, bifocal spectacles, watertight bulkheads for ships, the first smokeless fire place, the first wood burning stove, a new stove for burning pit coal, a washing mangle, a clock with only three wheels which gave hours, minutes and seconds, a coping machine, and devised a hydrometer for testing moisture in air.

His common sense seemed to guide him in matters which were far in advance of his times—for instance, he anticipated the 'germ theory' as causing colds, etc.

And still the wonder grew that one head (certainly not small) could carry all he knew."

Yours respectfully,

T. Kennard Thomson.

Changes at Manitoba

The University of Manitoba announces an interesting departure in its engineering curriculum. A course leading to a degree in Geological Engineering will be offered, thereby affording the necessary training for students who wish to enter the field of geological exploration and preliminary work such as surveying and mapping of geological formations and the proving of mining properties.

The first two years will vary but slightly from the existing engineering courses, but the third and fourth years will be taken up largely with geology and chemistry, and some general training in mining engineering, ore dressing, assaying, strength of material and structural design.

New and Revised C.E.S.A. Specifications

The Canadian Engineering Standards Association has issued the following new and revised Standard Specifications:

C 22.2—No. 48—1938

Construction and Test of Non-Metallic Sheathed Cable. Price $0.50

G30, G31, G32, G45 and G46—1938

Billet-Steel Concrete Reinforcing Bars; Rail-Steel Concrete Reinforcing Bars; Cold-Drawn Steel Wire for Concrete Reinforcement; Fabricated Steel Bar or Rod Mats for Concrete Reinforcement; Welded Steel Wire Fabric for Concrete Reinforcement. Price $0.75.

International Management Congress

On September 19th to 23rd, the Seventh Congress will be held in Washington, D.C. It is being held under the auspices of the International Committee of Scientific Management, an organization which represents seventeen countries, and which in the past twelve years has held Congresses in many European capitals. The President of the Committee is The Rt. Hon. Viscount Leverhulme, of Liverpool. It is expected that members of The Institute who are particularly interested in management will be in attendance. Further details of the programme and costs may be obtained from The Institute.

Meetings of Societies

The American Mining Congress, Western Division, will hold its annual Metal Mining Convention and Exposition at the Ambassador Hotel, Los Angeles, Calif., October 24th to 27th, 1938.

American Mathematical Society will hold their forty-fourth Summer Meeting and Semicentennial Celebration at Columbia University, New York City, September 6th to 9th, 1938.

Erratum

In the May Journal, The Combustion of Pulverized Coal by Henry Kreisinger, page 229, line 26, change 200 deg. to 2,000 deg.

A.S.M.E. Nominations

Word has been received of the nominations for Officers of The American Society of Mechanical Engineers for 1939 which were announced at a recent meeting of the Nominating Committee held at St. Louis, Mo., during the Semi-Annual Meeting. Election will be held by letter ballot of the entire membership closing on September 27th., 1938.

The nominees as presented by the Regular Nominating Committee of the Society are:

President............ (To serve 1 year)	Alexander G. Christie, Professor of Mechanical Engineering, Johns Hopkins University, Baltimore, Md.
Vice-Presidents...... (To serve 1 year)	Henry H. Snelling, Senior Member, Snelling & Hendricks, Washington, D.C.
(To serve 2 years)	W. Lyle Dudley, Vice-President, Charge of Design and Sales, Western Blower Company, Seattle, Wash.
	James W. Parker, Vice-President and Chief Engineer, Detroit Edison Company, Detroit, Mich.
	Alfred Iddles, Application Engineer, Babcock & Wilcox Company, New York, N.Y.
Managers.......... (To serve 3 years)	Clarke Freeman, Vice-President, Charge Fire Prevention Engrg. and Underwriting, Mfrs. Mutual Fire Ins. Company, Providence, R.I.
	Willis R. Woolrich, Dean of Engineering, University of Texas, Austin, Texas.
	William H. Winterrowd, Vice-Chairman, Franklin Railway Supply Company, Chicago, Ill.

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.

Notices appearing in the Situations Wanted column will be discontinued after three insertions, and will be re-inserted after a lapse of one month, upon request.

All correspondence should be addressed to

The Employment Service Bureau, The Engineering Institute of Canada
2050 Mansfield Street, Montreal

Situation Vacant

YOUNG CHEMICAL ENGINEER. A vacancy will shortly exist in a manufacturing plant in Eastern Canada. Applications are invited from young chemical engineers having a university degree and about four years practical experience in industry. Applicants should give full particulars of training and experience to date as well as personal particulars. No references need be sent in first instance. Apply to Box No. 1774-V.

Situations Wanted

ENGINEER, A.M.E.I.C., Combustion specialist heat balance. Steam, Mechanical. Refrigeration. Office routine. Correspondence. Plant layout. Apply to Box No. 5-W.

ELECTRICAL ENGINEER, JR.E.I.C., B.SC.; age 31; at present employed, desires change in location. Experience includes; three summers experience in power conduit construction; two years in telephone engineering; four years experience in radio, both development engineering and production; two and one half years in a paper mill on electrical maintenance, with a short time in the cost accounting and draughting departments. Would be interested primarily in electrical maintenance. Apply to Box 12-W.

PAPER MILL ENGINEER: B.A., B.A.SC. Married. Age 34. A.M.E.I.C. Ten years experience in paper mill costs, maintenance, design and construction. Now employed as cost engineer in Southern States. Hard worker with excellent references. Available immediately. Apply to Box No. 150-W.

SALES ENGINEER REPRESENTATIVE. Mechanical graduate with fifteen years experience in Eastern Canada in sales and service of mechanical equipment; full details upon request to Box No. 161-W.

MECHANICAL ENGINEER, JR.E.I.C., with thorough training in England and wide experience for past eight and a half years in Canada, is seeking a permanent position as mechanical engineer in an industrial plant. Has had varied experience in mechanical engineering, heating, ventilating and power plant equipment. Excellent references. Apply to Box No. 270-W.

PAPER MILL ENGINEER. If you are willing to pay around $5,000 per year for the services of an engineer, age 36, with twelve years experience in paper mill design, construction and operation, apply to Box No. 482-W.

CIVIL ENGINEER, B.A.SC., A.M.E.I.C. Married. Experienced in engineering and architechtural design and in supervision, office management, etc., wants to round out experience in the contracting field. Ten years experience since graduation. Present location Toronto. Apply to Box No. 576-W.

ELECTRICAL ENGINEER, B.SC. E.E., Age 39. Married. Seven years experience in operation, maintenance and construction of hydro-electric plants, and sub-stations. Five years maintenance and installation of pulp and paper mill electric equipment. Reliable and sober, with ability to handle men. Best references. Any location, at once. Apply to Box No. 636-W.

Situations Wanted

ELECTRICAL ENGINEER, B.SC. '28. Two years student apprenticeship at Can. Westinghouse Co., including test and electrical machine design. Also about two years experience in operating dept. of large electrical power organization. Available on short notice. Apply to Box No. 660-W.

ELECTRICAL AND CIVIL ENGINEER, B.SC. Elec. '29, B.SC. Civil '33. JR.E.I.C. Age 32. Experience includes four months with Can. Gen. Elec. Co., approximately three years in engineering office of large electrical manufacturing company in Montreal, the last six months of which were spent as commercial engineer, also experience in surveying and highway work. Year and a half employed in electrical repair. Best of references. Apply to Box No. 693-W.

CIVIL ENGINEER, B.A.SC. (Toronto '27), age 34, married. Five years railway and construction work as building inspector and instrumentman. Level engineer and on construction of a long timber flume for a pulp and paper mill. Field engineer for a sulphite company, in charge of the following mill buildings, acid, digester, blow pit, barker room, chip storage and acid towers. Available immediately. Apply to Box No. 714-W

MECHANICAL ENGINEER, JR.E.I.C. Technical Graduate. Bilingual. Married. Experience includes five years with firm of consulting engineers, design of steam boiler plants, mechanical equipment of buildings, heating, ventilating, air conditioning, plumbing, writing specifications, etc. Six years with large company on sales and design of power plant, steam specialties and heating equipment. Available on short notice. Apply to Box No. 850-W.

CONSTRUCTION ENGINEER, Grad. Toronto '07. Experience as resident engineer and superintendent on railroad, municipal, hydro-electric and industrial construction. Intimate with organizing, layout, survey, estimates and costs. Available immediately. Apply to Box No. 886-O.

CIVIL ENGINEER, B.SC. '29, JR.E.I.C., R.P.E.M. Age 31. Married. Experience includes railway and highway surveys and construction, land and mineral claim surveys, 4 years draughting, structural and hydraulic design, preparation of plans and estimates for hydro-electric development, sewage disposal project, water treatment plant, subway construction, buildings, etc. Experienced in reinforced concrete design including statically indeterminate frames. Also capable of preparing designs in steel and timber Desire permanent employment, preferably in structural design. Available immediately. Apply to Box No. 1023-W.

ELECTRICAL ENGINEER, B.SC. '29, age 30. Single. Eight and a half years experience on maintenance, on construction, floorman and operator on hydro-electric system. Desires construction, service, sales or research work. Any location. Excellent references. Apply to Box No. 1062-W.

ELECTRICAL ENGINEER AND GEOPHYSICIST. Age 36. 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.

Situations Wanted

TECHNICALLY TRAINED EXECUTIVE. General experience administrative, organization and management in business and industrial fields, including; business, plant, property and estate management; plant maintenance, modernization, production and personnel; economic studies, company reorganizations and amalgamations, valuations; railroad, highway, hydro, pulp, newsprint, housing, industrial surveys, investigations and construction; B.Sc. degree in engineering, age 49, married, Canadian. Apply to Box No. 1175-W.

CHEMICAL ENGINEER, grad. McGill '34, experienced in meter repairs, control work; and also chemical laboratory experience. Apply to Box No. 1222-W.

CIVIL ENGINEER, B.A.SC. (Toronto '33), S.E.I.C., age 27. Married. Five years experience includes highway surveys, bituminous and concrete paving, steel and reinforced concrete building construction, instrument work, draughting, cost accounting and estimating and some experience as foreman. Available immediately. Apply to Box No. 1265-W.

FIELD ENGINEER AND DRAUGHTSMAN, A.M.E.I.C. Age 36. Married. Fifteen years experience in civil engineering, general draughting and instrument work. Experience covers office and layout work on construction of sewers, water mains, gas mains, (6" to 30" dia.) and transmission line structures; topographic and stadia surveys. Draughting covers general civil, reinforced concrete and steel design, mechanical detailing and arrangements, and mapping. Present location Montreal, but willing to locate anywhere. Available at once. Apply to Box No. 1326-W.

ENGINEER SUPERINTENDENT, A.M.E.I.C., R.P.E., Que. and Atla. Age 47. Twenty years experience as engineer and superintendent in charge of hydro-electric, industrial, railroad, and irrigation construction. Specialized in rock excavation and suction dredging. Intimate knowledge of costs, estimating and organizing. Available immediately. Apply to Box No. 1411-W.

CIVIL ENGINEER, graduate 1927, age 34 years, desires position as town engineer. Eight years municipal experience. Location immaterial. Apply to Box No. 1628-W.

CIVIL AND ELECTRICAL ENGINEER, JR.E.I.C. (Univ of Man.). Married. Age 25. Good draughtsman. Four months draughting, one year instrumentman on highway location and construction, inspection and miscellaneous surveying and estimating. Six months as field engineer on pulp and paper mill construction. Prefer electrical or structural design. Available at once. Apply to Box No. 1633-W.

ELECTRICAL ENGINEER, B.SC. E.E. (Univ. of Man. '37). Age 24. Single. Experience in highway construction as inspector. Also experience in sales work and petroleum refining. Available on short notice. Apply to Box No. 1703-W.

CIVIL ENGINEER, B.SC. in C.E. '34. S.E.I.C. Age 27. Five years experience, including harbour construction, highway paving, one and a half years paper mill construction, instrument work, draughting, estimating, interested in design. Available on short notice. Apply to Box No. 1737-W.

CIVIL ENGINEER, B.A.SC. '33. O.L.S. Age 27. Married. One year and a half in charge of power plant construction. Four summers on land surveys and one summer on mine survey work. Also experience in draughting, electrical wiring, and highway engineering. Apply to Box No. 1757-W.

ELECTRICAL ENGINEER, B.E. in E.E., N.S. Tech. Coll. Single. Age 25. Experience in sales, electrical installation, and construction work. Available immediately. Will go anywhere. Apply to Box No. 1758-W.

CHEMICAL ENGINEER, graduate, Toronto '31. Seven years experience in paper mill, meter maintenance, control work and chemical laboratory. Speaking French and English. Location immaterial. Available at once. Apply to Box No. 1768-W.

CIVIL ENGINEER, B.A.SC., JR.E.I.C. (Toronto '35). Age 24. Experience in structural design, construction and surveying, including one year in South America. Details on request. Apply to Box No. 1784-W.

Preliminary Notice

of Applications for Admission and for Transfer

June 23rd, 1938.

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 August 1938.

L. Austin Wright, General 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.

BARRETT—MICHAEL JOSEPH, of Cheticamp, C.B., N.S., Born at East Saint John, N.B., March 11th, 1913; Educ., B.Eng. (Mech.), N.S. Tech. Coll., 1935; 1931-34 (summers), steelworker, Saint John Dry Dock; 1935-37, Diesel engine installn. and repair, Canadian Fairbanks Morse Co. Ltd., Saint John, N.B.; July 1937 to date, asst. mech. supt., National Gypsum Company, Cheticamp, Cape Breton, N.S.
References: J. R. Freeman, W. L. Ball, J. D. Garey, G. H. Burchill, J. N. Flood.

BURGESS—FREDERICK VICTOR, of Bridgeport, N.S., Born at Leicester, N.S., Oct. 12th, 1894; Educ., 1910-12, Mount Allison Univ., I.C.S. Gen. Engrg. and Dfting.; 1912-14, machinist, Truro Foundry and Machine Co.; 1914-15, with Burrel & Johnston, Marine Engrs., Yarmouth, N.S.; 1915-17, overseas with 85th Batt. Staff Machine Gun Section, Staff Sergeant; 1917-18, sent to U.S. recruiting; With the Dominion Coal Company Limited, as follows: 1918-21, dftsman., engrg., dept.; 1921-24, dftsman., mech'l. dept.; 1924 to date, chief dftsman., mech. dept., gen. machine shop practice, incl. turbine and plunger pump design, engines, safety devices, coal handling equipment, and power plant equipment.
References: F. W. Gray, T. L. McCall, A. L. Hay, S. C. Mifflen, J. A. Russell, W. C. Risley, M. W. Booth.

CONROD—GERALD RHODES, of Toronto, Ont., Born at Halifax, N.S., June 20th, 1908; Educ., B.Sc., Dalhousie Univ., 1931; R.P.E. of Ont.; 1928-29 (summers), student engr., Maritime Tel. and Tel. Co., Halifax, N.S.; 1931-33, wire and cable asst. of the commercial engr., and from 1933 to date, wire and cable sales engr., Northern Electric Co. Ltd., Montreal. Work includes introducing to the consumer developments in wires and cables, rural line design, soil heating cable, and its application, and electr'l. distribution in paper mills.
References: F. W. W. Doane, H. S. Johnston, W. P. Copp, W. H. Eastlake, A. V. Armstrong.

HORN—JAMES GORDON, of Hebburn-on-Tyne, England, Born at Winnipeg, Man., Dec. 2nd, 1914; Educ., B.Sc. (E.E.), Univ. of Man., 1936; 1936 to date, student apprentice, A. Reyrolle and Co., Hebburn-on-Tyne, England.
References: E. P. Fetherstonhaugh, N. M. Hall, G. H. Herriot, R. W. Moffatt, F. J. Bell.

RAYMENT—ARTHUR CHARLES, of 4274 Dorchester St. W., Montreal, Que. Born at Cambridge, England, Jan. 29th, 1885; Educ., Grad., Armstrong College, Newcastle-on-Tyne, 1907. Member, Inst. Elec. Engrs. (Great Britain); 1900-05, articled pupilship, Bailey, Grundy, Barrett, Engrs., Cambridge; 1905-07, asst. engr., 1907-10, senior engr., Newcastle-on-Tyne Electric Supply Co.; 1910-14, advisory engr. and technical mgr., Chapman & Walker Co. Ltd., Engrs., Toronto; 1914-16, advisory and inspecting engr., Rayment and Thompson, Melbourne, Australia; also 1914-16, managing director and chief engr., Electrical Engineering Co. Ltd., Melbourne; 1916-18, with Australian Imperial Forces in Belgium and France. Technical units, "Interalia," technical adviser to chief signal officer's dept., Australian Corps; 1920-23, chief technical and administrative officer, Northern Area, England, Ministry of Labour; 1925-28, consltg. and inspecting engr., private practice, England and Scotland; 1928, engr., Associated Appraisers Inc., Montreal; 1928-33, chief technical and commercial engr., Bruce Peebles Co. Ltd. (Canada), Montreal; 1933-35, res. engr., Bruce Peebles Co., Edinburgh, supervising the electrification of the Southern Railway; 1935-37, advisory and inspecting engr. on above, in connection with the British Grid scheme, and similar high capacity projects in Great Britain; in collaboration with consultants and prominent engrs., manufacturing for world wide markets; June 1937 to date, associate engr., R. A. Rankin Associates, Montreal, Que., advisory and inspecting engr., specializing in large capacity power plants and equipment.
References: K. O. Whyte, E. Cormier, G. T. Medforth, J. T. Farmer, F. L. Lawton, F. S. B. Heward.

ROBINSON—GORDON MILFORD, of 28 Scott St., Brampton, Ont., Born at Brampton, Sept. 30th, 1912; Educ., B.A.Sc. (C.E.), Univ. of Toronto, 1935; 1933-34 (summers), survey work and inspr. on concrete road work, Peel county; 1934 (summer), grade foreman, Armstrong Bros.; 1935 (summer), timekpr., on concrete bridge work, W. G. Campbell Constrn.; 1936, dfting. map water works system, Town of Brampton; 1936, inspr. cold mix road work, Peel county; 1936 (summer and fall), foreman, grading work, Armstrong Bros. Constrn.; 1937, detailing and dfting plans for municipal swimming pool. Bookpr., Dufferin Paving Co., hot mix road work in the Maritimes; 1937-38, detailing plans for survey notes.
References: F. H. Kitto, R. E. Smythe, C. R. Young, T. R. Loudon, J. A. C. Bowen.

SHERWOOD—MARVIN LORNE, of 5551 St. Hubert St., Montreal, Que., Born at Ottawa, Ont., Sept. 21st, 1913; Educ., B.A.Sc. (Mech.), Univ. of Toronto, 1936; 1933-34-35 (summers), Ottawa Car Mfg., Ottawa, machinist, installn. of compressed air lines in street cars and buses; 1936 (summer), dftsman., Dominion Bridge Co., Lachine; With the Barrett Co. Ltd., as follows: 1936-37, asst. district engr., mtce., Montreal, 1937, district engr., mtce., Montreal and Joliette; and at present, district plant engr., Montreal, on appropriations, new installns.
References: C. H. Mitchell, R. S. Eadie, E. A. Allcut, R. W. Angus, L. Sherwood, J. M. Gilchrist.

TITLEMAN—MORTON S., of 4643 Park Avenue, Montreal, Que., Born at Ottawa, Ont., Jan. 13th, 1910; Educ., B.Eng., McGill Univ., 1932; 1929-31 (summers), junior engr., Northern Electric Co. Ltd.; 1932-34, junior engr., A. Reyrolle and Co., England; 1935-36, chief constrn. engr., with Designed Homes Ltd., Montreal, and G. Martel and Co., of Montreal; 1936-37, constrn. engr. and supervisor, American Constrn. Corpn. of New York, on the Holt-Renfrew store, Montreal; 1937-38, design and gen. engrg. consltg. work, Dominion Technical Bureau Ltd., Montreal; at present, engr. and dftsman., research and development dept., Canadian Car and Foundry Co. Ltd., Montreal.
References: E. Brown, C. V. Christie, R. E. Jamieson, G. J. Dodd, G. A. Wallace.

WILLIAMS—EDWARD CLIFFORD, 109 Old Orchard Grove, 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 i/c 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; 1931-34, industrial heating specialist, at head office, Toronto, with responsibility for application engineering and commercial policies, for company's complete line of industrial heating products; 1934 to date, manager, air conditioning division (for all of Canada), incl. air conditioning equipment, oil and gas furnaces, commercial ventilating, commercial refrigeration and commercial cooking equipment.
References: D. L. McLaren, W. E. Ross, L. C. Prittie, L. DeW. Magie, C. E. Sisson, W. M. Cruthers, A. B. Gates.

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Building Invisible Edifices

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Presented before the Saint John Branch of The Engineering Institute of Canada on March 24th, 1938.

SUMMARY.—Here is chemistry written for the multitude. Beyond a doubt the average citizen has no idea of how the ingenuity of the chemist has created so many of the commodities that are now in every day use. Carbon, oxygen, hydrogen and nitrogen are the four principal elements that contribute to the existence of approximately 300,000 different organic compounds. The author makes a complex subject both interesting and simple.

During the early part of the 19th century, chemists believed that the products of animal and vegetable life could be created only within the body of a living organism. For this reason, these products were called organic substances. In due time, chemists began to investigate organic compounds and in the year 1828 the realm of science was startled by Wohler's discovery that the products of living organisms could be made in the chemical laboratory. Chemistry took on a new meaning and a new life. No longer was it regarded as only a science of analysis, destructive in its application. It was realized for the first time that chemistry could be constructive, that molecules could be constructed as well as torn apart. This was the beginning of creative or synthetic chemistry.

One hundred years have passed. Explorers in the vast and mysterious world of organic molecules have so far identified approximately 300,000 different organic compounds. The majority of these have yet to be found in nature. They are the children of creative chemistry. At one time, all of them were laboratory curiosities. Now many are important products of industry, entering into articles of commerce and adding a touch of their own complexity to the complexity of modern life.

Three hundred thousand compounds means 300,000 different molecules. Yet this vast army of molecules is fashioned from less than a dozen different kinds of atoms or elements. Most of them are made from only four elements, carbon, oxygen, hydrogen and nitrogen. Thousands contain only carbon and hydrogen. Many organic substances have the same chemical composition. There are at least sixty-six compounds of different physical properties with eight atoms of carbon, twelve atoms of hydrogen and four atoms of oxygen in each molecule. Substances so different in character as sugar, fats, alcohol and vegetable oils are composed of the same three elements, carbon, hydrogen and oxygen. These and similar observations so puzzled the early organic chemists that they were forced to go into a huddle and work out schemes to conquer the invisible empire of organic molecules. It was realized that a chemical analysis of an organic compound gave only a bill of materials; and that to distinguish and understand organic compounds an architectural plan of the molecule was required. Consequently, some amazing but workable theories regarding molecular structure were evolved. Chemists became molecular architects; they drew up the plans of molecules, making alterations and additions, like an architect working on the plans of a mansion. To carry out these plans there was developed a remarkable technique of molecular surgery. Molecules underwent operations to have certain atoms removed or others added. Then there was introduced into the molecular world the promoter's art of bringing about mergers. Two or more molecules of the same kind were caused to combine forming a larger, more useful molecule. Even molecules differing in kind were induced to join forces and make a new molecule of different design. By these and other equally amazing feats, the chemist has found out how organic molecules are constructed; how to build new ones; how atoms gang together forming definite groups which function like single atoms; and how these groups impart characteristic properties to the molecule.

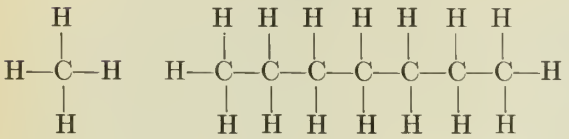
All truly organic compounds contain carbon. Indeed, carbon is the key element. Atoms of carbon constitute the skeleton or framework of organic molecules. The carbon atoms are linked together and to them are attached other atoms; the carbon atoms carry the structural load. For these reasons, carbon, either free or in combination with other elements, provides the basic raw material for the industrial synthesis of organic substances. The sources of carbon are manifold. The diamond is pure carbon but as a raw material it has certain obvious disadvantages. For practical sources there are petroleum oils, coal and vegetable matter.

An oil well houses the members of the petroleum family, compounds of carbon and hydrogen. This important family boasts of two branches, the paraffins and the naphthenes. The baby of the paraffins is methane, a gas, composed of one carbon atom decorated with four hydrogen atoms. The other paraffins are simply chains of carbon atoms with attached hydrogen atoms. As the chain is lengthened so the molecules change from gases to light oils like gasoline, heavier oils like lubricating oils and finally solids like paraffin wax. The naphthenes are ring compounds; that is, the carbon atoms are linked together in the form of a closed chain or ring. The smallest is triangular in shape having three carbon atoms, the next largest is a four sided figure and so on depending on the number of carbon atoms. The California naphthenes are the most elaborate in structure, having an endless variety of side chain attachments, highly fantastic and decorative, quite in keeping with the atmosphere of Hollywood. Naphthenes have associated with them an asphaltic substance whereas the paraffins have wax. Crude oil, then, is a complicated, indefinite mixture of complex molecules. This complexity causes the oil refiner many a headache and brings despair to the purchaser of petroleum products, especially if he is a stickler for specifications.

PLAN VIEW OF SOME HYDROCARBON MOLECULES
STRUCTURAL FORMULAE SHOWING IMAGINARY BONDS

C = Carbon atom H = Hydrogen atom

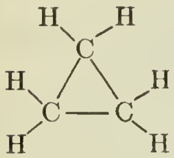
Paraffin Molecules



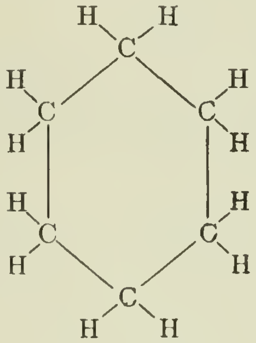
$C_{35}H_{72}$

Methane CH_4 (Gas) — Heptane C_7H_{16} (A gasoline molecule that tends to "knock") — Pentatriacontane (A solid that melts at 167 deg. F)

Simple Naphthene Molecules



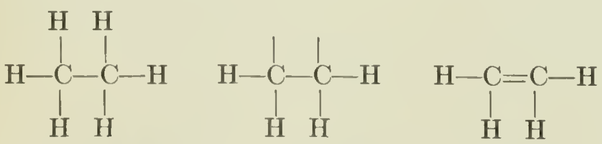
Trimethylene



Hexamethylene

Petroleum molecules do not lend themselves readily to changes in structure because they are saturated; that is, the carbon atoms are carrying a full load of other atoms; in this case hydrogen. For this reason the synthetic chemist has been inclined to let them alone. For the same reason the petroleum chemist has been inclined "to treat 'em rough." He scours them with sulphuric acid to remove gums and other molecular trash, then washes them with water and alkali. Being forced to produce more and more gasoline, he conceived the idea of breaking down the large less useful molecules and recovering from the wreckage smaller molecules coming within the group called gasoline. In this so-called cracking process, the heavier oil fractions are heated to about 1,000 deg. F. under a pressure of some 330 lb. per sq. in. This is quite a strain on molecular structure and the big fellows are so badly cracked-up that not only is gasoline produced but gases as well; and many of the molecules have hydrogen atoms knocked out of them. The molecules on losing hydrogen become another type. They are unsaturated and strange to relate they possess anti-knock properties. So cracked gasoline may be added to regular-run gasoline to impart anti-knock properties. Some of these unsaturated anti-knock molecules are present in gasoline as it comes from the refiner's still but they are removed by the acid wash. Therefore, the petroleum chemist has begun to mend his ways and use less drastic methods in refining. Today the trend is toward the production of gasoline with anti-knock properties, obviating the addition of anti-knock compounds like tetraethyl lead.

HOW ETHANE A "SATURATED" MOLECULE LOSES HYDROGEN ATOMS AND BECOMES ETHYLENE, AN "UNSATURATED" MOLECULE



Ethane C_2H_6 (Gas) — Ethylene C_2H_4 (Gas)

The synthetic chemist is always on the look-out for molecules showing a "To let" sign; for he known there is room for other atoms in the structure. One of the gases of this type, produced in large quantities in the cracking of oils, is ethylene. From ethylene the chemist has created a variety of useful organic compounds, prominent among which is ethylene glycol. Ethylene glycol has some of the properties of glycerine. It is sold as an anti-freeze and when treated with nitric acid ethylene glycol dinitrate is formed. As an explosive this compound is as effective as nitro-glycerine and is used in the manufacture of low freezing dynamite.

Coal is the most important raw material for the industrial synthesis of organic substances. Coal contains about 75 per cent of carbon in one form or another. From coal, limestone, air and water thousands of synthetic substances can be made. If you are an investor in the carbide industry you receive dividends, if you receive them at all, because of two simple chemical reactions. The first occurs when coal and limestone are heated together in the electric furnace with the formation of calcium carbide, a compound of the metal calcium and the element carbon. The second reaction takes place when carbide is dropped in water; acetylene gas is generated and hydrated lime is formed. In acetylene, we have an organic molecule composed of two carbon atoms and two of hydrogen. More important is the fact that the atoms of carbon are loaded to only one-third capacity; therefore, they are capable of carrying other atoms.

FORMATION OF ACETYLENE

$$CaC_2 + H_2O = CaO + HC{\equiv}CH$$

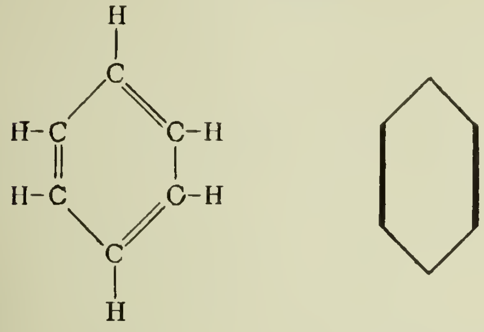
Calcium Carbide — Water — Lime — Acetylene

Note the triple bonds in the acetylene molecule.

Acetylene is the starting point for the creation of a multitude of important synthetic substances. There are several roads open to the traveller; the journey is full of amazing molecular changes; and at the end of the journey there is always a surprising product. One may find various alcohols used as solvents in the preparation of articles as quick drying paints and lacquers, such as Duco. One meets acetic acid and its offspring acetic anhydride, both of which are used to make cellulose acetate for photo films and celanese silk. Then there is acetone, an important solvent, used in manufacturing cordite, pyroxylin plastics and lacquers, artificial leather, celanese silk and book covers. One may get a whiff of butyric acid which gives to Limburger cheese its famous aroma; or have a taste of ethyl butyrate, a synthetic pineapple flavour made from ethyl alcohol and butyric acid. Over 20,000 tons of artificial rubber were made in Germany last year from acetylene. Plastics moulded into products ranging from dentures to radio cabinets, organic glass, safety glass, these and hundreds of others may trace their origin to acetylene gas.

Coal is the source of another class of valuable organic compounds. They belong to the benzene or aromatic family. This family inhabits coal tar, a product of the by-product coke oven industry. Benzene is both the baby and the daddy of the family, an unheard of state of affairs. It is the baby because the benzene molecule is the smallest; it is the daddy because all larger members of the family can be made from it. The benzene family is distinguished by a famous ring or closed chain structure that is a delight to the synthetic chemist, for there are offered exceptional opportunities for molecular construction. Other important members of the family are toluene, naphthalene, anthracene, xylene and phenol.

Structural Formula of the Benzene Molecule Also Abbreviated Form or Symbol Commonly Used for Convenience



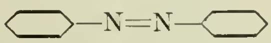
Benzene Abbreviated Form

By performing two minor operations on the benzene molecule aniline is made. Aniline is the starting point for the synthesis of aniline dyes. Similar operations on the molecules of other members of the family combined with extensive molecular construction result in the creation of other dyes. These and the aniline dyes constitute a chemical rainbow of over 900 different colours, many of which for sheer beauty and permanence excel nature's best.

The essential elements of a dye are: (1) A group of atoms called a chromophore. (2) An organic body containing the chromophore known as a chromogen. (3) A salt-forming group of atoms called auxochromes, as (OH), (NH_2), and (COOH) in which N = nitrogen and O = oxygen atoms.

—N=N—

Chromophore



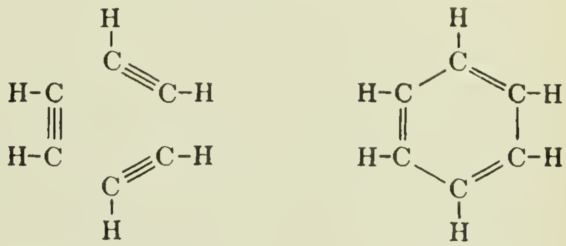
Chromogen
(Containing 2 benzene rings)

Butter Yellow Dye

The  NH_2 section is aniline. Generally, "by increasing the size of the molecule or by increasing the number of chromophores and salt-forming groups, the shade passes successively from yellow to orange, red, violet, blue, green and black."

Toluene is a liquid resembling gasoline. Yet when combined with chlorine, an evil gas, and treated with sodium cyanide, a deadly poison, the result is a wonderful smelling, non-poisonous substance called phenyl ethyl alcohol which is the principal constituent of rose water. When three molecules of nitrogen tetroxide are built into a molecule of toluene, trinitrotoluene or TNT is created. Picric acid, trinitrophenol, made in a similar way from phenol or carbolic acid, is a yellow dye, a remedy for burns and at the same time it is the proper thing to have in high explosive bombs. Phenol or carbolic acid is the source of salicylic acid, a powerful antiseptic, which when combined with poisonous wood alcohol forms methyl salicylate or oil of wintergreen used extensively in flavouring toothpaste, confectionery and so forth. Salicylic acid with a dash of soda water becomes a rheumatism remedy; or if the pain is in the head then salicylic acid is treated with acetic acid, made from acetylene, and Aspirin is made. Phenol, when heated with formaldehyde in the approved manner, forms a resinous liquid which on cooling becomes a solid capable of being moulded into various forms. This compound is known as polymerized oxybenzol methylene glycol anhydride. Some people call it Bakelite. Since the early days of Bakelite, numerous other synthetic resins have been created. Entering into the construction thereof are substances such as naphthalene (familiar to us in the form of moth balls); urea, an animal waste product, which is also produced synthetically; glycerine, derived from animal fats; ethylene glycol and formaldehyde. The final stage in the construction of synthetic resins is called polymerization or condensation, which is another way of saying that two or more molecules of a compound are caused to merge or amalgamate forming a larger, more complicated structure. The molecules which enter into the merger are called structural units and as the size of the molecular edifice is increased by the addition of a structural unit, the resulting resin changes from a liquid to a soft plastic and finally to a hard resinous substance. Synthetic resins may be an amber colour or colourless and as transparent as glass. They may be dyed, made oil-soluble, compounded with other materials, heat treated and moulded. Many find application in the paint and varnish industry, imparting properties not found in natural resins. They have become important as plastics furnishing a variety of articles as bottle caps, radio parts, lamp shades, dentures, safety glass, chemical tanks and piping to mention only a few. The important properties of these resins are resistance to water, acid and alkali; low temperature coefficient; high dielectric value; resistance to mechanical shock; low density; and structural strength. The hardened resins may be cut, threaded and machined.

A Simple Example of Polymerization is the Possible Conversion of Acetylene into Benzene



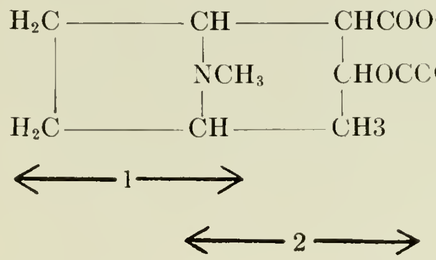
3 molecules of Acetylene polymerize Benzene

Atoms of carbon and hydrogen may be directly united forming hydrocarbons found in crude petroleum. This takes place in the hydrogenation or liquefaction of coal. Powdered coal is mingled with oil and the mixture is heated to 750 deg. F in an atmosphere of hydrogen under a pressure of 2,250 lb. per sq. in. in the presence of a catalyst. A catalyst is a chemical parson which brings about the union of elements or molecules without undergoing any permanent change itself. Catalysts are metals, metallic oxides, salts and organic compounds. They are used extensively in industrial synthesis and are of great importance in this age of synthetics.

Vegetable and fish oils may also be hydrogenated and when stuffed with hydrogen atoms they become fats. The commercial procedure is to suspend finely divided nickel in the oil heated to about 300 deg. F. and blow in hydrogen gas. The oil molecules are unsaturated and as hydrogen atoms enter into the structure the oil is transformed into a solid identical with the animal fats. In this manner edible oils may become lard and fish oils are made into soap.

Most natural substances are not chemically pure. The principal constituent is accompanied by various other substances. Wine is a natural fermentation product. But wine cannot contain more than about 18 per cent. alcohol because when this alcoholic content is reached the yeast gets drunk and quits work. So a man confined to wine or beer has to drink five to ten quarts of water to get one quart of what he is really after. The same is true of natural drugs. But the chemist has helped the situation by determining the active principle of many natural drugs, by devising ways of isolating the chemical in pure form and in many cases by finding a way to make it synthetically. Many synthetic drugs trace their origin to coal tar chemicals. Cocaine is one example. Brilliant researches revealed the structure of the complex cocaine molecule and how it could be made from benzoic acid, derived from coal tar chemicals. Although cocaine is a useful drug, it is extremely toxic and it is habit forming. To overcome these disadvantages, chemists disected the cocaine molecule and determined the groups of atoms which were toxic and those which were necessary to produce anesthesia. With this knowledge they set to work building new molecular structures and created several drugs like novacaine and butyn, both of which have the advantage over cocaine in being much less toxic, more stable in solution and not habit forming.

Cocaine



There are three important parts to the cocaine molecule. The ring group of atoms (indicated by 1) forming the left half is common with several alkaloids, such as nicotine; this part of the molecule is not necessary to produce local anesthesia. The righthand ring (indicated by 2) also occurs in other toxic alkaloids and plays a part in the anesthetic effect. The group —$OCOC_6H_5$ related to benzene, is very important for anesthesia. The righthand half, therefore, is the important one.

Another example is found in Veronal, a valuable sedative or hypnotic. Urea, an animal waste product, which as mentioned before is made synthetically, is a sedative, mild in action but safe because the body can tolerate it. Ethyl or grain alcohol, the principal constituent of whiskey, is also a sedative, as we may have observed, if not experienced, but alcohol is toxic. So the chemist built two ethyl groups of atoms into the urea molecule and made the powerful but not unduly toxic sedative called Veronal. Ethyl alcohol (C_2H_5—OH) is soluble in both water and fats. To the ethyl group C_2H_5— is attributed the property of penetrating the fatty tissues covering the nerves.

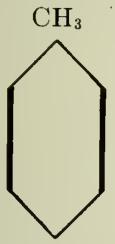
In nature a little perfume is made to go a long way. Twenty-five tons of violets yield only a single ounce of the violet oil which is worth $75 an ounce. It requires about 1½ tons of roses or approximately half a million blossoms to make a pound of rose oil or attar of roses. Musk is the most important single ingredient of a high grade perfume. Natural musk is obtained from certain glands of the musk deer that roams the mountain tops of Tibet. Crude musk is worth about $560 a pound, equivalent to $40,000 a pound for pure musk, if such could be obtained. The natural perfume of the lilac and of the lily-of-the-valley has never been bottled because no satisfactory means of extracting the perfume from these flowers has been found. In view of the high cost of the natural oils derived from flowers and other sources and because it is sometimes impossible to extract them, most of the natural perfumes have their synthetic substitutes. Some of these synthetics are made from coal tar chemicals; often the desired molecule is found in some inexpensive vegetable oil. The isolated molecules usually undergo a reconstruction or a remodelling and are often blended to give the desired imitation of the natural perfume. Oil of citronella, the mosquito's enemy and the fisherman's friend, is the source of the basic odour of synthetic lily-of-the-valley and also of synthetic rose oil. Synthetic violet perfume may be made from oil of lemon grass or from acetylene gas derivatives. What boy would believe that castor oil could furnish anything so delightful as the odour of peaches, the violet leaf odour or a jasmin perfume? From cocoanut oil is made a series of synthetics called aldehydes which are used in the preparation of the best French perfumes of today. A perfume is composed of four odour types: sweet, acid, burnt and what is known as the goat odour. This makes the modern perfume a symphony of odours, good and evil, skilfully blended by an artist from the extracts of leaves, wood bark, grasses, flowers, animal products and syntehtic creations. Synthetic perfumes have made it possible for industry to make inexpensive goods more attractive and to mask a disagreeable odour inherent in a product by incorporating a perfume.

Since time immemorial plants have synthesized chemical compounds and by so doing they have provided animals with food and clothing. The mulberry tree feeds the silkworm and this marvelous creature takes in mulberry leaves and turns out a thread of silk. Man's imitation consumes cellulose, the skeleton of plants, and turns out a thread of rayon, celanese or a sheet of cellophane. Cellulose as cotton or wood pulp is combined with a chemical to make it soluble in some solvent. The solution is forced through the minute openings of a spinneret immersed in an acid bath wherein the liquid thread is solidified. The several solid threads are combined and wound as a single thread on a bobbin. Later the chemical causing solution is removed. In the case of rayon silk the product is essentially the original cellulose, except that cellulose enters the process worth 5c a pound and comes out worth about $1.50 a pound. Cellophane is made in a similar manner using a flat aperture in place of the spinneret and the sheet is impregnated with glycerine; or if it is to be made waterproof a coating of lacquer is applied. Celanese silk is not cellulose but a compound of cellulose and acetic acid or vinegar and is called cellulose acetate.

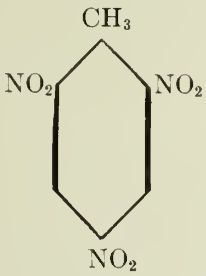
Our ancient ancestors fought each other with cellulose in the form of wooden clubs. Today nitrogen is the important thing; for this tempermental element is the key element of all explosives. The naval engagement off the Falkland Islands during the Great War was a battle over nitrogen. The important source of nitrogen then was the nitrate deposits in Chile and the Germans attempted to cut off the Allies' supply of this all-important war material. By winning the battle the British fleet cleared the nitrate route and saved the Allies' cause. Yet the air contains an exhaustless supply of nitrogen. We breathe in nitrogen only to lose it again, for which reason we are obliged to buy meat, eggs and other protein or nitrogen bearing foods. Free nitrogen costs nothing but it is good for nothing. It is fixed nitrogen that is in demand. Had not German chemists worked out a process for fixing atmospheric nitrogen in preparation for the last war, Germany might have been beaten within a year. Since then the fixation of atmospheric nitrogen has become of considerable commercial importance.

Nitrogen is not inclined to combine with other elements and in certain combinations it is liable to leave the party with explosive violence. This makes the capture of nitrogen from the air a difficult task and requires violent methods. In one process air is passed at a rapid rate through a broad or long electric arc, the temperature of which is about 6000 deg. F. The oxygen and nitrogen in the air combine forming oxides of nitrogen and these may be converted into nitric acid and nitrates. In another process a mixture of nitrogen and hydrogen gases sweep over iron oxide, a catalyst, under a pressure of 4,500 lb. per sq. in. at a temperature of about 900 deg. F. The ammonia produced may be used as such in refrigeration; or by catalytic oxidation converted to nitric acid; or it may be combined with sulphuric acid or phosphoric acid to make fertilizer. In the cyanamide process nitrogen is passed through heated calcium carbide forming calcium cyanamide. This compound finds application in fertilizers; or it may be steamed in an autoclave giving ammonia. Nitrogen fixed by these and other processes, is used in dye manufacture, fertilizers, various commercial chemicals and explosives.

The so-called nitro groups of atoms that put the roar in TNT and change so placid a substance as glycerine into dynamite are oxides of nitrogen derived from nitric acid. The more nitro groups built into the molecule of toluene or cellulose, for example, the more explosive is the compound. Nitrocellulose, used as a military powder, has 10 nitro groups in each cellulose molecule. Nitrocellulose used in preparing pyroxylin lacquers and celluloid contains less nitrogen. In this way the explosive property of nitrated compounds may be more or less regulated.



Toluene
$C_6H_5—CH_3$



Trinitrotoluene (TNT)
$C_6H_2—CH_3—(NO_2)_3$

Note that Toluene is benzene with the CH_3 group replacing the top H atom and that the nitro groups (NO_2) also replace H atoms.

The year 1856 was an important one in the history of applied synthetic chemistry. For it was in that year that William Henry Perkin, then only 18 years of age, discovered the first aniline dye and took steps to put the discovery to practical account. Perkin at the time was an assistant at the Royal College of Science, London, England, and he devoted his spare time to chemical research. The Easter holidays found him engaged on the very ambitious problem of making quinine synthetically from coal-tar chemicals. Each attempt ended dismally; the result was a black tarry mess. Starting again, this time with benzene, he converted it into aniline and oxidized this with bichromate of potash. He noted in the hopeless looking mixture a slimy precipitate which on further examination was found to be soluble in alcohol, giving a beautiful purple solution. Having satisfied himself by tests that the precipitate was a dye with practical possibilities, Perkin decided to give up his position, build a factory and manufacture the dye which he named aniline purple. Fortunately, his father was a contractor. Moreover, Perkin senior had a sublime faith in his son and he contributed the required financial backing. The factory was constructed and this apparently foolhardy enterprise got under way. Getting a laboratory experiment to work on an industrial scale is a difficult task under the most favourable circumstances. In this instance, Perkin and his associates were without industrial experience; they had nothing in the way of precedents to guide them. They were pioneers blazing a trail in new territory. Perkin had to design and test every piece of equipment. Even the raw material was practically unknown; and the coal-tar distillers had to be taught how to recover the benzene from which the aniline was to be made. Other chemicals required in the process were not being manufactured; and these had to be made specially for Perkin. After getting into production, Perkin was obliged to work out methods for applying the dye to different fibres and to instruct the dyers in the new methods. No wonder that at the age of 23, Perkin was regarded as the leading authority on coal-tar dyes and their application. Perkin's ability, courage and enterprise were rewarded with sufficient wealth to enable him to devote the remainder of a long, useful life to chemical research.

German chemists took up the trail where Perkin left off and built up a profitable business in dyes, drugs and other synthetic organic chemicals. By the year 1913, the German synthetic chemical industry had waxed so big and strong that one factory alone employed 8,000 workmen and 330 university trained chemists. Germany had practically a world monoply in dyes, drugs and organic chemicals which are essential to a well-balanced chemical industry. She lost this dominant position as the result of the World War. Other countries have since constructed their own organic chemical industry. Millions of dollars have been invested in synthetics. The Dupont Co., for example, spent forty million dollars to get into the dyestuff business and this company alone expends over six million dollars annually in research. Building invisible edifices is today a gigantic enterprise with many ramifications. The industry continues its forward march, replacing natural products with less expensive and often superior synthetics, fashioning countless new and useful articles of commerce, transforming luxuries of the past into commonplaces of the present.

The Petroleum Situation in Canada

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SUMMARY.—It is interesting to have in one place a concise description of Canada's petroleum situation. The paper deals principally with Alberta's present development and further possibilities, but touches on the other provinces as well. Canada's place in the world production picture is not too impressive, although there are prospects of it being improved.

WORLD PRODUCTION OF PETROLEUM

Petroleum has become an indispensable commodity of industry throughout the whole world. Not only has world production of crude oil from wells reached the enormous volume of 2,039,002,465 barrels for 1937 but in many countries substitutes are being artificially made to supply an ever increasing demand. In general, however, these manufactured petroleum substitutes are inferior in quality to products derived from crude oil or are produced at greatly increased costs. The main supply of petroleum, therefore, is still derived from wells in many countries as shown in Fig. 1 but with more than 60 per cent coming from United States and only a relatively small amount from Canada.

Production in Ontario

Production of crude oil began in Canada with the drilling of the first flowing well at Oil Springs in Lambton county, Ontario, in 1861. Discoveries at near-by Petrolia and at Bothwell in Kent county followed soon afterwards. These early wells in Ontario were only a few hundred feet deep but many flowed hundreds of barrels a day, some 1,000 to 2,000 up to 5,000 barrels and one as much as 7,500 barrels a day. At that time the demand for oil was mainly governed by the demand for kerosene or illuminating oil and in the distillation of the oil, the gasoline, as we

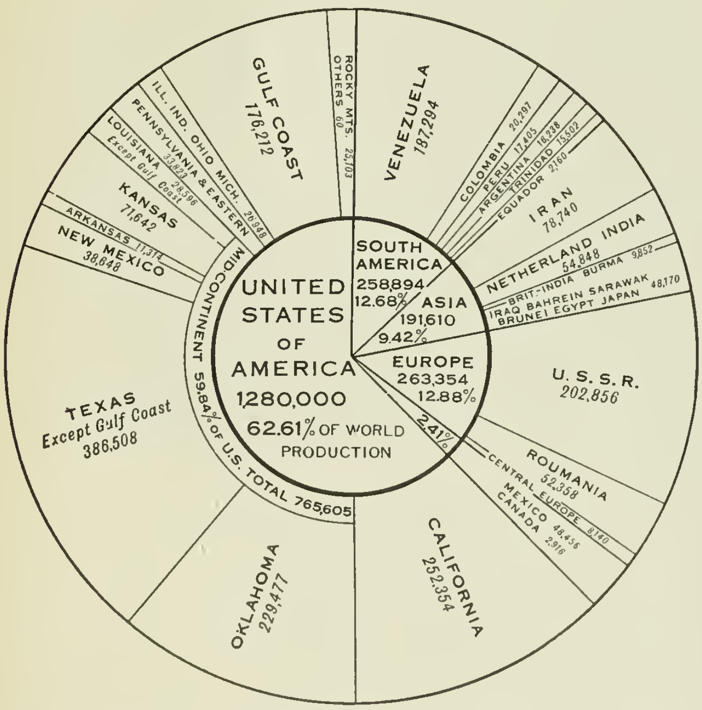


Fig. 1*—World Petroleum Production in 1937 (in thousands of barrels).

know it today, was a by-product that was driven off and wasted. After three-quarters of a century of continuous production the Ontario fields are still yielding crude oil and the main part of this comes from the earliest discovered areas at Oil Springs and Petrolia. Production per well is very low, in most cases not exceeding a few gallons a day, but the pumping operations inaugurated many years ago whereby a number of wells are pumped from one central power station are still profitable because of the very shallow depths at which the oil occurs. The production of Ontario now amounts to only 160,000 to 170,000 barrels a year with very remote prospects of materially increasing this yield.

*Through courtesy of World Petroleum, February 1938.

Production in New Brunswick

In addition to the Ontario production of oil there was in 1937 in eastern Canada a yield of 22,000 barrels from the Stony Creek field close to Moncton, New Brunswick. This field is primarily a gas field used to supply natural gas to Moncton, Hillsboro and other adjoining small centres of population. In the last few years the oil production of the Stony Creek field has been doubled and presumably some further increases may occur. In spite of this, however, the prospects of extending production from the field to any very large volume are not considered good.

Production in Northwest Territories

In the Northwest Territories, 50 miles north of Fort Norman on Mackenzie river two producing oil wells were drilled as a result of an exploration campaign inaugurated by Imperial Oil Company Limited, in 1920. These wells are on the east side of the river and quite close together. They were drilled in proximity to an oil seepage on strata which dip westward into the Mackenzie basin—a structure about 25 miles wide lying between the Norman range of mountains to the east of the wells and the Carcajou mountains at some distance west of the river. The dip of the strata at the wells is, therefore, monoclinal, i.e., in one direction only and the structure is not the usual arch or anticlinal fold with which most oil fields are associated. Eastward from the wells the west dip of the strata brings the bevelled edges of the formations to the surface and within three miles of the wells the oil horizons outcrop. A short distance east of this in the Norman range of mountains strata much lower than any reached in the wells are exposed. This is not the type of geological structure best suited for the retention of large volumes of oil although it is understood each of the two producing wells has still a capacity of about 125 barrels of a high grade crude oil per day. It is probable that the oil is held either in lenticular reservoir beds or in strata that have been sealed at their outcrop by a heavy tarry residue. With such evidence of oil, however, favourable anticlinal structures with the oil bearing strata buried under younger impervious beds would be highly regarded as prospects within the Mackenzie basin. The quantity of oil now available although relatively small is sufficient for local needs. A refinery is operated in the summer months and a considerable part of the mineral developments in the Northwest Territories, as for example the radium producing mines on the east side of Great Bear Lake, are dependent on this oil for fuel and power. During 1937 a pipe line to transport oil was built over the 8½ mile portage on Great Bear river. A storage of 2,000 barrels is provided at Fort Franklin at the head of Great Bear river and a 30,000 gallon barge is used to transport oil across Great Bear lake. During 1937 slightly more than 11,000 barrels of oil were produced. Thus although this oil on Mackenzie river is a highly valuable asset as far as the development of mineral resources in the Northwest Territories is concerned, it is not likely owing to its location, 1,200 miles north of Edmonton, to be speedily developed except as local need demands.

Production and Prospects in Alberta

The first drilling to be done for oil in southern Alberta was undertaken in the Waterton lake area. On Cameron Brook and Lineham Creek, a tributary of Cameron Brook, above Waterton Lake, there are active oil seepages. These seepages issue from very hard argillites that are now known to be late pre-Cambrian in age and which are known to have been thrust during the Rocky Mountain uplift over younger strata of Mesozoic and Palaeozoic ages. It seems entirely improbable that any oil originated in these pre-Cambrian strata so that it has been assumed that the seepages are due to the escape of oil from the younger rocks through fractures in the over thrust pre-Cambrian mass lying over them. In this early drilling only one well near Waterton Lake was able to get through the pre-Cambrian rocks into the underlying younger beds and this well is said to have obtained some oil. Other wells, however, got small flows of oil from fractures in the pre-Cambrian and some production resulted. The efforts at production were subsequently abandoned but in the last few years a further attempt has been made to drill a well at the former site of the production on Cameron Brook.

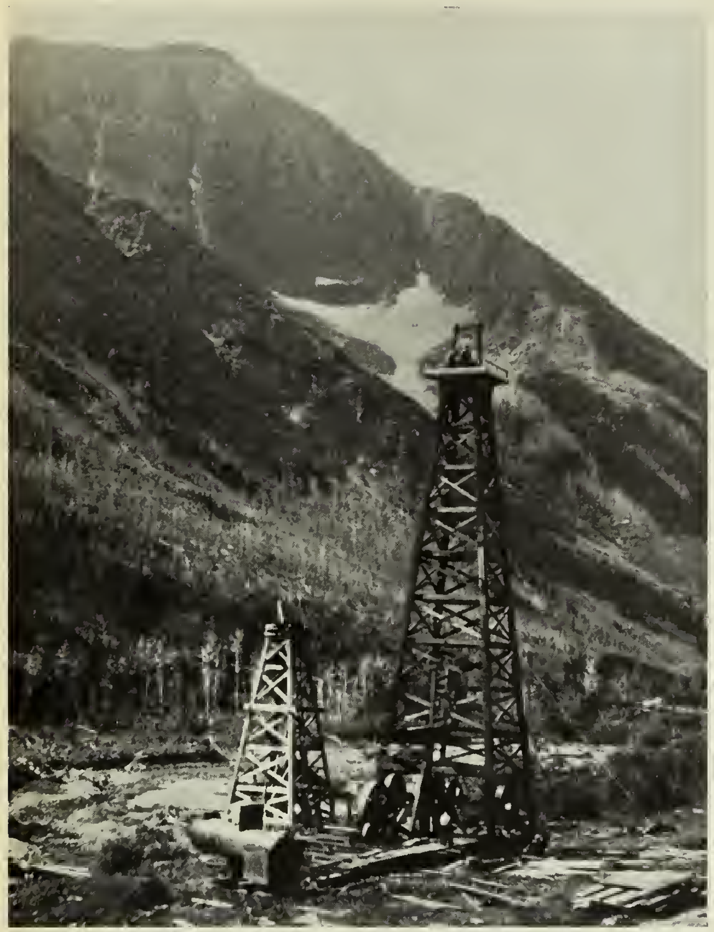
In many parts of the foothills there are seepages particularly of gas but to a less extent oil and it is not surprising that these attracted the attention of the early settlers. One such seepage existed on the north bank of Sheep river in what is now Turner Valley and in 1913 the first well, Dingman No. 1, was drilled close to this seepage. At a depth of 180 ft. sufficient gas to fire the boiler was obtained and in the autumn of 1913 some light oil was encountered in this well. This flow, however, soon exhausted itself and drilling was continued. On May 14th, 1914, oil was struck at a depth of 2,718 ft. This led to a frenzied oil boom in Calgary and although this collapsed some further drilling was done so that from 1914 to 1924 Turner Valley produced 65,945 barrels of light crude oil. A 6 in. gas main 15 miles long was laid from Turner Valley to Okotoks to join the trunk gas line to Calgary from Bow Island. Gas deliveries from Turner Valley began in 1922.

The second phase of development of Turner Valley began in the autumn of 1924 with the completion of Royalite No. 4 well at a depth of 3,740 ft. This well discovered a productive zone in the deep Palaeozoic limestone not hitherto reached by the drill and yielded about 20 million cu. ft, of gas with a content of high grade volatile naphtha of 500 to 600 barrels a day. Further drilling was immediately undertaken and up to June 1936 about 150 wells had been started of which 114 were successfully completed to the same productive limestone as in Royalite No. 4 well. These outlined a field 14 miles long by about one mile wide extending from a short distance south of the north branch of Sheep River to a short distance north of Highwood river. All of these wells produced large volumes of gas from which naphtha was extracted. During this period about 10,000,000 barrels of naphtha were recovered but since much more gas was produced than could be used, more than 750,000,000 thousand cu. ft. was burnt as waste. In heat value this waste is the equivalent of about 33,000,000 tons of good grade coal. Royalite No. 4, the first well drilled to this productive zone, was one of the best naphtha wells in the field producing from its inception in 1924 until it was abandoned in 1934 a total of 911,313 barrels of naphtha valued at over $3,-000,000.

During this period of naphtha production there was a marked decline in the pressures in the reservoir rock from a probable 2,000 lb. or more to the square inch to below 400 lb. in parts of the field where the gas had been heavily withdrawn. This decline allowed oil that originally was farther down the dip on the west flank of the structure but within the same reservoir zone as the gas, to migrate upwards into the gas area. This resulted in a number of wells that originally produced naphtha with gas turning into crude oil wells. This proof of crude oil was finally firmly established in June 1936 with the completion of Turner Valley Royalties well at a depth of 6,828 ft. and an initial flow of crude oil of about 850 barrels a day. This quickly led to further drilling and by the end of 1937, i.e., within 18 months, 26 additional wells had been completed to depths up to 7,475 ft. These with seven others that had originally produced gas with naphtha but had turned into crude oil wells, had a capacity of 26,803 barrels a day. In 1938 up to April 30th there have been nine additional crude oil wells completed and with the inclusion of two more that have changed from naphtha to crude oil wells the total number of crude oil wells now producing is 45. As announced at the end of April the potentials for these wells taken at two-thirds open flow capacity is 31,918 barrels a day. In addition about 2,000 barrels of naphtha a day are still being produced from wells yielding natural gas.

Brown No. 2 well coming into production. The mud fluid used in drilling, saturated with oil when the productive limestone was encounted, is being blown out and burnt at the end of a 6 inch flare line.

At the present time (April 30th, 1938) there are two separate crude oil producing areas in Turner Valley. The larger of these is in the south end of the field and embraces an area of slightly more than 3 sq. mi. which contains most of the wells. The other area in which Royalite No. 29 well was completed in March of this year is in the



The original discovery "John Lineham" No. 1 well (small derrick) drilled in 1902 on Cameron Brook, west of Waterton lakes and the modern drilling rig (large derrick) of Oil City Royalties Company.

north end of the field 14 miles north of the south end. Royalite No. 29 well has confirmed the conclusion that crude oil is present in the north end of the field. This had been previously demonstrated by the production of three wells of the Model Oil Company which originally produced naphtha with gas but which later turned to crude oil wells. Within the southern part of the field only one well has been completed that has not received an appreciable production. Three to five miles north of the producing south end two wells drilled on the west flank, where crude oil was expected, have been abandoned as dry holes. No satisfactory explanation for these dry holes is yet apparent because a former naphtha well, Advance No. 5A, situated in an intermediate position to them but somewhat higher structurally, is now producing crude oil. Recently also a well on the west flank of central Turner Valley has turned from a naphtha to a crude producer indicating crude oil prospects in that area. As far as structure is concerned the whole west flank of Turner Valley is favourable for production of crude oil but as demonstrated by the two dry holes already drilled, certain parts of it will be unproductive. In the south end of the field the area which has proved productive is more than 3 sq. mi. in extent with a width of about one mile and no limits are known except to the east where the oil is bounded by the gas area in turn sharply cut off by structural conditions. It is expected that the limit of the oil area to the west will be the oil-water line. In nearly all oil fields salt water occurs down the dip of the beds in the reservoir rocks. So far this oil-water line has not been reached on the west flank of Turner Valley but its presence west of wells now producing is to be expected. It can safely be said, however, that Turner Valley has excellent prospects for large production of oil. As yet reliable estimates of the oil content and recovery are impossible but petroleum engineers of the Alberta Departement of Lands and Mines have stated there may be an oil content of 500,000,000 barrels. Estimates by other authorities would place the recoverable oil in the best part of the oil area at 20,000 to 23,000 barrels an acre with perhaps 40 per cent of the total oil content recoverable. This then indicates a new major oil field for Canada and recent developments have been even more encouraging than when these estimates were made.

Turner Valley is the only producing oil field so far discovered in the foothills. The foothills, however, are a structural unit which extends 800 miles north from the International boundary to Liard river and have a width of 12 to 25 miles. Drilling to date outside of Turner Valley has not met with any success in the foothills but it will be singular indeed if within this large area, where already a few favourable structures are known, a number of fields like Turner Valley are not eventually found. In 1936 the Dominion Geological Survey undertook a sub-surface study of the Turner Valley field with the object of determining the details of the structural conditions and their relationship to oil production. Not only is such information of great value in the orderly development of any oil field but it is hoped by applying the knowledge of structure learned

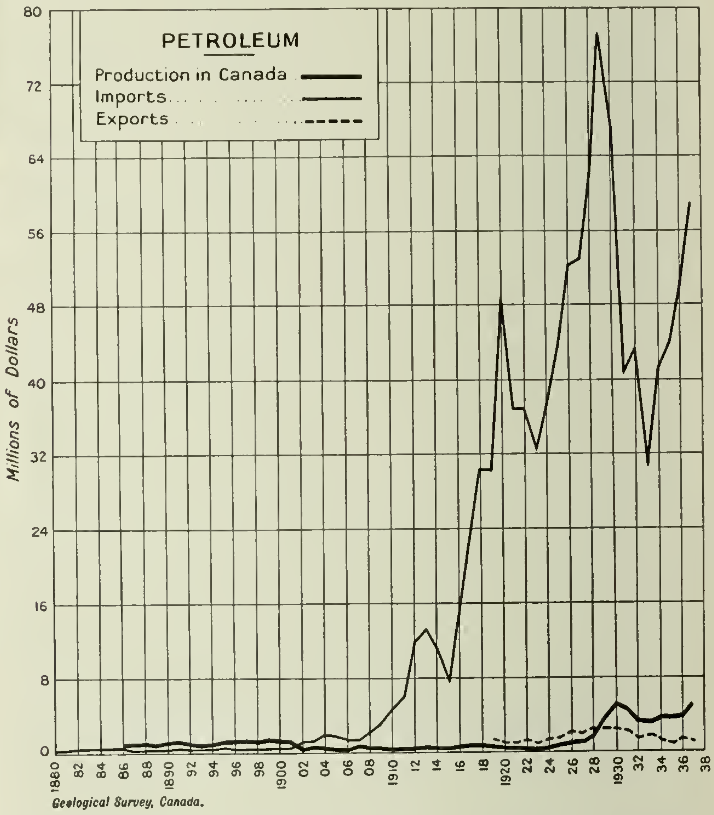


Fig. 2—Petroleum Production Imports and Exports of Canada.

in Turner Valley to other foothill areas to direct drilling to the more promising prospects. In comparison with the country in which oil fields are found the oil fields themselves are mostly confined to relatively small areas because of the fact that oil accumulations occur only under certain favourable geological conditions, in which the character of the structural features are the controlling factors. Thus it is hoped structural studies now being made will obviate much drilling in areas where drilling can hardly be expected to meet with success.

On the plains there has been production of oil from a few widely separated fields at Red Coulee and Skiff in southern Alberta to Wainwright and Ribstone in eastern central Alberta on the Battle river. Recently a promising oil field has been opened up at Taber east of Lethbridge and oil is now being shipped from this field to the Imperial Oil refinery in Regina. It is probable that more extensive developments will take place in the immediate future. Thus it can be said that never have prospects for large oil developments in Alberta looked so promising and never before has there been so much drilling and prospecting activity as at present.

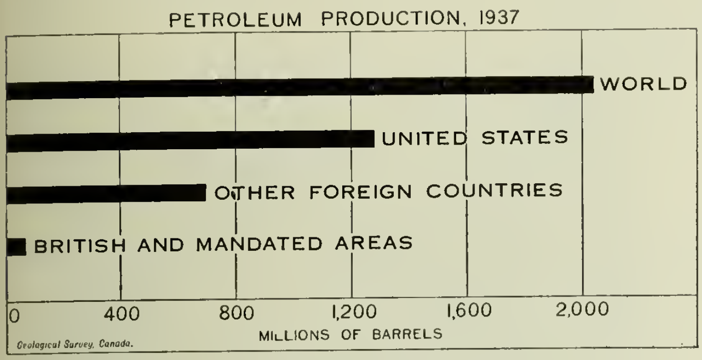


Fig. 3—Petroleum Production 1937.

MARKETS

The developments in Turner Valley have taken place so rapidly that transportation and market facilities could not be provided quickly enough to take care of the rapid increase in production. Under such conditions proration or restricted output has been put into effect. At present there are two 4 in. pipe lines from Turner Valley to Calgary and these have recently been handling about 13,000 barrels a day. An additional 6 in. pipe line now under construction will bring the capacity up to 24,000 barrels a day. The consumption of the Prairie market is said to be about 17,000 barrels a day on a yearly basis with a much larger volume used in summer than in winter. The pipe line capacity now available and under construction to Calgary will, therefore, take care of these needs and it is certain the volume of oil already indicated in Turner Valley is sufficient to supply the Prairie market for years to come. To insure expansion of markets beyond the Prairie Provinces there must be a guaranteed supply of a very large volume of oil over a long period of years so that the necessary transportation facilities and the refinery adjustments can be made with the assurance that they are warranted. Until the time when such market expansion is justified there will be a period when the output of the wells must be restricted below their capacity. The length of such a period will be dependent on the rate of development of reserves by drilling and there is no doubt the discovery of one or more other large fields like Turner Valley would quickly insure this stability.

The price paid for crude oil in Turner Valley by the major refining companies is $1.14 a barrel for oil with a gravity of 40 to 40.9 deg. A.P.I. increasing 2 cents for each degree Baumé to 1.62 for oil between 64 and 64.9 deg. A.P.I. Above 65 deg. A.P.I. the oil is classed as naphtha and brings $2.14 a barrel. The naphtha produced with the natural gas in Turner Valley had a gravity up to 73 deg. A.P.I. but the oil becomes progressively heavier down the west flank of the structure and oil just slightly more than 40 deg. A.P.I. is now obtained from some of the deeper wells. The costs for transportation by pipe line to Calgary are 15 cents a barrel. At Calgary there is a charge of 5 cents a barrel for loading onto railroad tank cars. By tank car the rates charged are 18½ cents a cwt. (51.8 cents a barrel) to Moose Jaw, 19 cents a cwt. (53.2 cents a barrel) to Regina and 39 cents a cwt. ($1.09 a barrel) to Winnipeg.

AVAILABLE CANADIAN MARKETS

United States with about 30 per cent of the world's automobiles consumes about 60 per cent of the world's petroleum production.* Russia ranks second and Great Britain third. Great Britain, however, does not consume as much oil in a year as United States does in a month. Canada ranks fifth with a consumption in 1936 of about 17,500,000 barrels of gasoline, 15,200,000 barrels of gas and fuel oil, 890,000 barrels of kerosene, 995,000 barrels of lubricants and 1,010,000 barrels of engine distillate, a total of 35,595,000 barrels of oil of various kinds in addition to other petroleum products. This consumption in 1936 was due to the use† of 1,035,198 passenger automobiles, 6,331 taxi cabs, 184,798 motor trucks, 2,154 buses, 10,825 motor cycles and 818 tractors, ambulances, service cars etc. It is difficult to accurately estimate what this means in consumption in relation to crude oil production since crude oil from different fields yield different volume of various products and in many cases the refinery can control the character and amount of the products according to market requirements. For example, by straight run distillation, i.e. without cracking, 100 barrels of Turner Valley crude oil will yield about 50 barrels of gasoline, 13 barrels of kerosene, 17 barrels of gas oil and 13 barrels of lubricants with some residues. If, however, the product left after the gasoline is taken off is "cracked" the same volume of crude oil can be made to yield more than 80 barrels of gasoline with a corresponding decrease of other products. From a comparison of consumption, however, it can be seen that Canada's requirements are many times in excess of the 2,995,025 barrels of crude oil produced in 1937. At the present capacity of Turner Valley which is at the rate of nearly 12,500,000 barrels a year it is

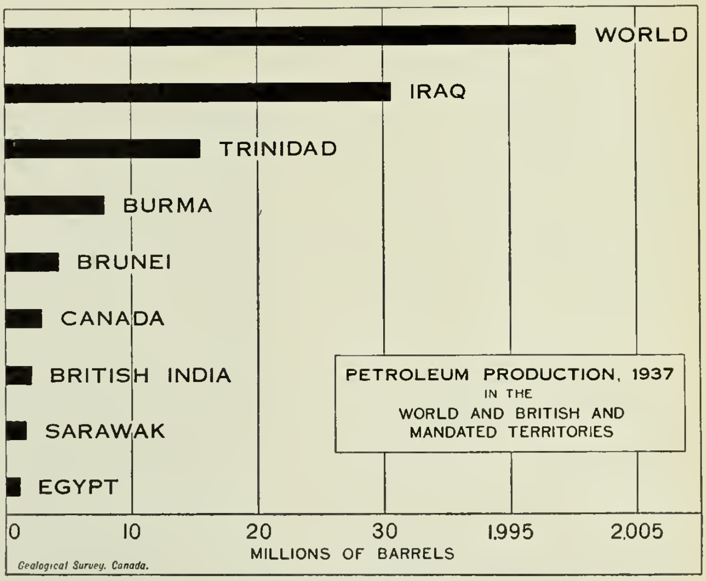


Fig. 4—Petroleum Production 1937, World, British and Mandated Areas.

probable that about one-third of Canada's needs could be met from this source alone. This development of a considerable domestic supply totally changes the situation in Canada from a few years ago. In 1924, when the naphtha zone of Turner Valley was first discovered, the total oil production of Canada, mostly from Ontario, amounted to only 160,773 barrels valued at $467,400, whereas the value

* Petroleum Times, London, Feb. 19, 1938, p. 230.
† Bureau of Statistics, Ottawa.

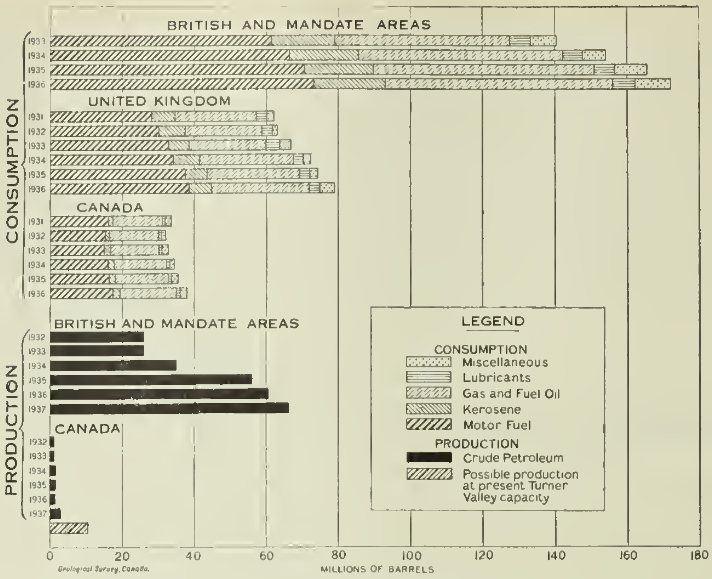


Fig. 5—Production and Consumption of Oil Lubricants and Petroleum in British and Mandate Areas.

of imports over exports amounted to $36,236,987. By 1929 owing mostly to the production of Turner Valley naphtha production in Canada rose to 1,117,368 barrels valued at $3,731,764 but the value of imports over exports rose to $75,111,338. Although the use of oil in Canada declined from 1929 to 1933 it is again rapidly increasing and will undoubtedly soon pass the record established in 1929 (See Fig. 2). Thus the development of a large supply of oil in Canada is an event of national importance and there seems little doubt as the reserves of oil are established in Alberta to justify market expansion, this will eventually take place.

Petroleum in the British Empire

During 1937 all Empire countries furnished about 5 per cent of British consumption of 70,000,000 barrels a year. These Empire countries with their yield in relation to world production are shown on Figs. 3 and 4. It is obvious that the British Empire is very deficient in oil supplies. Crude oil for refining in Great Britain in 1937 was supplied* by imports of 3,740,100 barrels from Venezuela, 2,373,300 barrels from Iraq, 2,242,100 barrels from Peru, 2,078,300 barrels from Iran, 408,100 barrels from Trinidad and other Empire territories and 283,500 barrels from Mexico. In addition to crude oil, however, Great Britain imports large quantities of refined products. A very considerable part of this comes from the Dutch West Indies which is the refining centre for Venezuelan oil. The remainder comes from Iran, United States, Trinidad, Mexico, Roumania, Iraq, Peru and U.S.S.R. The consumption of oil products for the British and mandate areas, the United Kingdom and Canada together with the production of crude oil within the British and protectorate areas and Canada are shown on Fig. 5. For comparison the possible production of Canada is shown provided Turner Valley was allowed to produce at capacity of 30,000 barrels a day (as in March, 1938). It can readily be seen that not only does Canada still fall far short of supplying domestic needs but that the production in all British and mandate areas including Canada has up to the present been insufficient for Empire requirements. It would appear, therefore, that in the expansion of production in Canada a market is offered by domestic consumption with a wider market within the Empire. In reaching these markets difficulties of transportation over long distances must be met but by modern methods of transporting large volumes of oil it is believed that much wider marketing facilities than at present will eventually be provided when sufficient reserves of oil are established.

* Petroleum Press Service, London, April 8, 1938, p. 159.

The town of Little Chicago and oil wells on the west flank of Turner Valley. The derrick on the right foreground is on Turner Valley Royalties, the original crude oil well, in South Turner Valley.

The Collapse of the Falls View Bridge

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Paper presented before the American Association for the Advancement of Science, Ottawa, June 27th, 1938.

SUMMARY.—The collapse of the Falls View Bridge was front page news for several days, but the newspaper accounts told nothing of it from the engineering point of view. This paper describes the unusual ice conditions that brought about the disaster, and the action of the bridge under the abnormal strain.

"There is probably no bridge site on the North American continent of greater technical and historic interest than that of the Niagara Arch." This is substantially a quotation from the opening words of a paper written forty years ago for the American Society of Civil Engineers by Major R. S. Buck, M.E.I.C., old friend and one-time chief of the writer, and now resident in Washington, D.C. What was true then is true still, and though no doubt many new and interesting sites have been found and crossed since 1898, as transportation conditions have changed and the touring automobile developed, the Falls View Bridge stood, and will stand again, on a site unsurpassed for historic, scenic, and romantic associations.

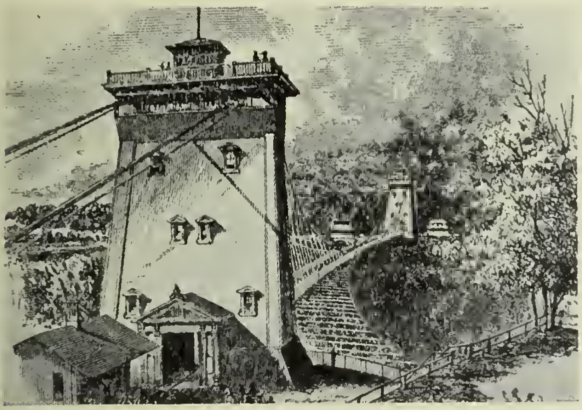

Fig. 2—Original Bridge 1868.

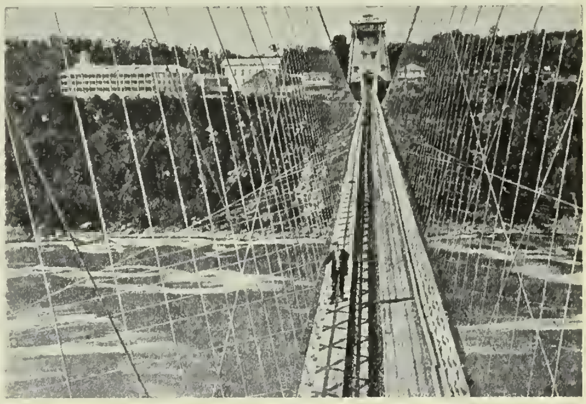

Fig. 3—Original Bridge 1868, Showing Span.

The Niagara river gorge from the Falls to Lake Ontario is in itself quite an interesting natural feature. This paper will not deal with the geology of the neighbourhood, but the geological data provided by the walls of this gorge with their sections of almost uniformly horizontal strata of deposited rocks, including clay, shales, limestones, and sandstones, is of outstanding value to those concerned with this science. The slow recession of the Falls during the centuries, the origin of the Whirlpool, and the evidences of an earlier channel north of this Whirlpool leading to the banks of the prehistoric Lake Iroquois, are some of the features which lead to the fascination which the Niagara gorge provides not only to the casual tourist or the 'honeymooner,' but also to the more seriously minded student of natural phenomena. The Niagara river is about thirty-two miles long by the international channel from Lake Erie at Buffalo to Lake Ontario at the Forts, but the gorge proper occupies only about seven miles from the Horseshoe Falls to the escarpment at Queenston-Lewiston. Below Queenston the river is quiet and navigable for its remaining six miles, and above the Falls on both sides of Grand Island there are navigable stretches used by boating clubs, etc.

There are several bridge sites on the Niagara river, some above the Falls and some below. The present paper is concerned particularly with one site, namely that just below the Falls, only a few hundred feet from the nearest part of the American cataract and ¾ of a mile distant from the furthest point of the Canadian, or Horseshoe Falls. The gorge in this neighbourhood is about 180 ft. deep from the banks to the average water surface, and the depth of the water reaches about the same figure in the area between the foot of the Falls and a point slightly downstream from the site of the Falls View bridge. North of this point the river bed rises, the gorge narrows, and the velocity correspondingly increases, giving rise to that stretch of rapids reaching down to the Whirlpool and beyond.

Fig. 1—Jan. 27th, 2.30 p.m., Showing Ice and Bowed Vertical.

The bridge that fell in January, 1938, was not the first occupant of its site and moreover two other sites along the gorge were occupied even before this one, namely those at Queenston-Lewiston (1850) and at "Suspension Bridge" across the Whirlpool Rapids (1848). The Queenston-Lewiston site was first bridged by a 1,040 ft. parallel-wire cable suspension span, designed by General E. W. Serrel (who also designed the old Suspension Bridge at Saint John, N.B., in 1862), and built by Mr. T. M. Griffith. This span was endangered by an ice-jam in 1864 but survived this experience only to be destroyed later in the same year by a gale. The

Fig. 4—Jan. 27th, 2.40 p.m., Showing Kink in Downstream Lower Chord.

collapse was directly due to its lateral cable guys not having been replaced after their removal during the said ice-jam. The bridge at Whirlpool Rapids thus stood alone until 1868, when the first crossing at Falls View was completed.

All these early bridges were of the suspension type, some of them being pioneers, and all of them being very light. Although the hope and intention of the promoters was to build a railway bridge at the Whirlpool Rapids site, the funds available in 1847 would not permit of this scheme, so Mr. Chas. Ellet constructed a carriage-way bridge only 7 ft. 6 in. wide, suspended from four cables each of which consisted of three ropes, each rope being composed of three No. 9 gauge wires. This bridge was however replaced in 1853-5 by a railway bridge 821 ft. in span carrying the Great Western (Grand Trunk) Railway, and Mr. John A. Roebling, the founder of that family so prominent in North American suspension bridge history, achieved a notable success on this occasion in applying mathematical studies to the practical problems of stiffness and erection. The old cable wires were absorbed into the new cables, and although certain repairs and some alteration work were carried out in 1877 and again in 1880 and 1886, this structure of 1855 stood until 1897-8 when it was taken down and the present arch span (lower arch) constructed to replace it.

The Queenston-Lewiston site seems to have stood empty from 1864 to 1898 when the present bridge at this location was erected, using for its cables those of the Falls View suspension bridge which had just been dismantled.

The Falls View site to which our attention will now be limited was first occupied in 1868 by the Clifton Suspension Bridge, 1,268 ft. in span, with its towers seated on the top of the banks of the gorge. The Clifton Suspension Bridge Company was chartered in Canada in May 1868, its American counterpart, the Niagara Falls Suspension Bridge Company having revived its powers in April 1867 although its charter actually dated back to March 1855. The companies merged in July 1868 and construction was completed by the end of that year, Mr. Samuel Keefer, M.Inst.C.E., being the responsible engineer. The bridge was opened on January 2nd, 1869, with appropriate ceremonial. The towers were of timber construction, each pylon being of pyramidal shape with four 12 by 12 in. sticks constituting each of its four legs. There were thus sixteen of these timbers brought together under each cable saddle.

Traffic on this structure was of the one-way type, the width of roadway being only 10 ft. and consisted principally of market gardeners taking fruit and vegetables from Ontario across to New York State. After sixteen years of service, the timber towers were replaced by iron or steel, of very similar design, and in 1887 work was commenced on new anchorages as part of a scheme for introducing additional cables and increasing the capacity of the structure by providing two-lane traffic and a 17 ft. wide roadway. Two new steel cables were placed, making four in all and new steel stiffening trusses were suspended from these to carry the new timber floor system. Traffic was apparently maintained without interruption, and the whole work of reconstruction was finished by December 15th, 1888.

Unfortunately it was less than a month later, namely, January 10th, 1889, when the whole suspended structure was destroyed by a severe storm which seemingly severed the horizontal sway-prevention cables and then swung the trusses and deck in the wind until the suspender ropes were severed by direct abrasion. Mr. L. L. Buck, the engineer responsible for the widening and reconstruction, describes this disaster in the following words. "The storm-cables or wind-guys were put up and adjusted during warm weather. During a high wind in severely cold weather in January, 1889, they became so taut that one end of that to windward broke loose from its anchorage, the suspended structure swung to leeward far enough to bring the upper chord of the steel truss against the suspenders, sawing them off at a distance of 300 ft. outward from the shore, and then the remaining suspenders gave way in succession like tearing cloth, and the stiffening truss fell into the river, leaving the cables intact." Another commentator states that the wind during that night blew through the gorge with such force and such noise that the gate-keepers, stationed in the bridge office 20 ft. from the end of the main span, neither heard the collapse nor knew anything of it until daylight the next morning.

Reconstruction of the suspender ropes, the stiffening truss, and the deck was immediately ordered, and 117 days later on May 7th, 1889, the span was again opened to traffic.

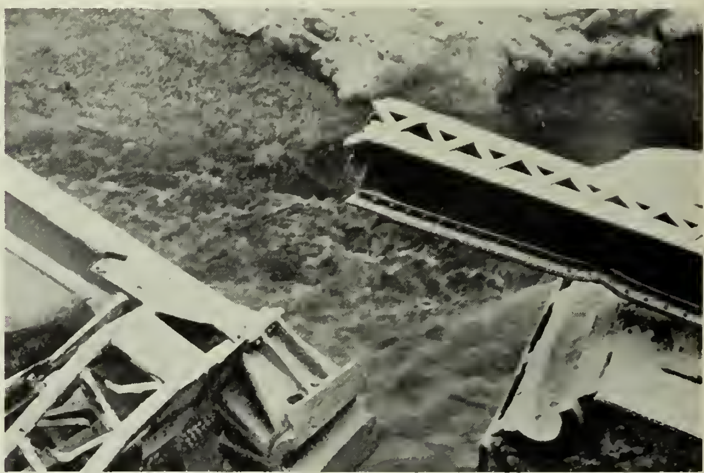

Fig. 5—Jan. 28th, 11 a.m., Downstream U.S. Corner.

During the next ten years great changes began to occur in the general conditions of life and travel. Electric railways were built, one such line being constructed on each side of the scenic portion of the Niagara [Gorge. It became desirable to connect these in order to provide a round-trip and therefore means had to be found to carry them across the gorge at approximately the site of the Falls View Bridge. This provision for the entertainment and the benefit of tourists, seemed to the owners to offer sufficient chances for profit to warrant the entire reconstruction of the Falls View Bridge, and the services of Mr. L. L. Buck were again retained for the purpose of preparing a new design. This time the suspension type was abandoned in favour of the arch and the Falls View Bridge, as we of this generation have known it, was built during the years 1895-98, being opened to traffic in August of the latter year. During the replacement it is recorded that the longest continuous period during which traffic was interrupted was about three days, and the aggregate time during the whole three years, was about 7 days.

Mr. L. L. Buck states, in describing this structure, that "The high-water level and the movement of the ice were investigated before fixing the span of the arch and the elevation of the abutments; according to the worst conditions previously known, danger from water and ice was amply guarded against, but on January 22nd, 1899, an ice-jam took place which exceeded all past experience. The ice-field, firmly anchored to both shores, then caught a heavy run of ice coming down the river, the water of which was greatly augmented by a stiff and long-continued southwest gale on the lakes. At about 4 p.m. the river-channel under the ice became choked, and within a few minutes the water near the head of the ice-field rose to a height of 25 ft. or 30 ft. above its level at the bridge, ¾ mile below, and began to pour over the pack for some distance below the Falls. The pressure caused the whole pack to move downstream. Not only was the ice piled up over the masonry abutments, but it was swept against the steelwork of the arch as high as the upper chord panel-point two on each side of the river. As it struck the rib-chords it was shaved off as with a knife and deposited in large masses upon the upstream truss members and the lower laterals. The bridge quivered from end to end as the ice ground against it, but did not sway. The pack moved about 250 ft. in about 10 minutes, after which the channel underneath the ice cleared and the water subsided as rapidly as it had risen. On each side of the river one main lateral and one sub-lateral, four members in all, were badly bent. The abutments were uninjured and no other damage was done. The bent struts were straightened immediately and served until they were replaced several months later. During the following summer, to guard against similar trouble in the future, heavy concrete walls were built around the abutments, extending as far out in front as possible, and the first two panels of laterals in the plane of the lower chords on each side of the river were changed from latticed struts to plate-webbed struts."

It is a matter of observation and record that great quantities of ice from Lake Erie come over the falls every winter, especially in January and February, and that in most years an ice bridge is formed across the gorge just about at the site of the Falls View bridge, which ice bridge or solid pack-ice extends itself up and downstream to greater or shorter distances, depending on the severity of the season.

The jam above-described as having occurred in January 1899 and being then without recorded precedent as to magnitude, seems to have been almost identical in many respects with that which occurred in January 1938, except that it persisted for a much shorter period of time, as will be appreciated later when recording the events leading up to the recent collapse.

The Falls View arch bridge continued to serve the local and travelling public for a generation, and actually outlived the electric railways which demanded its creation. In 1932 the gorge routes ceased to operate and in 1936 the rails were removed and the timber floor entirely renewed, being re-arranged at that time to carry modern bus traffic. This change however, unlike many changes which are due to modern developments, was not detrimental to the capacity of the structure, but actually eased conditions slightly as the writer, acting as consulting engineer, could quite confidently discontinue the practice of reserving a sensible percentage of the carrying capacity of the various structural members for the absorption of dynamic or impact stresses. Thus the bridge, although 39 years old, could, by virtue of its original sound design, the continued policy of proper maintenance, and the removal of trolley-car loading, be relied upon to furnish adequate and safe service for decades to come.

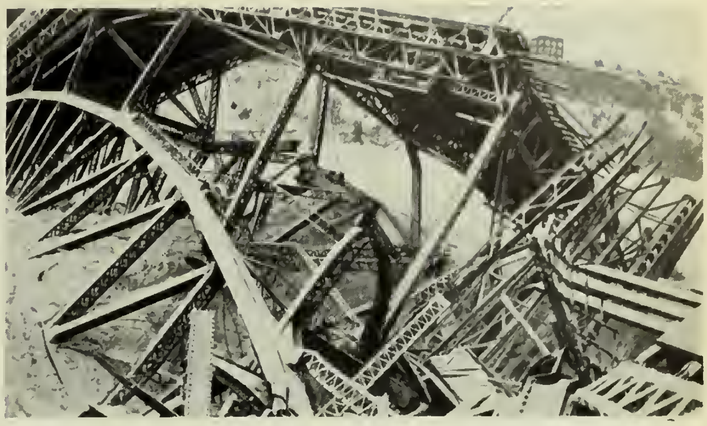

Fig. 6—Jan. 28th, 11 a.m., Wreckage at U.S. End.

However fate in the shape of natural phenomena, had the deciding voice, and to some of us was given the sorrowful experience of seeing an old and tried friend, although of steel and timber, go to its end, while we stood by helpless.

The immediate cause of the collapse was very obvious to spectators and is equally easy to explain. It was merely the enormous lateral pressure of the moving mass of ice brought over the falls in unusual quantities from Lake Erie. The more fundamental reason lies in the peculiar sequence of weather conditions and the successive changes in water-level experienced on Lake Erie during the two or three preceding days. During a cold snap of fairly short duration, ice of about 4 in. thickness formed over a large portion of Lake Erie, but a rise in temperature served to loosen this thin ice from the shores and strong winds from the southwest drove it to the east or Buffalo end of the lake. These winds were so persistent and so powerful that they not only broke up this ice and forced it into the mouth of the Niagara river, but they raised the water level at Buffalo on January 25th at quite an alarming rate, according to data supplied by the U.S. Engineers' office. (Fig. 14.)

Fig. 7—Jan 26th, p.m., Buckled Laterals.

Fig. 8—Jan. 27th, a.m., Kink in Downstream Bottom Chord.

According to the report on the St. Lawrence Waterways Project by the Joint Board of Engineers, page 90 of Appendix B, the formula for the discharge of the Niagara River would indicate that each foot rise of Lake Erie at Buffalo would increase this discharge by 22,000 cu. ft. per sec., so that the 3 ft. rise indicated in Fig. 14 would lead to a substantial increase in the amount of water coming over the Falls which water had to find its way through the limited channel left under the existing ice-pack in the gorge below the falls. Furthermore, at the normal rate of flow, the peak of this increased discharge would reach the Falls about 7 or 8 hours later than the time shown on the diagram at the Buffalo gauging station, which means that from approximately midnight to 6 a.m. on January 26th, the river was pouring over the falls with this augmented discharge, carrying a continuous load of 4 in. ice in small slabs which could only pass under the existing ice-pack if it were to reach Lake Ontario. In the early hours of the morning, this ice travelling at all depths in the turbulent waters, jammed this submerged channel and began to pack up solid beneath and behind the original ice-pack, extending this pack almost to the foot of the Falls. The orifice for passing water was thus gradually shut off, with the result that the augmented discharge over the Falls gathered enough energy to actually lift the whole of the ice-pack in the gorge below, and the entire sheet rose under this ever-increasing pressure until it cut loose from the bottom and the banks and moved in a mass downstream, the upper or more recently formed areas piling themselves onto the available shore space just south of the arch bridge and into the power-house on the Canadian side. This movement of course relieved the pressure somewhat and re-opened the submerged channel, allowing both water and ice to discharge through this orifice. The ice sheet over the river gradually sank again, leaving stranded on the shore all that ice, mostly small slabs of 4 in. thickness, that had been piled up during the movement.

Up to this time no visible damage appears to have been done to the steel bridge. Maintenance engineers of the International Railway Company, owners and operators of the structure, had been called to the site as early as 5 a.m. as observers reported that the ice field, including both the earlier pack-ice and the new Lake Erie ice, was rising. By 6.30 a.m. the movement above described had all taken place and these engineers began to clamber over the stranded ice south of the span on the U.S. shore in order to reach and examine the shoes of the structure which carried the thrust of the steel arch to the stone and concrete pedestals, familiarly known as "skewbacks." They found this stranded ice to be as high as 20 ft. above the shore and approximately the same amount above the elevation of the hinge-pins at the point where the arch bears on the masonry. But this was only true of the ice stranded on the shore. At the shore line just a few feet forward of the skewbacks there was then a sheer drop to the ice in the river of some 30 or 35 ft., and a definite crack or line of separation between the stranded ice and the river ice was visible up and downstream for several hundred feet, indicating that the river ice had moved north considerably more than the stranded ice, and had continued to so move as the river level was dropping and the ice that had overflowed the banks, was being left stranded.

The pile of ice directly against the upstream or south truss of the arch span was higher than elsewhere as it consisted partly of the shavings from the top of the ice that had moved down stream under the span, which shavings had been trimmed off by the steel members, and it was reported that the shaping effect of the steel arch on the ice could be seen several hundred feet downstream where the ice that had thus been shaved had come temporarily to rest as the first general movement ceased. The maintenance engineers' report states that at 6.30 a.m. the ice was no longer moving. This could only mean that the channel under the ice was temporarily open and that the discharge of the river was passing underneath the pack-ice once more. At the same time it could readily be recognized that this channel might block again and the whole incident repeat itself as the water and ice coming over the Falls was still abnormally high.

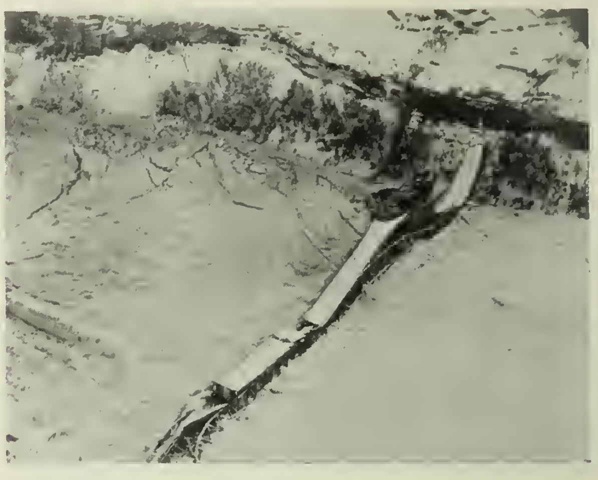

Fig. 9—Jan. 28th, a.m., Wreckage Looking Toward U.S. End.

A 30 minute inspection of the span was made but as far as could be seen no damage had occurred to the steel work and the maintenance engineers set out again on their return trip over the stranded ice to the stairway leading down from the Park concession to the shore. Before they could reach this point, however, and therefore at about 7.15 a.m. they noticed the river water beginning to overflow the new pack-ice, and new ice from the Falls being deposited on this pack or carried above it. This was evidence that a second jam had already begun to form under the ice-pack and the constriction apparently became very definite for the water rose rapidly, 10 ft. in 3 minutes being recorded, and a further 10 ft. in the next 7 or 8 minutes, at which time the stairway of the Park concession was actually flooded. However, the river ice immediately rose again and moved north, some of it climbing over the shore ice already stranded and pressing furiously against the bridge. It was at this moment, shortly before 8 a.m. on the 26th January, that the steel must have suffered its critical experience.

The submerged channel cleared again and the ice movement ceased. The river pack which now filled the whole area from the Falls to the bridge site and beyond this for several hundred yards, reaching almost to the rapids, settled down again and the discharge from above was diminishing. The new ice was carried under the pack-ice still in tremendous quantities and began to jam in the lower reaches of the river near Queenston. Between the hours of 8 and 11 a.m. on January 26th the steel could be seen to buckle and distort, and the Company's chief engineer, realizing that the safety of the structure was now in jeopardy, shut off all traffic at about 9.15 a.m.

Fig. 10—April 12th, 4.04 p.m., Last Portion of Wreckage Disappearing Below Water.

To explain the precise nature of the damage to the steel frame, which was confined to the eastern or U.S. end, and to sketch the sequence of failure, some general idea of the construction must be given. As diagrams and photographs will show, the bridge was of the "trussed-rib" type of arch, with end hinges only. The "rib" had upper and lower chords and a web framing between them consisting of alternate vertical and diagonal members. The upper and lower chord of each rib were so laid out at each end that their axes intersected on the hinge pin, the members themselves finishing on a common gusset plate, well stiffened and heavily reinforced and connected to a large shoe casting by bolts which passed through base angles (see Fig. 13). This casting also carried the end vertical post and was finished with a semi-cylindrical surface which bore on the 12 in. by 5 ft. 10 in. hinge-pin. This pin in turn bore against another semi-cylindrical surface furnished by a cast steel box which was built into and backed up by a structural steel shoe designed to spread the thrust to the masonry. These shoes, box-castings, and pins were not moved or even damaged by the ice pressure, and only in one instance out of four did the actual fall of the span displace the pin. This was at the northeast or downstream American corner, where the pin was lifted or pushed out of its bearing by some of the falling steel after the arch rib had pulled away.

The main span across the gorge was 840 ft. between hinge-pins, and the deck was carried at a height of about 167 ft. above these pins on a series of floorbeams and stringers supported by vertical posts, sway-braced together in pairs standing on the upper chords of the ribs. From each bank of the gorge to the end vertical posts above the shoes, was an approach span of bow-string truss construction, pin-connected to the top of the vertical posts, and provided with sliding roller-bearings at the abutments. These approach spans were not quite identical as the Canadian span was 210 ft. long and the American 190 ft. long. The whole bridge was thus 1,240 ft. long between end bearings, or about 1,244 ft. between the natural rock backwalls. The weight of steel in the structure as originally designed was 4,532,047 lb. to which some 30 or 40 tons may have been added during maintenance

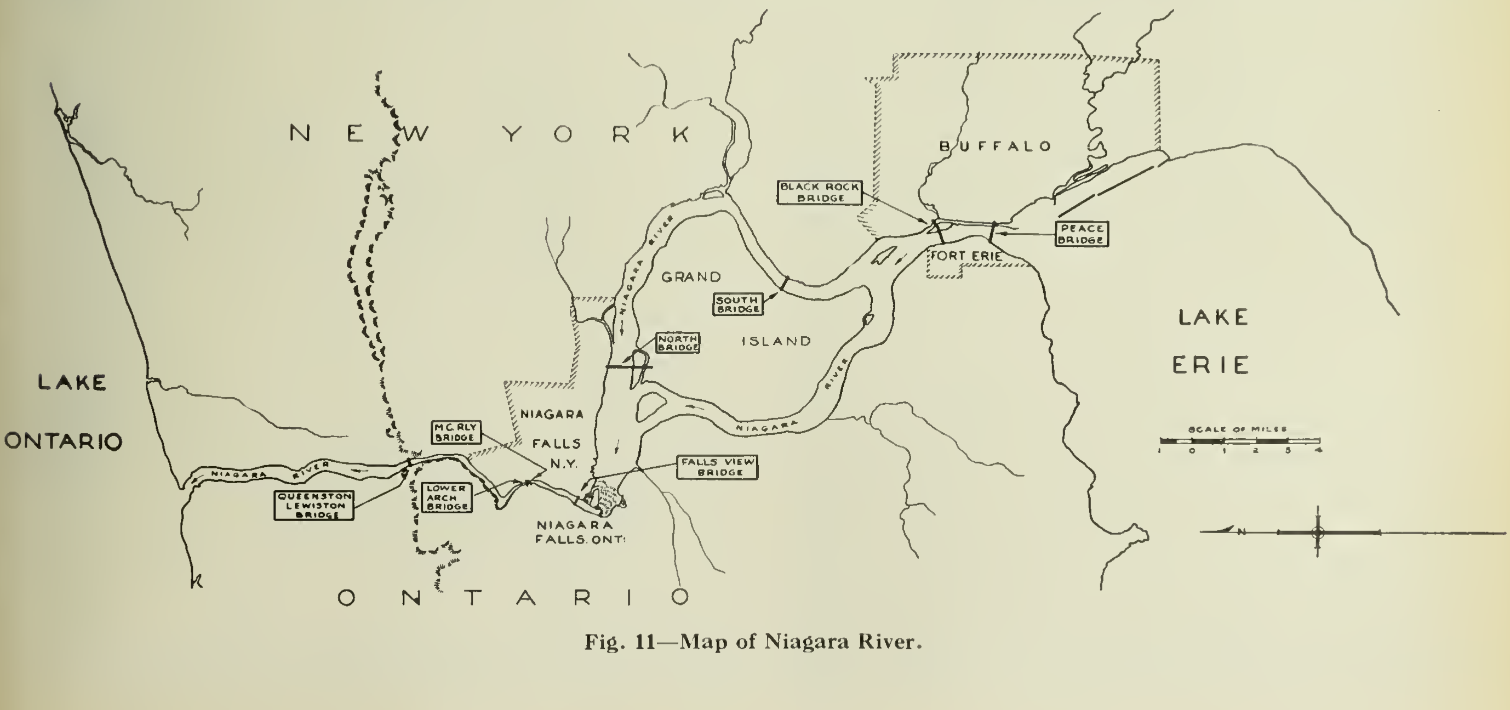

Fig. 11—Map of Niagara River.

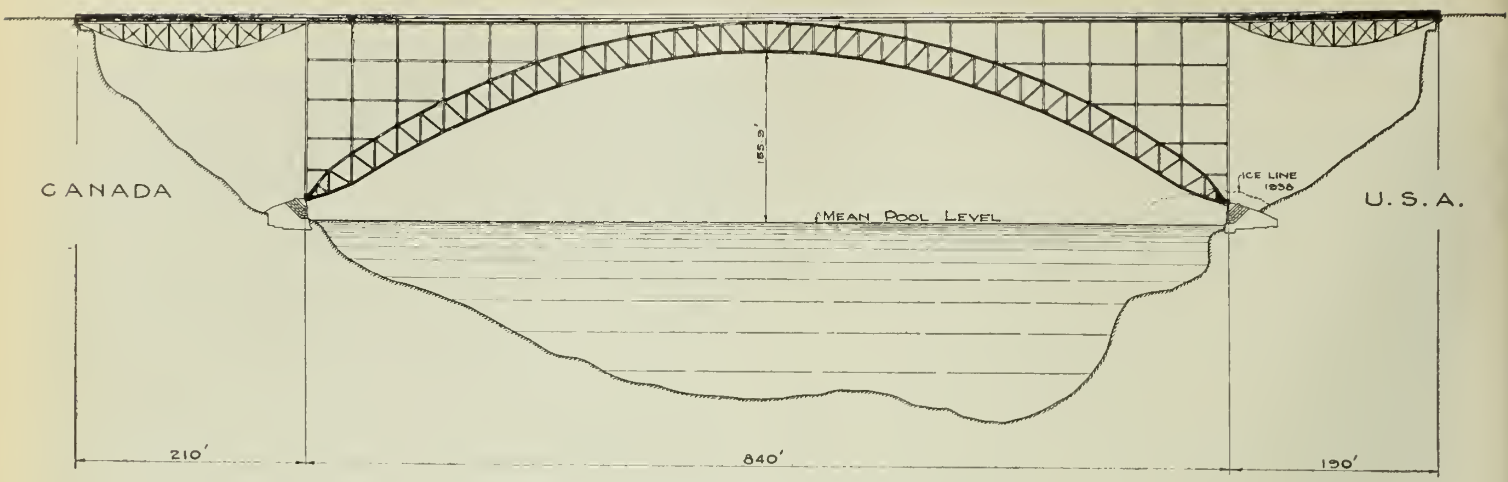

Fig. 12—General Diagram of Falls View Arch.

operations over the 39-year period. The timber deck as renewed in 1936 amounted to about 265M f.b.m., weighing possibly 500 tons.

The upper chords of the two ribs were braced together by a lateral system and the lower chords by another lateral system, each of these systems terminating in a transverse strut located close to the hinge-pin. A third transverse strut which formed part of the sway bracing of the end vertical posts also crossed from one side to the other, just above the shoe castings. The first panel of the lower chord laterals are those which were reinforced in 1899 when the webs were made of solid plate instead of lacing bars as is the case in all other members of the lateral system, and it is worthy of note that the main lateral diagonals of both the upper and lower systems are sub-trussed to shorten the otherwise long members, and that in both chords two short sub-members meet at a point midway between the main truss panel points.

As the ice pressure against the end lengths of the upstream lower chord at the American end developed, these chord members acted as continuous beams supported to various degrees at the connection to the shoe, the panel points of the vertical truss, and the panel points of the lateral system. The reactions at these points of partial support travelled by devious routes to the masonry, two or three per cent perhaps going to the Canadian end via the bridge as a whole, but by far the greater part to the two American shoes. The almost direct path to the downstream shoe via the lateral system, lasted only until the end laterals buckled, which was probably a matter of a few minutes. The path via the second set of panel laterals to the downstream chord at $L\,1$ also lasted a very short period until these laterals buckled. In each of these cases the resistance at the downstream end of the laterals was greater than the capacity of the laterals in compression, so that the buckling occurred quickly with little or no adverse effect on the downstream truss. At the mid-point $L\,1\frac{1}{2}$, where there was no other main truss member to assist, the downstream lower chord was not able to furnish sufficient resistance to the lateral thrust and the chord began to buckle before the lateral sub-diagonals were overloaded. Pressure travelling to the upper chord of the upstream truss, via the vertical and diagonal members, met little effective resistance from the top lateral bracing which readily collapsed in compression. The yielding of all these secondary paths meant that the remaining path, namely, that through the connection of the upstream truss to its shoe-casting, was compelled to bear the whole load. This it could only do if the two lateral end struts stood firm, but apparently they also began to fail, and crushed in toward their upstream ends, probably in succession, the lower lateral strut first. After this the whole load came onto the connection angles and their rivets. The enormous concentration at this point gradually bent these angles and pushed the gusset plates downstream firstly without severing the connection either from plates to angles or angles to casting. The failure was progressive and rivets began to shear, material to tear, and heads to fly off, so that as the gusset plates bent further and further downstream (Fig. 13) the normal dead load thrust became more and more eccentric and thus hastened and intensified the distortion. The upstream truss thus moved definitely eastward toward the U.S. skewbacks as the yielding of the gusset plates permitted, until the latter actually bore against the bottom lateral strut. It was this constant movement that forced the short horizontal strut from $U\,1$ to the end vertical post to push the latter out of line (Fig. 1). Meantime the buckling of the downstream chord at the midway panel point $L\,1\frac{1}{2}$ was increasing and the normal dead load in that member, approximately 822 kips, together with any unfavourable wind load, was acting with an ever growing eccentricity and thus creating a progressively increasing buckling moment. The two critical points were therefore the upstream chord-to-shoe connection and this point of buckling at $L\,1\frac{1}{2}$ downstream. Each of these had reached a state absolutely beyond hope of repair at 10.30 a.m. on January 26th.

The yielding of the upstream chord near the shoe, after the cessation of ice movement, most probably resulted in some decrease of the active ice pressure and furthermore the ice jammed in between the trusses probably assisted to some slight degree in delaying the severance of this connection. But in spite of these factors, the severance continued very gradually to develop, ominous sounds of tearing were heard, and sharp reports, as rivet heads flew off, but the process slowed down and the other critical point seemed to exhibit for a while more signs of immediate failure. The amount of buckling at $L\,1\frac{1}{2}$ downstream gradually increased during the 26th, and developed a component in the upward direction which introduced some distortion into the vertical posts above the truss and into the deck construction immediately overhead. The tearing of metal was also heard at this point occasionally during the afternoon and noticeably about 1 p.m., but matters all seemed to ease as with the approach of night. In the early morning of the 27th, observations and measurements showed some further displacement of the deck structure above the point $L\,1\frac{1}{2}$ in the downstream truss and also some further degree of severance of the connections at the upstream shoe. Examinations at noon revealed the fact that there remained some connection between the gussets and the casting at the lower extremity, but exactly how much could not be determined due to it being buried in ice. It was also noted at this time that the buckling of the downstream chord at $L\,1\frac{1}{2}$ had reached the amazing dimension of about 3 ft. horizontally and 17 in. vertically, but had apparently steadied down at these figures. The chord had tilted about 40 deg., the upper coverplate was ripped across for about three-fourths of its width from the south edge, leaving just a few inches in contact with the north upper flange angle.

The lower flange plates were almost entirely torn off and both the south flange angles badly crushed at the point of buckling. The outstanding leg of the lower flange angle on the north side was cracked through a rivet hole and the crack was slowly creeping past the fillet into the upstanding leg. An instrument was set up on the bank at the writer's request to observe any further movement at this point as he felt that this would be the place where final failure must inevitably occur. The figured stresses from dead load thrust, dead load eccentricity, and the much reduced and damaged cross-section were definite indications leading to this opinion, but no more movement was recorded between noon and 3.45 p.m. when the last reading was made.

In the meantime however further inspection at the upstream shoe showed continued slow movement and the observers reported that occasional tearing and shearing could be heard to take place. At 2.40 p.m. it became obvious to the writer that further observations were likely to be dangerous so that all men were ordered away from underneath the bridge except one observer who from a safe distance, was instructed to record any serious change in the situation or any ominous noise. At 4.10 p.m. this observer approached the upstream shoe with the idea of making some check measurement, but heard a distinct tearing report from the other truss and saw the structure begin to fold up. He naturally ran southwards and was about 20 ft. clear when the downstream truss collapsed, bringing after it the approach span and the whole structure. As mentioned above this downstream truss left its bearings, but the upstream truss just quietly lay down. The Canadian end was pulled forward as the American end dropped and the bridge went down to its rest at 4.12 p.m. with a rattle like distant light artillery. When the snow cloud cleared it could be seen that the axis of the deck as it lay on the fallen arch, was almost directly below its proper alignment for a distance of two-thirds of the length from the Canadian end toward the American end, after which it dipped northwards or downstream, partly due to the fact that the downstream truss failed first and partly because of the hole in the ice which had been caused by the water from the tail-race emptying alongside the downstream skewback. It was also noticed that a number of the lamps were still intact, both globes and glass shades being unbroken.

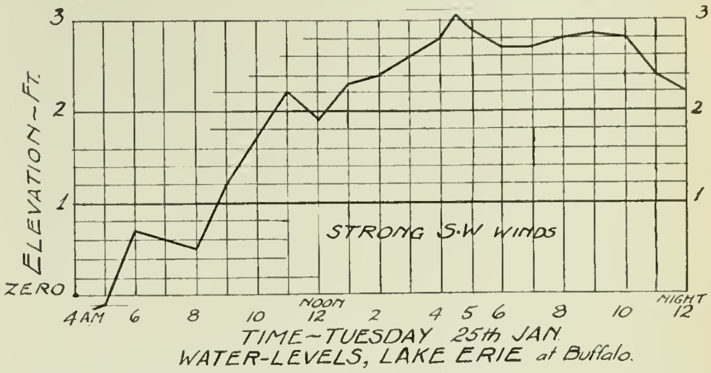

Fig. 14—Diagram of Water Levels, Lake Erie, on Jan. 25th, 1938.

In conclusion a brief statement as to the ultimate fate of the wreckage may be of interest. Arrangements were promptly made by the owners to cut the wreckage into sections and to cut it loose from the shores so as to minimize the danger of any quick movement of the ice leaving the span as a whole on the bottom of the river between the two sets of skewbacks. Local opinion was that the ice would remain for a goodly number of weeks, particularly on the Canadian side where it was apparently thick enough to rest on the bottom of the river profile. Further arrangements were made for the removal of the Canadian approach span, the salvaging of some of the timber and later on of some of the main span steel near the west or Canadian shore. The condition of the ice at the American end made it absolutely unsafe to carry out any operations in this vicinity. During the first few days of February, the hole in the ice caused by the tailrace near the downstream American corner enlarged itself and let the wreckage sink in this neighbourhood, but no really serious movement occurred until the beginning of April, when approximately half of the bridge at the American end dropped through the now rotting ice, and the remaining portion began to move downstream. A series of photographs taken on the 4th April record these movements and the last sight of any portion of the main structure was obtained about 4.04 p.m. on this day, several hundred yards downstream as the ice which carried a 200 ft. section upset and the steel sank to the bottom. The wreckage of the American approach span was finally removed during May and June so that the shore could be cleared as a preparation for the erection of a new bridge.

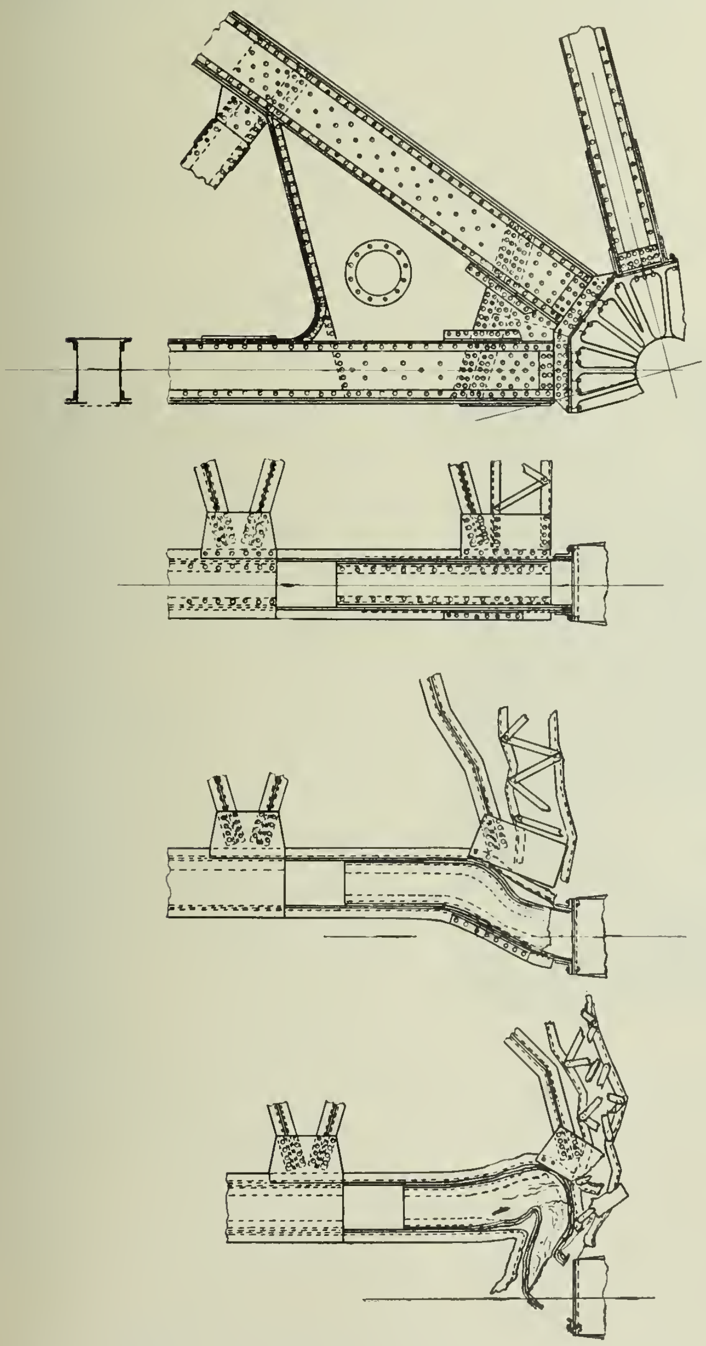

Fig. 13—Diagram of Collapse at Upstream Shoe U.S. End, (Not pricise or to scale, indicative only).

The New Viewpoint in Lighting

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Presented before the Niagara Peninsula Branch of The Engineering Institute of Canada, December 16th, 1936.

SUMMARY.—With the constant increase in the number of people with defective eyesight, the problem of lighting becomes more and more important. The author points out how bad lighting contributes to this condition and indicates the standards which should apply in order to enable persons to maintain their normal eyesight for a greater number of years.

Illuminating engineering is continuously embracing new fields of application. At no time has the practice of the art and science of illumination been so interesting and so expansive as in the present era. At no time has illuminating engineering served so broad a viewpoint—in eyesight conservation and human welfare, in decoration and aesthetics, in safety and convenience—as it does today.

The first and fundamental question on lighting design is as to the real objective to be accomplished by lighting. In seeking an answer to this question, it is necessary to depart from the traditional engineering boundaries and enter a totally different realm—that of human reaction—of likes and dislikes—of health, heritage and habits; only here can we find the full significance and purpose of lighting.

Lighting specifications, both as to quantity of light and quality of lighting, must be based logically first, on how lighting affects visual processes, following through to the contribution to human welfare. Definite and measurable scientific facts have come out of an orderly programme of research on seeing, which have placed new responsibilities on the designer of lighting. These new responsibilities deal directly with the conservation of eyesight, health and safety of those who use the lighting. This is the new approach to lighting: this is the new viewpoint in lighting.

This new viewpoint is founded upon the new science of seeing. Seeing is a partnership of light and vision. The science of vision is relatively old. It has to do with our eyes, their function, limitations, and the visual sense. The science of seeing is much broader. It extends the viewpoint of vision to an activity of the whole human organism, its behaviour, efficiency and its welfare. It treats of human beings as human seeing machines. No science can be more universally important, since seeing is something in which everyone is interested. It is of prime importance in our everyday activities and therefore worthy of careful thought, consideration, study and action. It is for this reason that lighting research has been directed to the investigation of seeing, and the light by which we see. Dr. Matthew Luckiesh and his co-workers in the Lighting Research Laboratory at Nela Park, have during the past 25 years developed many significant facts and have presented much new knowledge which is just being accepted today.

One is inclined to think that because we live in a modern civilized world of machines, concrete buildings and motor cars, we are well fitted to our work of today. Actually, civilization imposes a considerable burden on many parts of our body and only through ages and ages of accommodation and evolution could we ever become completely adapted to modern times and the conditions we have made for ourselves. Outstanding among out bodily functions not yet adapted to our living conditions, are our eyes, which through inheritance are still best fitted to work under the seeing conditions of several thousand years ago.

How many years has it taken man to develop into what he is today? Some say five million years, some two million years. Let us say half a million years to be conservative. Let us assume that the 12 hours on the clock from noon to midnight represents the half million years down through the ages and during which man has been developing into what he is today, and follow the hands of the clock around hour after hour to a point just before midnight—5 seconds before midnight. If we did this, these 5 seconds would represent your lifetime and mine. What a small fraction of man's total existence we are living today! Within the last minute or so of this journey of ours upon the clock man started to use his eyes for closer vision—pottery, weaving; and later, within the last 30 seconds, to reading books and papers.

Fig. 1—The Illuminating Engineering Society type study and reading lamp, built by several manufacturers to specifications issued by the I.E.S., provides an adequate amount of glare-free lighting for its designed purpose. Inside the shade is a translucent bowl with the open end upwards, containing but concealing the source of light. The light that passes through the bowl is reflected downwards by the shade and the balance goes upwards to the ceiling and walls, thus reducing the difference in intensity of illumination between the well lighted area and the balance of the room; such differences are a definite source of eyestrain.

Nature's Plan—Man's Plan

For the thousands and thousands of years that man has been developing, he has been essentially an outdoor creature. His eyes, for instance, were evolved to function under the high illumination of daylight. He used his eyes primarily for long-distance seeing, and when the sun went down, he went to bed. But what has happened now? Within the last two generations, we have become modern. We have developed all kinds of indoor-located machinery, which we run night and day, on dark days as well as on sunny ones.

Let us contrast the difference between nature's plan and modern man's plan. We moderns, tossing lightly aside the fact that our eyes have been in the process of development for hundreds of thousands of years, bring ourselves indoors, accelerate our tempo of living, and create all sorts of jobs for those eyes under conditions vastly different from those nature intended. Instead of distant vision, we have for most of our visual tasks close vision, 15 to 30 inches. Instead of broad daylight, we have relatively low levels of indoor natural and artificial light, and, not content with all this, we have, on the average, lengthened the working day that our eyes must serve.

Our eyes are so formed that the ideal distance for seeing is probably a range of 20 feet or more—no doubt because so far as our remote ancestors were concerned, objects seldom required close scrutiny at shorter distance than this. The eye is provided with muscles for converging the eyeballs into position for near vision, but nature intended these to be used for intermittent concentration and not to be under strain for many hours each day. Therefore, it is just as logical that fatigue should result from this continuous concentration as from any other unnatural action, such as holding your hand at arm's length for more than a few minutes' time.

Nature planned for the eye to cease functioning at nightfall and have a long period of rest. In the present century, while we have been busy shortening the hours of labour for the body, we have steadily increased the hours of hard labour for the eyes, to about 16 hours per day. Not long ago there was no daily newspaper to read and no magazines. There were no movies, no automobiles, no basement machine shops—all of which give us mental relaxation but plague our eyes and increase their burden. The contrast of nature's plan with modern man's plan begins to suggest some of the reasons back of the statistics on defective eyesight. But, you ask, how does this relate to lighting and the Science of Seeing? If modern civilization has chosen to impose such handicaps, what is there that we can do about it?

Outdoor Footcandles

Nature is very generous and on a bright sunny day gives us as much as 10,000 footcandles of illumination, and we moderns find no real discomfort in this amount as we engage in out of doors work or play; there is something really pleasant about it. Even on a dreary, rainy day, there are several hundred footcandles outdoors. In the shade of a tree there is an illumination of perhaps 500 footcandles.

Indoor Footcandles

When we come indoors the story is quite different. Take a modern building with large windows covering most of the sides. Surely there is a bright cheerful daylighting inside on a sunshine day. Measurement of the illumination inside with the light meter would probably show that near the window there is only about 100 footcandles, even though there are several thousands outside. At ten feet from the window, this value would have dropped to approximately 20 footcandles and at a distance of 20 feet would have dropped as low as five footcandles. Even on bright days in most of our interiors the light is poor, except at the windows. The use of light meters which detect lighting conditions is needed vastly more than the thermometers, the use of which is commonplace in offices, schools, and other work places. With a good modern system of lighting, automatic photo-electric lighting control is one sure safeguard again abusing the eyes by failure to turn lights on when needed. Tests in two schoolrooms showed that the lights in one classroom with automatic control set to maintain a minimum footcandle level, were on 40 per cent of the time. In an adjacent classroom with the same daylight exposure, the manually-controlled lighting was, through inattention, turned on only about 10 per cent of the time.

Light is the One Controllable Factor in Seeing

What are the elements which go into this process of seeing? They are three: the eye, the seeing task, and the light which makes it possible for the eye to see. We can do very little for the eyes themselves, beyond sharpening them with the aid of glasses, if these eyes need such aid. We can do very little about the seeing task. If we are typing in an office, we must continue to type. If we are working on a lathe, we must continually keep our eyes on this task. If we are reading a newspaper, we cannot change the type, or the colour of the paper.

The one big variable is the light, and that we can control in almost any manner we wish. We can make it high or we can make it low; we can make it harsh and glaring or we can make it soft and comfortable. How important it is, therefore, to study the effects of this one factor, to know how much light we should have, and how much light we are actually getting. The slow processes of evolution are inadequate to compensate for the changes man has made in his method of living. The eyes are not receiving the assistance from lighting that they should.

As people grow older, more and more of them have to turn to eyeglasses to help out an increasing percentage of defective eyes. Surely it is a rather startling fact that among people sixty years of age, only one in twenty has normal vision. A study of the progress of nearsightedness in school children and college students reveals appalling conditions. If 40 per cent of the adults we meet on the street were hobbling along on crutches, we would bend every effort to correct so distressing a situation. And yet, many of us give slight consideration to our eyes which probably all of us will admit are our most valuable possession.

How Much Light Do the Eyes Want?

For long years we have been recommending intensities of illumination based largely on guesswork, tempered with good engineering judgment, satisfying the question "Can you see?", rather than the more important one "How *well* can you see?" Now with the findings of researches in seeing, we have a rational basis upon which to base our recommendations. Even so, had we in previous years given our eyes a chance to judge how much light they want rather than theorize, we would have determined long ago that the footcandles intensities being recommended and used were pitifully inadequate.

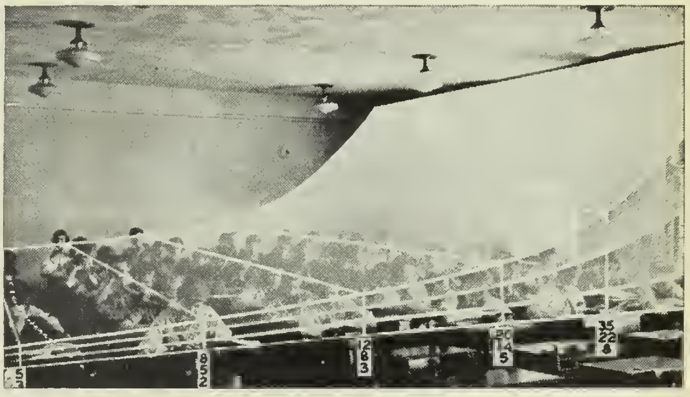

Fig. 2—Composite photograph showing the rapid falling off in natural daylight as the distance from the window increases. Top line represents a bright day, middle line a cloudy day, lower line a dark day. Good classroom lighting has been receiving much attention lately.

There has been adopted a device whereby any person can select for himself any intensity his eyes ask for between 1 and 1,000 footcandles. A summation of the results obtained by a number of people on a simple visual task such as reading a newspaper produces astonishing results: a few are satisfied with 10 and 20 footcandles, most ask for 50 footcandles; some want 100 and 200 footcandles, with an occasional one asking for 500 or more. In the light of the 2.5 to 10 footcandles we have been making our eyes work under, perhaps we would demand more, if our pocketbooks or past practices had not played a more important part in our judgment than our eyes.

There are Four Factors in Seeing

The Science of Seeing now tells us very definitely the proper amount of light recommended for the several grades of visual tasks. Also that every time we see an object, four principal factors come into play: the size of the object, the contrast, the time and the brightness. The first three of these factors are usually more or less uncontrollable in any specific instance; the fourth, brightness or the amount of light, can be controlled and its proper intensity is dictated largely by the other three factors. The second fundamental factor is that of contrast. Often our selection of clothes, shoes, wallpaper, and things of that character is influenced by the statement, "It won't show the dirt," but everyone will agree that in lighting laundries and food factories, we ought to be able to see the dirt. A dark hairline crack or flaw hiding in the grey background of a casting in a foundry doesn't show the dirt either, but it is quite vital to see it before it gets into the cylinder block of your automobile.

The third factor of vital importance in seeing is that of time—for it takes time to see. The eye is very much like a camera in its action. When the illumination is high the eyes take a snapshot; when the illumination is insufficient, they must take time-exposures.

More Light is Only Part of the Story

In the majority of instances, improving seeing demands higher levels of illumination. But this is just one factor that is under the control of the lighting engineer. Other elements of quality, control, direction, surroundings, enter into the problem and require an intelligent selection of reflecting and diffusing equipments and their proper location.

Probably the most apparent and at the same time the most undesirable factor of quality is that of glare. Glaring lights are hazardous to eyesight and positively wasteful because they reduce visibility. Similarly, reflected glare, that is brightnesses reflected from shiny work surfaces, glasstopped desks, store counters, and the like, may prove even more annoying and interfere with vision to an even greater extent than direct glare. The illumination of the surroundings, so as to relieve severe contrasts, is of extraordinary importance in relieving eye muscles and obviating the necessity for frequent adaptation of the pupils of the eyes.

Consider the many cases of serious complaints of factory and office workers, suffering from headaches and nervousness, with consequent loss of time, where the solution has time and again rested purely and simply on the matter of providing an adequate system of illumination with respect to both quality and quantity. The prevalence of defective eyesight will never be alleviated if we continue to install lighting systems in accordance with primitive notions and on a false basis of economy. Good lighting is not only a matter of saving eyesight. It is a matter also of stopping needless waste of untold quantities of nervous energy. The statement has been made that the office worker who uses his eyes all day under inadequate light may be actually more tired at night than the man who spends a day digging ditches. The Science of Seeing indicates quite clearly that it does take energy to see. In testing this in our Lighting Research Laboratory, we have discovered, after thousands of tests, that there is a direct relationship between low illumination and increased muscular tension. The higher the illumination, the greater the relaxation.

Good Lighting Helps Those Who Need It Most

It is a generally accepted fact that improved lighting increases efficiency. Fast workers with normal vision are enabled to produce more useful work when provided with the advantages of good lighting. Slower workers and those with subnormal vision receive even greater assistance from good lighting. The eyes are entitled to carefully designed lighting adequate for all periods in the life of the individual. During the formative period of childhood, young eyes are easily injured by the strain of inadequate and improper lighting. As the eyes grow older, physiological changes occur which impair vision, for example, the pupils of a 50-year old person admit slightly more than one-half as much light as those of a 20-year old person. In this, and in other ways, higher levels of illumination serve to offset the handicap in seeing imposed by advancing age.

In general, more and better lighting improves visibility, makes visual work easier, reduces eyestrain and fatigue and enables a greater proportion of the energy available for work to be converted into useful work. Increasing the amount of illumination, utilized in accordance with known relationships of lighting and seeing, is the most generally efficacious means at the command of the light specialist for assisting vision. In the business of lighting, many compromises are often made with respect to types of units, systems employed and lamp sizes, yet there can be no compromise with eyesight.

Application of the New Science of Seeing

Now let us give some consideration to the application of the principles of the new science of seeing to our modern lighting installations. The school lighting field is one which is of interest to the entire community and educators and lighting men have been giving much attention in the last year or two to the significance of adequate lighting in our schools. A survey indicates that even on a bright day the natural illumination in the inside row of desks is entirely unsuitable for the work which the pupils have to do. A carefully conducted test of the progress of students in a poorly lighted room and in a well lighted room in one particular school, showed the following results:

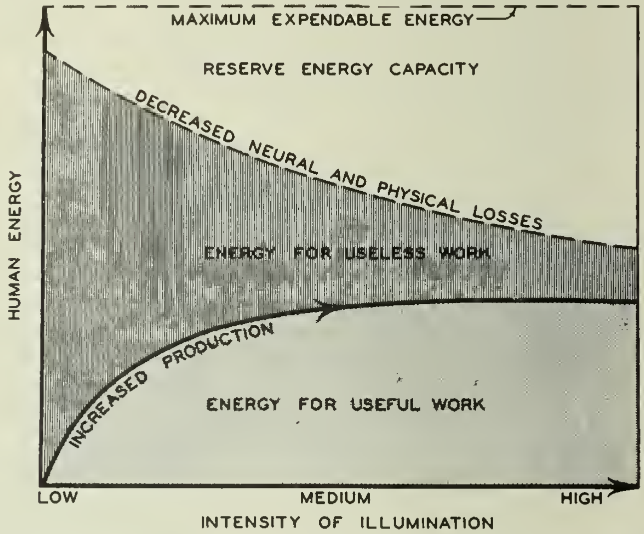

Fig. 3 — Curve showing the proportion of human energy available for useful work under various intensities of illumination.

1. The pupils in the well illuminated room showed approximately 28 per cent more improvement than those in the poorly lighted one.
2. The pupils in the better lighted room were more alert and more responsive.
3. The teachers commented on several occasions that the better lighted room was a much more pleasant location in which to teach.

Another three year study of the effect of adequate classroom lighting contrasted with poor lighting in schools was conducted. Over the three years an average of nine pupils per year failed in a poorly lighted room, compared with three in well lighted room. The total electrical energy used in each room was metered and the average cost for the additional consumption for the well lighted room was $24.33 per school year. The cost of educating each pupil in that location is about $28.00 per year for actual operating expenses. The results of this investigation indicated that better lighting paid for itself six times over when the additional cost of the higher lighting was compared with the cost of instruction for the pupils.

By far the largest amount of school money goes for formal instruction. Although learning is chiefly received through the eyes—psychologists tell us that 87 per cent of our knowledge comes through the sense of sight—only a tiny sum is spent for the one medium which can help the eyes and an analysis of the actual operation expenditures of the school system serving a city of 40,000, with average lighting in its schools, shows that even doubling the present lighting bill would increase the budget only ½ of 1 per cent. Improved lighting is a cheap way to reduce failures and protect the eyes of the school children.

Office Lighting

One can't very well move his desk outdoors under the shade of a tree, much as he may wish to have at his work the 500 or more footcandles of comfortable, well-diffused illumination that is to be found there. What can be done, however, and what is being done today by many business executives, is to provide for themselves and their employees lighting systems that produce illumination comparable in quality, if not in quantity, to that found in the shade of a tree.

As a matter of fact, it is not necessary to provide the quantity of foot candles indoors that nature provides outside. To do this would tax the ingenuity of the engineer and probably could not be justified from an economic point of view. What is desirable, however, is to provide illumination values indoors far in excess of the starvation levels that are to be found in the average office today. For not only does good lighting help to conserve human energy and human eyes, but adequate illumination also helps to increase the efficiency of the workers by enabling them to do more work with less effort.

There are three kinds of lighting systems applied to offices—indirect, semi-indirect and semi-direct. In the first two mentioned systems all or most of the light is directed from the luminaire to the ceiling, whence it is distributed as useful illumination throughout the office. In these systems, since the ceiling becomes the main source of light, distribution illumination to the desks, and being large in expanse, somewhat similar to an overcast sky, comfortable illumination of good quality results. In general, semi-direct systems of lighting which direct most of the light directly downward to the desks are only recommended where the ceilings are unsuitable as a secondary source of light.

The present recommended standards of illumination for office work are as follows: 20 footcandles for ordinary desk work; 30 to 50 footcandles for prolonged close work, computing, designing, and so forth; 30 footcandles for bookkeeping and accounting; 30 footcandles for drafting rooms.

Industrial Lighting

To understand factory lighting problems and solve them successfully demands that we have a knowledge of the Science of Seeing and appreciate the significance of light in relation to eyesight. The scientific knowledge is all-important and constitutes the basis for the specifications of lighting for every job where quick, accurate and safe seeing is involved.

Let us forget for the moment any ideas or notions about lighting we may have, and approach the discussion with an open mind and with simple logic; it seems we must consider these three questions:

1. Do we need better lighting for industrial work?
2. Do we have the knowledge and equipment to apply better lighting?
3. Can we afford better lighting?

Those of us who have been concerned with supplying artificial lighting now realize that light in itself has no value but becomes important only as a function of the processes of seeing. The Science of Seeing indicates the levels of illumination desirable for the many tasks which our eyes have in a factory. Surveys which have been made indicate that the present lighting is far below useful values. The results of tests made in measuring the illumination in the work areas of nearly 3,000 factories show the average value to be only of the order of about three footcandles.

During the past few years many industrial executives have been realizing the very definite need for higher intensities of illumination. Results have shown that a good number of outstanding installations have been accomplished. The practical results indicate that the present knowledge of illuminating engineering and the wide choice of lighting equipment are adequate to provide the advance of lighting needed. General illumination of the order of 10, 20, 30 or even 50 footcandles is now very practical, and even 100 to 500 footcandles over special local areas.

And now, as to the question "Can We Afford Better Lighting?" Some of its values are so far-reaching and complex as to defy measurement in dollars and cents. Humanitarian values in conservation of eyesight and benefit of the health and well-being of the workers, cannot be thus appraised. But, let us look at the cost of lighting. This is usually so small that in the majority of cases it is not known nor is it usually set down as a separate accounting item. From the best estimate it is possible to make it is indicated that factory lighting costs today are less than .3 of 1 per cent of the total production cost. Even the best lighting that we think of today would cost only a very small proportion of the total cost of doing business. And then, when we consider the benefits of better lighting which spread themselves over every phase of plant operation, and the values which come from any one phase, may more than offset the entire lighting bill. We must conclude that we have in lighting a commodity which cannot help but be a profit.

The fact that all plants use artificial light to some extent today indicates the inadequateness of natural lighting to provide the illumination required. The difference between the cost of poor lighting and good lighting is so small, coupled with the overwhelming evidence of its benefits, that judged either from the standpoint of investment required or operating expense, the conclusion that it is worth more than it costs appears almost inescapable.

Home Lighting

The lighting in the home is something in which everyone is interested. The lighting provided affects every member of the family. During the past few years we have heard much of the "better light—better sight" activities which has spread knowledge of better lighting into a good many of our homes throughout the country. This knowledge of better lighting has been warmly welcomed as has been indicated by the increase in the use of improved types of portable lamps and other lighting equipment. The advantages which will acrue in the conservation of priceless eyesight and human resources and the comfort and joy of a more restful, cheerful, inspiring and safe environment, in the sheer pride of a more attractive and up to date home, are worth thoughtful consideration in the lighting which we plan for our own residence.

Simplified Performance Calculations For Aeroplanes

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Presented before the Aeronautical Section of the Ottawa Branch of The Engineering Institute of Canada, March 22nd, 1938.

SUMMARY.—Through the use of two simple, generalized logarithmic curves, one representing Power Required, the other representing Power Available, the ceilings and high speed, climbing speed and maximum rate of climb at any altitude are determined rapidly for any aeroplane. The curves are in terms of general propeller and aeroplane parameters: shifting their positions relative to one another provides change of altitude.

The tools of the method are two generalized curves, prepared beforehand, and which relate to any aeroplane. The generalized Power Required curve (Fig. 1) is in terms of a variable K_{HP}, expressing the ratio of any power to minimum power, and a variable K_v expressing the ratio of any speed to speed at minimum power. The generalized Power Available curve is also in terms of the ratios of power and speed: in this case the ratio of any power available to maximum power available and any speed to maximum speed.

While the development of the two generalized equations upon which the curves are based is quite straightforward, it is not necessary to follow it through as the desired performance figures can be obtained by using the routine mechanically. It is proposed to demonstrate the use of the method first and to develop the equations later.

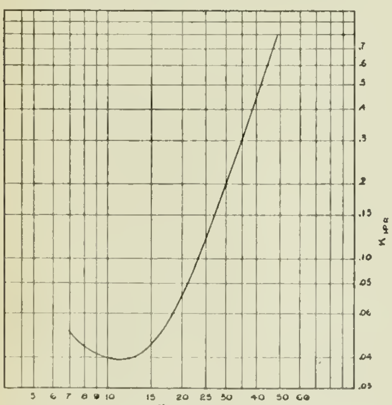

Fig. 1—Generalized Curve of Power Required.

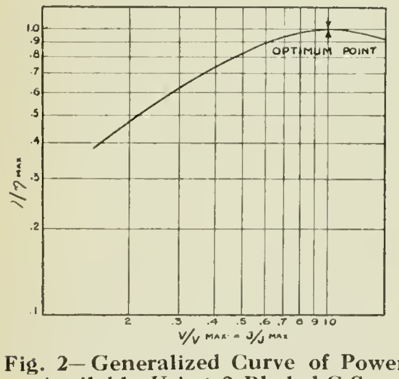

Fig. 2—Generalized Curve of Power Available Using 2-Bladed C.S. Propeller.

Assume we have given:

1. The generalized curve of Power Required plotted in terms of K_{HP} on K_v on logarithmic paper (Fig. 1).
2. The generalized logarithmic curve of Power Available (Fig. 2) cut from celluloid.
3. The usual working charts for propellers, such as References 5 and 6.
4. The general characteristics of the aeroplane, such as listed for the Sample Aeroplane in Table Ia.

From the figures of Table Ia, calculations are carried out to determine one value for K_v and one value for K_{HP} for each altitude. This locates a point for each altitude on the generalized Power Required sheet, Fig. 1 (see Fig. 5). The Power Available curve (assuming a constant speed propeller) for the desired altitude is then drawn by setting the Optimum point of the celluloid curve on the specified point of the Power Required graph and tracing out the curve—one curved line for each altitude. This set of curves may then be treated as an ordinary set of aeroplane power curves: their intersection represents the high speed at the specified altitude; their vertical differences represent Excess Power, from which the maximum rate of climb at the altitude may be determined, and hence the service and absolute ceilings obtained. The case of a fixed pitch propeller is treated in the same general manner, with slight differences.

Sample Calculations

Using the data given in Table Ia, the simple calculations of factors and sea level values of the parameters S_v and P_v are carried out as shown in Table I.

Case A. Sample Aeroplane with Constant Speed Propeller.

In Table II, the Sea Level values of S_v and P_v (as calculated in Table I) are listed in the Sea Level Altitude column: their values at various altitudes are obtained by multiplying the Sea Level value by $1/\sqrt{\sigma}$, as shown. Item 5 is taken from the engine power curve, or, if this is not available, the values are estimated by methods given in Reference 1. Items 7 and 8 are taken directly from Fig. 3 for the values calculated for Item 6. Item 9 is calculated as shown, the 2 being introduced because there are two engines. Items 9 and 10 give the ordinates and abscissae for the points marked on Fig. 5. On each of these points in turn is set the Optimum point of the Power Available celluloid curve, and the curve traced out and labelled with its altitude. This set of curves then represents the power curves for the sample aeroplane with constant speed propeller.

The high speed at any altitude is obtained by reading the value of K_v at the point where the power curves for that altitude intersect (Item 11) and multiplying this value $K_{v\,\max.}$ by the speed variable S_v (Item 3), relating to that altitude (Item 15). To determine the maximum rate of climb for a given altitude, the greatest distance between the Power Required curve and the Power Available curve *at the desired altitude* is determined (by subtraction of the ordinates) as set out in Item 13, and this value is multiplied by 3.3 P_v (the P_v used being that related to the desired altitude), giving the maximum rate of climb in feet per minute directly. The reader is cautioned that the figure 3.3 is peculiar to this sample calculation. The figure by which $P_v(K_{HP\text{av}} - K_{HP\text{req.}})$ is multiplied is 33,000 per gross weight, which in this case is 33,000 per 10,000 equals 3.3. The value for best climbing speed is that value for K_v (Item 12) at which Item 13 is measured. Then the value of the maximum climbing speed at the desired altitude is this value of K_v multiplied by the value of S_v for the altitude.

The results of the calculation have been plotted on Fig. 7.

Case B. Sample Aeroplane with Fixed Pitch Propeller.

Power curves for the same sample aeroplane with a fixed pitch propeller are now determined.

Here the propeller is assumed to be designed for full B.hp. at the critical altitude, and the blade angle is chosen to give the values at 5000 ft.,

$C_p = .0371$ $\qquad J$ at η max. $= .702$ $\qquad \eta$ max. $= .818$

using Reference 6, i.e. Fig. 3 as before. The value m is also read off from Fig. 3, where m is a function of C_p as explained later.

In Table III, the first six items are determined in the same manner as in Table II. Item 7 is calculated, being the ratio between C_p at η max. and the C_p value at altitude

Item 8 is read from Fig. 4. Item 9 is determined by multiplying Item 8 by the design J at η max. Item 10 is read from Fig. 4. Item 11 is calculated by multiplying Item 10 by η max. Items 12 and 13 are then calculated as shown, the figure 2 being introduced in Item 12 *in this case* because there are *two* engines. Items 12 and 13 then give the ordinates and abscissae for the points marked in Fig. 6.

$\frac{\eta}{\eta_{\text{max.}}} = \left(\frac{V}{V_{\text{max.}}}\right)^m$ Now the curve of propeller efficiency when plotted logarithmically is a straight line of slope m. Hence, through the marked points on Fig. 6, we draw lines of slope m which represent the Power Available at the stated altitudes. Since the power drops off at the same rate when the optimum point is passed, beyond the optimum point the power available will be represented by a straight line of the same slope m, but m will be negative.

The remaining calculations of Table VI are carried out from Fig. 6, in a manner similar to that of Case A. The speed and climb and ceiling values are plotted in Fig. 7.

Comparison of Calculated Values with Flight Test Figures

Performance figures obtained by this method were checked against flight test data for three aeroplanes (all high winged monoplanes, two single-engined, one twin-engined) and the following characteristics noted:

1. There was excellent agreement for speeds at all altitudes and for maximum rate of climb at sea level and critical altitude.
2. There was poorer agreement for maximum rates of climb above the critical altitude, and hence for ceilings. The method gave results about 7½ per cent. too optimistic for the absolute ceiling.

Discussion of Graphs

Before proceeding to the development of the equations, some points regarding the graphs and tables will be discussed.

Figure 1 is plotted from Table IV, and represents the equation $K_{HP\text{req'd}} = .00000683\ K_v^3 + \frac{.3329}{K_v}$ and is applicable to any aeroplane.

Figure 2 is plotted from Table V. These values were taken from Reference 1, and apply to 2-bladed propellers.

Figure 3 is plotted from References 5 and 6. The data of Reference 5 related to full-scale tests of a cabin fuselage with J-5 engine and N.A.C.A. type cowling. The propeller diameter was 9 ft. and the Blade No. Navy Design 4412, section R.A.F. 6. Similar curves for open biplane types, etc. may be obtained from this reference. Reference 6 gave data applicable to a 4 ft. propeller, Blade 4412, situated 30 per cent. of the chord ahead of the leading edge of a wing of 60 in. chord and maximum thickness 20 per cent. of the chord.

Values of m plotted on Fig. 3 were taken from Reference 4.

Figure 4 is plotted from Reference 6, the values being given in Table VI.

Reference 9 is useful in determining corrections to the blade angle for a fixed pitch propeller.

In adopting References 4 and 6 for general use, the inaccuracy, as noted in Reference 9, is introduced—namely, that test data which applies to specific propeller blade form and section used in connection with certain aircraft bodies, is applied regardless of blade form, section, etc. of the problem aeroplane. However, as more suitable data is obtained, the inaccuracy will dwindle.

The general Power Available curve of Fig. 2 applies to 2-bladed propellers only. It would be desirable to obtain a similar curve for 3 and 4 bladed propellers.

Table Ia lists as requisite data for calculation, the value of C_{D0} and the slope "a" of C_L^2 on C_D. These values presumably are obtained from wind tunnel tests of the aeroplane model, corrected for scale effect. Our generalized Power Required curve assumes a straight line variation of C_L^2 on C_D throughout its range. If, however, as seems sometimes to be the case, when C_L^2 is plotted on C_D, below a certain low value of C_L the slope of the curve increases suddenly, we take the value of C_D at this C_L as being the true value of C_{D0}. This brings our calculations in line with the peculiarities of the particular case.

Development of Generalized Power Required Equation

The development of this equation is from first principles and can be worked up from any standard text, as for example, p. 365 Reference 1.

$$C_D = C_{D0} + C_{Di} \qquad q = \frac{1}{2}\rho V^2 = .00256\ V^2\sigma$$

$$\begin{aligned} D &= C_D \cdot q \cdot S \\ &= C_{D0} \cdot q \cdot S \cdot + C_{Di} \cdot q \cdot S \cdot \\ &= .00256\ V^2\sigma C_{D0} S + .00256\ V^2\sigma S C_{Di} \quad \ldots\ldots\ldots (1) \end{aligned}$$

From Prandtl wing theory

$$C_{Di} = \frac{C_L^2 S}{\pi b^2 e^2}$$

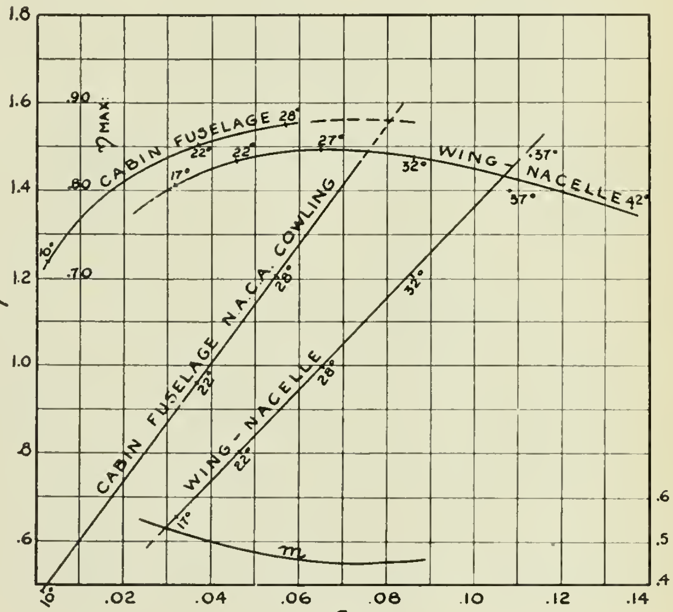

Fig. 3

But at small angles

$$L = W = C_L \cdot q \cdot S \cdot$$

or

$$C_L^2 = \frac{W^2}{q^2 S^2}$$

Hence

$$C_{Di} = \frac{W^2}{q^2 S^2} \times \frac{S}{\pi (b e)^2}$$

Substituting in (1)

$$\begin{aligned} D &= .00256\ V^2\sigma C_{D0} S + .00256\ V^2\sigma S \frac{W^2}{q^2 S^2} \cdot \frac{S}{\pi (b e)^2} \\ &= .00256\ V^2\sigma C_{D0} S + \frac{.00256\ V^2\sigma W^2}{(.00256)^2\ V^4\sigma^2\pi (b e)^2} \\ &= .00256\ V^2\sigma C_{D0} S + \frac{124.8\ W^2}{\sigma V^2 (b e)^2} \quad \ldots\ldots\ldots\ldots (2) \end{aligned}$$

Now HP required $= \frac{D \times V}{375}$

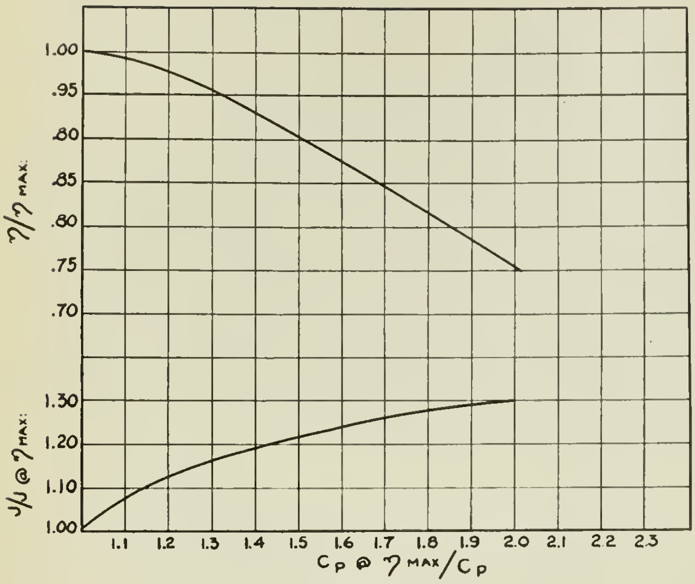

Fig. 4

Hence converting (2) into a power equation

$$HP_{\text{req'd}} = \frac{.00256}{375} V^3 \sigma C_{D0} S + \frac{124.8\ W^2}{375\ V\ (b\,e)^2 \sigma}$$

$$= .00000683\ V^3 \sigma C_{D0} S + \frac{.3329\ W^2}{(b\,e)^2\ V \sigma} \quad \dots\dots\dots\dots (3)$$

Differentiating (3) with respect to V

$$\frac{d\,HP_{\text{req'd}}}{d\,V} = 3 \times .00000683\ C_{D0} S \sigma V^2 + (-1) \frac{.3329\ W^2}{(b\,e)^2 \sigma V^2} \quad \dots (4)$$

If the power is a minimum, this equals zero, hence

$$V_{P.\min.}{}^4 = \frac{.3329\ W^2}{.00002049\ C_{D0} S \sigma^2 (b\,e)^2}$$

$$V_{P.\min.}{}^4 = \frac{11.28\ W^{1/2}}{(\sigma b\,e)^{1/2} (C_{D0} S)^{1/4}} \quad \dots\dots\dots\dots\dots\dots\dots\dots (5)$$

Equation (5) gives the flight speed for minimum power in terms of the air density and known aerodynamical characteristics of the aeroplane. We now express any other flight speed V as a multiple of $V_{P.\min.}$:

i.e. $V = K \cdot V_{P.\min.}$

or $$V = \frac{K \times 11.28\ W^{1/2}}{(\sigma b\,e)^{1/2} (C_{D0} S)^{1/4}}$$

or $V = K_v S_v$ where $K_v = 11.28\,K$

$$S_v = \frac{W^{1/2}}{(\sigma b\,e)^{1/2} (C_{D0} S)^{1/4}}$$

Substituting this value of V in Equation (3), we express the Power Required at any speed V in terms of variables and aeroplane characteristics.

$$HP_{\text{req'd}} = \frac{.00000683\ C_{D0} S \sigma W^{3/2}}{(\sigma b\,e)^{3/2} (C_{D0} S)^{3/4}} K_v^3 + \frac{.3329\ W^2 (\sigma b\,e)^{1/2} (C_{D0} S)^{1/4}}{(b\,e)^2 \sigma\ W^{1/2} K_v}$$

$$= .00000683 \frac{W^{3/2} (C_{D0} S)^{1/4}}{(b\,e)^{3/2} \sigma^{1/2}} \cdot K_v^3 + \frac{.3329\ W^{3/2} (C_{D0} S)^{1/4}}{(b\,e)^{3/2} \sigma^{1/2}} \frac{1}{K_v}$$

To simplify this unwieldy form, write

$$P_v = \frac{W^{3/2} (C_{D0} S)^{1/4}}{(b\,e)^{3/2} \sigma^{1/2}} = S_v^3 C_{D0} S \sigma$$

hence

$$HP_{\text{req'd}} = .00000683\ P_v K_v^3 + \frac{.3329\ P_v}{K_v}$$

or

$$\frac{HP_{\text{req'd}}}{P_v} = .00000683\ K_v^3 + \frac{.3329}{K_v}$$

Now $\dfrac{HP_{\text{req'd}}}{P_v}$ is simply a factor, which we will represent by K_{HP}

Then

$$K_{HP_{\text{req'd}}} = .00000683\ K_v^3 + \frac{.3329}{K_v} \quad \dots\dots\dots\dots\dots\dots (6)$$

Equation 6 is a general equation for Power Required applicable to any aeroplane, expressed in terms of variables which depend upon the aerodynamic characteristics of the aircraft. Figure 1 shows the generalized curve and is plotted from the values of K_{HP} and K_v as listed in Table IV.

Development of the Generalized Power Available Curves

From Reference 4, p. 18, we obtain a general equation for Power Available (for values of $V/V_{\max.}$ greater than .5) for aeroplanes using gasoline engines. This equation is written $T_v = R_v^m$ or $\dfrac{T_{HP}}{T_{HP\,\max.}} = \left(\dfrac{V}{V_{\max.}}\right)^m$.

The relation of the variables of this equation is in the form of a power function, hence the points of the curve, when plotted on logarithmic paper will lie on a straight line of slope "m". This means that, knowing the value of m, we can represent the Power Available curve by a straight line of given slope m.

The value of the exponent m varies with the engine. From the information given in the tables of Reference 4, we can cross plot and obtain values of m for values of C_p. These values we have plotted on Fig. 3. Hence having determined the value of C_p for the design condition of maximum speed from the equation $C_P = \dfrac{550\ B.HP}{\rho\, n^3 D^5}$ we read the value of m directly from the figure, and can reproduce a curve of the Power Available by a straight line on logarithmic paper. This line, of course, applies only to the altitude at which the design C_p applies.

The above applies to the case of an aeroplane with fixed pitch propeller, where, as the speed of the aeroplane

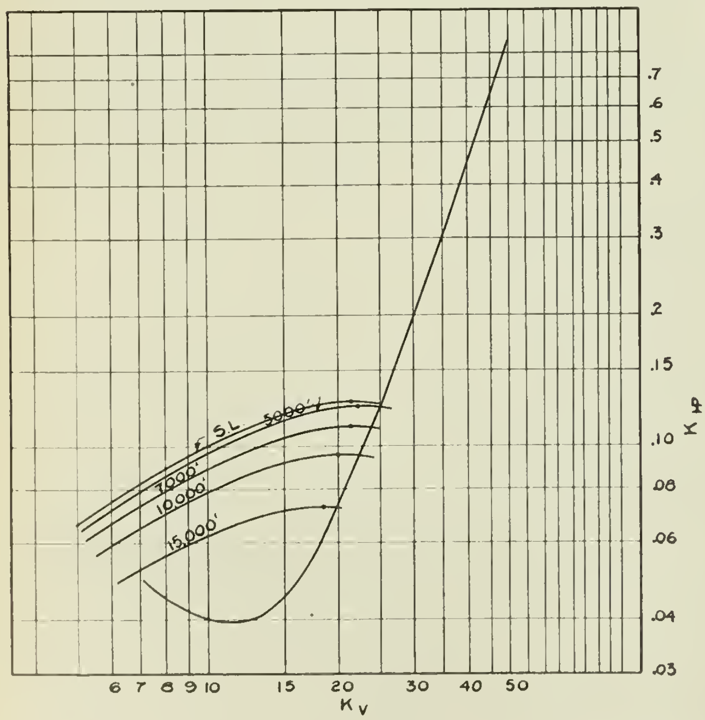

Fig. 5 – Sample Power Curves Using Constant Speed Propeller.

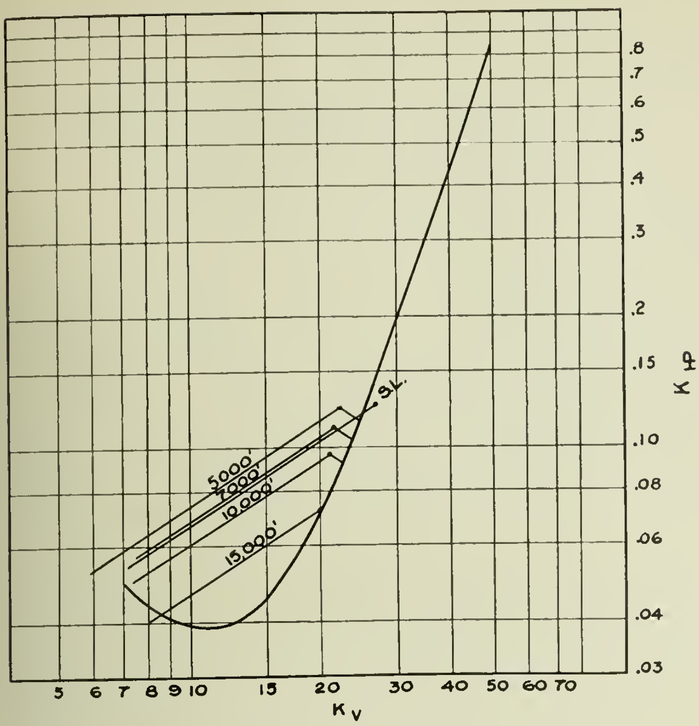

Fig. 6—Sample Power Curves Using Fixed Pitch Propeller.

changes, the r.p.m. changes. We need now a curve of Power Available for the constant speed propeller. In the equation $\frac{T_{HP}}{T_{HP\,max.}} = \left(\frac{V}{V_{max.}}\right)^m$ we can write, for the constant speed propeller,

$$\frac{T_{HP}}{T_{HP\,max.}} = \frac{\eta}{\eta_{max.}} \frac{B_{HP\,max.}}{B_{HP\,max.}} = \frac{\eta}{\eta_{max.}}$$

hence

$$\frac{\eta}{\eta_{max.}} = \left(\frac{V}{V_{max.}}\right)^m.$$

But $J = V/nD$, and both n and D are constant, so that J varies directly as V. Thus we can write, as shown in Reference 1,

$$\frac{V}{V_{max.}} = \frac{J}{J_{max.}}$$

and

$$\frac{\eta}{\eta_{max.}} \propto \frac{J}{J_{max.}}$$

This general Power Available curve as determined from N.A.C.A. full scale propeller test data is plotted in Reference 1, p. 337, and has been replotted on logarithmic paper as Fig. 2.

Superposition of the Power Curves

We have now two generalized curves, one of Power Required (Fig. 1), the other of Power Available (Fig. 2). If we can superimpose them in their proper relation to one another the point of their intersection will give values of K_{HP} and K_v which can be converted easily into horsepower and velocity values by multiplying by the variables shown, such power and speed values representing maximum speed at maximum power available. The point of maximum efficiency on the Power Available curve is the Optimum point, as marked on Fig. 2. The propeller-engine combination has been designed to give maximum efficiency at some particular value of propeller characteristics C_p at a specific B.hp., r.p.m. and altitude.

For the particular aeroplane we calculate the design value of C_p from $C_p = \frac{550\, B.HP}{\rho\, n^3 D^5} = \frac{.05105\, B.HP}{\sigma\, N^3 D^5}$. This C_p value has a certain value of J (at $\eta_{max.}$) and $\eta_{max.}$, which we read from Fig. 3. Then the power available and the speed of the aeroplane under these conditions are

$$HP_{av.} = \eta_{max.}\, B.HP$$

and

$$V_{max.} = \frac{J \text{ at } \eta_{max.}\, ND}{88}$$

But we can convert HP into a K_{HP} term by dividing by P_v; and we can convert a V into a K_v term by dividing by S_v. Carrying out these divisions we are able to locate the optimum point of the Power Available curve on the sheet Fig. 1.

In both cases, the fixed pitch propeller case and the constant speed propeller case, the curve shape for various altitudes will be the same as for the sea level altitude. In the case of the F.P. propeller it is a straight line; in the case of the C.S. propeller it is the curve of Fig. 2. To determine the position of the Power Available curve at various altitudes it is only necessary to determine the position of the optimum point for each altitude. This is simply

$$K_{HP} = \frac{K_{HP0}}{\sqrt{\sigma}} \text{ and } K_v = \frac{K_{v0}}{\sqrt{\sigma}}$$

since

$$V = V_0 \sqrt{\frac{\rho}{\rho_0}} = \frac{V_0}{\sqrt{\sigma}} \text{ and } HP = HP_0 \sqrt{\frac{\rho}{\rho_0}} = \frac{HP_0}{\sqrt{\sigma}}$$

Thus we are able to superimpose the curves upon one another in their proper relationship.

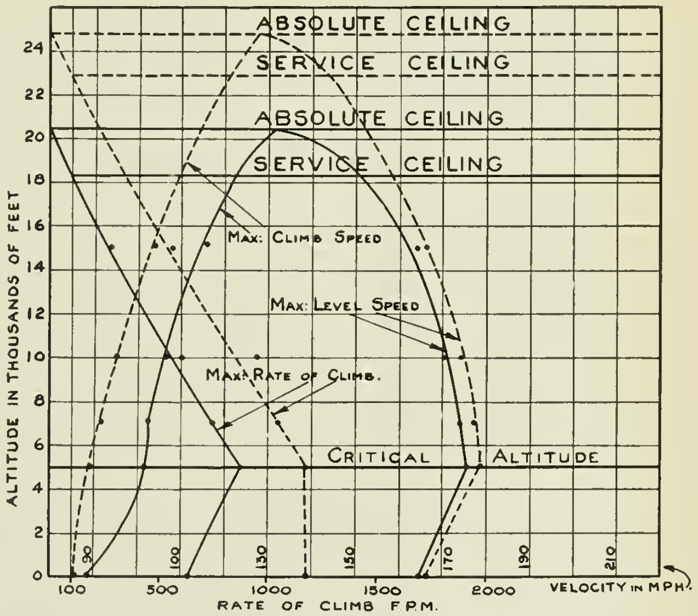

Fig. 7

Effect of Differences of Scale in Fig. 1 and Fig. 2

The curves of Fig. 1 and Fig. 2 have been plotted on logarithmic paper.

Now if we have an equation $y = ax^n$ where a is the scale factor, if we plot on log paper we are taking mechanically the log of both sides

$$\log y = \log a + n \log x$$

where $\log a$ is a constant representing the log of the scale factor. Hence changing the scale simply results in the addition of a constant representing the log of the multiplying factor.

While the scale factor of Fig. 1 may differ from that of Fig. 2, it will be constant for its own figure. Thus, locating correctly one point of Fig. 2 with respect to Fig. 1 will result in all points of Fig. 2 being located correctly with respect to Fig. 1. In our routine we have located the point called the Optimum Point of Fig. 2, correctly with respect to Fig. 1, hence the other points of Fig. 2 are located correctly.

Possible Advantages of this Method

Once the generalized curves have been prepared, the routine, the author believes, is as simple and rapid as that of References 4 and 7 (since Reference 4 is out of print, the value of the above method is increased), and it has the added advantage that curves of actual Horsepower upon Velocity can be determined readily if desired. The results obtained by the method are as accurate as those determined by the more laborious arithmetical methods of References 2, 3 and 10, and the generalized curves are developed from the same fundamental relationships as References 2 and 3.

Acknowledgments

The germ of the idea for the above development came from References 11 and 12. The author also gratefully acknowledges the assistance of Dr. J. J. Green and Mr. K. F. Tupper, both of the National Research Council, Ottawa, for corrections and suggestions regarding the presentation of this material.

List of Symbols

C_D	= Absolute coefficient of drag.
C_{D_0}	= Absolute coefficient of profile drag.
C_{Di}	= Absolute coefficient of induced drag.
S	= Area of wing in sq. ft.
q	= Dynamic head $= \frac{1}{2}\rho V^2$.
V	= Speed in mi. per hr.
ρ	= Density of air.
σ	= Relative density.
C_L	= Absolute coefficient of lift.
b	= Span of wing in ft.
e	= Span efficiency factor for aeroplane $= \frac{1}{\sqrt{\pi R a}}$
W	= Gross weight of aeroplane in lb.
D	= Drag in lb., also
D	= Diameter of propeller in ft.
HP	= Horsepower.
η	= Propeller efficiency.
n	= Engine speed in revolutions per sec.
N	= Engine speed in revolutions per min.
R	= Aspect ratio $= b^2/S$.
J	= V/nD.
C_P	= Propeller power coefficient $= \frac{550\ B.HP}{\rho n^3 D^5}$
$B.HP$	= Brake horsepower.
a	= dC_L^2/dC_D from wind tunnel curve of aeroplane.
THP	= Thrust horsepower.

List of References

1. Diehl, W. S., Engineering Aerodynamics, p. 337, The Ronald Press. Co., New York, Revised Edition, 1936.

2. Ober, Shatswell, Estimation of the Variation of Thrust Horsepower with Air Speed, T.N. 446, N.A.C.A., 1933.

3. Hartman, Edwin P., A Method of Calculating the Performance of Controllable Propellers with Sample Calculations. T.N. 484, N.A.C.A., 1934.

4. Oswald, W. Bailey, General Formulas and Charts for the Calculation of Airplane Performance. T.R. No. 408, N.A.C.A., 1932.

5. Weick, Fred E., Working Charts for the Selection of Aluminium Alloy Propellers of a Standard Form to Operate with Various Aircraft Engines and Bodies. T.R. No. 350, N.A.C.A., 1930.

6. Windler, Ray, Tests of a Wing-Nacelle-Propeller Combination at Several Pitch Settings up to 42 degrees. T.R. No. 564, N.A.C.A., 1936.

7. Oswald, W. Bailey, Methods of Performance Calculation for Airplanes with Supercharged Engines. U.S. Air Corps Information Circular No. 679, April 1, 1933.

8. Weick, Fred E., Aircraft Propeller Design, p. 95. McGraw-Hill Book Co., New York and London, 1930.

9. Thomas, Caldwell and Rhines, Practical Airscrew Performance Calculations. Journal Royal Aeronautical Society, January, 1938.

Also for enlarged graphs see discussion on same paper by F. M. Thomas: Aerodynamics of the Airscrew, Aircraft Engineering, April, 1938.

10. British Air Ministry: Handbook of Aerodynamic Calculations.

11. Lundberg, B., The Sinking Speed of Aeroplanes. Aircraft Engineering Vol. IX, No. 106 and Vol. X, No. 107, Dec. 1937 and Jan. 1938.

12. Schairer, George, S., An Airplane Performance Slide Rule. Journal of the Aeronautical Sciences, Vol. 5, Number 1, November, 1937.

Table Ia

Data Pertaining to Sample Aeroplane, Necessary for Calculations

Line	Characteristic	Symbol	Value
1.	Gross weight	W	10,000 lb.
2.	Span	b	57 ft.
3.	Wing area	S	450 sq. ft.
4.	Aspect ratio	R	7.21
5.	Propeller diameter	D	9 ft.
6.	Absolute profile drag coeff.	C_{D_0}	0377
7.	Slope dC_L^2/dC_D	a	.0461
8.	Engine data Two radial engines located in wing nacelles each 400 B.hp. at 2,200 r.p.m. at 5,000 ft.		

Table I

Preliminary Calculations for Use with any Propeller, on Sample Aeroplane

Parameter	Value
Parasite factor $= C_{D_0}S$	16.96
Span efficiency factor $e = \frac{1}{\sqrt{\pi R a}}$	0.979
Speed variable S_v at S.L. $S_v = \frac{\sqrt{\frac{W}{b\,e}}}{(C_{D_0}S)^{1/4}}$	6.6 (put this value in S.L. column of Tables II and III)
Power variable P_v at S.L. $P_v = C_{D_0}S\,(S_v)^3$	4890 (put this value in S.L. column of Tables II and III)

Table II

Performance Computations for Sample Aeroplane with Constant Speed Propeller

Item	Parameter	Altitude in Feet S.L.	5000	7000	10000	15000
1.	σ	1	.862	.809	.735	.626
2.	$1/\sqrt{\sigma}$	1	1.078	1.112	1.163	1.261
3.	$S_v = (1/\sqrt{\sigma}) \cdot S_v$ at S.L.	6.6	7.11	7.34	7.67	8.3
4.	$P_v = (1/\sqrt{\sigma}) \cdot P_v$ at S.L.	4890	5268	5432	5682	6160
5.	$B.HP$ at 2200 r.p.m.	385	400	372	335	276
6.	$C_P = \frac{.05015\ B.HP}{\sigma N^3 D^5} = .0008\frac{B.HP}{\sigma}$	0307	0371	0368	0364	0353
7.	η max. from Fig. 3	.805	.818	.816	.815	.812
8.	J at η max. from Fig. 3	.636	.702	.700	.684	.681
9.	$K_{HP\,av.} = \frac{B.HP \times 2 \times \eta}{P_v}$	.1268	.1242	.1117	096	.0727
10.	$K_v = \frac{N D J}{88\ S_v} = 225\frac{J}{S_v}$	21.68	22.2	21.45	20.05	18.47
11.	K_v max. from Fig. 5	25.2	25.2	24.2	22.8	20
12.	K_v climb from Fig. 5	13	12.5	12.5	12.5	12.5
13.	$(K_{HP\,av.} - K_{HP\,req'd})$ from Fig. 5	0728	.0672	.0582	.0462	.0280
14.	Rate of climb in f.p.m. 3.3 P_v ($K_{HP\,av.} - K_{HP\,req'd}$)	1174	1168	1043	866	569
15.	Max. vel. m.p.h. $= K_{v\,max.} \cdot S_v$	166	179	177	175	166
16.	Climbing vel. m.p.h. $K_{v\,climb} \cdot S_v$	86	89	92	96	104

Speeds and rates of climb plotted on altitude Fig. 7

Table III

Performance Computations for Sample Aeroplane with Fixed Pitch Propeller

Design conditions: C_P at $\eta_{max.} = .0371$ $\eta_{max.} = .818$ J at $\eta_{max.} = .702$
$m = .50$ β at .75 Radius $= 17^{3/4}$ degrees at 42″

Item	Parameter	Altitude in Feet				
		S.L.	5000	7000	10000	15000
1.	σ	1	.862	.809	.735	.626
2.	$1/\sqrt{\sigma}$	1	1.078	1.112	1.163	1.261
3.	$S_v = (1/\sigma)\ S_v$ at S.L.	6.6	7.11	7.34	7.67	8.3
4.	$P_v = (1/\sigma)\ P_v$ at S.L.	4890	5268	5432	5682	6160
5.	$B.HP$ at 2200 r.p.m.	385	400	372	335	276
6.	$C_P = \frac{.05015}{\sigma N^3 D^5} = \frac{.0008\ B.HP}{\sigma}$	.0307	.0371	.0368	.0364	.0353
7.	C_P at $\eta_{max.}/C_P$	1.206	1	1.007	1.017	1.049
8.	J/J at $\eta_{max.}$ from Fig. 4	1.125	1	1.01	1.018	1.042
9.	J	.79	.702	.709	.716	.731
10.	$\eta/\eta_{max.}$ from Fig. 4	.974	1	.999	.997	.992
11.	η	.797	.818	.816	.815	.812
12.	$K_{HP\,av.} = \frac{B.HP \times 2 \times \eta}{P_v}$	.1252	.1242	.1116	.0954	.0722
13.	$K_v = \frac{NDJ}{88\,S_v} = 225\ \frac{J}{S_r}$	26.95	22.22	21.72	21.02	19.83
14.	$K_{v\,max.}$ from Fig. 6	25	24.8	23.7	22.2	20
15.	$K_{v\,climb}$ from Fig. 6	13.5	14.5	14.0	14.0	14.0
16.	$(K_{HP\,av.} - K_{HP\,req'd})$ from Fig. 6	.0395	.050	.0422	0324	0147
17.	Max. vel. in m.p.h. $K_{v\,max.} \cdot S_v$	165	177	173.8	170.2	166
18.	Climb. vel. m.p.h. $K_{v\,climb} \cdot S_v$	89	103	103	107	116
19.	Rate of climb in f.p.m. 3.3 $P_v\,(K_{HP\,av.} - K_{HP\,req'd})$	638	870	756	608	298

Speeds and rates of climb plotted on altitude Fig. 7

Table IV

Values to be Used for Plotting Fig. 1 on Logarithmic Paper

K_v	$K_{HP\,req'd}$
7	.04987
8	.04511
9	.04196
10	.04009
11	.03932
12	.03952
13	.0406
14	.04252
15	.04524
16	.0488
17	.05313
18	.05832
19	.06436
20	.07125
21	.0791
22	.0877
23	.09747
24	.10831
25	.12001
27	.14667
30	.19539
33	.25568
35	.30241
40	.4455
45	.62949
50	.8599

Table V

Values from which to Plot Fig. 2 (Reference 1)

$\eta/\eta_{max.}$	J/J at $\eta_{max.} = V/V_{max.}$
.38	.15
.468	.2
.55	.25
.62	.3
.73	.4
.815	.5
.882	.6
.938	.7
.975	.8
.995	.9
1.0	1.0
.948	1.5

A Parking Survey in the Capital City

R. M. Simpson,
Survey Director for the Citizens' Parking Committee, Ottawa.

Presented before the Ottawa Branch of The Engineering Institute of Canada, April 12th, 1938.

SUMMARY.—A short account of the first comprehensive attempt of a Canadian city to scientifically solve its parking problem. The paper deals only with the survey and the recommendations.

Canada's first comprehensive parking survey was completed in the downtown business section of Ottawa in November, 1937. The project was originated by the Automobile Club of Ottawa which invited 34 public spirited organizations to join with them in the formation of a Citizens' Parking Committee. Civic officials cooperated by supplying the services of 240 relief men for a total of 3,000 hours of field work. A staff of six qualified assistants was obtained for the survey director and work started on October 15th.

As the guiding principle, the committee decided that all recommendations would be developed from the factual basis evolved from the survey findings.

The chart presented here indicates the first step (Fig. 1). It is interesting to note that Ottawa possesses fewer motorists and considerably more pedestrians than cities of similar size.

As the survey principally dealt with automobile congestion, the second step was to determine just what situation resulted from the fact that the majority of the persons using the central business district were automobile drivers or passengers. By measuring the street space, it was found that the district had a legal capacity of 1,728 parked automobiles on the streets with sufficient room for 2,026 off-street—a total capacity for 3,754 parked motor vehicles.

The accumulation of motor vehicles is illustrated (Fig. 2). That is, the number of vehicles left in the district; shown by half-hour periods. It is quite true that these figures include all vehicles either in motion or parked, but since all cordon counts are conducted in this manner, comparative purposes are served. On the three main business streets, Bank, Sparks and Rideau, 86 per cent of the vehicles parked were within the legal time limits but the 14 per cent who exceeded the allotted time of 30 minutes, used up 41 per cent of the total number of hour spaces. Flagrant violations, to the extent of four and five hours parking, existed in these locations where space is at a premium. Strict and impartial enforcement throughout the area under survey would give an increase of 28.97 per cent in space hours.

A further unestimated increase in capacity would be obtained if the practice of office employees being sent down to move several parked cars was eliminated.

Violations

The fact that out of 14,146 parked automobiles observed in one day 5,869 violated the civic ordinances speaks for itself. The percentage of violations is 41.49 per cent.

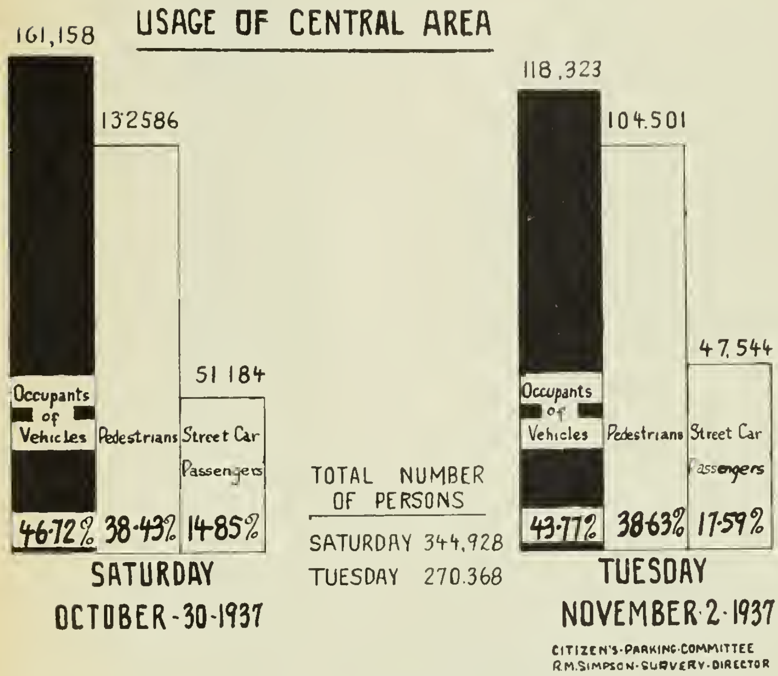

Fig. 1—Usage of Central Area.

This is a situation of vital concern to any citizen or group of citizens concerned with the unfortunate increase in the number of automobile fatalities. Beyond a doubt the practice of allowing vehicles to brazenly park under "No Parking" signs, too near corners, beside hydrants or improper parking, creates a disregard or disrespect for other motor vehicle laws such as those covering a vehicle in motion. Seventy-four photographs covering these conditions were secured by the survey staff.

That such a disregard for regulations and a lack of common courtesy on the part of motor vehicle drivers exists in Ottawa is amply borne out by two things. First, an increase of 46 per cent in the number of fatalities in 1937 over the previous year. Secondly, a death rate of 13.38 in a city where the registration is only seven persons per vehicle. The attempt made to ascribe the high death rate to the admitted slippery conditions of the street during the winter period was not confirmed by an examination of the accident statistics. Out of the 19 persons killed by motor vehicles during the last year, only one fatality occurred as a result of icy road conditions. A 25 per cent decrease in the number of fatalities could be obtained by strict and impartial enforcement of the parking regulations alone!

Parking Infractions

The following excerpt from the 1937 report of the police department presents a reason for some of the congestion in Ottawa.

Warnings issued	14,950
Persons summoned	883
Percentage of persons summoned	5.9

The committee recommended the adoption of the "cafeteria court" plan. Tickets are to be in triplicate, serially numbered, and issued by the City Treasurer to the police department. An audit is to be made each thirty days and shortages accounted for. Fines are $1.00 for each infraction, payable within 48 hours at the police station—failing compliance, a summons is issued and the regular fine of $3.00 plus $2.00 costs is applied if the motorist is found guilty of breaking the ordinance. This system is in vogue in nearly every city of size in the United States and Canada and was developed by the International Association of Police Chiefs.

The present system of two warnings with a summons on the third offence leads to too much abuse.

Business

The effect of the parking congestion on business was indicated by the tabulation of the questionnaires. Out of nearly 14,000 persons answering the questionnaire and who work in the downtown area, 4,580 or 33.9 per cent have definitely changed their shopping habits and now do their buying elsewhere.

The committee recognized the fact that any recommendations which they might make would not restore this lost business to the downtown merchants but, at least, the situation would be eased and further losses avoided. As a matter of general policy, it was decided that "Congestion causes decentralization, destroys values and creates hazards."

The fact that the majority of persons using the central business area employ automobiles for transportation purposes has been proved. A classification of the transportation methods used by the customers of the downtown retail establishments is now shown.

Classification of Business

	Pedestrians	Street Car	Auto
Uppertown department stores	35.9 per cent	30.9 per cent	33.15 per cent
Lowertown department stores	27. " "	30. " "	43. " "
Specialty stores	25.3 " "	29.3 " "	45.2 " "

In addition, the automobile trade has been established as being the most valuable class for the retail merchant to have. In a survey of a large American city, automobile passengers made up 40 per cent of the total number of customers but bought 60 per cent of the total value of the sales.

Thus, automobile congestion becomes a serious problem for the merchant. All business districts must be regarded in the light of a market. Political boundaries mean nothing to a motorized buyer and most important of all, the prosperity of any business or business section is enhanced by easy accessibility—or, if it is difficult to find a parking space—loss of business results.

Therefore, retail merchants are vitally concerned with congestion and parking regulations.

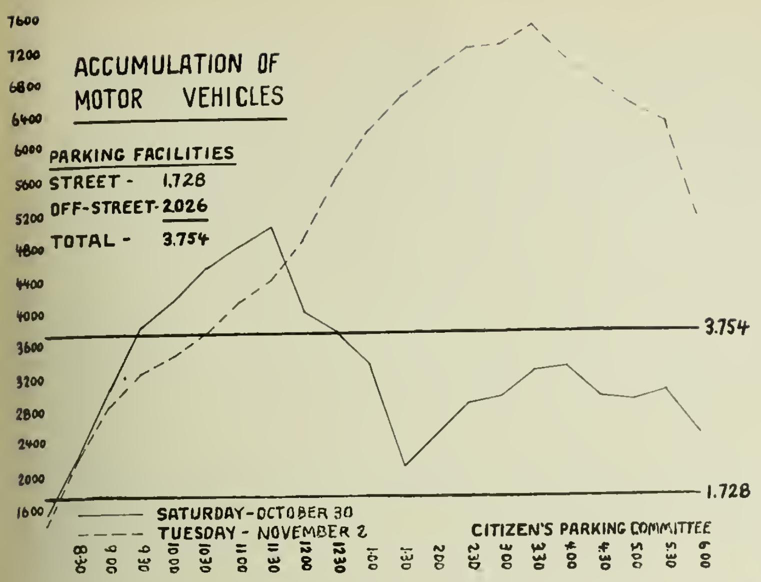

Fig. 2—Accumulation of Motor Vehicles.

Large Office Buildings

A serious situation with respect to the large office buildings was discovered. Taking one building as an example, 149 tenants or employees drive their cars, 118 additional people would drive provided space was available. Of the 149 first mentioned, 79 parked their cars on the streets and 70 off-street.

The fact that these 79 cars were parked on the streets within a radius of 460 ft. from the building means that prospective customers of the tenants have difficulty in finding a parking space in order that they may conduct the business which provides the livelihood of the tenants and makes the office space rentable. Similar information was complied for each large building.

There is an expressed willingness on the part of motorists to pay a reasonable charge for convenience, 2,877 or 72.39 per cent of those answering the question stated that they would be willing to pay on an average of $2.06 per month for off-street space.

In addition, the concentration of the Dominion Government offices within a small area presents a problem peculiar to Ottawa. 37.8 per cent of the civil servants drive to work in their automobiles.

In the city of Washington, the government decided as follows:—

> "While it is recognized that the government is not legally responsible for the facilitation of any means of transportation that the civil servants may desire to use—it is equally apparent that the concentration of the government buildings in a small area presents a problem—impossible of solution other than by the government itself. Therefore, provision shall be made for off-street parking facilities in any new buildings and open air lots shall be provided for certain existing buildings."

A delegation headed by Chairman W. G. Keddie interviewed the Minister of Public Works, Honourable P. J. A. Cardin, and received an extremely favourable hearing. Evidences of the success of the appeal were obtained in the provision of off-street facilities as included in the plans of M. Greber, who had been commissioned by the government as a town planning expert.

Conclusions

It was quite evident to the committee that the parking problem would never be solved at the curb. That is, the amount of curb space would never increase but the demand for its use would. Since the principal characteristic of the area under survey was the prevalence of retail establishments, a general policy along this line was adopted:—

"Parking on the streets during the business hours should be confined to short time parkers of one hour or less. Those persons requiring more than one hour should park off-street."

The four main recommendations of the committee to relieve the situation are as follows:—

(1) Recognition of the Dominion Government and large office buildings of their responsibility in providing off-street space for employees and tenants.

(2) Removal of the business tax amounting to 10 per cent of the regular assessment at the current tax rate on vacant property devoted to the sole use of parking automobiles.

(3) Installation of mechanical policemen or parking meters to assist in the enforcement of regulations. The

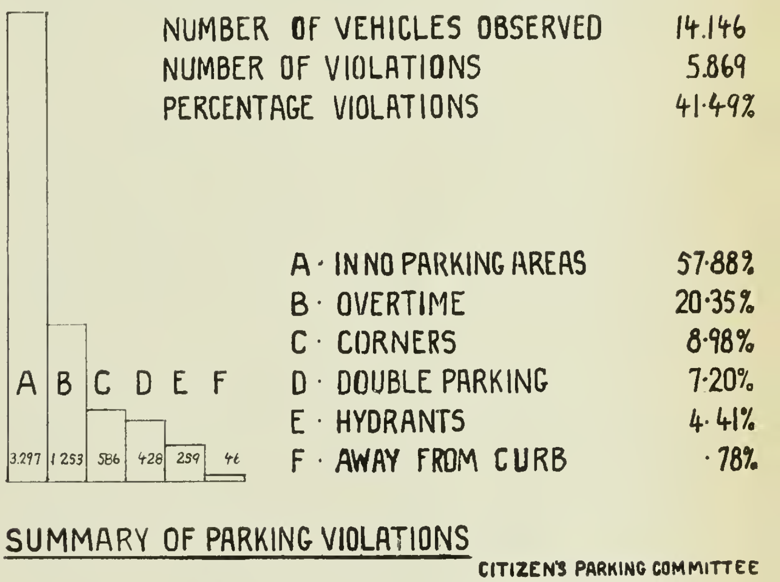

Fig. 3—Summary of Violations.

committee after an exhaustive study of the metered system of parking control and as a result of some 89 letters received from Traffic and Civic officials, Retail Merchants Associations, Automobile Clubs and Chambers of Commerce of cities where meters were installed, recommended that immediate consideration be given to the installation of these devices.

(4) A $1.00 fine applied to every parking infraction; tickets in triplicate, serially numbered; issued by the City Treasurer to the Police Department with a 30 day audit.

Fines payable within 48 hours at the police station. Failing compliance, summons issued in the usual manner and the regular fine of $3.00 plus $2.00 costs applied if the motorist is found guilty.

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."

VOLUME XXI AUGUST, 1938 No. 8

The Saskatchewan Agreement

Negotiations with the Association of Professional Engineers of Saskatchewan have advanced to the stage that the proposed agreement is now published in The Journal for the information of all members, and in compliance with By-law No. 76. It will be found on page 396. Members are asked to read it carefully, and see for themselves the simplicity with which such far reaching agreements can be worded and executed.

This agreement has been unanimously approved by the local executive committee of each body, at a joint meeting held in Regina in April 22nd. It now only remains for The Institute to submit it by ballot to all Councillors and to members resident in Saskatchewan. This will be done in such time that results can be disclosed to Council at the September meeting.

This is a very important document. When it is finally accepted by both organizations and put into effect, it will be the first firm step towards full co-operation between engineering bodies in Canada. It will be the first tangible result of years of thought and effort on the part of many members of the several engineering organizations which have been interested. Its final consummation will be very gratifying and encouraging to them and to engineers at large.

Membership List

Usually mere lists of names do not make very interesting reading, but judging from the number of inquiries that are received at Headquarters the membership list of The Institute has a very definite interest to many people. The last list was issued in 1935, and the supply is now exhausted, but inquiries continue to come in from all points of the compass, and many parts of the world. A new list is urgently required.

The preparation of such a list is not as simple as it may seem. There is a great deal of detail work and an unbelievable amount of checking and rechecking. Already the task is under way, and will be worked at continuously, and yet it will not be completed until December. The list will appear as a supplement of The Journal, as was done with the last one, and will therefore reach every member.

Members are asked to co-operate in this effort. Do what you can to make sure that the right details are on the records. After all, you are the only authoritative source from which such information can be secured, and if it does not come from you, there is some chance that it may not be accurate or up-to-date. Cards were circulated not long ago, but many were not returned. To those who did not reply, and to those whose position or address has changed recently, we particularly direct our inquiry. Right now, before it is forgotten, will you please turn to page 403 and fill in the form that is provided there for your convenience. Your co-operation will make it possible to prepare an accurate and complete list that will be a reliable source of information for all members.

Tragedy Strikes Mining Engineers

The sympathy of the entire profession will go out to the families of the five young engineers who lost their lives so suddenly on July twenty-eighth in a mine catastrophe at Bourlamaque, Quebec.

On behalf of The Engineering Institute of Canada The Journal extends the heartfelt sympathy of its officers and members to the relatives and friends of Peter Downey, James Crocker, Arthur Hewat, Harry Field and Clarke Isbister.

Minutes of Council

The decision to send minutes of all Council meetings to past-presidents, branch chairmen, and ex-councillors, in the latter case for one year after their term of office, will be received with general approval. The decision was reached at the Ottawa meeting, after the announcement of the return of a ballot from all councillors, which showed an almost unanimous approval of the suggestion.

This more than doubles the number who formerly received the report, and will thereby make possible a wider dissemination of the decisions and actions of the governing body. It was felt by Council that an increase in the number who were familiar with the aims and activities would result in an increased interest in Institute affairs, and would eventually react to the benefit of Council itself.

Montreal Branch Makes Generous Gift Towards Headquarters Renovation

In spite of the fact that members of the Montreal Branch pay an extra $3.00 over and above the fees paid by any other branch, the executive offered Council a contribution of $250.00 to assist with the cost of the work of "rejuvenation" of the building. Council accepted the offer at the June meeting and, on a motion by Colonel L. F. Grant, M.E.I.C., and W. R. Manock, A.M.E.I.C., placed itself on record as being very appreciative of the assistance.

The work is already under way, and it is expected will be completed before the Fall activities commence. The record of the last time the building was overhauled and redecorated is beyond the memory of the oldest "inhabitant," and it is painfully evident that the work is long overdue. From the point of view of depreciation alone, it is good business to have the work done now in order to arrest the ravages of time, and to bring the building up to the standard that is expected of The Institute.

Past-Presidents' Prize

An unusual number of subjects has been submitted by branches for this competition, the total running to more than forty. The regulations say "Council shall confer with the branches, and use its *discretion*, with the object of selecting a subject which may appear desirable in order to facilitate the acquirement and the interchange of professional knowledge among the members of The Institute." More than discretion is required in making a selection from such an extensive list. A degree of judgment such as made Solomon's name a by-word, would be more useful and more welcome.

The committee, appointed by the President, on behalf of Council, to make the selection, has given the subject a great deal of consideration. The purpose of the competition, as disclosed in the regulations, has been kept in mind. The possibility of finding some phase of engineering to which our members could make a definite contribution, and the hope of selecting a subject upon which many members could write, have also influenced the decision. It will be interesting to watch results and to see how closely the committee comes to its objective.

The subject is

"Highway Planning"

Highways are something in which all engineers as citizens are interested. Traffic problems are essentially engineering problems. Therefore it appears that many members will be able to write on this subject. Mistakes in planning and absence of planning are evident to all of us. We all suffer from them—both because of the waste of money and because of the attendant inconveniences. Surely we can contribute something that will assist in the solution of at least some portions of this problem.

The subject referred to most often in the branch recommendations was highways, three branches including it in their lists. The committee believes that all the recommended titles, as well as all others that go to make up the complete subject, can be included under the title selected. It is therefore somewhat of a composite selection which, it is hoped, will make it acceptable to all branches.

The title may be construed very broadly. The only definite restrictions are that papers must deal with Canadian roads and problems, and that the actual type of construction or design of the roadbed is not to be considered as part of the subject. The term "highway" may be taken to cover any road for motor traffic, either in the city or in the country.

The paper may deal with the situation in one particular city, or in one province, or may cover the national situation and take in the whole Dominion. Whatever the geographic limits may be, the paper should contribute something to the solution of the present and future traffic problems of that area.

It may include something on the economics of transportation, and deal with safety and speed of travel, real estate values, tourist considerations, and, from the national point of view, the utility of the roads in time of war. This latter consideration has been recommended as of sufficient importance to justify a full paper in itself, and if any contributors feel specially qualified to deal with this particular division of highway planning, such a paper will be considered as coming within the scope of the subject. If any prospective contestant has a phase of highway planning upon which he would like to write, and is in doubt as to its suitability, it is suggested that he write to Headquarters for a ruling.

There is a prize of one hundred dollars and much honour awaiting the winner of this competition. The closing date is June 30th, 1939.

Journal Cover Competition

The Publications Committee is having difficulty in picking out any one of the many designs as being superior to all of the others. It had been hoped that a selection could be made in time for an announcement in this Journal, but it is now evident that, in fairness to all competitors, much more time must be spent in judging. The committee is very pleased with the quality and quantity of the designs, and is confident that the new cover—when decided upon—will merit the approval of all readers.

Council Entertains Engineers from England

Joint Gathering in Canada Affords Opportunity to do Honour to Distinguished Delegates

The Council of The Institute was quick to seize the opportunity to entertain some of the well known engineers from England who were in Canada attending the Fifty-Seventh Annual Meeting of the Society of Chemical Industry in Ottawa in June.

On Thursday, June 30th, a luncheon was given at the University Club, Montreal, in honour of Dr. W. E. Cullen, President of the Institution of Chemical Engineers, Dr. R. E. Stradling, C.B., M.C., Ph.D., Councillor of the Institution of Civil Engineers, and Director, Building Research Station of the Department of Scientific and Industrial Research, and Mr. H. V. Potter, Councillor of the Society of Chemical Industry, and Managing Director of Bakelite Limited. Other guests included Victor G. Bartram, newly elected President of the Society of Chemical Industry, and E. J. Carlyle, Secretary-Treasurer of the Canadian Institute of Mining and Metallurgy.

Dr. Cullen is one of those quiet speaking, modest little Englishmen who impress you instantly as having great reserves of poise and ability. He has a cheerful voice and a merry twinkle in his eye that attract you to him immediately. To him belongs that magic word "charming." He makes a fine ambassador for his homeland.

This was Dr. Stradling's first visit to Canada. He remarked that he had never before been in a country that had impressed him so favourably. He said "My admiration for Canada is such as I thought I should never have for any other country than England." He spoke of the advantages of laboratory work in conjunction with practical engineering, and referred to the research work being done in his department. He was greatly interested in the work of the National Research Council at Ottawa, and found a great similarity with what was being done in England. He said "The subjects are the same, but the emphasis is different."

Mr. Potter will be remembered for his part in the Semicentennial celebration. He presented an illuminated address on that occasion from the Society of Chemical Industry. It was renewed pleasure to have him with us again. He spoke most kindly and enthusiastically of Canada, and made an emphatic reference to his last visit here. He said he had never seen a celebration carried out so well as was the Semicentennial.

Mr. Victor Bartram spoke very briefly, giving as justification for the brevity, the fact that he was already a half hour late for his golf appointment with a group of chemists from the Old Country. He was excused.

President J. B. Challies was in the chair. He mentioned the great pleasure and satisfaction it gave councillors to have so many past-presidents at the luncheon, particularly Dr. Herrick Duggan, who is the senior of them all. Dr. Surveyer and Dr. Lefebvre were the others who were present. Guests, councillors and past-presidents made up a party of twenty-two.

Proposed Agreement Between The Engineering Institute of Canada and the Association of Professional Engineers of Saskatchewan

The agreement printed herewith is in the form recommended by accredited representatives of the Council of The Institute and of the Association of Professional Engineers of Saskatchewan. It is now published in The Journal in accordance with the requirements of By-law No. 76.

The executive of the Saskatchewan Branch of The Institute, and the executive committee of the Association have both approved of this agreement.

MEMORANDUM OF AGREEMENT made in duplicate at the City of Montreal, in the Province of Quebec, this day of 1938,

By and Between

THE ENGINEERING INSTITUTE OF CANADA having the head office at the City of Montreal, the Province of Quebec, hereinacting by its President and Secretary, duly authorized for the purpose hereof by a resolution of its Council passed at a Meeting duly called and held on the day of 1938, hereinafter called "The Institute,"

Party of the First Part

and

THE ASSOCIATION OF PROFESSIONAL ENGINEERS OF SASKATCHEWAN having its head office at the City of Regina, in the Province of Saskatchewan, hereinacting by its President and Registrar, duly authorized for the purpose hereof by a resolution of its Council passed at a Meeting duly called and held on the day of 1938, hereinafter called "The Association,"

Party of the Second Part.

Whereas it is desirable in the interest of the Engineering Profession that there be close co-operation between the Institute and the Association, and

Whereas such close co-operation will be promoted if, so far as it is practicable, there is effected:

(*a*) A common membership in the Province of Saskatchewan of the Institute and the Association;

(*b*) A simplification of existing arrangements for the collection of fees;

(*c*) A reduction in the total fees payable by those who are members of both the Institute and the Association;

(*d*) Management by a common executive.

Now, Therefore, the parties hereto agree with each other as follows:

1. All persons who are, on the date of this agreement, or who may be hereafter during the term of this Agreement, registered as Professional Engineers under the provisions of Chapter 173 of the Statutes of the Province of Saskatchewan for the year 1930, and any subsequent amendments thereto, and who are not on the date of this Agreement, nor on the date of such future registration, as the case may be, Corporate Members of the Institute, shall under the provisions of this Agreement automatically become Corporate Members of the Institute on and after said date, subject to the terms and conditions of this Agreement, as hereinafter set forth.

2. Any person registered as a Professional Engineer in the Association shall be accorded the class of membership in the Institute warranted by the age, experience and professional qualification of such person, according to the By-laws of the Institute and the decision of the Council of the Institute. Any person dissatisfied with such classification shall be entitled to have his classification and qualifications for the same reviewed by the Council of the Institute.

3. All persons who are, on the date of this agreement or who may be hereafter during the term of this Agreement, registered under the By-laws of the Association as Engineers in Training and who are not on the date of this Agreement, nor on the date of such future registration, as the case may be, Junior Members of the Institute, shall, under the provisions of this Agreement, automatically become Junior Members of the Institute on and after the said date, subject to the terms and conditions of this Agreement as hereinafter set forth.

4. All persons who are, on the date of this Agreement or who may be hereafter during the term of this Agreement, registered under the by-laws of the Association as Students and who are not on the date of this Agreement, nor on the date of such registration, as the case may be, Students in the Institute, shall, under the provisions of this Agreement, automatically become Students of the Institute on and after said date, subject to the terms and conditions of this Agreement as hereinafter set forth.

5. The entrance fee of the Association shall be remitted to any Corporate Member of the Institute, who, at the date of this Agreement, is a bona fide resident of the Province of Saskatchewan and who applies for membership in the Association within 12 months. The entrance fee shall also be remitted to any Corporate Member of the Institute who, after the date of this Agreement, becomes a bona fide resident of the Province of Saskatchewan, provided application for membership in the Association is made within twelve months of the date of such residence.

6. The Association will collect one Joint annual subscription fee from each of its members from which the Association shall pay to the Treasurer of the Institute, in lieu of the ordinary membership fees of the Institute, the sum of six dollars ($6.00) per annum for each member of the Association having the Institute classification of Member (M.E.I.C.); the sum of Five Dollars ($5.00) per annum for each member of the Association having the classification of Associate Member (A.M.E.I.C.); the sum of Three Dollars ($3.00) per annum for each member of the Association having the Institute classification of Junior, and Two Dollars ($2.00) per annum for each member of the Association having the Institute classification of Student. These fees shall entitle the members of the Association to those privileges of the Institute membership provided by its By-laws and shall include the annual subscription to the Institute Journal.

These fees shall be due and payable to the Institute by the Association annually in advance on the 31st day of March of each year. The provisions of this Section 6 of this Agreement shall not be effective until the 1st day of January, 1939.

7. The Saskatchewan Branch of the Institute shall consist of all members of the Institute resident in the Province of Saskatchewan and all members of the Association.

8. During the term of this Agreement, the officers and the Council of the Association shall *ipso facto* be and become the officers and the members of the Executive Committee of the Saskatchewan Branch. Any Saskatchewan member of the Institute elected president or vice-president or councillor of the Institute, shall be an ex-officio member of this Executive Committee. The Executive Committee as so constituted will be responsible for the financing and the management of the Saskatchewan Branch.

9. The Councillor representing the Saskatchewan Branch will be nominated and elected in accordance with the By-laws of the Institute.

10. As a principal objective of this Agreement is the achievement of a common membership between the Saskatchewan Branch and the Association, all meetings will be announced as a "Meeting of the Engineering Institute of Canada and the Association of Professional Engineers of Saskatchewan," with the exception of any legally required special or annual meetings of either the Branch or the Association.

11. The term of this agreement shall be the period commencing on the date hereof and ending on the 31st day of December, 1941, on which date this Agreement shall terminate provided either party has given to the other a notice of termination at least six months prior to the 31st day of December, 1941, and if no such notice is given this Agreement shall continue after the 31st day of December, 1941, from year to year, but may be terminated at the end of any calendar year by either party giving notice in writing to the other of such termination at least six months prior to the end of any calendar year.

12. The terms and provisions of this Agreement may be amended by mutual agreement, in writing between the parties hereto, duly executed by them.

13. Any changes in nomenclature of the various classes of membership in the Institute will automatically apply to the provisions of this Agreement.

In Witness Whereof these presents have been duly executed on behalf of the parties hereto on the date and at the place first above written.

In the Presence of: THE ENGINEERING INSTITUTE OF CANADA

....
President

....
Secretary

THE ASSOCIATION OF PROFESSIONAL ENGINEERS OF SASKATCHEWAN

....
President

....
Registrar

Presidential Activities

On Friday, July 1st, the President and a group of Headquarters engineers were down at the *Duchess of Atholl* to say good-bye to Dr. and Mrs. Cullen and to Dr. and Mrs. Stradling. Both these distinguished engineers, who are members of the British delegation to the recent meeting of the Society of Chemical Industry, promised to take home to the Councils of their own Institutions the loyal, friendly greetings of The Engineering Institute. In spite of the short notice which made it quite informal, it was a rare pleasure and a delightful privilege for the Headquarters of The Institute to honour the presence in Canada of Dr. Cullen, the President of the Institution of Chemical Engineers, and of Dr. Stradling, a member of Council of the Institution of Civil Engineers of Great Britain.

At London, on Tuesday, July 19th, the President conferred with the chairman of the Nominating Committee, H. F. Bennett, M.E.I.C. He also discussed with the Management Committee of the London Branch the plans which the London and the Border Cities Branches are making for an appropriate engineering celebration at Sarnia shortly after the formal opening, on August 19th, of the new international highway bridge across the St. Clair river.

At the "Soo" on Wednesday, July 20th, President Challies entertained at luncheon the Management Committee of the Sault Ste Marie Branch, when Institute matters were discussed at length. Following a dinner at the Golf Club he addressed a well attended meeting of nearly sixty engineers. As many of those present were recent graduates, the President took advantage of the occasion to urge an active interest in and a loyal support for both the Ontario Provincial Professional Association and The Engineering Institute of Canada.

A few notes and some correspondence just received as we go to press indicate the President's enthusiasm for the future of the Sault Ste Marie Branch as a robust centre of Institute activities.

Mr. Challies' visit to the "Soo" at this time was made possible by the fact that he was spending a short vacation in Ontario.

Air Raid Precautions Exhibition

An interesting exhibition dealing with the subject of air-raid precautions was arranged by the Building Centre, 158, New Bond Street, London, W.1, at the Charing Cross Underground station of the London Passenger Transport Board. This exhibition, which was opened by Wing-Commander E. J. Hodsoll, C.B., Inspector-General of Air Raid Precautions, on Thursday, May 5, and remained open for the next few weeks, consisted mainly of a room such as might be found in any house. This room on the ground floor, had been treated against air raids in accordance with the recommendations of the Home Office publication *Protection of Your Home Against Air Raids*, and the various methods of treatment were distinctly labelled. The ceiling was supported in the centre by timbering in order to protect the occupants as far as possible from falling debris. The windows were sealed and protected on the outside by sand bags. The fire-place and door were also sealed against gas and all cracks in the plaster and skirtings filled in. A transparent material was pasted over the windows and fixed with cellulose varnish as a protection against glass splinters. It is not suggested that the room shown was bomb proof. It was merely treated for protection against demolition splinters and gas.

Among the other exhibits were three types of shelters, one in steel and two in pre-cast concrete. These were built below ground. Various alternative methods of protecting windows and doors were exhibited, as well as covers for underground shelters such as have been described in *Engineering*. In fact, how protection can be obtained against every form of damage except that caused by a direct hit was shown.

We understand that the exhibition was a preliminary to a permanent exhibition and information centre on air raids precautions in buildings, to be opened at the Building Centre.—*Engineering.*

Alternative Firing of British Men-of-War

In all quarters concerned with maritime affairs, increasing attention is being directed to the risks inseparable from the complete dependence of the Navy upon a foreign fuel supply. The similar dependence of half of our Merchant Marine, of the Air Force and mechanized Army, and of a large proportion of our land-transport and industry, has necessarily accentuated the growing disquiet. Many well-known flag-officers, as well as other authorities in the shipping and engineering worlds, have shown that in the unhappy event of war, against which this nation is so expensively re-arming, the oil supply, upon which every branch depends, will be endangered at its source, in transport through pipe-lines and on its long ocean passages, and while in storage in the great tank-farms in Home territories. No one seriously disputes that risks are being accepted; indeed, the Government has explicitly admitted that some risks do, in fact, exist, and it is known that this question is engaging the unremitting attention of the authorities.

But on the purely naval aspect of this difficult problem, and the aspect which the author desires to examine, there are two opposed schools of thought. One school, while admitting some risk, regards that risk as sufficiently slight to justify its acceptance for the sake of the technical advantages claimed for the ship designed exclusively for oil-firing. The other school considers the risk so serious that it should be eliminated altogether, if this can be done without crippling the fighting power of the Navy, or unduly extending its commitments in tonnage or personnel. The latter school, however, is itself loosely divided into two groups. One of these groups shares, more or less, the prevailing conviction that the very high speed and great mileage endurance, for which provision has been made in post-war ships, are necessary characteristics of up-to-date British men-of-war. This group therefore advocates that all future men-of-war, while retaining their existing, or contemplated, speeds and mileage endurances as exclusive oil-burners, should, by dual-firing, and by an appropriate modification in design, be equipped with the safeguard of coal-burning, so that, in the event of an interruption of oil supplies, the vessel can steam at economical speed for a reasonable period.

The other group disputes the fighting value of the extremities of speed and what it regards as excessive mileage endurance, in view of the sacrifice in guns and armour which, on any given tonnage, these two characteristics entail. It therefore advocates a reduction in speed and endurance, and the restoration of native fuel, either as the basic fuel in a dual-firing system or as the sole fuel.

The author's own conviction is, when the worship of the speed god becomes out of date among seamen, that future British men-of-war should rely entirely upon coal. Need it be doubted that British marine engineers and constructors, if called upon to do so, will be able and anxious to apply to men-of-war the remarkable advances in coal-combustion and engineering which, since coal went out of fashion at sea, mechanical engineers have so remarkably achieved on land?

In the past nine years, as can be seen from perusal of official statistics, the improvement in steam generating stations has been about 45 per cent, and it is estimated that at least 6,000,000 tons less coal would be needed to generate the electricity sold in 1936 at the higher efficiency now attained than at the lower efficiency of only nine years ago. The dirt and exertion of coal-firing and bunkering can, furthermore, be eliminated by up-to-date practice. An alternative fuel would, in addition, increase the likelihood of obtaining oil, and at prices which the nation might be able to afford to pay.—Captain B. Ackworth, D.S.O., R.N. (ret.). in *Engineering.*

Performance Code for Air-Conditioning Equipment

A "Code of Minimum Requirements for Comfort Air Conditioning" just adopted by the American Society of Heating and Ventilating Engineers, and developed jointly with the American Society of Refrigerating Engineers, has set up a uniform procedure for establishing the fundamental basis for the design of conditioning installations.

In the making for the past two years, its sponsors aim at establishing minimum design standards by which purchasers can judge the performance of equipment.

For winter air conditioning, 70 deg. indoor temperature with 35 per cent relative humidity, when outdoor temperature is 30 deg., is set as a minimum design standard. For summer air conditioning, an indoor design schedule of "effective temperatures" (which are index of comfort based on a combination of temperature, relative humidity and air motion) is established ranging from 71 deg. "effective temperature" when it is 80 deg. outside to 75.5 deg. "effective temperature" when it is 105 deg. outdoors.

The code specifies the introduction of outside air for ventilating purposes at a rate of not less than 10 cu. ft. per hr. per occupant, or not less than 15 cu. ft. in premises where smoking is permitted, with removal of 95 per cent of ordinary dust particles to provide requisite air purity.

Air velocities which account for drafts and are a frequent cause of complaint in air conditioning systems, are limited to not more than 50 lin. ft. per min., according to the new code. Control of air temperatures within 3 deg. at the five foot level or the "breathing zone" is also specified in the code.

—*American Society of Heating and Ventilating Engineers.*

Ottawa Branch Entertains Council

Head Table (left to right): President J. B. Challies, W. F. M Bryce, A.M.E.I.C., T. H. Hogg, M.E.I.C., G J. Desbarats, HON.M.E.I.C., de Gaspe Beaubien, M.E.I.C., Dr. C. Camsell. M.E.I.C., J. L. Busfield, M.E.I.C., F. S. B. Heward, M.E.I.C., W. R. Manock, A.M.E.I.C., A. B. Gates, A.M.E.I.C., F. Newell, M.E.I.C.

Others who may be easily identified are: General Secretary L. Austin Wright, W. E. Bonn, M.E.I.C., H A. Lumsden, M.E.I.C., J. A. Vance, M.E.I.C., L. F. Grant, M.E.I.C., J. A. McCrory, M.E.I.C., F. A. Gaby, M.E.I.C.

John Murphy, M.E.I.C.

It is news of interest to members of The Institute, that John Murphy is retiring from active service with the Federal Government. Mr. Murphy has been so closely associated with the Ottawa Branch, and the general activities of The Institute that events which are of importance to him become of importance to The Institute at large. Fifty-four years of service and usefulness to society surely entitles a man to the privilege of at last becoming master of his own time. Mr. Murphy is just about to enter that Elysian field, and no one will acknowledge his stirling qualities, or wish him more happiness therein than members of The Institute.

It is not possible within the present limitations to give a satisfactory account of such an active life. Only certain mileposts and highlights can be mentioned. Such things as his intense interest in athletics—particularly tennis—service clubs, his church, and so on must be passed by and yet they tell so much about the man himself. The following paragraphs give a brief account of the business end of his life and will be of interest to all engineers, both old and young.

John Murphy, M.E.I.C., senior electrical engineer of the Department of Transport and the Board of Railway Commissioners, and acting superintending engineer of the Rideau Canal, has recently completed 32 years of service with the government. He has been receiving expression of the high regard in which he was held by officials of the Department of Transport but his outstanding ability as an electrical engineer draws admiration from fellow members of the profession as well.

His career is linked with the early development of the hydro-electric power industry in Ottawa. At the age of 16 he entered the employ of the Bell Telephone Company. He was here only a year when he was placed in charge of an electric light plant at Chelsea. Two years later, in 1887, he was placed in charge of the newly established Chaudière Electric Light and Power Company. His duties and responsibility were increased in 1891 when he was given charge of the Ottawa Electric Railway Company and the Chaudière Electric Light and Power Company. He continued in this position for the next 20 years.

When Mr. Murphy joined the staff of the Department of Railways and Canals in 1906 as electrical engineer he brought with him wide experience gained as a consulting engineer. Later he was promoted to the position of senior electrical engineer to the Department as well as to the Dominion Board of Railway Commissioners.

Mr. Murphy has identified himself prominently with numerous technical associations, among which are The Engineering Institute of Canada (Chairman of Ottawa Branch 1916-17), Canadian National Committee of the International Electro-Technical Commission (President 1927-1937), Canadian Committee of the World Power Conferences, Illuminating Engineering Society, Canadian Electric Railway Association, Railway Signal Association, American Electrical Railway Association, Professional Engineers of Ontario, American Institute of Electrical Engineers, Canadian Electrical Association, Canadian Engineering Standards Association (member of several committees), the National Research Council, the Professional Institute of Civil Service and the Civil Service Association. He has also acted as official delegate to the World Power Conference at Wembley in 1924, and to the International Electro-Technical Commission plenary meetings at Bellagio and Rome in 1927, to Japan in 1929 and to Germany and Scandinavia in 1930.

Mr. Murphy will be seventy years of age on December seventeenth this year.

W. L. Malcolm, M.E.I.C., Goes to Cornell

In the July Journal an announcement was made of the appointment of Dr. William Lindsay Malcolm, M.E.I.C., of Queen's University as director of the School of Civil Engineering at Cornell University. The following information, which augments that previously given, will be of interest to our readers.

Dr. Malcolm has a brilliant record as a teacher, an army engineer, and a practising engineer in civil life. Entering Queen's University in 1902 with scholarships in mathematics, physics, and chemistry, he received the M.A. degree in 1905, and the B.S. in Civil Engineering in 1907. Cornell awarded him the degrees of Master of Civil Engineering in 1934 and Ph.D. in Civil Engineering in 1937. He has been a member of the Faculty of Queen's University since 1907, including five years overseas during the World War.

During 1914-1919 he served with the Canadian Engineers, attaining the rank of lieutenant-colonel, and command officer of engineers, successively, of the Fifth and Fourth Divisions of the Canadian Army. He is now a member of the Advisory Board of the Royal Military College.

Since 1905, Professor Malcolm has also been acquiring varied experience in municipal engineering, construction, and other phases of engineering practice. He has been city engineer of Stratford, associate city engineer of Guelph, and a consultant on highway construction and building design and construction. He designed and built the stadium and ice hockey rink and the sanitary engineering laboratory at Queen's University, as well as numerous factories and other structures.

He is a member of The Engineering Institute of Canada, the American Water Works Association, the Canadian Institute of Sewage and Sanitation, the New York State Sewage Works Association, and the Professional Engineers Association of Ontario, and holds licenses as Ontario and Dominion land surveyor.

The news of this appointment will be well received by engineers throughout Canada. Beyond a doubt Queen's is suffering a serious loss, but they can be proud of the fact that their staff is strong enough to contain engineers of this calibre. All Canadians, and particularly members of The Institute, will share with Dr. Malcolm, in the pride and pleasure that can be taken from such an appointment. The Journal wishes him great success and much happiness in his new field.

Annual Western Meeting C.I.M.M.

The Canadian Institute of Mining and Metallurgy holds this important annual meeting in Vancouver this year on November 9th to 12th. President E. A. Collins of Copper Cliff, Ontario, has arranged to attend, and The Journal is informed that he expects many others from central and eastern Canada to do likewise.

President J. B. Challies and the General Secretary L. Austin Wright have been specially invited by the President and Council of the C.I.M.M. The schedule of Mr. Challies' western trip will permit his party to be in Vancouver at that time, so that it has been possible to accept the invitation. Mr. Challies has expressed himself as being delighted at the prospect of participating in the proceedings of the Mining Institute.

The entire arrangements for the western meeting are in the hands of the British Columbia Division. Each year this division renders this valuable service to the profession and the industry, and in spite of the great amount of work involved is satisfied with the recompense of a satisfactory attendance.

Meetings of Council

A meeting of Council was held at Headquarters on Friday, May 20th, 1938, at eight o'clock p.m. President J. B. Challies and twelve other members of Council were in attendance.

Considerable discussion was given to a report from the chairman of the Committee on Membership and Management, Professor R. A. Spencer, dealing with the subjects of Council reorganization and classification of grades of membership. It was decided that the committee's first proposal be submitted to all branch executives for their consideration during the summer, with a view to their considered opinions being available early in the fall.

Councillor Newell reported on behalf of the Committee on Professional Interests. He referred to the legislative difficulty which had arisen in Nova Scotia, thereby delaying the consummation of the co-operative agreement with the Professional Association of that province. He also indicated how this obstacle would be overcome in the near future. He touched on the situation in the provinces of New Brunswick, Manitoba, and particularly Saskatchewan, where an agreement has been approved of in principle. Mr. Newell was authorized to proceed with further negotiations.

Consideration was given to a suggestion which had come from many sources that copies of the minutes of Council meetings should be sent to past-presidents, branch chairmen, and ex-councillors for one year after the expiry of their term. It was decided to consult all councillors by means of a ballot to be returned in time for the next Council meeting.

The Sir John Kennedy Medal award was discussed, and it was decided to send out a preliminary ballot so that the final ballot would contain only one name.

The chairman of the Finance Committee, Mr. J. A. McCrory, reported that revenue and expenditure to date were keeping well within the budgeted amounts. Four resignations were accepted; one Member, four Associate Members and one Junior were reinstated; Life Memberships were granted to two members on the recommendation of their branches, and consideration was given to two special cases.

Mr. Gordon McL. Pitts, A.M.E.I.C., was appointed as The Institute's representative on the C.E.S.A. Committee on Fire Tests for Building Construction and Materials.

Councillor D'Aeth reported for the Library and House Committee, with particular reference to the maintenance and alteration work which was being planned for the Headquarters building. He was authorized to proceed with the work in consultation with the chairman of the Finance Committee and the General Secretary.

Mr. D'Aeth also reported on the suggestion which had been made that the practice of other societies might be followed and a per diem charge made for the use of books in the library. He reported that it did not seem an opportune time to make such a change. It was felt that the small financial benefits which might accrue would not justify the proposed new procedure. Council endorsed his recommendation.

At the President's suggestion it was decided that a special meeting of Council should be held in Regina at the time the President and the Headquarters party would be there on their western trip.

The programme of the Annual Meeting was discussed, and the President and Mr. Gaherty gave reports of the progress which had already been made. It was also agreed that a Council meeting should be called during the Annual Meeting under such circumstances that sufficient time could be given to the many important items of business that would develop.

A letter from E. P. Muntz, M.E.I.C., The Institute's representative on the National Construction Council of Canada, was read. In this he reported on the Construction Council's brief which had been presented to the Royal Commission on Dominion-Provincial Relations. The Commission had asked for a further report as to how the recommendations might be implemented, and Mr. Muntz asked that an emergency stand-by committee be appointed to co-operate with him in the preparation of such a supplementary draft. Past-Presidents J. M. R. Fairbairn and F. A. Gaby, Councillor W. E. Bonn, and the President, were appointed as this committee.

It was unanimously agreed that Mr. Muntz be asked to continue as The Institute's representative on the National Construction Council of Canada, with Dr. A. H. Harkness, M.E.I.C., as alternate.

In response to an invitation from the Canadian Society of Chemical Industry, Mr. Challies was appointed official delegate to the President's Reception and the Convention's Dinner and Dance at Ottawa.

Mr. F. A. Combe, M.E.I.C., was asked to represent The Institute on the Committee dealing with the Safety Code for Mechanical Refrigeration, this in response to a request from the C.E.S.A.

The following elections and transfers were considered and approved:

Elections		*Transfers*	
Members	3	Associate Member to Member	2
Associate Members	4	Junior to Associate Member	5
Juniors	7	Student to Associate Member	1
Students admitted	7	Student to Junior	5

One application for admission as Associate Member was approved, subject to the passing of The Institute's examinations, and one special case was considered.

The Council rose at eleven o'clock p.m.

Ottawa Meeting

A meeting of Council was held at the Chateau Laurier, Ottawa, Ontario, on Friday, June 24th, 1938, at two thirty p.m. President Challies, sixteen members of Council, and fifteen guests were in attendance. The guests were past-presidents, ex-councillors and the present officers of the Ottawa Branch.

The President expressed his appreciation of the excellent attendance at Council meetings this year, and he invited all the guests to participate freely in the discussions of the meeting. He particularly welcomed Councillor A. B. Gates, of Peterborough, who had recently recovered from a long and serious illness.

After considerable discussion it was decided that an invitation be sent to the Institution of Mechanical Engineers to visit Canada either before or after the joint meeting with the American Society of Mechanical Engineers which is being held in New York in September 1939.

Past-President Desbarats reported on the work which is being done by the engineering societies in England to improve the prestige of the profession with the public. It was thought that some similar movement might be undertaken in Canada.

Councillor Busfield reported progress for the Publication Committee, and dealt with the designs for a new cover, and with the formation of a Technical Advisory Board for The Journal.

Considerable discussion was given to the progress report of the Committee on Membership and Management. Eventually it was pointed out by the President that Professor Spencer, chairman of the committee, was on his way east, and suggested that no action should be taken until the members of the committee in the east should have an opportunity of discussing the situation with him. This was agreed upon.

The Secretary reported that the ballot of Council, dealing with the matter of sending minutes of Council meetings to others than councillors, had carried almost unanimously. It was therefore decided that minutes of all Council meetings should go to all past-presidents, branch chairmen, and ex-councillors for one year after their term of office.

Councillor Newell reported for the Committee on Professional Interests, touching on conditions in Nova Scotia, New Brunswick and Manitoba. He also reported that negotiations with the executive of the Saskatchewan Branch and the Council of the Saskatchewan Association had reached a complete understanding on the form of agreement. The proposed agreement was examined clause by clause, and unanimously approved. It was hoped that the agreement would be ready in time for the President's signature at the time of his visit to Regina in October.

Council made special recognition of the appointment which had come to Dr. W. L. Malcolm, M.E.I.C., of Queen's University. Dr. Malcolm has been made Director of the School of Engineering at Cornell University.

The chairman of the Library and House Committee submitted a report on the renovation of the Headquarters building. It was expected that the work would be under way by the 1st of July.

Particular reference was made to the offer of a contribution from the Montreal Branch towards the cost of the Headquarters renovation. The sum of $250.00 was offered by the branch and, on the motion of Colonel Grant, seconded by Mr. Manock, was accepted with sincere thanks.

The President submitted a draft itinerary of his visit to the western branches, and pointed out how it had been arranged that his party would be in Regina at the time of the Semi-Annual Open Meeting of the Association of Professional Engineers of Saskatchewan.

The Annual Meeting received much attention. The President reported that Colonel Wilfred Chevalier had accepted the invitation to be the guest speaker at the Annual Dinner. It was also hoped that Sir Gerald Campbell, the newly appointed High Commissioner to Canada from the United Kingdom, would be able to take a part in the proceedings.

Mr. Gaherty, chairman of the Committee on Western Water Problems, made a very full report dealing in detail with the negotiations he was able to complete while on his western trip, with many speakers who were to take part in the papers and discussions. Mr. Gaherty's revised programme was approved of, and the arrangements were left in his hands in consultation with the President and the General Secretary.

The advisability of including papers other than those on western water problems was discussed, and it was decided that other subjects should be included, but action was delayed until the matter could be given proper consideration.

The Past-Presidents' Prize competition was reported on by the General Secretary, and a committee was named by the President to finally select a subject from the many which had been suggested by the branches. The committee consisted of the Treasurer, the General Secretary, and the Secretary Emeritus.

Past-President Gaby drew the attention of the meeting to the recent announcement of the honour which is to be conferred upon the President by the University of Toronto. A Doctorate of Engineering is to be given to him on October 14th.

Vice-President McCrory reported for the Finance Committee, and stated that the financial condition was still very favourable, and that it was expected that the year would finish as it had been planned when the budget was originally drawn up.

Seven resignations were accepted; two Associate Members and one Junior were reinstated, and the names of eight over age Students, in arrears for two years, were removed from the list of members.

A joint meeting of the Border Cities and London branches at Sarnia in September was reported on by Councillor Vance. It was hoped that a large number would be in attendance, and that the President and members of Council would make a special effort to be present. The special occasion was the opening of the new bridge between Canada and the United States at that point.

Councillor Bonn reported in detail for the Membership Committee, and made particular reference to the comprehensive information which has been gathered by Mr. Huet Massue, one of the members of the committee. Particular reference was made to the membership situation in the province of Ontario. Mr. Bonn made some definite recommendations which it was hoped would be of assistance to the membership committees of the Ontario branches. A discussion of our relationship with the Technical Service Council resulted in a decision that Mr. Bonn, along with Mr. Busfield and Mr. Heward and the General Secretary, should go into this whole question thoroughly and report to a subsequent meeting of Council.

The Secretary reported on the Seventh International Management Congress which is to take place in Washington in September 1938, and drew attention to the interest which has developed in Industrial Management by members of The Institute. Members of the Montreal Branch Industrial Management Group had urged that The Institute should have official representation at the Congress, so that Council could decide on the share of the participation which The Institute should take in this development. Following some discussion it was resolved that the General Secretary be authorized to attend the Congress, and that T. M. Moran, A.M.E.I.C., of the Montreal Industrial Management Group, be also accredited as an official representative.

In compliance with the request of the C.E.S.A., it was decided to ask Colonel C. S. L. Hertzberg, M.E.I.C., to represent The Institute on the Committee on Building Materials.

Councillor Heward reported on the meetings of the Canadian Chamber of Commerce with particular reference to the convention which is to be held at the Seigniory Club in September.

Past-President Desbarats presented a report of the Annual Meeting of the Royal Society of Canada in Ottawa, at which he officially represented The Institute.

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

Elections		*Transfers*	
Associate Members	8	Associate Member to Member	8
Juniors	5	Junior to Associate Member	4
Students admitted	4	Student to Associate Member	1
		Student to Junior	3

One application for admission as Associate Member was approved, subject to the passing of The Institute's examinations, and four special cases were considered and disposed of according to their merits.

It was decided that the next meeting of Council should be held in September, it being understood that the President would call a special meeting during July or August if such should become necessary.

The Council rose at six o'clock p.m. to attend the President's dinner at the Rideau Club.

OBITUARIES

Paul Baily, A.M.E.I.C.

The death of Paul Baily, A.M.E.I.C., occurred July 14th in Montreal, where he had been residing. Mr. Baily was born in Namur, Belgium, on July 23rd, 1890. He received his technical education in Belgium at the University of Ghent, from which he was graduated in 1912. After a year's engineering work with the Belgium Government and a year with the Fabrique Nationale d'Armes de Guerre at Herstal, Liege, he left Belgium for England where he was connected with Aerators Limited of London. Coming to Canada in 1915, he entered Canadian Vickers Limited, Montreal, as assistant chief engineer and naval architect. He remained in this position until 1920 when he accepted the position of designing engineer with the Belgo Canadian Pulp and Paper Company, Shawinigan Falls, for a year. Since that time he has held the positions of assistant city engineer of Verdun, Que., and designing engineer with John Stadler, consulting engineer, Montreal.

Mr. Baily joined The Institute in 1922 as an Associate Member.

Conway Edward Cartwright, M.E.I.C.

On July 4th in Vancouver, Conway Edward Cartwright, Life Member of The Institute, died at the age of 74.

Mr. Cartwright was born in Toronto, Ont., on October 14th, 1864. He graduated from the Royal Military College, Kingston, Ont., in 1884 and began his career as a railroad engineer even before this date. Between the time of his graduation and his location in Vancouver in 1899 as a consulting engineer he was engaged in railroad work in various parts of Canada and the United States. From 1885 to 1887 he was on location and construction surveys and works for Pontiac Pacific Junction and Gatineau Valley Railways. From 1887 to 1890 he was in charge of the draughting office of the Norfolk and Carolina Railroad at Norfold, Va. In 1890 he left railroad work for a time and became resident engineer of improvement works at Salem, Va. From 1891 to 1892 he was principal assistant engineer, Nashua, N.H. In the latter year he returned to railway work and was on location and construction of the Vandalico Line, Indiana. In 1896 he began his connection with the New York and Ottawa Railroad, at first in the capacity of surveyor and later as assistant chief engineer.

In 1912 Mr. Cartwright entered the firm of Cartwright and Matheson and Company, Vancouver. He formed his own company in 1920, but later became divisional engineer for the Canadian Pacific Railway in Vancouver.

Mr. Cartwright joined The Institute as a Student in 1887, becoming a member in 1898. He served as a member of Council from 1912 to 1914.

William Thomas Thompson, M.E.I.C.

The tragic death of William Thomas Thompson, M.E.I.C., was confirmed, July 18th, 1938. He set out July 8th to survey quartz mineral claims in the Cold Lake district, 450 miles northwest of Winnipeg, and was to have met two companions at Cranberry Portage. When he did not appear they spread the alarm and for ten days Indians, fishermen and trappers joined in an exhaustive search. On July 18th the body of Mr. Thompson was discovered on the shores of Cold Lake a few feet from where he had mounted his large surveyor's blue prints on a short stick. This distress sign had been blown down.

Mr. Thompson was born at Cannington, Ont., on November 1st, 1853. He received the degree of B.A.Sc. from McGill University in 1877 and that of M.A.Sc. from the same university in 1882. He was engaged on base line and principle meridian surveys for the Dominion Government from 1879 to 1884 in what are now the Provinces of Saskatchewan and Alberta. He then undertook surveys for the Dominion Government in Western Canada, subdividing townships, with correction and inspection work in connection with the townships. In 1896 he became one of the first surveyors and engineers appointed by the Old North West Territories Council and on organization of the Provinces of Saskatchewan and Alberta he continued in that appointment for Saskatchewan, resigning during 1922 to take up private practice in The Pas, Man. He remained here until 1931 when he removed to Cranberry Portage, Man., where he made his home until the time of his death.

Mr. Thompson joined The Institute as an Associate Member in 1894, becoming a Member in 1910.

The following items refer to deaths which occurred some time ago, notice of which has just reached headquarters.

John William Burke, M.E.I.C.

The death of John William Burke, M.E.I.C., occurred in New York, on August 29th, 1937. Mr. Burke was born at Westford, Mass., on May 7th, 1865. He received his technical education at the Worcester Polytechnic Institute, being graduated in civil engineering in 1887. In 1895 he began his practice as consulting engineer in New York and was still in active practice at the time of his death.

Mr. Burke joined The Institute as a Member in 1903.

Major Alan Bruce Ritchie, A.M.E.I.C.

Word has just been received of the death of Major Alan Bruce Ritchie, A.M.E.I.C., in a mine accident at Kimberley, B.C., in December last. Major Ritchie was born at Halifax, N.S. on August 15th, 1882. He was graduated from McGill University in mining engineering in 1906. He was employed with various mining companies but since 1921 held the position of general superintendent of the Consolidated Mining and Smelting Company of Canada Limited at Kimberley.

His service during the war was acknowledged by the Military Cross.

Major Ritchie joined The Institute as a Student in 1904, becoming an Associate Member in 1911.

George R. Wright, A.M.E.I.C.

We have just received notification of the death of of George R. Wright, A.M.E.I.C., in Vancouver, B.C., on January 1st, 1938. He was born at Salisbury, N.B., on September 28th, 1882. He received his B.A. degree from Mount Allison University, Sackville, N.B., in 1903 and that of B.Sc. from McGill University in 1907. In this latter year he entered the Canadian General Electric Company in Peterborough, Ont. Serving in various departments he became district manager in 1916 and was at that time located in Winnipeg. In 1925 he was transferred to Vancouver, B.C., and remained there until his death.

Mr. Wright joined The Institute in 1920 as an Associate Member.

April, May and June Journals Required

Copies of the April, May and June 1938 issues of The Engineering Journal are required for binding and it would be appreciated if members having no further use for these issues would forward copies available to Headquarters at 2050 Mansfield Street, Montreal, Que.

PERSONALS

Professor R. A. Spencer, M.E.I.C., Chairman of the Committee on Membership and Management, is making a lengthy visit to Toronto. He will be in Montreal for the Council meeting of August 19th. His Toronto address is 166 Balsam Avenue.

Lesslie R. Thomson, M.E.I.C., has again made a substantial contribution to the solution of one of Canada's great economic problems. The Macmillan Company of Canada announces the printing of his book "The Canadian Railway Problem," shortly to be available to the public. The prospectus describes a very interesting publication, and certainly one whose table of contents indicates a very broad and thorough treatment of the subject. A review will appear in a later number of The Journal.

John F. Plow, A.M.E.I.C., former Assistant Secretary of The Institute, has recently qualified for the rank of provisional lieutenant-colonel. At present he is major in the 1st Medium Battery Royal Canadian Artillery.

Lt.-Col. T. S. Morrisey, D.S.O., M.E.I.C., has recently been appointed secretary-treasurer of the Associated Screen News, Montreal. Col. Morrisey is commanding officer of the McGill University C.O.T.C.

Jules LeBlanc, A.M.E.I.C., has been appointed engineer with the Provincial Electricity Board, Montreal. Mr. LeBlanc was graduated from the Ecole Polytechnique in 1928 with the degree of B.A.Sc. and from the Massachusetts Institute of Technology in 1929 with the degree of B.Sc. He was formerly assistant chief engineer of the Provincial Relief Works of the Ministry of Labour.

H. A. Matheson, Jr.E.I.C., is now with the Tropical Oil Company in Barranca-Bermeja, Colombia, S.A. Mr. Matheson is a graduate of the University of Saskatchewan, Regina, in 1933 with the degree of B.Sc. He entered the Imperial Oil Company in 1935, as engineer of maintenance and construction at Regina. The following year he was transferred to Sarnia, Ont., remaining there until accepting his present position.

F. C. Jewett, A.M.E.I.C., has been recently appointed chief engineer of the Newfoundland Airport. Prior to going to Newfoundland he was resident engineer of the Capitol Works, National Harbours Board, Saint John, N.B.

G. R. Langley, M.E.I.C., has been appointed to succeed **L. De W. Magie,** M.E.I.C., who is retiring after having held the position of works engineer at the Peterborough plant of the Canadian General Electric Company for 38 years. A native of Toronto where he attended Upper Canada College, Mr. Langley is a graduate of Union University at Schenectady, N.Y., in electrical engineering. Following graduation he became associated with the General Electric Company in the Test Department, Research Laboratory and Switchgear Engineering Department. Since 1913 he has been the engineer in charge of the Switchboard Engineering Department at Peterborough. For many years he has taken a keen interest in athletics. Before going to Peterborough as works engineer in 1900, Mr. Magie gained wide experience with the Stanley Electric Company in Pittsfield, Mass., and the Royal Electric Company in Montreal. He is a member of the E.I.C., the A.I.E.E., and the Engineering Club in Toronto. He is a well-known member of the Peterborough Library Board and is a great lover of books and flowers.

J. W. Stafford, S.E.I.C., who has been located at Arvida, Quebec, with the Saguenay Power Company Limited as junior engineer has been transferred to the company's Isle Maligne Station as plant engineer. Mr. Stafford graduated from the University of Alberta in 1937 with the degree of B.Sc. in electrical engineering.

REQUEST FOR INFORMATION

To all members of The Engineering Institute of Canada

It is proposed to publish a membership list before the end of the year. In order that complete and up-to-date information may be available, will you kindly fill in this form and return it to Headquarters. The work is already under way; therefore a prompt response will be appreciated.

L. Austin Wright, *General Secretary*

Name in full..

Residence address..

Business address..

(*Underline the one to be used for mail*)

Membership classification in Institute..

Name of Employer..

Position occupied..

College, Degrees and year..

Military or Civil titles and honours..

Visitors to Headquarters

Brig.-Gen. Sir Godfrey Rhodes, C.B.E., D.S.O., M.E.I.C., was in Montreal for a few days on his way to England. We were very pleased to have him visit Headquarters on July 7th. He is general manager of the Kenya and Uganda Railways and Harbours, Kenya Colony, British East Africa. He is a graduate of the Royal Military College, 1907. The Vancouver Branch had the pleasure of entertaining him at luncheon on June 13th.

Major-General A. Clyde Caldwell, Master-General of the Ordnance, Department of National Defence, Ottawa, was a welcome visitor on July 15th. General Caldwell is having a paper prepared dealing with an important phase of industry which is to be printed in an early edition of The Journal.

Special Meeting Planned for Sarnia

The opening of the new bridge from Port Huron, Michigan, to Sarnia, Ontario, has been seen as an opportunity for a special celebration on the part of the London and Border Cities branches. The President and the General Secretary intend to be present, and councillors and officers of other branches are also expected.

The date is set for late September and the meeting will be in Sarnia. The tentative programme includes a visit to the Imperial Oil Refinery, with one of the officials of that company as speaker at the luncheon; a visit to the bridge and a dinner at night when it is expected that a prominent engineer of the highway department will be the speaker. Visitors from across the border are expected.

Council Entertains English Engineers

Dr. W. E. Cullen
President of the Institution of Civil Engineers.

Dr. R. E. Stradling, C.B., M.C.
Councillor of the Institution of Civil Engineers.

ELECTIONS AND TRANSFERS

At the meeting of Council held on June 24th, 1938, the following elections and transfers were effected:

Associate Members

BRYDEN, Donald Charles, B.Sc. (E.E.), (Univ. of Alta.), power sales engr., Winnipeg Hydro Electric System, Winnipeg, Man.

CLARKE, Robert Arthur, (Crystal Palace School of Engrg.), res. engr., highway divn., Dept. of Public Works of N.B., Lewisville, N.B.

COOK, Clarence Arthur, B.Eng. (Civil), (Univ. of Sask.), teacher, Bedford Road Collegiate, Saskatoon, Sask.

DESLOOVER, Jean Raymond, B.Sc. (E.E.), (McGill Univ.), engr., Provincial Electricity Board, Montreal, Que.

HUBER, Albert Lloyd, (Ottawa Collegiate Institute), chief engr., Link-Belt Ltd., Montreal, Que.

JONES, Allan John, B.A.Sc. (Civil), (Univ. of B.C.), engr., purchasing agent and asst. mgr., B.C. Bridge and Dredging Co. Ltd., Vancouver, B.C.

MINSHALL, Harry Hugh, (Hamilton Technical Institute), engr. of erection, Dominion Bridge Co. Ltd., Vancouver, B.C.

STROYAN, Philip Bateman, B.A.Sc., (Univ. of B.C.), asst. supt. and engr., Board of Park Commissioners, Vancouver, B.C.

Juniors

CHAPUT, Omer, Jr., B.Sc. (E.E.), (Queen's Univ.), ap'tice engr., Aluminum Co. of Canada, Arvida, Que.

DOW, Walter Kerr, B.A.Sc. (E.E.), (Univ. of Toronto), ap'tice engr., Aluminum Co. of Canada, Arvida, Que.

DRIEDGER, Edwin Wilfrid, B.Eng. (Civil), (Univ. of Sask.), dftsman., Canadian Bridge Company, Windsor, Ont.

FLEMING, Frederick Alexander, B.A.Sc. (E.E.), (Univ. of Toronto), asst. meter engr., Can. Gen. Elec. Co. Ltd., Peterborough, Ont.

SUTHERLAND, Gordon Alexander, B.Sc. (E.E.), (Univ. of Man.), designing engr., Kipp-Kelly Ltd., Winnipeg, Man.

Transferred from the class of Associate Member to that of Member

ARMSTRONG, Arnold Victor, B.Sc. (E.E.), (McGill Univ.), sales mgr., Canadian Cutler-Hammer Ltd., Toronto, Ont.

CRASE, George Hobart, B.C.E., (Univ. of Mich.), gen. sales mgr., Horton Steel Works Ltd., Toronto, Ont.

DICKENS, Harry Blundell, co-ordinating officer, Royal Arsenal, Woolwich, England.

MANNING, Ralph Clark, B.A.Sc., (Univ. of Toronto), engr. and mgr., Canadian Institute of Steel Construction, Toronto, Ont.

MICHAUD, J. Arthur, (Univ. of Toronto), Dept. of Public Works, Toronto, Ont.

O'HALLORAN, James, B.Sc. (Mech.), (McGill Univ.), plant engr., Anglo-Canadian Pulp and Paper Mills Ltd., Quebec, Que.

RYBKA, Karel Rudolf, Mech. Engr., D.Sc., (Technische Hochschule, Prague), engr. in charge and mgr., Walter J. Armstrong, M.E.I.C., Consltg. Engr., Toronto, Ont.

WHITAKER, Albert William, Jr., Chem. Engr., (Univ. of Penn.), gen. supt., Arvida works, Aluminum Co. of Canada, Arvida, Que.

Transferred from the class of Junior to that of Associate Member

BAIN, Archibald Marcus, B.Sc., (Univ. of Man.), M.Sc., (McGill Univ.), struct'l. designer, Dominion Bridge Co. Ltd., Lachine, Que.

LeBOUTILLIER, William Percy Cecil, B.Sc. (Civil), (McGill Univ.), asst. groundwood supt., Price Bros. & Co. Ltd., Kenogami, Que.

RICHARDSON, William Gordon, B.Sc. (E.E.), (Queen's Univ.), engr., Canadian Broadcasting Corporation, Montreal, Que.

VICKERSON, George L., B.Sc. (Civil), (McGill Univ.), i/c of contracts, G. R. Locker Co. Ltd., Montreal, Que.

Transferred from the class of Student to that of Associate Member

SANDILANDS, Adam, Jr., B.Sc. (E.E.), (Univ. of Man.), elect'l. and sales engr., Power and Mine Supply Co., Winnipeg, Man.

Transferred from the class of Student to that of Junior

BARNHOUSE, Frank William, B.Sc. (E.E.), (Univ. of Alta.), wire and cable sales engr., Can. Gen. Elec. Co. Ltd., Toronto, Ont.

BOOTH, Keith Alexander, B.Sc. (E.E.), (Univ. of Man.), B.Eng. (Mech.), (McGill Univ.), engr. i/c records office, Price Bros. & Co. Ltd., Kenogami, Que.

CROTHERS, Donald Coverdale, B.Sc. (Mech.), (Queen's Univ.), sales engr., Canadian Ingersoll-Rand Co. Ltd., Vancouver, B.C.

Students Admitted

DAVIS, Samuel, B.Sc. (Civil), (Univ. of N.B.), 42 Spring St., Saint John, N.B.

HARLAND, Robert Thompson, B.Sc. (E.E.), (Univ. of Man.), 241 Waverley St., Winnipeg, Man.

LOW, Ernest Gerald, B.Sc. (E.E.), (Univ. of Man.), 830 Hillcrest Ave., Calgary, Alta.

VATCHER, Chesley Holmes, (Univ. of Toronto), 65 St. George St., Toronto, Ont.

ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

Association of Ontario Land Surveyors: Annual Report and Proceedings of the Forty-Sixth Annual Meeting; Toronto 1938.

Canadian Institute of Surveying: Proceedings of Thirty-First Annual Meeting, Ottawa, 1938.

Institution of Electrical Engineers: List of Members, 1937.

Asphalt Institute and Association of Asphalt Paving Technologists: Eleventh National Asphalt Conference, Memphis, Tennessee, 1937.

Society of Naval Architects and Marine Engineers: Transactions, Vol. 45, 1937.

U.S. National Research Council Highway Research Board: Proceedings of the Seventeenth Annual Meeting, 1937.

Reports, etc.

American Foundrymen's Association: Silicosis in the Foundry Industry, by Dr. Leonard Greenburg (Reprint No. 38-35).

American Institute of Electrical Engineers: Standards, Oil Circuit Breakers (rev.).

American Standards Association: Relays Associated with Power Switchgear; Automatic Stations.

Bell Telephone System: Recent Development in Hill and Dale Recorders; Microgasometric Analysis with the Dilatometer; High-Speed Motion Picture Photography Applied to Telephone Apparatus Design; Fatigue Properties of Non-Ferrous Sheet Metals; Transmission Measuring Systems for Telephone Circuit Maintenance; Cable Carrier Telephone Terminals; On the Theory of Space Charge Between Parallel Plane Electrodes; A New Single Channel Carrier Telephone System; A Carrier Telephone System for Toll Cables; Crystal Channel Filters for the Cable Carrier System; The Impedance Concept; Crosstalk and Noise Features of Cable Carrier Telephone System; An Application of Number Theory to Gear Ratios; A Theory of Noise for Electron Multipliers; Theory of Order for the Copper Gold Alloy System; Composition and Structure of Hevea Latex; Ultraviolet Microscopy of Hevea Rubber Latex; Sorption of Water by Rubber; Dielectric Losses in Polar Liquids and Solids; Mixed Linear Condensation Polymers. (Monographs B-1047-64, B-1066, B-1068.)

Canada Civil Service Commission: Annual Report, 1937.

Canada Bureau of Mines: The Canadian Mineral Industry in 1937.

Kenya and Uganda Railways and Harbours: Report of the Genera Manager of the Administration of the Railways and Harbours for the year ended 31st December, 1937, Pts. I and II.

Ontario Hydro-Electric Power Commission: Annual Report, 1937.

U.S. Bureau of Mines: Crushing and Grinding, Coal-Mine Accidents in the United States: 1935 (Bulletins 402, 409); A Study of a Solvent Analytical Separation of Waxes from Petroleum and its Lubricating Fractions (Technical Paper 583).

University of Illinois: Pressure Losses Resulting from Changes in Cross Sectional Area in Air Ducts, A. P. Kratz and J. R. Fellows; Papers Presented at the Short Course in Coal Utilization, Univ. of Illinois May 25-27, 1937. (Bulletin Nos. 52, 55.)

University of Nevada: Effects of High Voltage on the Bacterial Content of Milk. (Engineering Experiment Station Bulletin No. 3.)

Technical Books, etc.

The Golden Gate Bridge, Report of the Chief Engineer to the Board of Directors of the Golden Gate Bridge and Highway District, California. San Francisco, 1938. 246 pp., front. illus., tables, charts, 11¼ by 8½ in., cloth.

U.S. Works Progress Administration, **Bibliography of Aeronautics**, Pt. 1 Air Transportation; Pt. 3 Insurance; Pt. 5-6-7 Seaplanes, Flying Boats, Amphibians; Pt. 11 Medicine; Pt. 27 Aircraft Propellers; Pt. 46 Gliding and Soaring; Pt. 48 Parachutes.

Vibrations Caused by Blasting and Their Effect on Structures. By E. H. Rockwell. Wilmington, Del., Hercules Powder Company 1934. 69 pp., fig., tables charts, 6¼ by 9 in., paper.

BOOK NOTES

The following notes on new books appear here through the courtesy of the Engineering Societies Library of New York. As yet, the books are not in The Institute Library, but inquiries will be welcomed at Headquarters, or may be sent direct to the publishers:

Air Conditioning, Heating and Ventilating. By J. R. Dalzell and C. L. Hubbard. Chicago, American Technical Society, 1938. 571 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $4.00.

A practical treatise on the principles and general application of steam, hot water, vapour, vacuum, and forced air for heating; split systems for heating and ventilating; and air conditioning for all types of buildings. Calculations have been made as simple as possible, and a profusion of diagrams, tables, and practice problems increases the utility of the book.

Applied Thermodynamics. By V. M. Faires. New York, Macmillan Co., 1938. 374 pp., illus., diagrs., charts, tables, 10 x 6 in., lea., $3.90.

An elementary textbook covering the theories of thermodynamics involved in engineering problems. It includes the material contained in the author's "Elementary Thermodynamics," plus further chapters on entropy, combustion, steam engines and steam power plants, steam flow, and heat transfer.

Autographic indicators for Internal Combustion Engines. By J. Okill. London, Edward Arnold & Co., 1938. 88 pp., illus., diagrs., charts, tables, 8 x 5 in., cloth, $1.80 (obtainable from Longmans, Green & Co., New York).

Only indicators of the combined piston, spring, and pencil-lever type are considered, thus limiting the discussion to moderate-speed large cylinder engines with crank-shaft speeds under 500 r.p.m. History, development, descriptions of actual instruments, diagrams, calculations, disturbing factors, and errors are included in the discussion.

The Chemistry and Technology of Rubber Latex. By C. F. Flint. New York, D. Van Nostrand Co., 1938. 715 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $14.00.

Based on the translation of a French book on latex, but considerably enlarged, this book covers the various phases of rubber latex in industry. The gathering, composition, properties, and handling for shipping of latex are discussed; the numerous applications in manufacturing fields are considered in detail; and information is given concerning artificial dispersions of rubber.

Design of Machine Members. By A. Vallence. New York and London, McGraw-Hill Book Co., 1938. 514 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $4.00.

This textbook, the first of a series devoted to production development, is intended for students with some training in kinematics, mechanics and factory processes. With this basis, the work explains the theory involved in the design of the elements of operating machines and points out the variations from theory required by practical operations.

Direct and Alternating Currents, Theory and Machinery. By E. A. Loow. 2 ed. New York and London, McGraw-Hill Book Co., 1938. 730 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $4.50.

This volume is intended primarily for students desiring a short survey course in the theory of the electric circuit and the operating principles of electric machines. The author stresses fundamental principles rather than mere factual information. Alternating-circuit theory is stressed largely in terms of vectors. Mathematical discussions are omitted or reduced to simple forms. The new edition has been thoroughly revised. New material has been added and new problems presented.

Electrical Engineering. By C. V. Christie. 5 ed. New York and London, McGraw-Hill Book Co., 1938. 717 pp., diagrs., charts, tables, 9 x 6 in., cloth, $5.00.

This standard textbook has undergone a fifth revision, which has incorporated additional details of a practical nature to make the book of more permanent value. New material includes the two-reaction method for analyzing the operation of synchronous machines; an outline of the theory of the three-winding transformer; additional information upon induction motors; and a chapter on symmetrical components. The book aims to present a logical development of the theory of electrical circuits and machinery which will give a background for advanced study in any special field.

Elementary Thermodynamics. By V. M. Faires. New York, Macmillan Co., 1938. 225 pp., illus., diagrs., charts, tables, 9 x 6 in., lea., $2.60.

A presentation of the topics of importance for short courses in thermodynamics. These topics include energy equations, reversible non-flow gas processes, thermodynamic cycles, compression and expansion of air, liquids, vapours and vapour cycles, refrigeration, nozzle flow, and the properties of mixtures. Many problems are appended.

Elements of Mechanism. By P. Schwamb, A. L. Merrill and W. H. James. 5 ed. New York, John Wiley & Sons, 1938. 400 pp., diagrs., charts, tables, 9 x 6 in., cloth, $3.50.

Intended to give familiarity with the application of the fundamental principles of kinematics in the field of mechanical movements, this book treats of vectors, velocity analysis, motion transmission by various means, and the characteristics of gears, wheel, trains, cams, wedges, belts, and other such transmitters of power.

Essays in Science and Engineering, compiled by F. Montgomery and L. N. Backlund. Rev. ed. New York, Farrar & Rinehart, 1938. 523 pp., charts, tables, 9 x 6 in., cloth, $2.00.

A collection of essays and articles on scientific and technical subjects designed to provide reading material for engineering English courses. The first part comprises a selection of more general essays, while the second and larger part consists of "expository models" for various kinds of technical composition.

Foundations of Wireless. By A. L. M. Sowerby. 2 ed. London, The Wireless World, Iliffe & Sons, Limited, 1937. 266 pp., illus., diagrs., charts, tables, 8 x 5 in., cloth, 4s. 6d. + 5d. postage.

An elementary textbook on radio fundamentals and the radio receiver in particular. Circuits, tubes and the process of detection are considered fully, and new material contained in this edition includes negative feed back, automatic tuning and automatic selectivity control.

Gas Analysis. By A. McCulloch. London, H. F. & G. Witherby, Limited, 1938. 166 pp., illus., diagrs., charts, tables, 9 x 6 in., lea., 7s. 6d.

The construction and manipulation of five well-known types of gas analysis apparatus are described in this book for students taking laboratory courses in fuel technology. Calorific value and other miscellaneous determinations, absorbents, and sampling of gases are also discussed.

Great Britain. Scientific and Industrial Research Dept. Chemistry Research Special Report No. 4. **An Investigation into the Causes and Prevention of the Corrosion of Tar Stills.** By D. D. Pratt with H. C. K. Ison and R. G. Wood. London, H.M. Stationery Office [obtainable from British Library of Information, 270 Madison Ave., New York, $0.30], 1938. 30 pp., charts, tables, paper.

The objectives of this investigation were to identify and isolate the tar constituents responsible for corrosion and to suggest means for reducing or eliminating the latter. The methods of investigation are described and the conclusions reported.

Handbook of Aeronautics, Vol. 1. By Royal Aeronautical Society, 3 ed. enl. London, Sir Isaac Pitman & Sons; New York, Pitman Publishing Corp., 1938. 639 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $10.00.

This handbook, which is issued under the authority of the Royal Aeronautical Society, has an established place as an authoritative collection of data needed by designers and builders of aircraft. In the new edition, of which this is the first of three volumes, the material has been brought up to date by specialists. Aerodynamics, airplane performance, construction, materials, instruments, air surveying and photography, meteorology and the design and construction of gliders and sailplanes are covered in volume one.

Hearing, Its Psychology and Physiology. By S. S. Stevens and H. Davis. New York, John Wiley & Sons, 1938. 489 pp., illus., diagrs., charts, tables, 9 x 6 in., lea., $4.50.

This book discusses fundamentals of the science of sound, analyzes the auditory process, and describes the systematic relations between stimulus and sensation. Later chapters offer a study of the functional anatomy and physiology of the ear. The relations of the science of audition to architectural acoustics, phonetics, noise and music have been omitted. A glossary and long list of references are appended.

Jigs and Fixtures. By F. H. Colvin and L. L. Haas. 3 ed. New York and London, McGraw-Hill Book Co., 1938. 354 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $3.50.

A complete, practical manual dealing with the fundamentals of jig and fixture design. Includes new material on economies of design and standard practices from large concerns which is of importance in figuring costs. There are also new details of various features to assist the designer in producing efficient and economical work-holding devices.

Machine Guns. By G. S. Hutchison. New York and London, Macmillan & Co., 1938. 349 pp., illus., maps, 9 x 6 in., cloth, $7.00.

The development and tactical employment of the repeating weapon is traced from antiquity to modern times, with special emphasis on three major operations: the Franco-German War; the Russo-Japanese War; and the Great War. A history of the British Machine Gun Corps, 1915-1922, is included with the more general context.

Men and Iron, the History of the New York Central. By E. Hungerford. New York, Thomas Y. Crowell Co., 1938. 424 pp., illus., tables, 10 x 6 in., cloth, $3.75.

This history of the New York Central Railroad is mainly concerned with the beginnings, development, and consolidation of the smaller rail units east of Buffalo which went to form the original New York Central. The book is to a great extent written around the men whose foresight and energy carried on the work, and demonstrates the importance of railroad men and events in the progress of the country as a whole.

The Mind of the Ancient World. By H. N. Wethered. New York, Longmans, Green & Co., 1937. 302 pp., tables, 9 x 6 in., cloth, $4.00.

A review of Pliny's "Natural History," presenting many excerpts from a famous Elizabethan translation with critical comment by the author. In two appendices appear short discussions of medieval natural history and ancient science in literature.

(A) **Modern Spanish-English and English-Spanish Technical and Engineering Dictionary.** By R. L. Guinle. New York, E. P. Dutton & Co., 1938. 311 pp., 10 x 6 in., cloth, $4.00.

There are relatively few dictionaries of Spanish and English technical terms, and still fewer that have been revised recently. As a result, any modern one is a useful addition. This one is a well-printed volume of convenient size, the work of an English engineer with long experience in South America. The vocabulary covers the terms used in civil, mechanical and electrical engineering.

Motion Picture Sound Engineering, a Series of Lectures presented to the classes enrolled in the courses in Sound Engineering given by the Research Council of the Academy of Motion Picture Arts and Sciences, Hollywood, Calif. New York, D. Van Nostrand Co., 1938. 547 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $6.00.

The material included in this book is taken from a series of lectures presented to a selected group of employees of various motion picture studios. The lecture subjects varied from fundamental discussions of sound, electricity, and the chemical elements, through the mechanical processes of recording and projecting, to highly technical descriptions of filters, networks, amplifiers, etc.

The Physics and Chemistry of Surfaces. By N. K. Adam. 2 ed. Oxford, Clarendon Press; New York, Oxford University Press, 1938. 402 pp., illus., diagrs., charts, tables, 10 x 7 in., cloth, $7.50.

A comprehensive, detailed account of present knowledge in the field of surfaces and surface films. The sections on capiliarity, molecular properties, and the measurement of surface tension have been revised, and much new material has been added to the sections dealing with insoluble films, adsorption on liquid surfaces, and the structure and properties of solid surfaces, including lubrication. A new chapter has been added on electrical phenomena at surfaces.

The Principles and Practice of Lubrication. By A. W. Nash and A. R. Bowen. 2 ed. rev. New York, Chemical Publishing Co., 1937. 345 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $7.25.

A presentation of the salient features of the subject of friction and lubrication, covering the chemistry, characteristics, testing and care of lubricants, friction fundamentals and testing machines, and the design and lubrication of bearings. Useful tables and charts are appended.

Principles of Engineering Economy. By E. L. Grant. rev. ed. New York, Ronald Press Co., 1938. 431 pp., diagrs., charts, tables, 8 x 6 in., cloth, $3.75.

Demonstration of a practical technique providing an engineering basis for making economic decisions is the purpose of this book. Interest, valuation, and rate of return calculations are explained. The making of estimates for new enterprises, replacement problems, and the planning of future developments are discussed. Appendices contain notes on cost estimating, interest tables, and a list of selected references.

Problems on Applied Thermodynamics. By V. M. Faires and A. V. Brewer. New York, Macmillan Co., 1938. 137 pp., charts, tables, 9 x 6 in., paper, $1.40.

Contains 1,403 problems designed especially for use with Faires' "Applied Thermodynamics," but usable with other textbooks as well. Tables of the properties of fluids and charts depicting those properties are included in the volume.

Reinforced Concrete Bridge Design. By C. S. Chettoe and H. C. Adams, with a foreword by Sir H. Maybury. 2 ed. new and enl. London, Chapman & Hall, 1938. 412 pp., illus., diagrs., charts, tables, 10 x 6 in., 42s.

Detailed information on the design of reinforced concrete bridges. There are four introductory chapters on structural theory, concrete, design essentials, and live load on highway bridges. The next five chapters contain practical design data with all details. The concluding chapters cover such allied subjects as piling, excavation, curves, expansion, bridge strengthening and widening, aesthetics of design, and location problems.

Standard Plumbing Details for Architects, Engineers, Contractors, Plumbers and Students. By L. J. Day. New York, John Wiley & Sons, 1938. 119 pp., diagrs., charts, tables, 12 x 9 in., cloth, $6.00.

A collection of 119 plates intended to show the connections required in plumbing installation and how they fit together, so that proper spaces may be provided in a building. The drawings are drawn to scale. They cover fixtures, equipment, installations and layouts, for all usual requirements, and conform to general codes.

Steels for the User. By R. T. Rolfe. New York, Chemical Publishing Co., 1938. 280 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $8.50.

Carbon steels, with particular reference to bright and free-cutting steels, are the subject of this expansion of material which appeared in a series of articles in "Iron and Steel Industry." Composition, heat treatment, case hardening, mechanical testing, and the selection of steels are discussed, with a special chapter on the use of steels at elevated temperatures.

Testing and Grading Foundry Sands and Clays, Standards and Tentative Standards, adopted by the American Foundrymen's Association, 222 West Adams St., Chicago. 4 ed. 1938. 208 pp., illus., diagrs., charts, tables, 9 x 6 in., lea., $4.00.

Standards for sampling, analyzing and testing foundry sands and clays, including descriptions of the testing equipment. There are also foundry sand grading classifications, a short glossary, and a large bibliography on sand testing and control.

Year Book on Coal Mine Mechanization, 1937. Ed. by American Mining Congress, Washington, D.C. 428 pp., illus., diagrs., charts, maps, tables, 9 x 6 in., lea., $2.00.

"Listard" Processed Cylinders and Liners
(*Van der Horst Patents*)

Consolidated Engines and Machinery Co. Ltd., Read Bldg., Montreal, have available for distribution a 12-page booklet describing the "Listard" process of chrome hardening cylinders and cylinder liners. It is illustrated by photographs and graphs which describe tests comparing the wear of "Listard" and ordinary hardened iron cylinders, which showed 400 per cent increased wear resistance in favour of "Listard."

BRANCH NEWS

Border Cities Branch

J. F. Bridge, A.M.E.I.C., Secretary-Treasurer.
F. J. Ryder, Jr.E.I.C., Branch News Editor.

The April monthly meeting of the Border Cities Branch was held on April 29th, 1938, with dinner preceding the meeting. Thirteen were present for dinner and twenty-two for the meeting.

Professor H. O. Warner, of the University of Detroit, was introduced by the Chairman as the speaker of the evening. His topic, "The Mysteries of Electrical Sciencc," did not prove so mystifying as the title would lead one to believe. He defined engineering as "the science of controlling forces and utilizing the materials of nature for the benefit of mankind." Electric current is merely a flow of electrons. He described thc transmitting system invented by himself for transferring voice waves from the linesman on a football field to the scoreboard. A telephone transmitter is used in series with a thoroid coil and a set of telephone batteries by the linesman. He remains immediately over a pair of No. 14 wires strung longitudinally up the field and tied in to an audio amplifier at the scoreboard. So long as the coil is carried at right angles to the pair of No. 14 wires, reception is good. Professor Warner also described the body resistance of a human being. This value is 2,500 ohms of an average. Twenty milliamp. are sufficient to produce muscular contraction and two amp. will cause death if it passes through a life-giving vital organ. The current destroys tissue either by burning or causing vital organs to fail to function.

Professor Warner proved himself to be a scholar versed in many fields of engineering by answering all questions in the discussion following the lecture.

A hearty vote of thanks was moved by Boyd Candlish, A.M.E.I.C., and responded to by all.

The meeting adjourned at 10.30 p.m.

There were 32 persons present at the regular monthly meeting held Friday, May 27th, 1938. E. Krebser, A.M.E.I.C., chairman, introduced the speaker, Major C. V. Brunett, manager of the Detroit City Airport. The subject of his talk was:

The Operation of a Modern Airport

Planes today leave very little for the pilot to do compared with the earlier flights. The air is criss-crossed with directional radio beams which guide the pilot as surely as a railroad track. The intersection of one beam with another tells the pilot his location even though he may not be able to see the ground. When coming into an airport, the beam that he is following intersects a vertical beam from the airport and he then knows his exact location. Then by following the rules laid down for that airport as to altitude, flying speed, etc., it is possible to bring his ship to the ground even though he cannot see it or the landing lights. At present, research work is being done on a curved radio beam which will take from the pilot all the responsibility of landing a ship. For once he arrives at the airport, he will switch over to the automatic pilot which will bring the plane down following the curved beam. Very few accidents have been caused by forced landings due to lack of fuel as the cruising radius of a plane is greater than actually required.

One cause of air accidents has been the formation of ice on the wings. It is not the added weight that causes the harm. The manner of changing the contour of the air-foil causes a loss of lifting power. The Goodrick de-icer has overcome this harmful effect. A rubber membrane along the leading edge of the air-foil is inflated which raises the edge of the ice layer and the rushing air rips in under and tears it off. Propellers are kept free of ice by using glycerine which is introduced onto the whirling propeller through openings in the hub and the centrifugal force spreads it over the face of the propeller. The development of the full-feathering propeller has overcome the harmful effect of "windmilling" of a propeller on an engine that has gone dead. The blades can be rotated at right angles to their flying position thus preventing the turning of the propeller as it is forced through the air.

The Airway Traffic Control Station, which is under government control, directs the landings and take-offs of planes at the airports thereby avoiding confusion between the various companies. When a plane arrives at the airport the company reports to the Control Station. The pilot is assigned a cruising altitude if there is another plane ahead of him, if not he is given the o.k. to land. At times, there may be five or six planes over the airport waiting to land.

Present day transports are equipped with dual and even triplicate equipment and though much is made of and heard of airplane crashes, the insurance rates on travellers in planes is nearly as low as that on railroad travellers and in some cases is the same.

Many interesting questions were asked and answered and doubtless the air-mindedness of most those present was considerably increased by this paper.

The meeting then adjourned until the fall.

Lakehead Branch

H. Os, A.M.E.I.C., Secretary-Treasurer.

The annual meeting was held at the Prince Arthur hotel, Port Arthur, June 22nd, 1938. The meeting took the form of a dinner meeting and thirty-four members and guests were present. The chairman, G. R. Duncan, A.M.E.I.C., presided at the meeting.

Reports by the chairman and secretary of the year's activities were read and adopted.

The following slate of officers were proposed by the Nominating committee and elected to the Executive committee for the coming year:—Chairman, E. L. Goodall, A.M.E.I.C.; Vice-Chairman, K. A. Dunphy, A.M.E.I.C.; Secretary-Treasurer, H. Os, A.M.E.I.C.; Executive, J. R. Mathieson, Jr.E.I.C., D. Boyd, A.M.E.I.C., B. A. Culpeper, A.M.E.I.C., S. E. Flook, M.E.I.C., H. Olsson, A.M.E.I.C., M. Gregor, E. A. Kelly, M.E.I.C. (Outside West), A. T. Hurter, M.E.I.C. (Outside East).

A vote of thanks to the outgoing chairman and executive was moved by R. J. Askin, M.E.I.C., and seconded by H. G. O'Leary, A.M.E.I.C.

Ottawa Branch

R. K. Odell, A.M.E.I.C., Secretary-Treasurer.

LUNCHEON TO COUNCIL

At the Chateau Laurier on June 24th, 1938, the Ottawa Branch held one of the largest attended and most interesting luncheon meetings of the year. The Branch took advantage of the presence in Ottawa of many members of the Council of The Institute who were in Ottawa to attend a council meeting during the afternoon. It was the first occasion for a meeting of The Institute Council in Ottawa, apart from the times when an annual convention of The Institute itself was held in the city.

The chairman of the Branch, W. F. M. Bryce, presided, with the following guests at the head table: President J. B. Challies; Vice-President J. A. McCrory; the new Treasurer, de Gaspe Beaubien; the new General Secretary, L. Austin Wright; Past Presidents Dr. F. A. Gaby, of Toronto; Geo. J. Desbarats, of Ottawa, and the Chairman of the Hydro-Electric Power Commission, Dr. T. H. Hogg, of Toronto; Councillors J. L. Busfield, R. H. Findlay, F. S. B. Heward, and Fred Newell, all of Montreal; Councillors J. A. Vance, of London; A. B. Gates, of Peterborough; Major L. F. Grant, of Kingston; W. E. Bonn, of Toronto; H. A. Lumsden, of Hamilton; W. R. Manock, of Niagara Falls; Dr. R. W. Boyle and E. Viens of Ottawa.

In his address President Challies sketched the great progress made by the engineering profession since Confederation. In 1867, he pointed out, there was no purely engineering faculty in the Canadian universities; today there are 11 Canadian engineering colleges with over 3,500 students in attendance. Fifty-two years ago, there was no purely professional national engineering body in the Dominion; today The Engineering Institute is the envy of the American and British engineer. Thirty years ago, the engineer in the federal public service had no more status than that of a clerical clerk; today he is an officially recognized member of one of the leading professions and rewarded as such. Twenty-five years ago there was no licensing body in any of the provinces; today in every mainland province there is a provincial professional association that is protecting the public from the quack and the charlatan, just as acceptably as do the Bar Associations or the Medical Councils. Ten years ago, there were no engineers among our political leaders and very few occupied key executive positions in the public service anywhere; today in the political world and in the public service everywhere engineers are bearing a prominent share of the responsibilities of government.

Mr. Challies paid an eloquent tribute to Sir Wilfrid Laurier for establishing in 1908 the Civil Service Commission and thus rescuing the Civil Service from the blight of political interference. He praised Sir Robert Borden for forcing upon the Civil Service, in 1918, the scientific classification of all professional positions, and he made generous reference to all succeeding prime ministers—the Rt. Hons. Arthur Meighen, W. L. Mackenzie King and R. B. Bennett—for refusing to remove the ban from political interference in the public service.

Following the address of the President the new Secretary, Mr. L. Austin Wright, spoke briefly on matters pertaining to The Institute and particularly with reference to The Engineering Journal. This was the first visit of Mr. Wright to the Ottawa Branch in his official capacity as General Secretary.

At the conclusion of the afternoon meeting of the Council of The Institute, a dinner was held at the Rideau Club at which Past Presidents, Honorary Members of The Institute and Councillors were the guests of President Challies.

Vancouver Branch

T. V. Berry, A.M.E.I.C., Secretary-Treasurer.

The Vancouver Branch, on June 13th, 1938, entertained at luncheon Brigadier-General Sir Godfrey Rhodes, C.B.E., D.S.O., M.E.I.C., General Manager of the Kenya-Uganda Railroad, East Africa. Sir Godfrey Rhodes, who is a native of British Columbia, for a number of years subsequent to the war, was chief engineer of the Kenya-Uganda Railroad, later becoming general manager. Following the introduction of the guest of honour by Lieut.-Col. J. P. Mackenzie, Sir Godfrey, in an interesting manner, described life in Kenya.

A number of questions by the members, more particularly relative to railroad engineering in East Africa, were answered by Sir Godfrey. A vote of thanks was proposed by Major F. P. V. Cowley, R.M.C., M.E.I.C.

On the occasion of this luncheon, the Vancouver Branch were very pleased to welcome Elizabeth Muriel Gregory MacGill, A.M.E.I.C., the recently elected lady member of The Institute, who has also been spending a holiday with her parents in Vancouver.

Colonel Mackenzie also introduced to the meeting Group Capt. G. O. Johnston, A.M.E.I.C., officer commanding R.C.A.F. Stations, Western Canada, who has recently been moved to Vancouver from Ottawa.

Twenty-six attended the luncheon.

Meetings

American Society of Civil Engineers—Fall Meeting, October 12th-14th, 1938, at Rochester, N.Y.

American Society of Mechanical Engineers—Fall Meeting, October 5th, 6th and 7th, at Providence, R.I.

Canadian Chamber of Commerce—1938 Convention, September 28th-30th and October 1st, at the Seigniory Club, Montebello, P.Q.

The Canadian Institute of Mining and Metallurgy—Annual Western Meeting, November 9th, 10th, 11th, at Vancouver. H. Mortimer Lamb, Vancouver Secretary, British Columbia Division.

The Engineering Institute of Canada—Annual General and Professional Meeting, February 20th-22nd, 1939, at Ottawa.

The Seventh **International Management Conference**—September 19th-23rd, 1938, at Washington, D.C.

The Iron and Steel Institute, and The Institute of Metals (London, England), Autumn Meeting, September 22nd Quebec; 23rd Shawinigan Falls; 24th and 25th Montreal; 26th Ottawa; 28th and 29th Toronto. Canadian Institute of Mining and Metallurgy are acting as hosts for Canadian visit.

Additional information about any of these functions may be secured from the General Secretary.

American Association for the Advancement of Science Meets in Ottawa

Starting on June 27th, the Association held its Summer Meeting as a series of papers occupying three days and dealing among other things with many phases of engineering and aeronautics. The chairman of the Canadian Committee for arrangements was Dr. Charles Camsell, M.E.I.C. F. E. Lathe was in charge of the programme committee. Norman Marr, M.E.I.C., was Canadian representative of the Engineering Section.

The Section on Engineering held one session with four papers on widely diverse subjects. About 80 persons attended. The first paper by P. L. Pratley, M.Eng., M.Inst.C.E., M.I.Struct.E., M.E.I.C., F.R.S.A., dealt with the collapse of the Falls View Bridge at Niagara Falls during extraordinary ice conditions in the Niagara river in January 1938. The second paper delivered by Mr. F. B. Friend for Dr. Marcel Pochon, chief chemist of Eldorado Gold Mines Limited, Port Hope, Ontario, discussed mining, concentration and transportation operations in connection with mining and treating radium bearing ores on Great Bear lake in the sub-arctic region of Northern Canada. The third paper by R. H. Field, A.M.E.I.C., described some instrumental aids to mapping from air photographs as practised in Canada. The fourth paper by Mr. W. B. Buchanan, B.A.Sc., M.Am.Inst.E.E., dealt with some aspects of applied science from the viewpoint of an electrical engineer.

Serving for Mr. A. A. Potter as chairman was G. J. Desbarats, Hon.M.E.I.C., immediate past-president of The Engineering Institute of Canada, and for Secretary F. M. Feiker, Norman Marr, M.E.I.C., chief hydraulic engineer, Dominion Water and Power Bureau, Department of Mines and Resources, Ottawa.

Preliminary Notice

of Applications for Admission and for Transfer

July 20th, 1938.

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 1938.

L. Austin Wright, General 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

BLOXHAM—HORACE WILLIAM, of 116 Aberdeen Ave., Hamilton, Ont Born at Coventry, England, Sept. 18th, 1889; Educ., 1906-08, Coventry Technical Institute; 1912-13, instrument work, C.P.R., Calgary; 1914-16, dfting and field work, Welland Ship Canal; 1917, instrument work on highway constrn., Toronto-Hamilton Highway Comm.; 1918-19, transitman, rly. mtce., G.T.R.; 1920-21, asst. engr., i/c field party, G.T.R.; 1922-23, City of Toronto, valuation of street rly., field engr.; 1925-33, C. S. Boone Dredging Co. Ltd., Toronto, Ont., engr. for rock drilling and dredging of Port Colborne Harbour and rebldg. of breakwater; responsible for layout and checking of quantities and estimates; Apr. 1936 to Oct. 1937, Ontario Paper Co. Ltd., Thorold, Ont., field engr. on rly., wharf and mill yard on Baie Comeau Quebec development; responsible for constrn. and quantities; mill yard contained water supply, sewers, steel girder bridge, coaling plant, and conveyors for coal and pulp wood; at present, res. engr., subway constrn., C.P.R., Toronto (Bruce Divn.)
References: V. A. G. Dey, C. N. Geale, A. R. Hannaford, E. G. Hewson, E. P. Muntz, H. B. Stuart, W. J. W. Reid.

BRADLEY—JOSEPH GERALD, of Cap de la Madeleine, Que., Born at Sydney, N.S., May 13th, 1904; Educ., 1925-26, first year engrg., McGill Univ., not completed. 1927-28, first year, School of Commerce at McGill, completed; 1926-27, cost accting and mech. dfting., Fraser Brace Engrg. Co., Gatineau, Que.; 1928 R.C.A.F., Prov. Pilot Officer; 1928-29, supervision of 75 mile freight route, Island Falls, Sask., and 1929-30, inspn. of pipe and pump installn. of concentrator plant, Copper Cliff, Ont., for Fraser Brace Engrg. Co.; 1931 to date, asst. supt., i/c of mtce., calcining furnaces and milling plant at Red Mill, Que. for The Sherwin Williams Co. of Canada Ltd.
References: W. M. Mitchell, K. S. LeBaron, G. R. Stephen, J. M. Mitchell, L. Sterns.

JONES—REGINALD ELSDON, of Toronto, Ont., Born at Toronto, Oct. 18th, 1891; Educ., Univ. of Toronto (S.P.S.), 1911-13; R.P.E. of Ont.; Member, A.I.E.E.: 1909-11, fixture dept., Toronto Elec. Light Co.; 1912, Miller Lake O'Brien Mine, Gowganda; 1913-15, distribution dept., Toronto Elec. Light Co.; 1915-19, overseas, C.E.F.; 1919-20, distribution dept., Minneapolis Gen. Elec. Co.; With the Hydro-Electric Power Commission of Ontario as follows: 1920-29, i/c rural distribution constrn. in eastern Ontario, investigation and development of improved design of lines; 1929-37, i/c rural line specifications and development of new methods of installn. of rural lines; 1938 to date, i/c design and installn. of highway lighting and traffic signals for Dept. of Highways.
References: C. E. Sisson, E. T. J. Brandon, A. A. Smith, W. Maclachlan, W. P. Dobson, R. H. Mather, T. H. Hogg.

MARCOTTE—ROLAND, of Arvida, Que., Born at Roberval, Que., Jan. 19th, 1908; Educ., B.S. (Elect'l.), School of Engrg. of Milwaukee, 1933; 1927 (6 mos.), electrn., Milwaukee Electric Light and Power Co.; 1934 (6 mos.), electrn., Alloy Products, Waukesha, Wis.; 1934 to date, with the Saguenay Power Co. Ltd., power engrg. dept., from 1936 to date, asst. power engr.,
References: F. L. Lawton, J. R. Hango, C. Miller, R. H. Rimmer, J. W. Ward, J. L. Delisle.

MELDRUM—ALAN HAYWARD, of 126 Pilgrim St., Sault Ste Marie, Ont., Born at Lethbridge, Alta., May 24th, 1913; Educ., B.Sc. (Chem.), Univ. of Alta., 1938; 1935-36 (summers), underground and surface surveying for the Lethbridge Collieries Ltd.; 1937, open hearth dept., and at present, observer for metallurgical dept., Algoma Steel Corpn., Sault Ste Marie, Ont.
References: P. M. Sauder, C. S. Donaldson, J. T. Watson, R. Livingstone, J. L. Lang.

McMULKIN—FRANCIS JOHN, of 123 Upton Road, Sault Ste Marie, Ont., Born at Sault Ste Marie, Dec. 7th, 1916; Educ., B.S. (Metallurgy), Michigan College of Mining and Technology, 1937; Summer 1936, prospecting; June 1937 to date, asst. metallographer, Algoma Steel Corpn., Sault Ste Marie, Ont.
References: F. Smallwood, R. A. Campbell, E. M. MacQuarrie, C. W. Holman, C. Stenbol.

WANLESS—GRAHAM GEORGE, of 2095 Grey Ave., Montreal, Que., Born at Sutherland, Sask., Nov. 29th, 1912; Educ., B.Sc. (Honours in Chemistry), McGill Univ., 1934; 1933 (summer), chemist, General Foods Corpn.; With the Dominion Rubber Co. Ltd., as follows: 1933-35, asst. chemist, 1935-37, asst. chemist i/c of group of development workers on latex rubber, and at present, i/c of office staff of Montreal Branch mech'l. dept.
References: T. M. Moran, J. E. Dion, R. Ford, E. R. Smallhorn.

YOUNG—JOHN PATERSON, of 176 Alfred Street, Kingston, Ont., Born at Owen Sound, Ont., Apr. 16th, 1893; Educ., B.Sc., Queen's Univ., 1922; R.P.E. of Ont.; 1912-15, ap'tice in machine shop and dfting office; 1916-19, Canadian Army; 1922-24, mech. dftsman., and sales engr., Herbert Morris Crane Co.; 1924-31, mech. dftsman. and field supt of constrn. for Detroit Gas Co., about 3 years designing all equipment used in the manufacture of coal and water gas incl. layout of steam plants, and 4 years as field supt. of all constrn. work; 1931-33, part time only on constrn. for firms in Detroit, and in private contracting; 1933-38, supt. of constrn. for the Dept. of National Defence on constrn. of the Signal Corps Barracks near Kingston, including the erection of permanent bldgs., all services such as pumping station, sewage disposal plant, lighting services, roads and sidewalks; at present, asst. supt of constrn. on the erection of the Ontario Mental Hospital at St. Thomas, for the Dept. of Public Works.
References: R. E. Smythe, L. M. Arkley, L. T. Rutledge, V. W. MacIsaac, F. A. Bell, E. L. Zealand.

YOUNG—ROSS A., of 5275 Cote St. Luc Road, Montreal, Que., Born at Neepawa, Man., Mar. 28th, 1899; Educ., B.Sc. (C.E.), Univ. of Man., 1925; Summers, 1923, surveying, Manitoba Power Co., 1924, dftsman., City of Winnipeg Hydro-Electric System, 1925, dftsman., Kelker De Loew and Co.; 1925-27, detailer and checker, American Bridge Co., Gary, Indiana, and Chicago; 1928 (3 mos), dftsman., State of Illinois, Divn. of Waterways; 1928 (Apr.-Sept.), designer and dftsman. on struct'l. steel, Universal Portland Cement Co., Chicago; 1928-29, detailer and checker on mill and office bldgs., McClintic-Marshall Constrn. Co., Chicago; 1929-30, estimator and designer on steel and concrete, Dominion Bridge Co. Ltd., Winnipeg, Man.; 1930-32, designer on subways and bridges, City of Winnipeg; 1934 (Jan.-June), assayer and asst. to mgr., Wylie-Dominion Gold Mines Ltd., Cranberry Portage, Man.; 1935-36, asst. to mgr. on constrn., Neepawa Salt Limited, Neepawa, Man.; 1936-37, designer of concrete and steel on sewage disposal plant, Greater Winnipeg Sanitary District; 1937 (May-Dec.), steel and concrete design on paper mills, J. Chas Day, M.E.I.C., consltg. engr., Montreal; Jan. 1938 to date, dftsman., Canadian Car and Foundry Co., Montreal, Que.
References: E. F. Viberg, J. C. Day, H. G. Hunter, C. T. Barnes, W. P. Brereton.

FOR TRANSFER FROM THE CLASS OF ASSOCIATE MEMBER TO THAT OF MEMBER

GEIGER—DOUGLAS GEORGE, of Toronto, Ont., Born at Ottawa, Ont.; Oct. 19th, 1900; Educ., B.Sc. (Elec.), 1922, B.Sc. (Mech.), 1923, Queen's Univ.; 1920 (summer), student engr., Can. Gen. Elec. Co. Ltd.; 1922 (summer), student engr., Can. Westinghouse Co.; 1922-23 and 1923-24, demonstrator, and 1926-27, lecturer, dept. of elec. engrg., Queen's Univ.; With the Bell Telephone Company of Canada as follows: 1924-26, engr., 1928-29, supervising engr., transmission divn., gen. engrg. dept., 1930, transmission engr., gen. engrg. dept., eastern area, Montreal, and July 1930 to date, transmission engr., gen. engrg. dept., western area, Toronto, Ont. (*St. 1922, A.M. 1928.*)
References: J. L. Clarke, G. H. Rogers, L. T. Rutledge, D. M. Jemmett, H. R. Sills, W. P. Dobson, A. M. Reid, C. E. Sisson.

McCOLOUGH—REGINALD WALKER, of 73 Oakland Road, Halifax, N.S., Born at Dartmouth, N.S., Oct. 24th, 1887; Educ., S.B., N.S. Tech. Coll., 1911; 1911, transitman, loc. surveys, Guys. R.R.; 1912-15, res. engr., Dartmouth-Musquodoboit; 1919-20, res. engr., N.S. Dept. of Highways; 1915-19, Capt., attached to R.C.E., Halifax; With the N.S. Dept. of Highways as follows: 1920-21, divn. engr., 1921-24. insptg. engr., 1924 to date, chief engr. (*A.M. 1918.*)
References: I. P. MacNab, R. R. Murray, C. H. Wright, H. S. Johnston, R. L. Dunsmore.

WALLACE—GORDON LESLIE, of 36 Evelyn Crescent, Toronto, Ont., Born at Saintfield, Ont., Oct. 25th, 1889; Educ., B.A.Sc., Univ. of Toronto, 1911; 1909-12 (summers), constrn., field work; Can. Gen. Elec. Co. Ltd.; Canada Foundry Co., struct'l.; transitman, Ont. Govt. survey; Several winters, demonstrator, Univ. of Toronto; 1913 (summer), struct'l. dfting., Canada Foundry Co.; 1914, residence constrn.; 1915, Toronto-Hamilton Highway Commn.; 1916, field engr., Raymond Constrn. Co.; 1917-18, struct'l. checking, design and inspection, 1918-19, chief checker on reinforced concrete and struct'l. steel, dept. of bldgs., City of Toronto; 1919-21, chief engr. on design of large theatres across Canada, for Thos. W. Lamb, of New York, theatre architect; 1921, engr. on design, for Norman McLeod, contractor; 1921-22, struct'l. design, Toronto Board of Education; 1922 to date, private consltg. practice, as consultant to the architectural profession in Toronto and environs on large bldg. constrn., such as Canada Permanent Bldg., Globe and Mail, Royal Trust, etc. (*A.M. 1923.*)
References: R. C. Manning, D. D. Whitson, C. D. Carruthers, A. R. Robertson, P. N. Grose, K. R. Rybka, C. R. Young, W. S. Wilson.

WILLIAMS—EDWARD CLIFFORD, 109 Old Orchard Grove, 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 i/c 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; 1931-34, industrial heating specialist, at head office, Toronto, with responsibility for application engineering and commercial policies, for company's complete line of industrial heating products; 1934 to date, manager, air conditioning division (for all of Canada), incl. air conditioning equipment, oil and gas furnaces, commercial ventilating, commercial refrigeration and commercial cooking equipment. (*Jr. 1930,, A. M. 1934.*)
References: D. L. McLaren, W. E. Ross, L. DeW. Magie, C. E. Sisson, W. M. Cruthers, A. B. Gates.

FOR TRANSFER FROM THE CLASS OF JUNIOR

CRUMP—NORRIS ROY, of 2314 Elphinstone St., Regina, Sask., Born at Revelstoke, B.C., July 30th, 1904; Educ., B.Sc., 1929, M.E., 1936, Purdue Univ.; With the C.P.R. as follows: 1920-25, machinist ap'tice, machinist; 1928 (3 mos.), transitman, Swift Current; 1930, night loco. foreman, Sutherland, Sask.; 1931-33, shop foreman, Lethbridge and Calgary; 1933-35, loco foreman, Wilkie, Sask.; 1935-36, night loco. foreman, Moose Jaw; 1936 to date, divn. master mechanic, Regina, Sask. (*St. 1928, Jr. 1931.*)
References: T. C. MacNabb, H. B. Bowen, H. R. Miles.

CULLWICK—ERNEST GEOFFREY, of Edmonton, Alta., Born at Wolverhampton, England, May 24th, 1903; Educ., B.A., Engrg., M.A., Cambridge Univ., 1925; Assoc. Member, Inst.E.E., Member A.I.E.E; 1925-26, student ap'tice, British Thomson-Houston Co. Ltd., Rugby, England; 1926-28, test course, dftsman., price setter, Can. Gen. Elec. Co. Ltd., Peterborough; 1928-34, asst. professor of elect'l. engrg, and 1935-37, associate professor of elect'l. engrg., Univ. of British Columbia, Vancouver, B.C.; 1934-35, lecturer in elect'l. engrg., Military College of Science, Woolwich, England; 1937 to date, professor and head of dept. of elect'l. engrg., University of Alberta, Edmonton, Alta. (*Jr. 1926.*)
References: R. S. L. Wilson, J. N. Finlayson, L. DeW. Magie, H. J. MacLeod, P. H. Buchan, R. L. Dobbin, H. R. Sills.

GRANT, ALEX. J., Jr., of 3847 Wilson Ave., Montreal, Que., Born at Port Colborne, Ont., May 4th, 1904; Educ., B.Sc. (Civil), McGill Univ., 1929; R.P.E. of Que.; 1923-25 (summers), timekeeping, cost accounts, A. W. Robertson Ltd.; 1926-27 and summer 1928, dfting. and field engr., Steel Gates Co. Ltd.; 1929-32, detailer, checker, designer, and field engr., Dominion Bridge Co. Ltd.; 1933-35, contract work, gen. bldg. work, etc., in Montreal; 1935 to date, engr., Angus Robertson Ltd., Montreal, Que. (*St. 1925, Jr. 1931.*)
References: E. Brown, R. DeL. French, E. S. Miles, F. P. Shearwood, F. Newell, C. R. Redfern, E. G. Cameron.

FOR TRANSFER FROM THE CLASS OF STUDENT

AYER—THOMAS H., of Rapide Blanc, Que., Born at Moncton, N.B., Sept. 30th, 1906; Educ., B.Sc. (Elec.), N.S. Tech. Coll., 1930; 1928-29 (summers), transformer dfting, Toronto, factory work and dfting, Peterborough, Can. Gen. Elec. Co. Ltd.; 1930-32, control operator, Shawinigan Water & Power Company, LaGabelle, Que.; 1935-37, instr'man. and asst. to res. engr., highway grading, Dept. of Public Works, Prov. of N.B.; Jan. 1938 to date, shift operator, Shawinigan Water & Power Company, Rapide Blanc, Que. (*St. 1930.*)
References: M. G. Saunders, S. Ball, C. E. Sisson, W. M. Cruthers, G. L. Dickson, V. C. Blackett, H. J. Ward, T. M. Moran.

DOBBIN—DAVIN CRAWFORD, of St. Jerome, Que., Born at Westmount, Que., Feb. 24th, 1911; Educ., B.Eng. (Civil), McGill Univ., 1932; 1928-31, rodman, instr'man., checker, Beauharnois Constrn. Company and Associated Companies; 1932-34, factory operator, Canadian Lastex Ltd.; 1934-38, time study man., Dominion Rubber Co. Ltd., St. Jerome, Que. (*St. 1931.*)
References: F. H. Cothran, D. F. Noyes, G. D. Sauer, P. H. Morgan, R. Ford, C. V. Christie, R. E. Jamieson.

GERSOVITZ—FRANK, of 3980 Cote des Neiges Rd., Montreal, Que., Born at Montreal, Nov. 9th, 1909; Educ., B.Eng., McGill Univ., 1932. R.P.E. of Que.; 1924-32, constrn. work; 1932 to date, private practice, design and constrn. of residential bldgs. (*St. 1930.*)
References: E. Brown, R. E. Jamieson, G. J. Dodd, G. L. Wiggs, F. M. Wood.

LANGSTON—JOHN FRANCIS, of 504-3rd Ave. West, Calgary, Alta., Born at Calgary, Alta., Mar. 11th, 1911; Educ., B.Sc. (Civil), Univ. of Alta., 1937; 1929-33, material checker and timekpr. with various companies; 1934-35 (summers), foreman, Belyea Constrn. Ltd., Calgary; 1936 (summer), asst. observer, Canadian Western Natural Gas Co. Ltd., Calgary; May 1937 to date, ap'tice engr., Calgary Power Co. Ltd., Calgary, Alta. (*St. 1937.*)
References: R. S. L. Wilson, H. R. Webb, C. A. Robb, J. McMillan, H. B. LeBourdeau, H. J. McLean.

McCOLL—WILLIAM ROSS, of 12 Caroline St. South, Hamilton, Ont., Born at Windsor, Ont., Mar. 22nd, 1911; Educ., B.A.Sc., Univ. of Toronto, 1933; 1929-32, field and office asst., McColl and Patterson, municipal engrs., Windsor, Ont.; 1935-36, constrn. work on Dept. of National Defence Relief Camps, instr'man., dftsman., sub-foreman and foreman; 1936 to date, with the Steel Company of Canada, Hamilton, Ont., material handling studies in rolling mills, stock chaser, concrete inspr., and instr'man. on bloom mill constrn., and at present, asst. to the supt., Ontario works. (*St. 1933.*)
References: C. R. Young, R. E. Smythe, H. W. Patterson, W. E. Harry, R. E. Butt, N. Hartmann, G. E. Medlar, W. J. Fletcher.

McKNIGHT—CHARLES E. V., of Kirkland Lake, Ont., Born at Ottawa, Ont., May 20th, 1909; Educ., B.Sc., Queen's Univ., 1933; 1928-29-30 (summers), Topographical Surveys; 1934 to date, with the Lake Shore Mines, Kirkland Lake, Ont., as follows: 1934-35, underground miner, 1935-37, engr's. asst., 1937 (Feb.-July), bonus engr., 1937 (Aug.-Oct.), transportation captain; Nov. 1937 to date, safety director. (*St. 1933.*)
References: A. D. Campbell, L. M. Arkley, A. Macphail, W. L. Malcolm, L. T. Rutledge.

Memory of Sir Casimir Gzowski to be Honoured

Word has been received that a special service is to be held in Toronto on Sunday, August 28th, probably in Massey Hall, commemorating the fortieth anniversary of the death of the great Canadian Sir Casimir Gzowski, who was President of The Institute in 1889, 1890 and 1891. His Excellency the Governor-General, the British High Commissioner, and the Ambassador of Poland in London, Count E. Raczynski, are Honorary Patrons of the function. The same day a wreath will be laid on the grave of this famous engineer and citizen.

The History of the Canadian Forces in the Great War

by an Engineer

The following article appeared in the editorial page of the Montreal Gazette. Colonel Duguid is a member of the Ottawa Branch of The Engineering Institute and therefore the article will be of particular interest to our readers.

The first volume of the long-awaited Official History of the Canadian Forces in the Great War, 1914-1919, has been issued. Volume I (accompanied by a volume of appendices and maps) deals with the outbreak of war, the raising of the First Contingent, the crossing to England, the winter on Salisbury Plain, the first appearance in the British battle line; also with other Canadian forces raised and sent overseas prior to the formation of the Canadian Corps in 1915. Hence it will be of particular interest to the Originals and to members of earlier subsequent forces sent overseas.

In this volume (there are eight others to follow) the compiler, Colonel A. Fortescue Duguid, D.S.O., B.SC., R.C.A., A.M.E.I.C., announces that his purpose has been "to assemble established facts and figures into a form that can be readily grasped, to reproduce verbatim typical or important documents, and to arrange in pertinent relation a series of significant pictures, so that in the light of ordered testimony the reader, relieved of the speculative drudgery of groping in the dark after elusive facts, may be free to follow the action closely, to draw his own conclusions and to form his own opinions."

The formation, the campaigning and the disbandment of the Canadian Expeditionary Force provide a theme of national importance to the people of this Dominion. Proudly the achievements of Canada's citizen soldiers were followed during the war, and in this history these achievements are set down clearly, dispassionately analyzed, and always with the hallmark of authenticity.

The work is well indexed, and the sketches and maps cover all sections of the battlefields in which Canadian soldiers were engaged. This official history is published by authority of the Minister of National Defense.

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.

Notices appearing in the Situations Wanted column will be discontinued after three insertions, and will be re-inserted after a lapse of one month, upon request.

All correspondence should be addressed to

The Employment Service Bureau, The Engineering Institute of Canada
2050 Mansfield Street, Montreal

Situations Wanted

ENGINEER, A.M.E.I.C., Combustion specialist heat balance. Steam. Mechanical. Refrigeration. Office routine. Correspondence. Plant layout. Apply to Box No. 5-W.

ELECTRICAL ENGINEER, Jr.E.I.C., B.Sc.; age 31; at present employed, desires change in location. Experience includes; three summers experience in power conduit construction; two years in telephone engineering; four years experience in radio, both development engineering and production; two and one half years in a paper mill on electrical maintenance, with a short time in the cost accounting and draughting departments. Would be interested primarily in electrical maintenance. Apply to Box 12-W.

PAPER MILL ENGINEER: B.A., B.A.Sc. Married. Age 34. A.M.E.I.C. Ten years experience in paper mill costs, maintenance, design and construction. Now employed as cost engineer in Southern States. Hard worker with excellent references. Available immediately. Apply to Box No. 150-W.

SALES ENGINEER REPRESENTATIVE. Mechanical graduate with fifteen years experience in Eastern Canada in sales and service of mechanical equipment; full details upon request to Box No. 161-W.

MECHANICAL ENGINEER, Jr.E.I.C., with thorough training in England and wide experience for past eight and a half years in Canada, is seeking a permanent position as mechanical engineer in an industrial plant. Has had varied experience in mechanical engineering, heating, ventilating and power plant equipment. Excellent references. Apply to Box No. 270-W.

CIVIL ENGINEER, M.A.Sc., A.M.E.I.C. eight years survey and municipal engineering experience, and three years draughting, detailing steel, concrete, and timber structures. Apply to Box No. 467-W.

PAPER MILL ENGINEER. If you are willing to pay around $5,000 per year for the services of an engineer, age 36, with twelve years experience in paper mill design, construction and operation, apply to Box No. 482-W.

CIVIL ENGINEER, B.A.Sc., A.M.E.I.C. Married. Experienced in engineering and architechtural design and in supervision, office management, etc., wants to round out experience in the contracting field. Ten years experience since graduation. Present location Toronto. Apply to Box No. 576-W.

ELECTRICAL ENGINEER, B.Sc. E.E., Age 39. Married. Seven years experience in operation, maintenance and construction of hydro-electric plants, and sub-stations. Five years maintenance and installation of pulp and paper mill electric equipment. Reliable and sober, with ability to handle men. Best references. Any location, at once. Apply to Box No. 636-W.

ELECTRICAL ENGINEER, B.Sc. '28. Two years student apprenticeship at Can. Westinghouse Co., including test and electrical machine design. Also about two years experience in operating dept. of large electrical power organization. Available on short notice. Apply to Box No. 660-W.

Situations Wanted

ELECTRICAL AND CIVIL ENGINEER, B.Sc. Elec. '29, B.Sc. Civil '33. Jr.E.I.C. Age 32. Experience includes four months with Can. Gen. Elec. Co., approximately three years in engineering office of large electrical manufacturing company in Montreal, the last six months of which were spent as commercial engineer, also experience in surveying and highway work. Year and a half employed in electrical repair. Best of references. Apply to Box No. 693-W.

CIVIL ENGINEER, B.A.Sc. (Toronto '27), age 34, married. Five years railway and construction work as building inspector and instrumentman. Level engineer and on construction of a long timber flume for a pulp and paper mill. Field engineer for a sulphite company, in charge of the following mill buildings, acid, digester, blow pit, barker room, chip storage and acid towers Available immediately. Apply to Box No. 714-W

ELECTRICAL ENGINEER, B.Sc. '31 (U.N.B.), Jr.E.I.C. Age 30 years. Single. Experience in electrical wiring, construction of concrete wharves, inspection of piling, rip rap, concrete reinforcing, forms, and dredging. Also junior engineer. Available at once. Apply to Box No. 722-W.

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Welding in Ship Construction

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Principal Lloyd's Surveyor for the United States and Canada, New York.

To be presented before the Montreal Branch of The Engineering Institute of Canada, October 27th, 1938.

SUMMARY.—The field for welding has expanded so much in recent years that no one would dare attempt to describe its ultimate limit. This paper goes back into the history of welding in ship construction, and also describes the most successful practice of today as indicated in modern specifications.

Such a paper as this may very easily start with a bit of the history of the earliest examples of welded ship construction. Therefore we will begin with the M.S. "Cedros" ex "Fullagar," the first sea-going vessel to be constructed in which electric arc-welding was used to the total exclusion of riveting. She was built in 1920 by Messrs. Cammell Laird and Co., Ltd., of Birkenhead, and was classed "+100 A1," with the notation "electrically welded," "subject to annual survey," "experimental."

For some years she was engaged in the coasting trade and in 1924 she grounded on a sandbank in the Mersey, but, floating off the next tide and remaining intact, although showing signs of serious damage, she proceeded on her voyage. When dry-docked on her return to Liverpool it was found that the bottom plating was set up over a length of about 50 ft. After this examination the vessel proceeded under her own power to Leith for repairs, which were effected by pressing the bottom back into position by means of shores and hydraulic jacks. It is interesting to note that in spite of the damage received, the repairs proved satisfactory, the vessel later (in 1928) being classed with the amended notation, "subject to biennial survey."

Subsequent to the foregoing repairs, the vessel was purchased by a Canadian cement company, was taken across the Atlantic and out to British Columbia, where she was again placed in coasting service, but this time the service was of a distinctively different type. The welding was carefully examined at each special survey, and no failures have been reported. In addition, the Vancouver surveyor made the interesting statement, that corrosion was entirely absent throughout the vessel, except in some shell rivets in way of the double bottom fuel oil tank. This was a tank which had been repaired by riveting.

In 1930, when the vessel was about 10 years old, she ran head-on into a cliff at full speed in fog, in consequence of which extensive damage was done to her stem and bow plating. It was reported by the surveyor that the welded seams withstood the impact of this damage equally as well, if not better, than the solid plates. Shortly after this repair (in 1933) the confidence established in the welded construction of this vessel induced the Committee to eliminate the word "experimental" in the vessel's class.

Fig. 1—All Welded Motor Lake Freighter "Franquelin."

Recently sold to a firm in Mexico, this famous pioneer in arc-welded ship construction was renamed the "Cedros," and as proof of the confidence of the Committee of Lloyd's Register in this type of construction, it may be stated that in 1935 the condition "subject to biennial survey" was withdrawn, thus enabling the vessel to be surveyed at her regular four-yearly periods. Unfortunately the "Cedros" was recently involved in a serious collision off the west coast of Mexico, as a result of which she sank, after a successful period of service of seventeen years.

Motor Lake Freighter

Figure 2 shows the midship section of an all-welded motorship, and Fig. 1 gives a photograph of the vessel when completed. Built by Messrs. Swan Hunter and Wigham Richardson, Ltd. at the Wallsend Shipyard in 1936, the vessel had a successful crossing of the North Atlantic to Canada, and was delivered to her owners, the Quebec and Ontario Transportation Company, the same year. She was the fourth all-welded vessel built by Messrs. Swan Hunter, to the design of Messrs. Lambert and German of Montreal. The vessel was designed for carrying pulpwood, newsprint, or grain, on the Great Lakes. Her dimensions are as follows: length overall, 259 ft.; breadth moulded at deck, 42 ft. 10 in.; depth moulded, 22 ft.; deadweight about 3,100 tons on 14 ft. draft in fresh water.

She was built to Lloyd's class, +A1 "for service on the Great Lakes and Gulf of St. Lawrence," "electrically welded" and, as may be seen from her plans, she is designed with a "conduit bilge." It is claimed this protects the bilge from damage and leakage due to contact with canal sides and dock walls.

The framing is arranged transversely except in the fore peak, where a system of cant frames has been substituted for the more usual arrangement, and extra stiffening has been incorporated at the fore end to meet the conditions encountered in the particular trade in which the ship will be employed.

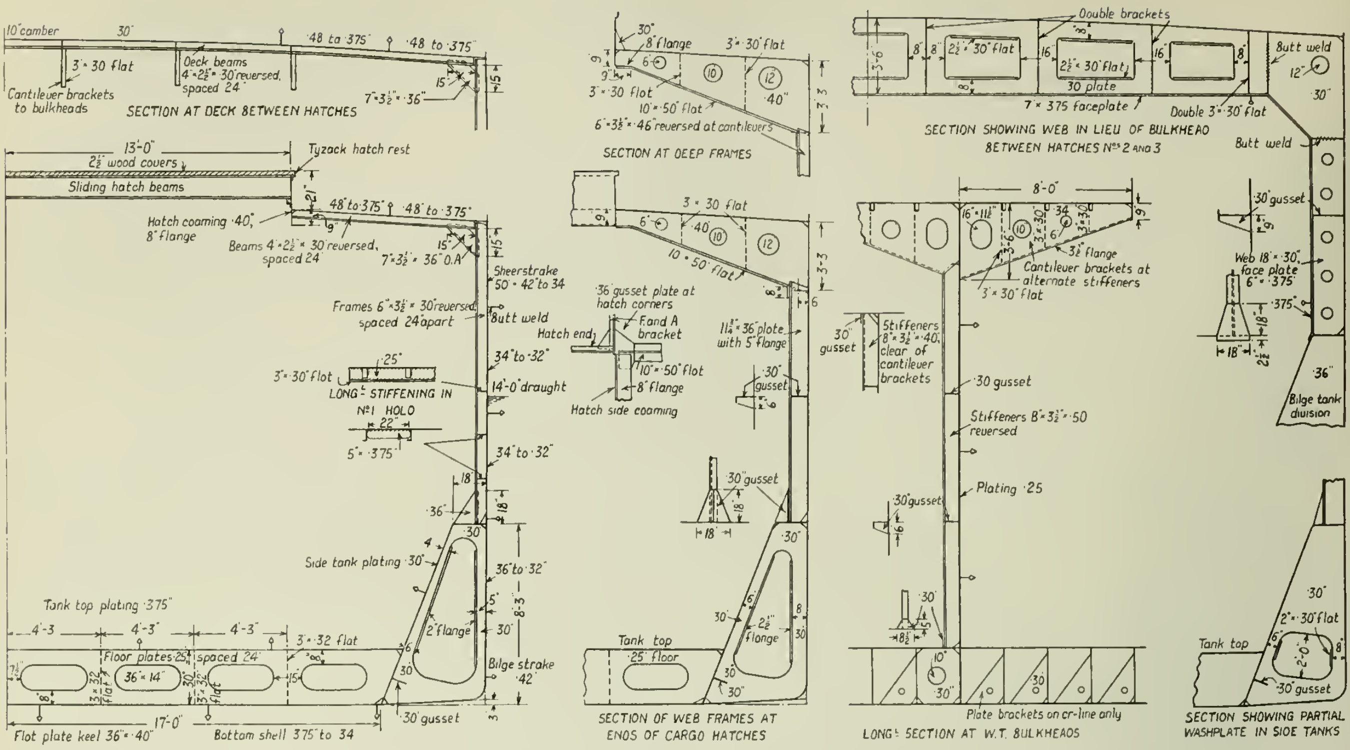


Fig. 2—Midship Section of the "Franquelin."

The system of fabrication adopted to suit the welding of the structure, was based on the builders' experience in constructing all-welded ships. Butt-welding was adopted throughout the main structure generally, lap-welding being used only for such items as beam knees and the large brackets in way of the hatches where welding to the side frames or to the bulkhead stiffeners was followed.

The keel and outer bottom plating were erected plate by plate on the berth, faired up and welded together, the plate edges being veed 60 deg. on their upper edges. The welding was thus carried out in the "down" direction, except the closing weld on the underside.

The inner bottom plating, complete with floors and centre girder, was welded in large panels on the welding skids upside down to obtain a "down" welding position for the floor connections, and turned over on erection in position on the berth.

The bilge tank was also welded complete with shell, bottom and side plating, in sections about 30 ft. long, and afterwards erected in position on the berth.

The side shell and deck were similarly treated, all butts being flush. Each transverse bulkhead was welded complete with stiffeners on the skids, lifted into position on the berth, and welded direct to the inner bottom shell and deck, no boundary bars being fitted.

245 ft. Oiltanker

This vessel is 245 ft. B.P., 42 ft. 2 in. beam, 18 ft. moulded depth, 2,240 tons deadweight, and 16 ft. 9¾ in. draft. She was built by Messrs. Swan Hunter and Wigham Richardson, Ltd. and delivered to her owners the Dampskibsselskabet Marna A/S Company, Oslo, Norway, in 1935.

The vessel was built to Lloyd's highest class, +100A1 "carrying petroleum in bulk," "longitudinal framing in double bottom," "electrically welded." The construction is quite novel, providing smooth surfaces inside all tanks to allow for easy drainage and cleaning. This is provided by the fitting of a double skin to the shell, deck and bottom. There are five main tanks divided by a centre-line bulkhead into 10 compartments. The design of the transverse and centre-line bulkhead consists of a series of "trough" or corrugated plates welded together, thus dispensing with all projecting stiffeners. A special tank-cleaning apparatus is installed in which steam, water, caustic soda solutions or cleaning oil, may be sprayed over the internal surfaces of the tanks.

The shell plating is butt welded, with the exception of the joint at the bilge, which is lapped onto the side plating and welded in a "down" position. This vessel has made several North Atlantic crossings in both summer and winter, and her all-welded construction has shown no weakness so far.

Motor Tanker

Another interesting example of an all-welded vessel is an oiltanker, built in 1937 by the Pennsylvania Shipyard, Inc. of Beaumont, Texas, to the designs of George B. Drake of New York. She is owned by the Cleveland Tankers, Inc. of Cleveland, Ohio, and classed by Lloyd's Register +100 A1 "for service on the Great lakes, etc.," "carrying petroleum in bulk," "longitudinal framing," "bracketless" and "electrically welded."

Her principal dimensions are:—Length (overall) 258 ft.; length (B.P.) 251 ft. 3 in.; beam 43 ft.; moulded depth 16 ft. 6 in. These dimensions are the maximum possible to permit transit through the New York State Barge Canal. On her maiden voyage she took a cargo of oil from the Gulf via New York, up the Hudson river, through the barge canal to Oswego, into Lake Ontario, and thence through the Welland Canal into Lake Erie. She will be used for the carriage of petroleum products generally, from Chicago to Great Lakes ports.

The vessel's framing is longitudinal and bracketless, and she has a continuous expansion trunk over the oil tanks. Five pairs of main cargo tanks are arranged, with a continuous centre-line bulkhead. The total carrying capacity of the tanks is stated to be about 22,000 barrels on a draft of 13 ft. 4 in. Figures 3 and 4 show some photographs of this interesting new tanker, whose structural plans clearly show her all-welded construction. This applies from stem to stern, to the total exclusion of rivets.

The shipyard welding specifications required: the plate edge overlaps to be not less than 1 in. plus twice the thickness of the plate, and both edges continuously welded; all plate butts to be lapped, with both edges continuously welded, and having fillets equal to the thickness of the plates joined; the bulkhead plates to have continuous weld on both sides to shell and deck, each fillet being of size equal to the thickness of the bulkhead plating; the extreme ends of the unbracketed longitudinals to be double continuously welded to shell or deck for one-tenth the spacing of the transverses; the unbracketed bulkhead stiffeners to be double continuously welded for one-tenth their length each end, and intermittent welded elsewhere; all brackets to be continuously welded all around.

Motor Tanker, Made in Canada

Another interesting vessel, and one recently constructed in Canada, is an oiltanker, the "Beeceelite," built by Marine Industries, Ltd., Sorel, Quebec, to the order and designs of the Imperial Oil Shipping Co., Ltd. of Toronto. This interesting single screw Diesel tanker is intended for oil and gasoline distributing service on the British Columbian coast, and reflects much of the latter company's wide experience in tanker requirements. She is the largest all-welded vessel of this type to be built in a Canadian shipyard, and was classed with Lloyd's Register +100A1 "British Columbia coasting service," "carrying petroleum in bulk," "longitudinal framing," and "electrically welded."

With a length B.P. of 120 ft., beam 27 ft., and moulded depth 12 ft. 6 in., this vessel follows very closely standard tanker practice, with cargo tanks amidships and a dry hold forward. Immediately forward of the engine room a large pump room is arranged, the pumps being driven by motors placed in the engine room. A feature of the vessel is the elaborate cargo transferring arrangements which permit independent pumping of all tanks. A considerable number of drums may also be carried on the deck, with substantial retaining stanchions and chains.

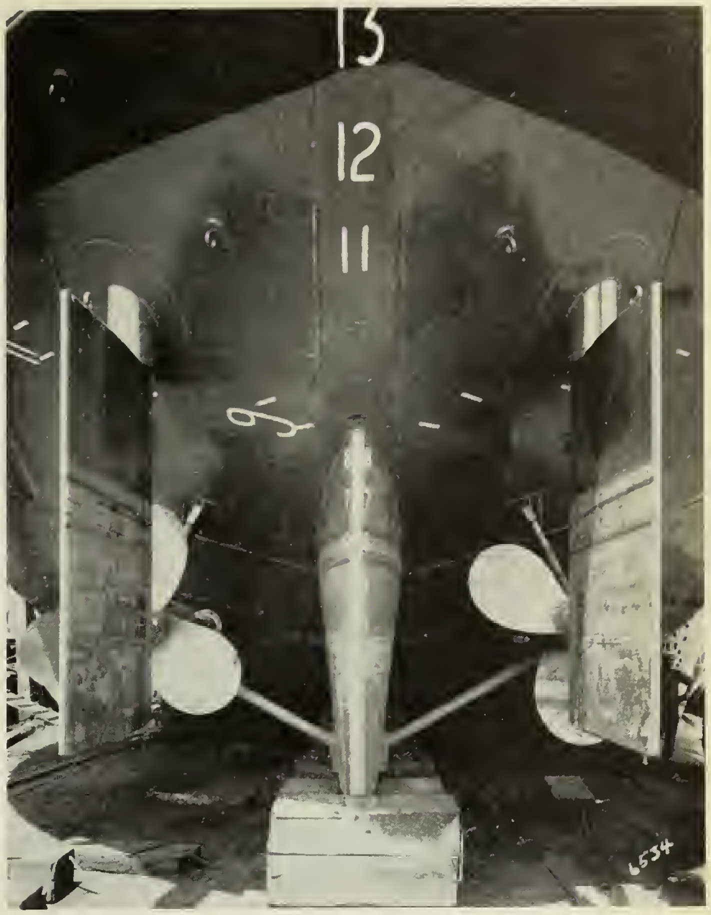


Fig. 4—All Welded Oiltanker "Mercury," Stern View.

Fig. 3—All Welded Oiltanker, "Mercury," Bow View.

The cargo tank space, as may be seen from her plans (Figs. 5, 6 and 7), is closely subdivided, six tanks port and starboard being arranged within a length of about 43 ft., with an oiltight centre-line bulkhead their entire length. Each pair of tanks has a common circular oiltight hatch on the centre-line, relief valves being fitted to the hatches.

Being completely welded, this vessel presents many interesting ideas in construction, with closely spaced transverse bulkheads, longitudinal framing in way of tanks and transverse framing at the ends. The bulkheads are fitted with boundary angles fully welded at both toe and heel, while all shell frames have faying flanges in order to reduce the area of unsupported plating, and are tack welded to the shell. The bulkhead stiffeners have no faying flanges, thus providing an economy in weight. An interesting feature is the fitting of the brackets on the ends of the shell longitudinals in way of the bulkheads. These brackets are slotted through the bulkheads and welded on both sides of the latter.

Butt welding was generally adopted, the V-butts being about 60 deg. angle, and the plates about $\frac{1}{8}$ in. open at the root of the V prior to welding. The electrodes were coated $\frac{3}{16}$ in. rods, used generally on all "down" work, and $\frac{5}{32}$ in. rods elsewhere, with about five runs in the average butt or seam. As much of the work as possible was welded on the skids, the transverse and longitudinal bulkheads having the horizontal stiffeners welded first, and the plates then being fully welded out from the centre of the bulkhead. In constructing the shell, all plates were erected and tacked before starting the welding. The butts were welded first, working out from the centre-line on both sides simultaneously, and finally the seams were welded, working from midships forward and aft.

Generally speaking, very little serious distortion was experienced, the bulkheads being quite satisfactory. The shell plates which had considerable curvature, such as in the bow, showed very fair when completed. Below the

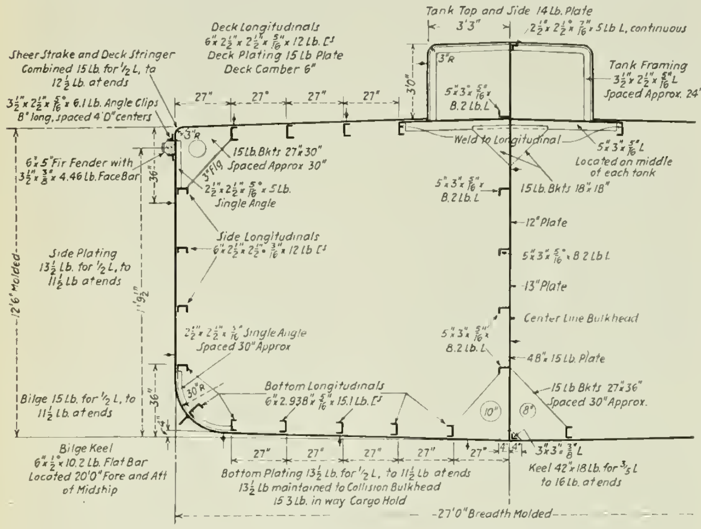


Fig. 5—"Beeceelite," Cross section Through Cargo Tank.

waterline all beads on the seams and butts were left full, and not buffed off, in order to provide a margin against corrosion. Where some rivets were necessary, such as in the shell connections to the stem and stern frame and in the plate rudder, these attachments were fully welded before drilling and finally riveted up. Figure 8 gives some indication of the work entailed in the construction.

The equipment used in the construction of this vessel consisted of sixteen 300-ampere welding machines with 20-25 volts open arc. The steel masts were all-welded, as were also many miscellaneous items, such as goose-neck vents, air pipes, strum boxes, skylights, etc.

Some Recent Vessels

Such great strides have been made in recent years in this subject that it is difficult to make a condensed statement which would do justice to it. Naturally the use of welding was first confined largely to the smaller types of vessels such as barges, scows, tugs, etc., but within recent years the construction of new oiltankers has developed more and more along electric-welding lines, until today we find that all oiltankers are being constructed, partially or wholly electrically-welded.

There are being built in the United States at the present time three large oiltankers of dimensions: 521 ft. by 70 ft. by 40 ft., and of 18,500 tons deadweight, the first of which has already been launched; and most of the other oiltankers presently being built in the U.S. are being constructed with all-welded bulkheads. The three all-welded oiltankers above mentioned are being constructed at the Sun Shipbuilding and Drydock Company, Chester, Pennsylvania, and it is not the writer's intention to go into details regarding their construction as this has already been very ably done in a paper entitled, "Recent Practice in Welding Large Oiltankers," written by J. W. Hudson and T. M. Jackson. The builders have introduced a new method of automatic welding which is being used in the shops for the construction of the bottom, side, deck, and bulkhead panels; the boundaries on the ship being done by hand-welding. Lloyd's Register of Shipping has carried out a series of tests on this type of welding with very satisfactory results, the essential particulars of which are quoted in detail in the above-mentioned paper. This is the only automatic method of welding that has been submitted to and approved by Lloyd's Register of Shipping in the United States to date.

Of the other oiltankers recently built, or presently being built, all have incorporated more or less welding to suit the owner's requirements. Most of this welding has been done by hand, but in the Sun Shipyard, the bulkheads are all being done by the automatic welding process. In most of the vessels now referred to, the shell has been riveted and, as already stated, all bulkheads welded. Sometimes the longitudinals have been welded to the shell and deck. Either flanged-plate longitudinals are used or, as in some cases, ordinary rolled channel or other sections have been used.

The various methods of connecting the longitudinals at the shell on either side of the bulkheads are of interest in passing. The method most frequently used has been the well known "bracketless" system (see Figs. 9 and 10).

A system was recently adopted whereby the longitudinals on opposite sides of the bulkheads were linked by means of a thick plate which is slotted through the bulkhead, afterwards welded on both sides of the bulkhead, and along the top of the longitudinals. This is clearly illustrated in Fig. 11, in which detail the longitudinals are cut quite clear of the bulkheads.

Another method is shown in Fig. 12, but in this case the longitudinals are brought close up to and welded to the bulkheads, and in addition, plates are slotted through the bulkhead, and welded similarly to that mentioned in the previous paragraph.

In Fig. 13, instead of the slotted plate shown in Fig. 11, a round bar is used and similarly welded. The illustrations clearly show the essential points of these connecting systems. All have been approved by Lloyd's Register of Shipping and each has its adherents and its claimed advantages.

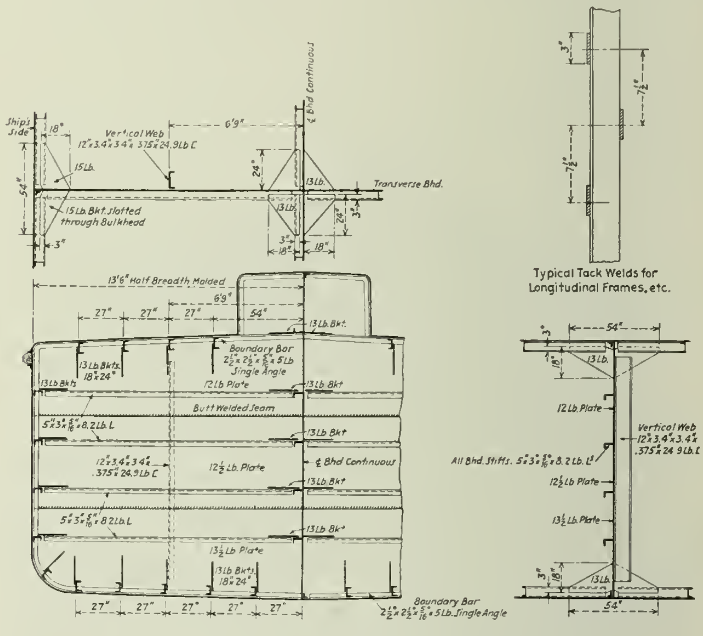


Fig. 6—"Beeceelite," Oil Tight Transverse Bulkhead.

In the case of some vessels building in Canada at present, the welding specifications contain the following interesting items:

1. All electrodes must be of the heavily coated variety and to the owners' and Lloyd's approval.

2. As far as practicable, the welding is to be performed in the "down" position.

3. Shell: The bottom is to be welded in the "down" position, the open side of the "V" joint being to the inside of the vessel. The actual welding of the "V" joint is to be made from the inside, after which a finishing reinforcing run is to be applied from and on the outside, and dressed off smooth.

On the side shell the welding may be from the outside or inside at the builder's option, but the owners prefer that as much of the shell plating as practicable be welded from the inside. In either case the welding of the "V" joint is to be done from the open side of the "V" first, and then a finishing run is to be applied from the opposite side. When the welding of a joint is completed, the outside of the joint is to be dressed off smooth. In welding a vertical butt joint or a vertical fillet-weld, the operator is to work from the bottom up, and never from the top down.

4. A careful record is to be kept of all welding, how performed, kind and size of electrode for each pass, also voltage and amperage. A periodic check of the individual welders is also to be made.

5. The current used during the welding is to be kept to a minimum to prevent undercutting, and all joints are to be thoroughly cleaned to bright metal before commencing to weld. After each pass, the surface of the weld is to be brushed clean, and is to be entirely free from slag before commencing the next pass.

6. In all cases the ground connections are to be as near the actual weld as practicable, and it is preferable to have the operators work away from the ground connection, instead of towards it, to avoid a "bent" arc and excessive slag deposit.

7. To avoid distortion, as much of the welding as possible is to be applied from the centre of the vessel outwards, and from amidships towards the ends.

8. Prior to water testing, all oiltight and watertight welding is to be painted with distillate. Faulty welding will show an oily stain on the reverse side, and all faulty work is to be cut out and re-welded.

9. Sample welds of all types are to be made up as specified by Lloyd's and to be submitted for testing and approval, before commencing work on the vessel.

It will be observed in paragraph 3 of the above that the root of the V in the shell joints is on the outside, the joints being welded from the inside. This gives a smaller area of exposed welded joint from the appearance and corrosion standpoints, and a smaller area to grind off, if a flush surface be desired.

In connection with the above welding specification the following suggestions are offered for consideration:

(1) All surfaces to be welded should be cleaned (or ground if necessary) to bare metal and should be free from scale, rust, paint, or dirt. In the Unionmelt automatic method of welding adopted at the Sun Shipyard, the bulkhead plates are ground before the stiffeners are automatically welded thereto.

(2) Where several beads are laid in a welded joint, each layer should be wire brushed and cleaned of all slag, before the next bead is laid down.

(3) As far as possible, all welding should be done under cover, or at least shielded from wind, rain, and low temperatures.

(4) In an all-welded ship-structure the welding should, as far as possible, proceed equally and simultaneously on both sides of the vessel, commencing amidships and working uniformly towards the ends, and towards the sides.

(5) The shell butts on any one plate should be welded first, before any seam welding is commenced, to allow for contraction.

(6) The welding procedure, as well as the technique and the sequence, should be given careful consideration by the welding superintendent, and instructions delivered to the welders, prior to the work being started. A staggered or back-stepped welding procedure should be used in the seams to eliminate residual stress, contraction, and distortion. No standard procedure in this respect can be prescribed. This must be decided upon after careful study of the details in each case.

(7) The welding of the shell should be completed, and the welding of the internal structure should be completed, before the shell and structure are welded to each other.

(8) The smaller the electrode, the less is the heat disturbance in the adjacent plates. This statement should not be construed, however, as a recommendation to use small electrodes, without full consideration of all the circumstances of the case. Generally speaking, the amount of distortion is somewhat increased if the number of runs is increased; and the relative cost is decreased by using a larger rod. A saving of about 15 per cent is obtained by the use of a $\frac{3}{16}$ in. rod, as compared with a $\frac{5}{32}$ in. rod.

(9) Where several beads of welding are laid in a joint, the second and subsequent beads impose a slightly heat-treated effect on those previously run; and in a welded V-butt the weld at the root should be chipped out, and a final back run made.

(10) Care should be taken not to over-weld any joint; and in fillet welds the welding should preferably be concave rather than convex.

(11) Careful examination should be made with a view to condemning or preventing all undercutting, distortion, residual stresses (as far as possible), porosify, inclusions, lack of penetration, and lack of uniformity in the finished weld.

GENERAL

Generally speaking, a combination of welding and riveting should be avoided in the joints of a structure such as a ship, due to the difference in their elastic properties under stress. If such a joint be subjected to stress, the joint will, in general, be resisted by the welding, and the rivets will offer little assistance.

In some cases the shell butts have been welded and the seams riveted, which eliminates scarping of the shell plates at the junction of butts and seams. Some authorities

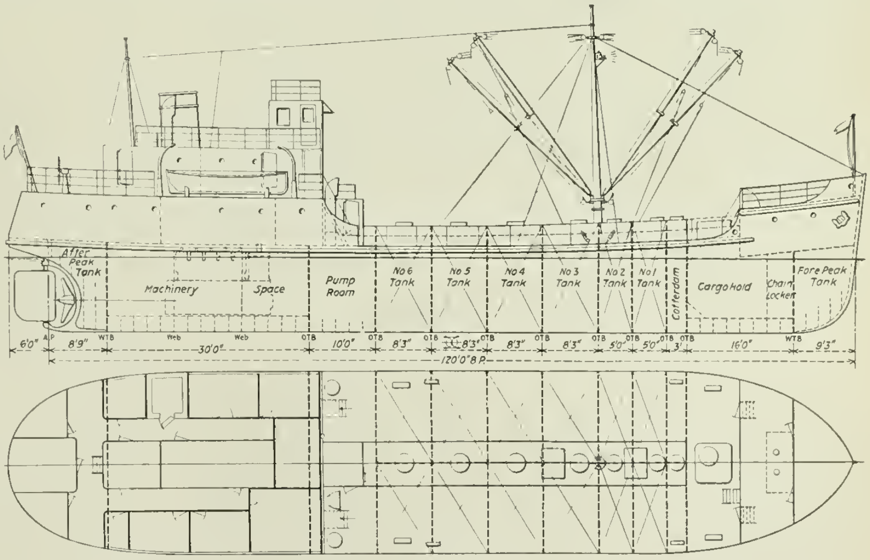


Fig. 7—"Beeceelite," Elevation and Deck Plan Showing Cargo Tank Layout.

contend that the welding of shell seams should be avoided.

The practice of using intermittent welding in joining frames to shell, stiffeners to bulkheads, etc., has recently been superseded in some shipyards by the fitting of a light continuous weld on both sides, which is stated to be desirable both for strength reasons and for reduction of buckling, although there appears to be some difference of opinion on this point.

Some owners, such as in the 120 ft. tanker described, prefer to use frames with the usual shell flange, whereas others prefer to take advantage of the saving in weight, by eliminating the use of this shell flange, and simply welding the toe of the shape to the shell. Undoubtedly the former practice provides better support to the shell and is to be recommended for vessels which frequently come in contact with piers, lockwalls, canal banks, etc.

Oiltight bulkheads are now almost universally welded in the U.S.A. and the experience gained with such bulkheads in service would seem to point to the universal adoption of welding for all such bulkheads in the near future.

A question which arises is whether the butts should be fitted edge to edge or overlapped. There again the

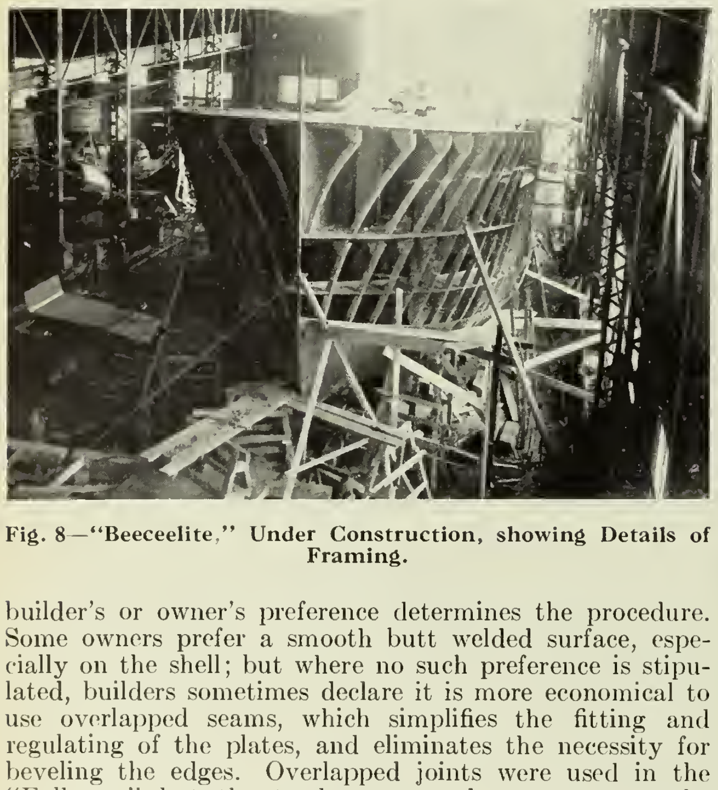


Fig. 8—"Beeceelite," Under Construction, showing Details of Framing.

builder's or owner's preference determines the procedure. Some owners prefer a smooth butt welded surface, especially on the shell; but where no such preference is stipulated, builders sometimes declare it is more economical to use overlapped seams, which simplifies the fitting and regulating of the plates, and eliminates the necessity for beveling the edges. Overlapped joints were used in the "Fullagar," but the tendency nowadays appears to be towards butt welded joints throughout. This applies particularly to the bottom shell in oiltankers for the purpose of better drainage, absence of pockets where residue can remain, and consequent corrosion prevention. The plate edges are now commonly flame-cut in the U.S.A. instead of planed.

The welding of engine seatings, rudders and tank tops which are required to be flush, is quite common.

Fractures After Welding High Tensile Steel

While we might report innumerable cases of satisfactorily welded vessels, unfortunately now and again cases of difficulty arise, and one of these is quoted here as a matter of information. This vessel was not built to Lloyd's classification, but the writer was invited into the discussion which ensued during construction, in behalf of the owners. This was the case of a small tanker which had been in the gasoline service for years, and for which it was decided to build a new midship body; the old midship body throughout the oil tanks having become thinned out by corrosion.

The vessel was transversely framed with overlapped butts and seams, and with full welds on same, inside and outside. The transverse frames had full welds on both sides. It was originally intended to construct this new midship body of mild steel, but later it was agreed to build it of a high tensile steel; the tensile strength being in the range of 65,000 to 75,000 lb. per sq. in.

During the building, several cracks developed, mostly at the proximity of a butt and seam, until some seven shell plates were affected and in need of repair.

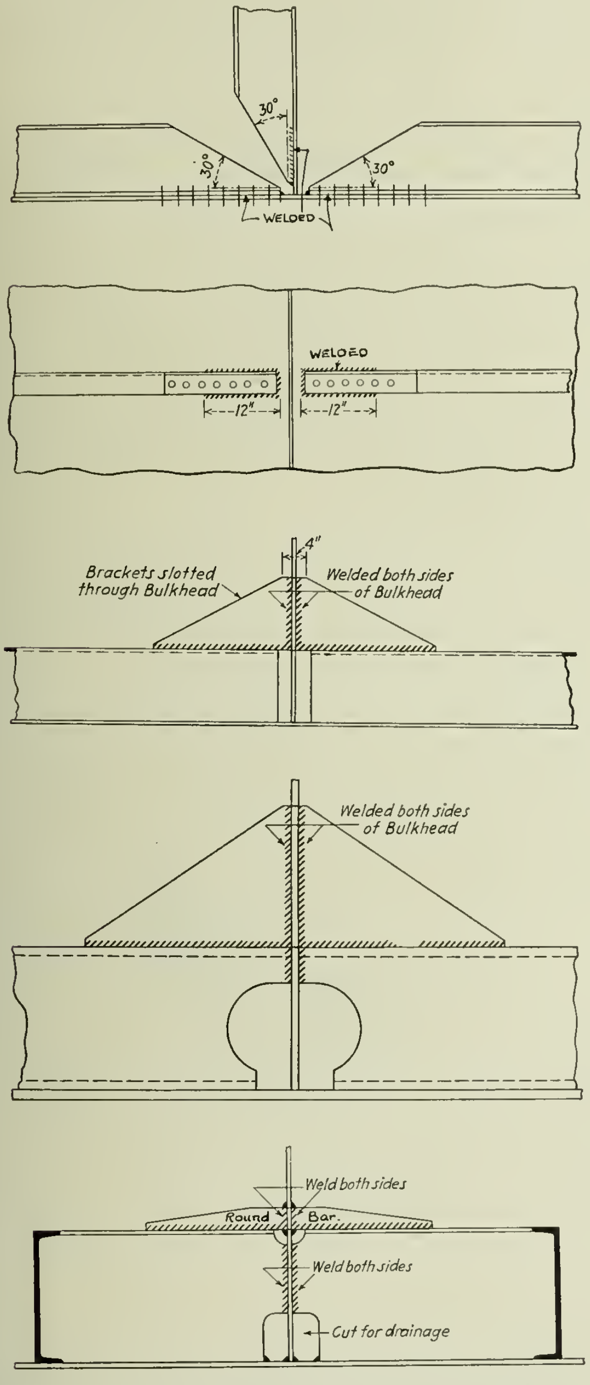
Investigations were made into the physical properties of the material and the welding, with the result that the cause of the trouble was laid to the welding. It was the opinion that either the electrode, the procedure, technique or sequence was at fault (one or more), these not having been fully developed for this particular material, prior to the structure being commenced. These difficulties, too, were accentuated by the excessive amount of welding at the joints. At the welded butts there were two and sometimes three full vertical continuous welds in close proximity to each other. The seams had also two continuous welds in close proximity, and each frame too, was continuously welded on both sides. Lloyd's rules require full welds on both sides only on shell and deck butts; on the seams the rules call for a full weld outside and a light weld inside; and on frames to shell plating, Lloyd's requirements are, an intermittent weld each 3 inches in length, spaced 7½ in. centre to centre. My own experience with welded construction indicates that it is just as important, if not more so, to prevent overwelding (with consequent locked-up stresses), than to prevent underwelding.

In the case under review, tests were made by removing 3 in. dia. discs from the shell to ascertain the amount of the locked-up stresses at various points of the shell plating. For this purpose, five positions were selected, the necessary measurements taken, and the discs drilled out. It was found that the readings varied to a considerable extent, some tensile and some compressive; the maximum being a compressive stress of about 27,000 lb. per sq. in. The centre of the discs were about 6 in. away from the nearest edge of the welds, and had they been close up to the edge it is possible the maximum stresses would have been larger, probably up to the breaking point of the material.

It is obviously impossible to ascertain with any degree of certainty the maximum stresses operating in a welded structure, the exact amounts and directions being unknown and therefore indeterminable. If, however, there is an elastic strain locked up in various parts of a welded ship, the stress corresponding to this strain will represent the actual starting point for any further superimposed stresses caused by working loads. This will, therefore, initially at any rate, reduce the margin of safety provided. Note the word "initially" in the preceding sentence, as it is uncertain whether these locked-up stresses eventually dissipate, either by slight buckling of the plates, or by slight permanent extension of the plates (i.e., beyond the yield point).

There is a considerable difference between a riveted and a welded floating vessel. The riveted ship is essentially a jointed structure with a certain amount of freedom to relieve itself of residual stresses, by slippage of the riveted joints or otherwise. On the other hand, a welded structure is a unit structure, rigidly held at all parts through the welded butts and seams. In the welded structure, if the physical properties of the welds are higher than those of the plate or parent metal the rigidity is accentuated, thus rendering the finished structure more susceptible to failure under impact, and more so with high tensile alloy steels.

In a welded joint, the aim is to produce a weld which has the same physical properties as that of the plate, in order to provide a homogeneous structure, all parts being equally elastic and able to take the same deformation under any type of loading; each plate and joint thus working in harmony with each other. This is much more essential in a welded, than in a riveted ship. A riveted ship after a few months is said to "shake down," and the riveted joints are supposed to readjust slightly to suit any unequal stress condition at any part. In reality this readjustment is more likely to be wholly or partially due to a form of stress relief under service conditions. In a welded structure, however, it is evident that no such "shaking down" process can be predicted, certainly not to the same extent. Locked-up stresses, due to the unity and non-slipping nature of the joints, can only be relieved in the early stages by change in contour, and if this does not take place, the stresses will remain locked-up indefinitely, or until they are relieved in some such manner as already mentioned. In other words, a riveted ship may relieve itself of residual stresses due to faulty construction or misalignment of holes, whereas a welded ship cannot do so initially. This may take place over a period of time, of which we have little experience at present.



Figs. 9, 10, 11, 12, 13—Methods of Connecting Longitudinals at the Shell on Either Side of Bulkheads.

Another consideration of interest is whether the full strength of the weld material itself can be used in computing the available strength of welded joints in a ship. There may be a possible change in the structure of the material adjacent to the weld, i.e., say along the edge of a seam, due to material changes resulting from the welding, of an indeterminable magnitude. This change might lower the physical properties of the material locally adjacent to the weld to such an extent that it is almost at the breaking point, due to the locked-up stresses above-mentioned.

Mild steel is, in my opinion, the best all around material at present on the market for a welded structure. High tensile steels have higher ultimate strengths than mild steel, but the elongations are less. In the former, the plates are stiffer, less subject to distortion, but by the same token are much more susceptible to locked-up stresses. In mild steel, any stresses imposed by welding are naturally relieved (altogether or to a large extent) by a slight weaving of the plate and the greater ductility of the material. In the high tensile plating, where the plates are stiff enough to withstand the buckling tendency, locked-up stresses are more likely. While these locked-up stresses may not in themselves be such as to cause the plate or welding to fracture, the fact that they are there raises the question in our minds whether a sudden shock, added to the stresses already locked-up, will cause the plate to fail later. Unfortunately, stress-relieving is impossible in a ship's structure.

Weather conditions are also important. There is no doubt that better welding can be done in summer than in the extreme of winter, but if care is taken, mild steel has proved its ability to withstand satisfactorily being welded under all conditions.

In the vessel referred to, the fractured plates were repaired, the tanks re-tested and hammer-tested, and the vessel was placed "experimentally" in the Coastwise service. No further cracks have developed, which leads one to the conclusion that severe locked-up stresses in welded structures may become relieved in course of time, probably by readjustment of the plating; i.e., either by slight local weaving, or by slight permanent stretching of the material, in way of the stressed conditions.

The Structure of the Earth as Revealed by Seismology*

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Presented before the Niagara Peninsula Branch of The Engineering Institute of Canada, April 5th, 1938., and before the Ottawa Branch, April 21st, 1938.

SUMMARY.—The author has succeeded in discussing a very technical subject in simple terms that permit an untechnical audience to understand and enjoy it. The importance of earthquake study is explained and the methods used in Canada are described in clear detail.

You remember what Doe said of Dopey,† "He don't know if he can talk or not; he ain't never tried." For the same reason I do not know whether I can succeed or not—having never tried to deal with this phase of seismology before a general audience—but I hope it will be possible for me, without recourse to technical details, to present a clear and convincing picture of the means by which we have learned something of "The Structure of the Earth as Revealed by Seismology."

As usual, "The Greeks had a word for it." Their word for earthquake was seismos; hence, seismology, the study of earthquakes.

Why study earthquakes? Coming closer home, let us ask the very pertinent, perhaps sometimes disconcerting, question, "Why study earthquakes in Canada?" Earthquakes merit study. According to good authority approximately 800 earthquakes, strong enough to destroy cities and towns, have occurred on land since the beginning of the Christian era. History shows that an average of 30,000 persons have been killed each year during the past two centuries by these phenomena. More than 20,000 earthquakes occur each year; a widely recorded shock each fourteen hours; a destructive earthquake each six and one-half days—on the average of course.

Perhaps, then, it may be assumed without argument that major earthquakes should be studied. Why be prepared to study them in Canada? Since Cartier's first voyage in 1534 an earthquake of major proportions has occurred, in Canada, every fifty or sixty years—on an average. These earthquakes have been, in general, more severe than the one which, in 1933, caused fifty million dollars damage at Long Beach, California. It has just so happened that structures liable to damage were not situated near the origins or epicentres of these shocks. Canada is building up rapidly; the earthquakes will continue. You may draw the obvious and inevitable conclusion.

It was an attempt to ameliorate in some measure the damage caused by earthquakes that led initially to their being studied by scientifically trained men. Progress was slow at first, but there has gradually evolved a branch of the subject which may be called "engineering seismology." Considerable progress has been made of late years, particularly in Japan, in Italy, and in California. It is now possible to design houses which, except in the most extreme cases, will not be destroyed by an earthquake, will not be set on fire thereby, and will not kill their inmates or passers-by with falling débris. Moreover, the specifications for such structures are now written into some building codes, for example those in parts of California.

Taking for granted part of that which we shall later find to have been revealed by seismology, we may consider the earth to be a sphere consisting of three main divisions: a central core, with a radius of about 2,200 miles; surrounded by the mantle, a concentric sphere a little less than 1,800 miles thick; which is, in turn, surrounded by a crust of a varying thickness which may be set down roughly as 25 miles. We take in our stride the responsibility for the approximations as to the sphericity of the earth and the various dimensions given. We shall discuss the theory and the technique of determining earth structure under four different conditions and in the order named: the crust; the

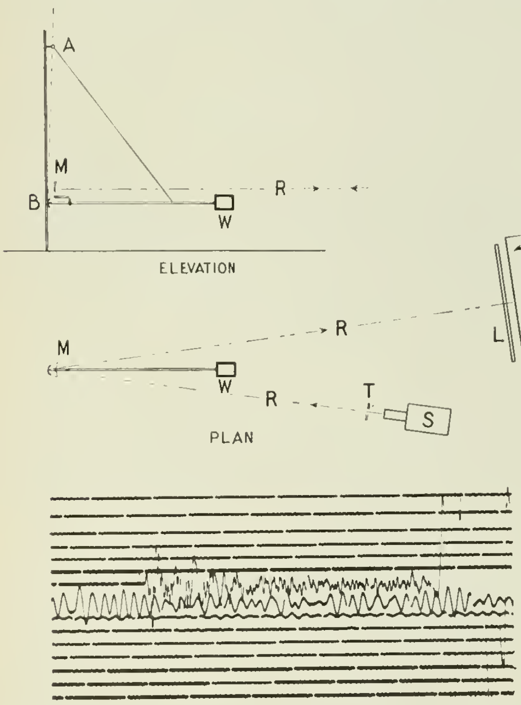

Fig. 1—Schematic diagram of a typical horizontal seismograph and a section of a record showing time breaks and an earthquake.

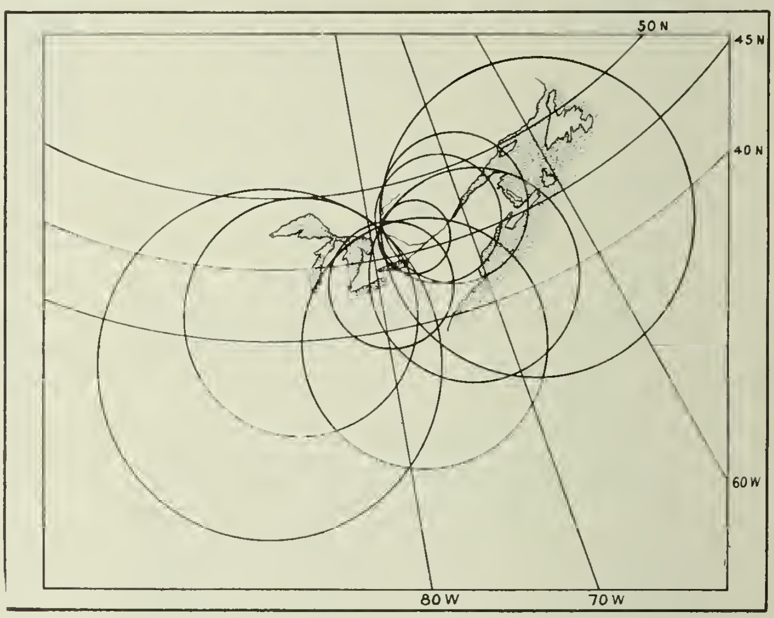

Fig. 2—Intersection of distance circles indicating the epicentre of the Timiskaming earthquake of November 1, 1935.

*Also appears without abridgement in the Journal of the Royal Astronomical Society of Canada, Vol. 32, No. 6, July-August 1938.

†Walt Disney's "Snow White and the Seven Dwarfs."

mantle; the core; and, finally, returning again to the upper part of the crust—that region which is within reach of the drill.

One of the first things that men learned about the crust of the earth is that it does not have uniform stability. Earthquakes occur frequently only in certain seismic zones. One of the routine activities of seismological investigation is that of locating as accurately as possible all recorded earthquakes. To do this, international co-operation is necessary. At the present time more than 250 seismic stations are in operation, reporting regularly to each other and to a central station at Oxford, England, where an agency under the joint auspices of that University and of the International Union of Geodesy and Geophysics determines the position of all locatable shocks and publishes a statistical summary of the data. We now know that the most active seismic regions of the world may be defined as a belt about the Pacific with an offshoot zone across Asia and Europe north of India and along the north shore of the Mediterranean to meet another belt running north and south through the relatively shoal water of the mid-Atlantic. We know, further, that all earthquakes are not confined to these more active belts. We have very good reason for saying that there is no region of the earth in which a major earthquake might not take place. This international service was begun in 1895 and has been growing steadily ever since. Canada has participated since 1897.

How then can seismic stations determine from their records where an earthquake has occurred? It would take much too long to sketch the slow degrees by which men learned to construct seismographs and deduced the method of interpreting from their records the distance from the recording station to the source of an earthquake. The abstract mathematical foundations of the theory were laid as early as 1849, but it was not until 1889 that, by chance, the first record of an earthquake was made at a distance. At that time an earthquake in Japan was found to have been recorded on a very sensitive instrument at Potsdam, Germany, set up for the purpose of determining to what extent the earth itself has tides similar to, though smaller, than those caused on the sea. Not until 1900, however, was such a distant earthquake record interpreted to yield a value of the distance from station to origin.

Before explaining how distance can be read from the record, we must know just a little about the instrument known as a seismograph. Suppose someone asked you to describe a ladies hat—not some particular hat—just a hat. That difficulty is comparable with an attempt to describe the appearance of a seismograph. Such instruments vary in size from one you could hold in your hand to one which stands more than six feet high and weighs twenty tons. One thing, however, seismographs have in common. A relatively-heavy weight is held very delicately suspended from a framework which is, itself, in firm contact with the earth.

When the earth moves, the weight stays behind as you tend to do when the street car starts suddenly. The relative motion of the weight and the frame attached to the earth is recorded continuously and gives the record. When the earth is at rest the record line is straight. When a shock impulse arrives, the line is deflected. At regularly-timed intervals, normally once a minute, a slight motion is given the recording mechanism so that a small, recognizable, offset (or in some cases a short interruption) occurs on the line. A diagram of one sort of seismograph is shown in Fig. 1 together with a small section of a record showing the timing marks. All we wish to emphasize here is that an instrument has been developed which enables the inertia of a weight to give us a record indicating that an impulse has arrived at the recording station and telling us the exact moment of its arrival.

The earth is an elastic body—almost as elastic as steel. That is to say, if any part of it be deformed by force, that deformation will vanish when the force is removed. It is the elastic properties of steel which, for example, cause a suspended bar of the material to give off a ringing note when struck by a hammer. It is the elastic properties of the earth which cause it to transmit earthquake waves.

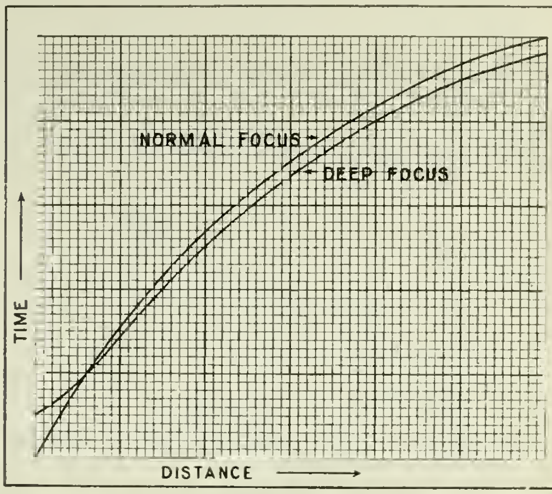

Fig. 3—Characteristic form of the time-distance curve for normal focus and for deep focus.

As early as 1849 it was deduced mathematically that an elastic body should transmit two kinds of waves and mathematical expressions for the speeds of the two waves were found. These two classes of waves are known as longitudinal and transverse. The first is propagated by the back-and-forth motion of the earth particles in the direction of the wave, somewhat after the manner in which a bump from an engine is transmitted down a long

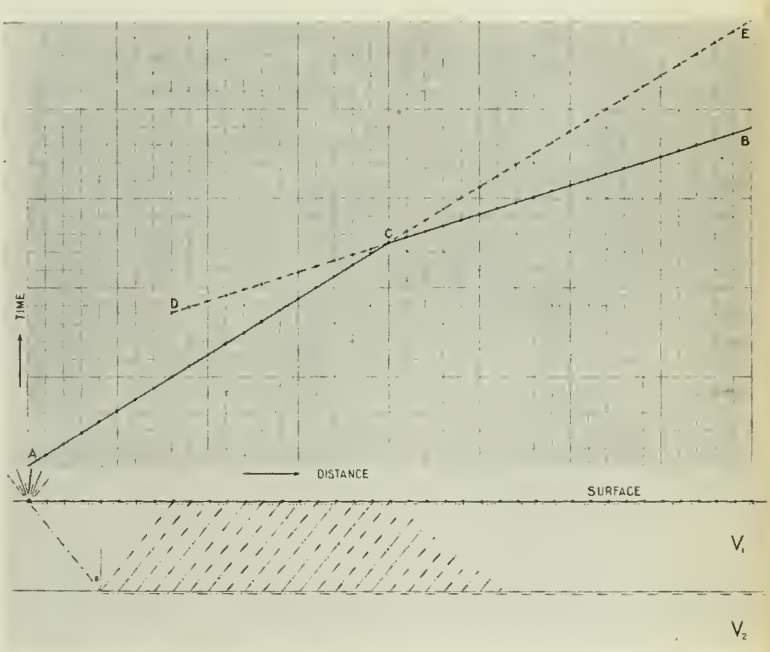

Fig. 4—Diagram illustrating the refraction method of probing surface layered structure. Velocities in the upper and lower layers are respectively V_1 and V_2. At distance C the energy by surface and sub-surface paths arrives simultaneously. For lesser distances, the earlier arrival is by the surface path. For greater distances, the earlier arrival is by the sub-surface path. The critical angle a depends on the velocities V_1 and V_2 which are given by the two graph slopes. Having V_1, V_2, C, and a the thickness of the upper layer may be computed.

line of freight cars. The second is propagated by a transverse motion of adjacent particles somewhat after the manner in which a water wave travels; the floating débris shows that the water particles move at right angles to the direction of propagation of the wave.

The difference in velocity depends on the elastic properties of the body through which the waves travel. For short distances it is a sort of neck and neck race. No laboratory is large enough to enable the waves to separate sufficiently for the fact to be established experimentally. So for many years there was no experimental verification of the two types of waves. After earthquakes were registered at considerable distances, it was found that a second burst of energy showed on the record among the

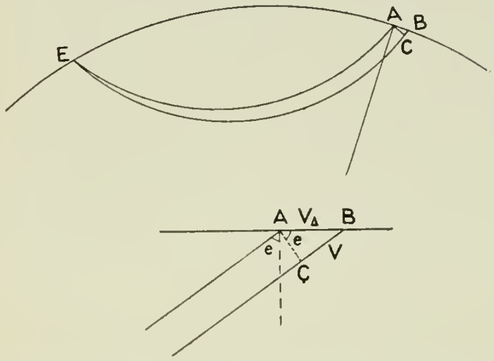

Fig. 5—Diagram illustrating the method of deducing the angle of emergence e of a ray at any chosen epicentral distance EA.

dying vibrations of the first impulse (see Fig. 1). The greater the distance from earthquake to station the greater was found to be the separation of these two impulses. It was finally established that these were the arrivals of the two types of waves which had left the origin of the earthquake together but had travelled at different speeds. The difference in time of arrival is thus a measure of the distance.

The two types of waves of which we have been speaking are designated, respectively, P and S waves by seismologists since, in point of time of arrival, they are primary and secondary. It is readily seen that, if observers possess a time table showing the time required for the P-wave to reach various distances on the earth's surface and a similar one for the S-wave, a table could be prepared showing the relation between S-P times and the epicentral distances. The first table of this sort was prepared by Oldham in 1900, since when a steady improvement has been effected. Such compilations are called time-distance tables or if plotted on graph paper, time-distance graphs. Given the table, it is easily seen how the distances from each station to the epicentre can be deduced. Now, if it be known how far the epicentre lies from any station then the epicentre must lie on a circle drawn about that station with the proper distance radius. If the circles for all the stations be drawn, their point of intersection makes the X which marks the spot (see Fig. 2).

A well defined earthquake can be located no matter where it may have occurred. Thus, routine statistical seismology is piling up accurate records of where earthquakes occur and when. Furthermore, we are now able to deduce the depth at which the shocks originate.

The point within the earth from which the earthquake energy is liberated is called the focus; the point vertically above it on the earth's surface is the epicentre. Now if the focus be on the surface we have what may be called, for want of a better name, a normal earthquake. To simplify our discussion we shall from this point confine our attention to the P-wave—the first impulse on the record. Obviously, the time-distance graph of a normal earthquake begins at the zero-zero point—at the origin of coordinates. Suppose another earthquake should happen with the focus at a depth of, say, 100 miles. All distances for our time-distance graph are measured from the epicentre. The epicentre is thus at zero distance. The time required for the impulse P to reach the epicentre at distance zero is in this case more than nothing and the time-distance graph must begin a certain distance up on the time axis, i.e., it must begin above the graph for a normal earthquake. But, at the antipodes of the epicentre, the shock must arrive earlier for a deep focus than for a normal one and the second curve must here lie below the first. The curves must cross. If the focal depth were 200 miles the new time-distance graph would start even later and arrive earlier than before—and so for successively-greater depths of focus. A typical pair of graphs is shown in Fig. 3. If the arrival times of the P-wave at a sufficient number of stations can be obtained, it is possible to determine from such a set of curves not only the distance to the epicentre but also the focal depth. In passing, let us note that Canada with her great expanse of territory would leave a wide gap in many of these curves did she not maintain a certain number of stations at strategically spaced positions. Her seven stations are little enough coverage for a country of such dimensions.

Depths of focus as great as 500 miles and more have been established and are a distinct contribution to the knowledge of the structure of the earth. They show that the earth can sustain built-up strain at depths previously considered impossible. We can no longer maintain that the crust alone is crystalline and that the mantle is plastic. At least the mantle is not plastic in the sense it was thought to be until deep focus earthquakes were established as a

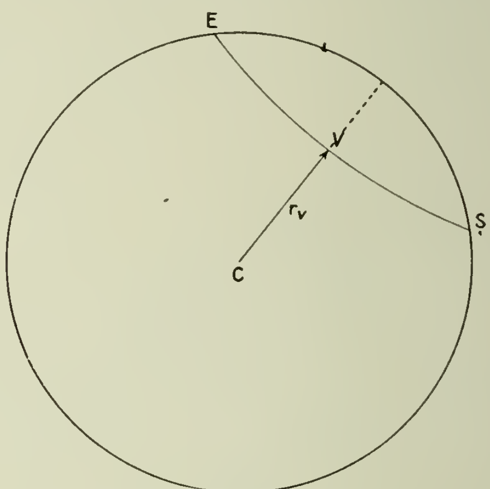

Fig. 6—The Herglotz-Wiechert method applied for any chosen epicentral distance ES yields the value of the vertex radius r_v, and the true velocity of the earthquake waves V at that depth.

fact. Probably no contribution of the science has aroused a greater interest among those concerned with learning something of the structure of the earth.

Suppose that the upper stratum of the earth transmits elastic waves at a velocity which is less than that for the deeper lying material. In this case, deeper means something of the order of fifty to a hundred feet. The diagram in Fig. 4 shows the approximate path of two rays of the waves propagated from an explosion at the surface. Let us take for granted that the rays are of the form shown and concentrate on visualizing the speed with which the nose of the advancing wave radiates over the surface.

If the surface were a calm lake, we could see the water waves radiate in ever-widening circles from the shock. Those waves would be gravity waves not the elastic waves which we are now considering but the same sort of ever-widening circles marks the progress of the energy transmitted by the earth. If the surface were covered with a thin layer of mercury we could actually see the nose of the disturbance spreading out from the source. If we were to put a dish of mercury on the ground at not too great a distance we could see a segment of the expanding circle pass over it. If we wish to know very exactly when the energy passes regularly-placed points on a line outward from the source and extending to a considerable distance, say twenty miles or more, we place sensitive seismographs at those points and have them record on a strip of moving paper which carries time marks. In this way we can tell when the initial impulse reaches each station and, if the seismographs be properly designed, we can also discern the arrival of later impulses —points on the common radius through the source, of the familiar circles within circles which can be seen when gravity waves radiate from a stone thrown into still water.

A little reflection is sufficient to show that, near the source, the arrival of the wave at successive stations will be at the rate v_1, if we may so designate the velocity in the upper layer. At a particular distance from the source is some station at which the energy, travelling along the surface with velocity v_1, will arrive at the same instant as that which has travelled down to the surface of discontinuity at velocity v_1, along the under surface of that layer at velocity v_2, to a point from which it rose again to the surface with velocity v_1. The greater distance travelled is just compensated for, by part of the path being traversed at greater velocity.

Let us suppose that we are equipped with properly designed seismographs at each station, from the source outward. The records for the very near stations will show only one arrival—the wave through the surface layer. At a certain minimum distance (which depends on the angle with which the ray reaches the surface of discontinuity, which again in turn depends on the ratio of the two velocities v_1 and v_2) energy will begin to arrive via the lower path; but it will arrive after the surface transmitted energy and will appear on the record as a second impulse. Farther out will be a station at which the energy by the two paths arrives simultaneously. Beyond that point, the first impulse will be that arriving via the lower stratum; but there will still be a second impulse on the records, due to the energy via the upper stratum. The arrival times of the two classes of impulse may be plotted and will result in defining two intersecting straight lines as shown in the diagram. The slope of these lines gives the velocities v_1 and v_2. The point of intersection defines the distance at which the arrivals by the two paths are simultaneous. The two velocities enable us to define the angle with which the ray impinges on the surface of discontinuity. Knowing the distance to the point of intersection, the two velocities and thence the angle of incidence, we can determine the depth of the upper stratum.

Considerable time has been devoted to explaining this seismic method of determining the thickness of a surface layer and the velocities in upper and lower strata because it is so important and far reaching in its application. The method can be extended to more than two layers—three, four, or even more—yielding the thicknesses of the layers and the velocities in each. It can also be used to determine whether the surfaces of discontinuity are parallel to the surface or tilted and will give the angles of tilt. It is known as the refraction method and will, henceforward, be referred to by that name.

In attempting to explore the entire thickness of the crust (about 25 miles) a difficulty presents itself—the explosions we can safely and economically use are inadequate to produce energy sufficient to travel to the depths and

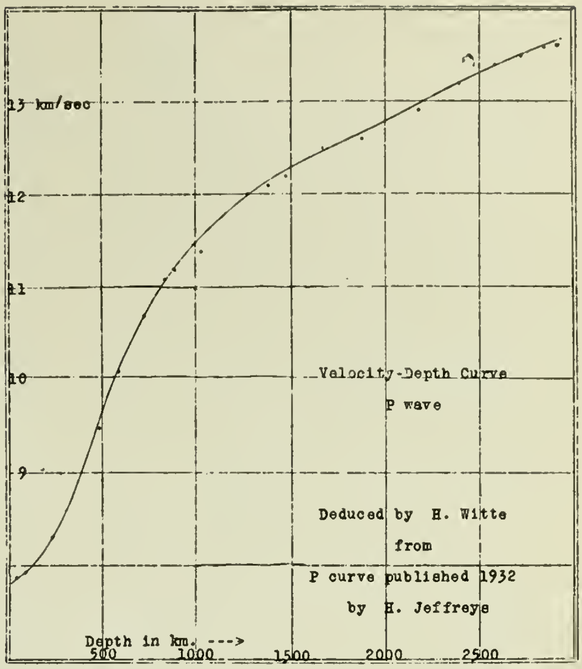

Fig. 7—Velocity-depth curve by Witte, 1932, based on Jeffreys' *P* curve.

distances required. Recourse must be had to earthquakes —not severe, but well located. Such small shocks usually follow a severe earthquake and are known as aftershocks. Immediately after a major earthquake, portable seismographs may be rushed to the epicentral region, a timing system arranged, and continuous records made. The aftershocks will originate not far from the original source. Several hundred of these, sharply-defined, will often be experienced. The data obtained yield much information as to the structure and thickness of the earth's crust in that particular vicinity.

Studies of this kind have been made in Japan, in central Europe, and in California. The crustal structure determined for Japan seems to be the simplest, that in California the most complex. No such studies have been made in Canada, but the data obtained from the records of the Timiskaming earthquake of 1935 show that the velocity in the outer edge of the mantle immediately under the crust is higher in Canada than in the outer edge of the mantle under Japan, central Europe or California. However, we are here considering the methods of determining earth structure not the results obtained, so we shall pass on to the methods of probing the mantle of the earth, that spherical shell about 1,800 miles thick below the crust and above the central core.

Before doing so it is necessary to note one further very necessary contribution from crustal analysis. In speaking of the methods used for locating earthquakes care was taken to say: "given a dependable time-distance graph." Science gives nothing gratis and yields her most valued and most valuable data only to those who seek; sometimes, it is true, not knowing exactly for what they are looking nor why they require it. One of the difficulties of obtaining a time-distance graph has been mentioned—the great areas on both land and sea unserved by seismograph stations at which to record the exact time of arrival of the elastic waves from an earthquake for which is accurately known the epicentre, focal depth, and time of occurrence. Even had we the optimum distribution of stations, it would still be necessary to have, for each of a series of selected earthquakes, the position of the epicentre, the focal depth, and the focal time. In other words, to locate an earthquake we must have accurate time-distance graphs and to con-

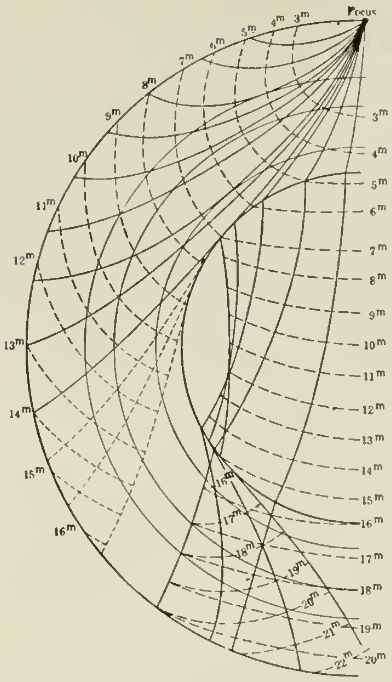

Fig. 8—Cross section of the earth showing rays and wave fronts of earthquake waves and the "blind zone." The last direct *P*-wave to emerge at the surface is the one grazing the core whose wave front is marked 14*m* indicating that the transmission time from the focus to this point is 14 minutes.

struct such graphs we must accurately locate an earthquake or earthquakes. It appears to be an impasse; but seismology has advanced, nevertheless, by a series of approximations—applications of the method of "cut-and-try."

Progress has been slow but steady over the years, as seismologists have gradually arranged for more stations, devised more efficient seismographs, and perfected timing arrangements. We may not here enter into details. Suffice it to say that remarkably good time-distance graphs are now available—so good that it is becoming necessary to take account even of the fact that the earth is not quite spherical.

The location of epicentral position and the determination of focal depth and focal time (for earthquakes which can serve to improve the existing time-distance graphs, yielding more accurate values for focal depth which we have seen to be of so much interest) are to be accomplished only by means of seismographs concentrated over an actively seismic area. The instruments must be in place at stations situated near a prospective earthquake source and must operate continuously until a shock occurs sufficiently strong to be recorded up to great distances. The near-station data can then be used, after the manner of the refraction method previously described, yielding definite knowledge of the epicentral position, focal depth and focal time. These, with accurately timed registration at stations over the entire distance range (or as much of it as possible), will permit a new refinement of existing time-distance graphs.

A sufficient concentration of seismographs over a seismic area is found at only a few places in the world—Japan, central Europe and California at the present time. Now, for an earthquake at any one of these places, some parts of the distance range must lie over water-covered areas where seismographs cannot be placed and also over other regions where, as yet, no stations are in operation. It is for this reason that efforts are being made by all seismologists to continue the operation of existing stations at as high an efficiency as possible and also to arrange for the inauguration of new stations at strategic points. Canadian stations are particularly valuable, as yielding data for parts of the distance range otherwise not covered, for earthquakes in Japan and California.

In order to co-operate in the attack on this major problem of seismology—the perfecting of the basic time-distance tables—a seismologist may decide to make a complete study of all records of some earthquake which appears from preliminary reports to be a promising source of fresh data. Requests are sent out to all the seismograph stations of the world asking for the loan of their records for this particular earthquake. Such a thorough study may extend over as much as two years. Canada has made complete studies of three major earthquakes and has loaned records of many others to seismologists engaged in research. Studies of this kind are most efficient means of obtaining data for furthering our knowledge of earth structure.

Let us, however, take for granted that we have a perfected time-distance graph for the *P*-waves of a normal earthquake. That is taking a great deal for granted but we already have very good graphs and we fully expect to have better ones as time goes on. The hypothetical, perfect graph tells us the rate at which the nose of the ever-widening circle of *P*-waves is radiating outward from the epicentre about the surface of the earth. That is all we ask to know. It is this which we crave to apprehend better year by year.

If we knew the varying velocity with which this surface circle of energy progresses throughout the entire distance range from the epicentre to its antipodes, we should be able to deduce the rate at which the waves travel at various depths within the earth and through what surfaces of discontinuity they pass. We may speak of the nose of surface energy as the trace of the wave and speak of its velocity as the trace velocity or apparent surface velocity in contradistinction to the true wave velocity at any point within the earth.

The time-distance graph gives the data for determining at any given distance the trace velocity; for we have only to find the rate at which distance varies with time at that particular distance range. For example we can take as our distance say 2,500 miles. We find how long it takes the trace to reach a distance of 2,500 miles by simply reading the ordinate of the graph for this distance. Now we read off the time it takes to go to 2,600 miles. The difference in these gives the time it takes the trace to travel 100 miles at the distance 2,500 miles. For those who are used to the process we simply say that the tangent to the time-distance curve at any distance value gives the apparent surface velocity or trace velocity at that distance. Suffice it to note that it may be deduced from the time-distance graph.

The most difficult part of the task set by this discussion now appears, that which the speaker so far "ain't never tried yet." It is hoped, however, that it may prove feasible to present, without recourse to technical details, a clear and convincing picture of just how the time-distance graph contains in its very shape the data from which may be deduced the velocity at any given depth within the mantle of the earth.

Before doing so, it is necessary to take drastic liberties with the earth. We have a time-distance curve for an earth, the crust of which varies from one point to another. We require for consideration a time-distance curve for an earth stripped of its outer crust. We may not be able to do this physically but we can use our knowledge of surface structure to cut off a little bit of distance and a little bit of time from each end of every focus-to-station path, obtaining time-distance values for that part of the earth which lies below the crust.

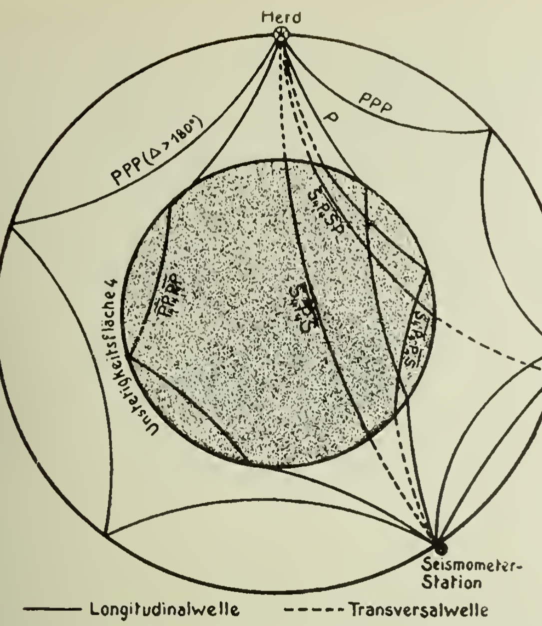

Fig. 9—Some typical complex earthquake rays from the focus (herd). The subscript 4 indicates the passage of the so-called fourth surface of discontinuity within the earth (Unstetigkeitsflache 4), which marks the boundary of the core.

After a procedure of this nature, we may assume we now have a new and hypothetically perfected time-distance graph for an earth stripped of its crust. We know that by applying the refraction method we can obtain the time velocity just at the bottom of the crust and in the outer edge of the mantle. We assume that, throughout any part of a concentric spherical shell defined by any given radial distance from the earth's centre, the conditions are the same—the true velocities are uniform over the whole shell. Thus, the velocity deduced just below the shell is taken as uniform over the entire earth.

You will remember that it has been stated that we have recently learned that this is not so. The true velocity at the outer edge of the mantle under Timiskaming is greater than that for the outer edge of the mantle in Japan. Very well! we shall have to continue this process of stripping the earth and adjusting our time-distance curve to a still greater depth until our premised conditions are satisfied. It will be sufficient if it is here made plain that we can use seismological methods to get a time-distance curve for an earth stripped of all lack of uniformity throughout any concentric shell; that we can find the trace velocity at any distance from the tangent to such a curve; and that we can determine the true velocity at the very surface of our stripped earth by application of the refraction method described for surface conditions. We have also, in effect, moved the origin from some point within the earth—the focus—to a point exactly in the surface of our stripped earth. Our amended time-distance graph begins at zero-zero—at the origin of co-ordinates. We may choose any point on the surface of our stripped earth and image an earthquake focus there. Proceeding to some distance about the surface of the stripped earth, we come to a point where the conditions of Fig. 5 obtain. Here two separate rays from the focus emerge at the hypothetical surface of the stripped earth. It is assumed that they are chosen so that the second ray reaches *B* just one second after the first ray reaches *A*. Thus the distance *AB* is a measure of the trace velocity; for it is the distance travelled by the trace in one second. We draw the line *AC* perpendicular to *CB*; thus the distance *CB* is a measure of the true velocity at the surface; for it is the distance travelled by the wave along the ray *CB* in one second. Now if we know the sides *AB* and *CB* of a right-angled triangle we can measure the angle of emergence, *e*, defined as angle *CBD* or *CAB*. We know the trace velocity from the amended graph and the true velocity from the refraction method so we can in this way find the angle of emergence of the rays at all distances, provided they do not dip into the core and become deflected. Up to more than half the distance around the earth from the epicentre chosen, we can deduce the angle of emergence of the rays.

As we saw in the refraction method, a ray passing from a stratum of lower velocity to one of higher velocity is bent toward the surface. If the true velocity increases at successively-deeper levels the ray will be bent more and more until it is at right angles to the radius. This is its deepest point. It then traverses the second half of its path which is the mirror image of the first half; and it emerges at the surface (of the stripped earth let us remember) at the same angle of emergence with which it started. That is to say, the ray is symmetrical about its centre radius through the vertex (see Fig. 6).

Clearly the amount of bending to which the ray is subjected is the sum of all the effects within its path; and the angle of emergence of the ray at any given distance is determined by the velocity at every depth through which the ray passed. If we could set up a mathematical expression giving the value of the depth of vertex and the velocity at that vertex of any chosen ray defined by its epicentral distance of emergence in terms of the emergence angle for that epicentral distance we could get one value of a true velocity at a known depth. For, as we have seen, we can determine emergence angles at every epicentral distance on the stripped earth. That, very briefly, is exactly what has been done. It is known as the Herglotz-Wiechert method.

Applying the Herglotz-Wiechert method once, we get one depth and the one corresponding true velocity. Applying it repeatedly, we get other depths and their corresponding velocities and thus bit by bit we get the complete graph which shows the variation of velocity with depth at all distances, down to the core. The velocity depth curve deduced by Witte in 1932 is reproduced in Fig. 7.

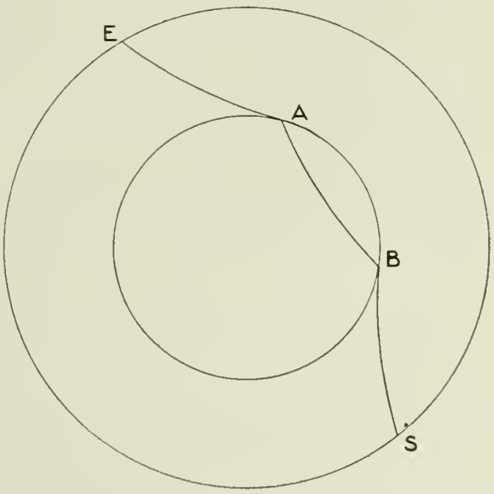

Fig. 10—**Path of *PKP*-ray, sometimes designated P_4P_4P or P_cP_cP.**

Down to the core, why not farther? Because the ray which barely grazes the core is the last direct *P*-wave to reach the surface. All others are deflected into the core in such a way that, beyond a certain distance range, no direct ray emerges at the surface. There exists a "blind zone" as shown in Fig. 8. No single part of the earth structure defined by seismology is quite so certain as the presence of the core. The blind zone is very clearly demarcated. It is possible to read off directly from a velocity-depth curve, such as that of Fig. 7, the depth to the core. The fact that the blind zone begins abruptly shows the surface of discontinuity to be sharply defined.

If a mathematician is given the dimensions of the earth, the structure of the crust, the variation of velocity in the mantle, and the depth to the core, he can compute the time it should take various waves, reflected within the earth, to reach the surface and the seismograms may be searched to see if they confirm the work which gave us

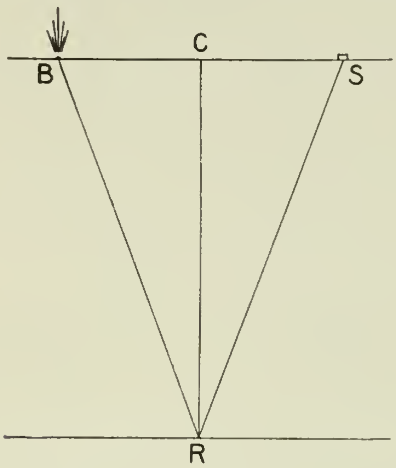

Fig. 11—Ray from blast to seismograph. The average velocity from the reflecting layer at *R* to the surface is found from shots fired in dry wells in the region, or by refraction shooting. The elapsed time shot to seismograph is known. Hence the distance *RS* is known. The distance *BS* is measured. Hence the depth *CR* may be calculated.

the velocity-depth curve. Not only the reflected *P*-waves but the *S*-waves of which we have nearly forgotten; for, as we got a velocity-depth curve for the *P*-waves, so we can get one for the *S*-waves. Furthermore, when an elastic wave either of *P* or *S* type is reflected or refracted it generates other waves of both types. Thus we may have a *P*-wave reflected at the under side of the surface as an *S*-wave and so on. The number of such possible, complex wave paths is very great and the times once computed may, as we have said, be checked on seismograms. Some of the possible paths are shown in Fig. 9.

So, step by step, by cut-and-try, by modification of theory and data, we have the means of probing the earth not only in the crust but in the mantle down to a depth of about 1,800 miles. But we stand at the barrier—the margin of a core of radius 2,200 miles. What can we learn about the core?

We can learn something of the nature of the material in the crust and mantle by knowing the velocity with which earthquake waves traverse them. We know from gravity measurements the total mass of the earth. The mantle and crust do not nearly make up their share of mass per volume (density). The core must be very heavy; the density must be great. We can deduce the approximate average density of the core. If we had a time-distance curve for the core and knew the true velocity just inside its boundary, we could apply the Herglotz-Wiechert method again to an earth stripped to the core and find a velocity-depth curve for that greater depth. So far no means has been found to do this. We know the total time for a wave such as that shown in Fig. 10 to reach the surface. We can compute the time required for the sections outside the core and we can find the end points of these branches at the core boundary. We know thus the time required for a wave to traverse the core along a path which has its end points fixed. But, not knowing the variation of velocity with depth in the core, we cannot say what shape the path has therein.

However, to make a long story short, there are, as we have partly indicated, a certain number of conditions which must be met if an assumed variation of velocity with depth within the core can be true. Over twenty such variations have been assumed by Gutenberg, checked with end data, and the most probable one selected. The research continues. We have still much to learn about the core.

Returning to the surface, let us see how we may use seismographs to probe the outer layers of the crust to depths which the drill may reach and confirm. We may use the refraction method which was described; and indeed it was used to excellent effect up to about 1929, when researches in radio made possible a new method which is now so useful that, in the United States alone, more than a million dollars a month are being spent in applying it to probe the upper earth strata in search of oil.

It is known as the reflection method. A shock generated from the explosion of from a quarter to a half pound of dynamite is recorded on a series of seismographs placed a measured number of feet apart at a measured distance from the blast. A very common "spread" is to have six seismographs at intervals of fifty feet with a thousand feet from the nearest seismograph to the shot point. The shot is buried in a hole drilled, usually, fifty feet deep; and the recording is done on very rapidly moving paper with time marks each tenth of a second. Time fails here to do more than say that this method uses electrical seismographs which feed their impulses through wave filters and amplifiers

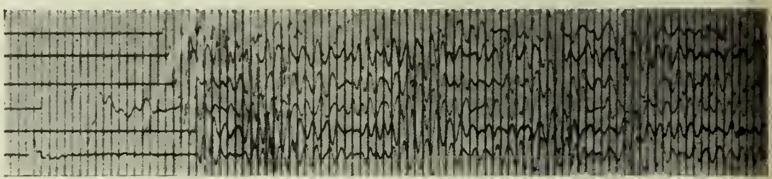

Fig. 12—Section of a typical six instrument seismogram.

so that the direct ground motion is killed out and those waves enhanced which have been reflected from a selected subsurface stratum which is thought to have oil-bearing possibilities.

The average velocity within the upper strata above the reflecting layer being studied can be measured by the refraction method or, where dry wells exist in the area, by measuring "up-hole time" from a shot in the well. Knowing the average speed and the elapsed time, and the distance from shot to seismograph, we have sufficient data to solve the conditions shown in Fig. 11 and learn the depth to the reflecting surface.

The crews work over the networks of country roads, finding the depth from point to point to the selected layer or "horizon" within the earth, until they find some place where it up-bulges about the same way as a large carpet would up-bulge if you were to put an inverted soup plate in its centre. Imagine a carpeted dining room with a table on the centre of the carpet and with an inverted plate under the carpet and under the table. The table top represents the earth's surface—the carpet represents the oil-bearing reflecting layer. The geophysicist seeks the invisible, up-bulged part represented by that hump in the carpet pushed up by the inverted plate. In practice, the layer may be at any depth up to a couple of miles. The bulge may be only fifty feet above the general level of the layer. But if such a bulge exists in those invisible depths, to learn of it is worth money; for that is where the oil will be—if there is any.

Figure 12 shows a typical record in the field. To deal adequately with this subject would take a whole series of lectures, for it is a very live business; and new technique and new discoveries are being reported every month. Some idea of the magnitude of the business may be given when it is stated that more than 200 seismograph crews are working in the United States alone, and that it costs at least $30,000 to equip a crew and $3,500 a month to run it. Crews with equipment may be hired at an inclusive charge of $9,000 per month. No companies are organized for this work in Canada, but some United States companies have operated here and also some from Germany.

It has been a long story, with many very summary and sketchy flights over details. We have seen how seismology penetrates to depths of a mile or two so quickly and surveys wide areas so rapidly that the expensive wielding of pick or drill need not be resorted to without some reasonable hope of reward. Aftershocks permit the extension of such methods to the bottom of the crust, which we have found to be of varying stability, varying thickness, and varying structure. The work on the crust permits us to arrive at a time-distance curve for an hypothetically stripped earth, after which the Herglotz-Wiechert method enables us to obtain a velocity-depth curve for the mantle. With these data at hand, we may compute the arrival times for various complex waves which should record at the surface, thus checking the previous deductions. We know some things about the core but it still remains to a large extent an unsolved problem—by no means the only one in seismology of course.

So, step by step, year by year, slow but steady progress is being made, by co-operative international effort, toward a more accurate knowledge of earth structure. This is one of the main reasons for studying earthquakes, whether in a seismic region or in relatively-quiescent Canada.

Railways Progressing Toward Continuous Rails

H. C. Drake,

Director of Research, Sperry Products, Inc., Hoboken, N.J.

Presented before the Montreal Branch of The Engineering Institute of Canada, April 21st, 1938.

SUMMARY.—An interesting description of welding methods and equipment, that facilitate a new development in railway practice. The elimination of rail joints is considered from the angle of construction and from the angle of maintenance and operation. It is possible that this development is pointing the way to a whole new chapter in railway history.

Continuous rail has been the dream of railway engineers since the introduction of the iron rail more than a century ago. The forces of expansion and contraction, as potent in 1830 as in 1938, lengthened those early rails in summer and shortened them in winter, compelling the engineer to make provision for rail movement at the joint. Throughout the evolution of the rail joint, from the first splice bar to the present modern joint bars, will be found the ever present provision for longitudinal rail movement.

In the year 1889, an intrepid engineer on the Lynchburg and Durham Railway decided to prevent rail expansion by brute force. He riveted 56 lb. rails together into a 3 mile stretch of track with no allowance for expansion. The ties were buried to provide maximum resistance to movement and the rail was kept in service 17 months. At the end of this period no buckling or movement of the rail was apparent although the track had not been surfaced or lined. This first stretch of continuous rail was discontinued due to deterioration of the covered ties.

In more recent years many electric railways have made use of continuous welded rails buried in street paving where the temperature changes are relatively small and the forces resisting rail movement large. The steam railways have also installed many stretches of welded rail in crossings, platforms and tunnels, where similar favourable temperature conditions obtain.

Continuous large section rail in open track became a reality in 1933, with the pioneer installation of welded rail by the Delaware and Hudson Railroad at Albany, New York. In this initial installation 131 lb. 39 ft. rails were welded in lengths up to 2,700 ft. by thermit pressure welds and were held to the ties by M. and L. construction. This type of rail fastening consists of double shoulder canted and crowned tie plates fastened to the ties by compression screw spikes. The rail is held by two spring clips bolted to the tie plates at the centre of the crown and bearing on the face of the rail. Each clip exerts a pressure of approximately 2,500 lb. on the rail base. This first installation of continuous rail proved entirely satisfactory and was followed by one mile in 1934, four miles in 1935, two miles in 1936 and some 35 miles of track in 1937. This latter figure represented their entire new rail programme for 1937, and brings the total mileage of continuous rail on the Delaware and Hudson Railroad up to approximately 43 miles. Of this total mileage approximately 65 per cent of the welds were flash welds and the remaining 35 per cent were thermit pressure type.

Included in the 1937 programme was a 7,700 ft. stretch of flash welded rail, the longest continuous rail on record.

Behaviour of Continuous Rail in Service

From 1933 to 1937, many tests were made on the Delaware and Hudson welded track, covering rail lengths ranging from 2,665 ft. to 7,700 ft. The object of these tests was to determine:—

1. The amount and distribution of rail movement throughout the long lengths.
2. Tie movement.
3. Stresses in rail and insulated joint bars.

The results of these tests may be summed up in the following statements:

1. Longitudinal movement of the ends of these continuous rails due to wide temperature changes was practically the same as for 39 ft. rail. There was no evidence of rail creepage.
2. There was no noticeable movement of the ties.
3. The insulated joints at the ends of these long lengths of rail at times exerted a restraining force of possibly 75,000 lb. on the rail end. Thus no particular difficulties were experienced from contraction or expansion of continuous rail on the Delaware and Hudson Railroad.

In May, 1937, Mr. F. R. Layng, Chief Engineer, Bessemer and Lake Erie Railroad, mentioned some interest-

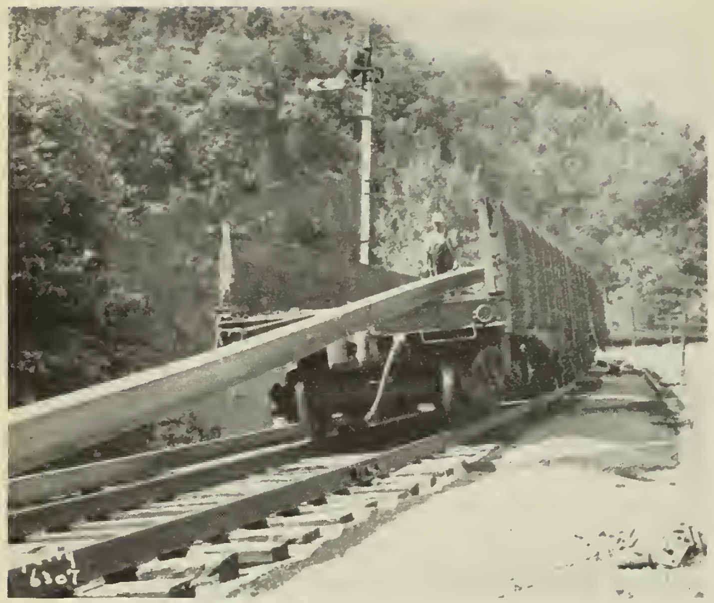

Fig. 1—Unloading Welded Rail.

A cable fastened to the end of a string of welded rail is anchored to the ground, then the flat cars are pulled forward and long welded rail appears to unload itself. Even around curves, it gives no difficulty in unloading as it naturally conforms to the curvature of the track over which it is drawn.

ing facts about the experimental welded rail installed by his road.* Tests were carried out on a stretch one mile in length, a little less than half of which represented tangent track; the remainder being a 1 deg. 30 min. curve and a compound curve having a maximum curvature of 5 deg. 43 min.

The traffic over this rail, at the time of tests, consisted of eight to ten heavy tonnage freight trains, containing up to 125 cars, daily. These trains operated at an average speed of about 30 m.p.h. One local passenger train also used this track, operating at a maximum speed of 50 m.p.h. It was estimated that the average annual gross tons which would be hauled over this rail was between 12 and 15 million; 18 million gross tons had been hauled over it at the time of test, with standard locomotives of the Texas types having a maximum weight per axle of 75,900 lb. and 70-to 90-ton capacity cars. The rail concerned was welded by the thermit process; the tie-plates were of the G.E.O. type, secured to ties with four screw spikes. Permanent monuments were set at appropriate locations along the track to record longitudinal and transverse movements of the rail, readings being made monthly.

*Official Proceedings, New York Railway Club, May 1937.

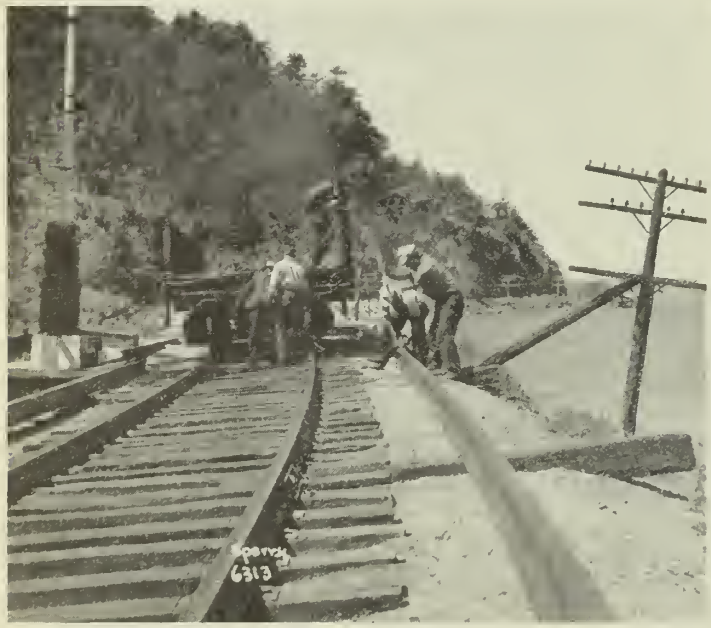

Fig. 2—Spiking down welded rail in temporary position, prior to placing it in permanent track. (Welded rail can be left thus until a convenient time for substituting it in track for the short length rails.)

This welded track was turned over for service November 9th, 1935. By May 1937, at the time Mr. Layng summarized results, this welded track had been in operation through two winters, one quite severe, and one summer during which there was an unusually long period of hot weather. The minimum temperature recorded was minus 15 deg. F., while the maximum was 104 deg. F. No longitudinal movements of special interest were recorded during this period, except at the extreme ends of the installation. Here, the rail movement covered a range of 1 in. at the south end, and $\frac{3}{4}$ in. at the north end. The following transverse movements were recorded: $\frac{5}{16}$ in. to the west, at a point 100 ft. from south end; $\frac{3}{16}$ in. to the east, at a point near the north end of compound curve; $\frac{3}{16}$ in. at the north end of the welded rail. To quote Mr. Layng: "As a whole, the track remained in excellent line and surface." No lining or surfacing was necessary throughout the above period—November 1935 to May 1937.

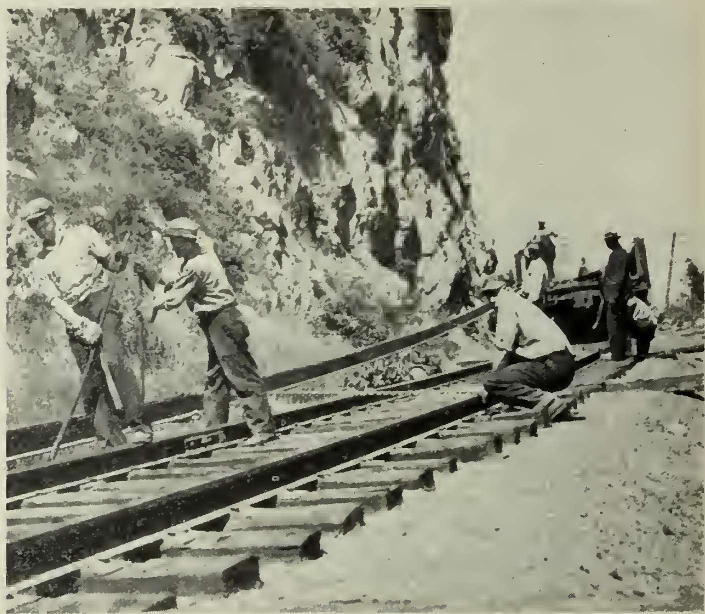

Fig. 3—Distributing Welded Rail Beside Curved Track.

Welded rail is hauled off flat cars and distributed alongside the permanent track until such time as it is convenient to substitute the conventional jointed rail with the welded rail.

A trial installation of 112 lb. continuous rail on the Central of Georgia Railroad is receiving considerable attention from railway engineers throughout the country. This welded track, located about 30 mi. from Atlanta, Georgia, is 2,180 ft. long and is the only open continuous rail with conventional type of fastenings. The rail is supported on double-shoulder canted tie-plates. Cut spikes are used to secure the tie-plates to the ties and to hold the rail in position. Rail anchors are used to prevent longitudinal movement of the rail ends. This track has been in service one summer and winter with no more than normal movement at the rail ends. However the temperature range at this location is not more than 100 deg. F.

Explanation of Performance under Temperature Variation

In these long stretches of welded rail there is no major movement of the rail ends because the expansion and

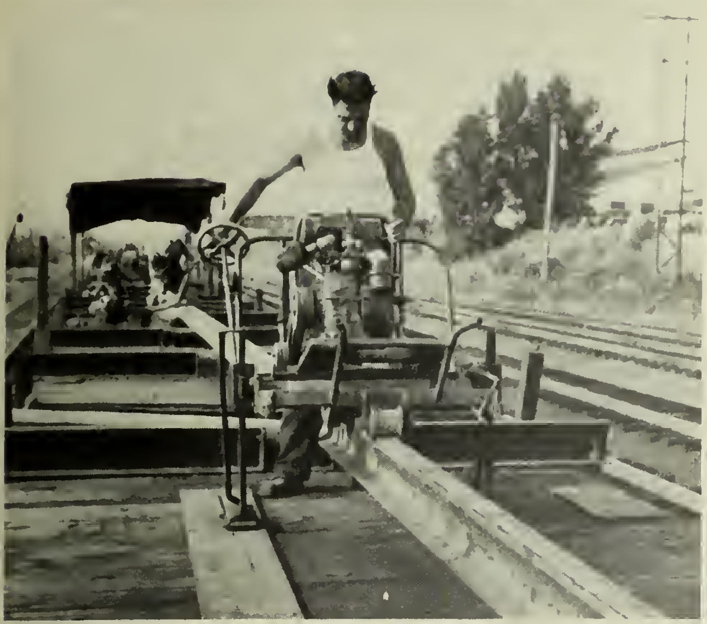

Fig. 4—Grinding Upset Metal off the Rail Head.

One of three grinding stations by which upset metal formed at the line of weld is contoured off; in the background a workman can be seen removing upset metal from the fillet of the rail.

contraction forces are equalled by the restraining forces. If a one mile length of rail is placed in track at 80 deg. F. and securely anchored against movement, there will be an average tension stress of 21,900 lb. per sq. in. in the rail when its temperature drops 100 deg., that is, to a minus 20 deg. F. If this mile of rail were free to move it would contract 46¼ in. due to the 100 deg. drop in temperature. This same mile of free rail would also stretch 46¼ inches if given a tension force at the ends of 21,900 lb. per sq. in. Actually with these two forces, contraction on the one hand and tension on the other, acting in opposition the rail remains in its original position. These forces of expansion and contraction in the long rails are not serious as the resulting stresses are far below the elastic limit of the steel.

Restraining Forces

Abnormal movement of continuous rail in track is prevented by five major restraining forces:

(1) The frictional resistance of the rail to movement due to weight on the tie-plates.

(2) Restraining effect of the insulated joints at the ends of the long rails.

(3) The positive grip fastenings with which the rail is held to every tie-plate.

(4) Rail anchors when used as on Central of Georgia Railroad.

(5) The ties well bedded in suitable ballast.

Development of Electric Flash Butt Weld

Continuous rail to be all that the name implies must be of uniform strength throughout its entire length. The welded joints must be comparable to the rail steel for hardness, tensile strength, impact value and resistance to fatigue.

In 1933, Sperry Products, Inc., in co-operation with the General Electric Company and the Delaware and Hudson Railroad, initiated a programme of research to develop the ideal weld for modern high carbon, large section, steel rail. Initial tests were conducted on every available type of welded rail joint to determine first, the state of the art and second, the type of weld best suited for continuous rail.

This early investigation, while including such physical tests as tension, impact and hardness determinations, was chiefly concerned with the resistance of the weld to fatigue. Railroad rails are subject to severe fatigue stresses due to the repeated application of wheel loads. In the year 1937, more than 20,000 transverse fissures were found in rails of the American railroads. These transverse fissures were fatigue failures produced by repeated wheel loads and had as their nucleus some minute shrinkage or shatter crack. It was feared that welded joints might contain some slag inclusion, oxide, or other discontinuity which would act as a nucleus for an internal transverse fatigue failure. The fatigue test, therefore, was of major importance and a rolling wheel load machine (Fig. 7) was immediately installed in the laboratory.

The rail is mounted in this machine as a cantilever beam with the weld line located 1½ in. from the support. The wheel is spring loaded to 65,000 lb. and the weld is passed back and forth under the wheel 120 passes per minute by means of a motor driven crank arm. This machine will produce failures in a rail containing incipient cracks in from one million to three million passes, while sound rail will stand up indefinitely under the load.

Drop of potential tests were made daily on the rolling load samples to detect incipient cracks and watch their growth. The rolling load test data for five different types of welded rail joints is given in Fig. 6. No flash welds are included in this tabulation. Failure started in all of these welds at less than one million passes of the 65,000 lb. wheel load. An internal transverse fatigue failure in a resistance butt weld is shown in Fig. 8. This fatigue crack was produced by 800,000 passes of the wheel load, and was growing at a rapid rate when removed from the machine.

The electric flash weld stood highest in all of the initial tests and had the added advantage of being rail steel throughout, whereas all other types of welds required the addition of foreign metal, or the use of special fluxes. Flash welding consists essentially of three operations, preheating, flashing and push-up. The rail ends are held by gripper dies, one fixed, one moveable, and are connected by heavy current clamps to the secondary of a low voltage transformer.

Fig. 5—Rail Alignment Gauge.

One of the tests to which each new weld is immediately subjected. Note upset metal at the line of the new weld; upset metal is ground off and the rail contoured to uniform smoothness.

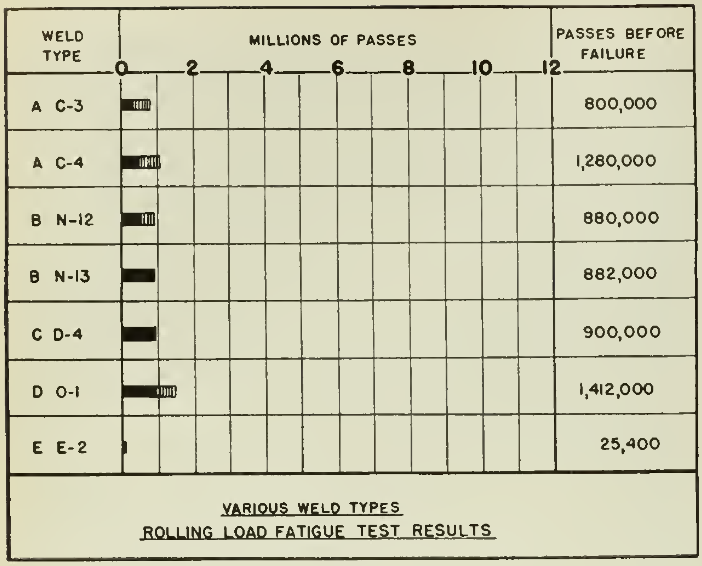

Fig. 6.

Preheating is accomplished by intermittently short-circuiting the rail ends for a definite period. Following this initial cycle, the rail ends are brought together at a predetermined velocity, resulting in repeated short-circuiting or flashing of the rail ends. When this flashing period has been completed, the rail ends are brought together under great pressure, thus squeezing out the molten metal and producing a sound homogeneous weld between the plastic faces of the rail ends.

In developing the correct welding technique it was necessary to determine the proper values for such variables as preheating time, flashing velocity, push-up pressure, voltage and current requirements and stress-relieving procedure. Flashing must be rapid and continuous, as it is the gas pressure due to flashing that excludes the atmosphere from the weld and thus prevents formation of oxides. The welding current must be sufficient to give rapid flashing. However, if the current density is too high it will result in tearing or flashing large chunks of metal from the faces of the rail ends. The push-up pressure must be sufficient to insure squeezing out of the liquid steel, but must not reach a value that will produce cold working of the metal.

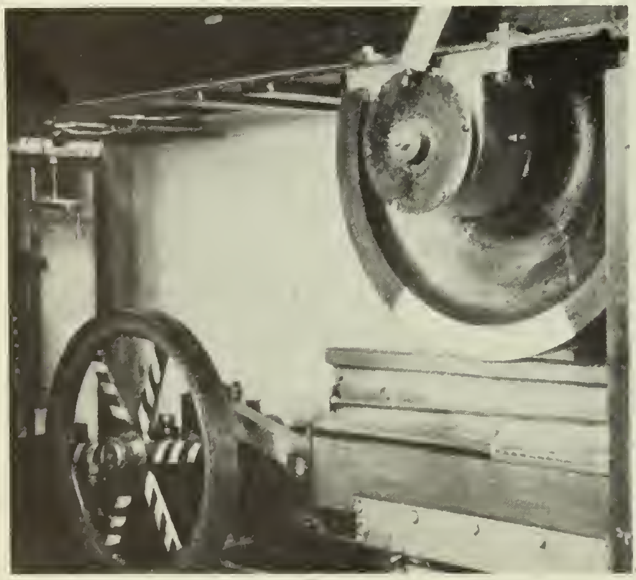

Fig. 7—Rolling Wheel Load Machine for Fatigue Tests.

The final welding cycle required 1¾ min. and with time for clamping and removal, a total of approximately 3½ min. With the production rate at 3½ min. per weld, it was necessary to develop a rapid yet effective stress-relieving cycle. The final procedure required three minutes heating in an oil fired furnace, followed by a 20 min. slow cooling by means of asbestos hoods.

Quality of Improved Flash Weld

Rolling load test data on flash welds, shown in Fig. 9, illustrate the improvement in weld quality which resulted from development of the proper welding technique. The final standard weld procedure resulted in welds which stood up under 12 million passes of the 65,000 lb. wheel load, 6 million with the rail mounted as a cantilever and 6 million with the rail mounted as a simple beam. These welds withstood one, two and three drops on a standard drop test, that is, a drop of the 2,000 lb. tup from a height of 22 ft. The physical properties, given in Fig. 10, show the remarkable strength of the weld. Etched samples of the weld disclose a sound homogeneous bond with no trace of cracks or slag inclusions.

Production Flash Welder

The equipment designed and constructed by Sperry Products, Inc., for production flash butt welding of rails consists of:

(*a*) A welding car, housing a specially constructed flash welding machine.

(*b*) A generator car, housing two turbo-generators for supplying current to the welding machine and to auxiliary equipment.

(*c*) A steam locomotive for supplying steam for the turbine driving the generators.

(*d*) A rail rack car, for lining up rail preparatory to movement into the welder car.

(*e*) A series of flat cars, on which are situated respectively:

1. An inspection station, where welds are inspected directly they come from welder car.
2. A stress-relieving oven.
3. A system of controlled cooling for complete removal of stresses set up in the rail during welding.
4. Three grinding stations.

The first grinder removes the upset metal from the sides of the rail head; the second grinder removes upset metal from the top of the rail and brings the point of weld to rail contour; the third grinder removes upset metal from the fillet (immediately beneath the rail head, on both sides) and from top of base of rail on both sides. All operations are simultaneous; that is, while a weld is being made in the machine, the weld previously made is being inspected, and so on.

Making the welds, inspecting, stress relieving, cooling and grinding may, therefore, be looked upon as a group of operations forming a complete cycle. Upon completion of this cycle, a weld is ready to meet the conditions of service in track. Upon completion of each particular operation, at the various stations, the rail is hauled one rail's length along the flat cars by means of a winch, thus permitting all operators to start afresh, on the next weld brought to them, without moving from their stations.

Welded rail is transported, conforming to curvature of track while on flat cars without the necessity of its being fastened in any way. In order to unload a long string of welded rail from the flat cars, the end of the rail is attached, with a cable, to an anchorage on the ground. The train of flat cars is then moved ahead, and the rail is hauled off at the rear of the train.

Out on track, "closure" welds are made between long strings of flash-welded rail. Thus in track is formed "continuous" rail, which can be installed in any lengths desirable, and limited only by the necessity for insulated joints for signal circuits, frogs and switches.

To insure uniform high quality production welds, the human element has been practically eliminated by making the welder operation automatic. As additional safeguards to weld quality, permanent records are made of the welding voltage, wattage, platen movement and the stress-relieving temperature for every weld fabricated. These records together with the inspector's report are permanent tangible evidence of weld quality.

Advantages of Welded Joint Continuous Rail

(1) *Joint Maintenance*

Welded rail eliminates joint maintenance items such as tightening bolts, oiling joints, building up battered rail ends, applying reformed bars and replacing damaged signal bonds.

(2) *Track Maintenance*

It is estimated that 45 per cent of the track labour is now consumed in keeping joints in proper line and surface. Vertical motion of the welded joint, due to axle oads, is no more than the motion of unwelded rail. Consequently, the amount of lining and surfacing to be done in the case of welded rail is extremely small.

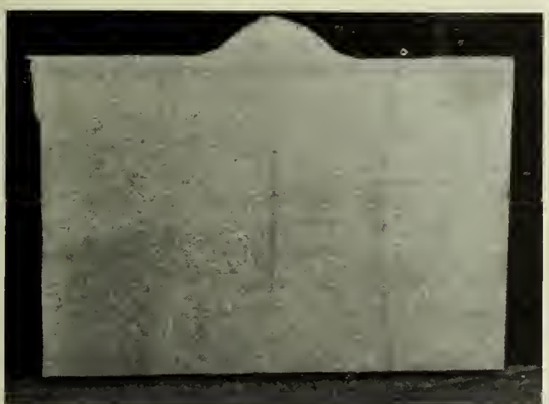

Fig. 8—Internal Transverse Fatigue Failure in a Resistance Butt Weld.

(3) *Rail Batter*

Rail end batter is responsible for a large percentage of the yearly rail renewals. Various methods have been developed for heat treating the rail ends to reduce the batter. Periodic building up of battered and chipped rail ends by welding has become common practice on a good many railroads. With welded joints there is no opportunity for batter.

(4) *Passenger Comfort*

Continuous rail gives the passenger a smooth, quiet, comfortable ride free from the noise and vibration caused by rail joints.

(5) *Rolling Stock Maintenance*

Rolling stock maintenance will be materially reduced when the impacts due to rail joints are eliminated.

(6) *Track Creepage*

There is no creepage with continuous rail, as uninterrupted wave motion of the track takes place with no longitudinal movement.

(7) *Tie Deterioration*

The rail joint plays a major part in tie deterioration. Installation of continuous rail results in a very definite increase in tie life.

(8) *Bonds*

Signal circuit bonds and power bonds are eliminated by the welded joint.

(9) *Safety*

Welded rail is safe rail. Rail rolled for welding is not drilled at the mill and, therefore, will have no failures

ULTIMATE TENSILE STRESS LB. SQ IN	RAIL HEAD	WELD METAL	132,800	SAMPLE BROKE OUTSIDE WELD
		PARENT METAL	133,200	
	RAIL BASE	WELD METAL	135,000	SAMPLE BROKE OUTSIDE WELD
		PARENT METAL	133,800	
E.L. TENSILE STRESS LB. SQ IN	RAIL HEAD	WELD METAL	59,000	
		PARENT METAL	44,000	
	RAIL BASE	WELD METAL	62,000	
		PARENT METAL	59,000	
BRINELL HARDNESS	RAIL HEAD	WELD METAL	270-300	WELD ZONE
		PARENT METAL	240-265	

Fig. 9—Rolling Load Test Data on Flash Welds.

due to bolt hole fractures. Another important safety item is the fact that the entire rail and also the flash weld may be tested by the detector car, whereas it is impossible to test for defects that portion of an ordinary rail within angle bars.

Welding Two or More Rails

A survey of the benefits derived from welded rail reveals the fact that it is the elimination of the rail joints, rather than continuous rail *per se*, which accounts for most of the savings enumerated. Increasing the standard rail length from 33 ft. to 39 ft. resulted in a 15 per cent reduction in joints per mile. In recent years trial installations of 66 ft. rails have been made, thus cutting in half the number of joints per mile as compared with 33 ft. rail. One mile of 78 ft. rail has been installed on the Kansas City Southern Railroad and the subject of long rails is a live one today. In Europe the welding together of two or more lengths of rail has been practised for several years. In fact, the total number of welded joints in Europe today runs well over 400,000. The popularity of the 78 ft. or 99 ft. lengths of welded rail lies in the fact that substantial benefits are obtained from reduction of joints with no added cost for special track fastenings.

Continuous rail with its many advantages to the railroad and its assurance of added safety and comfort to the travelling public seems destined to take its place as the latest addition to the list of modern railway developments resulting from railway engineering research.

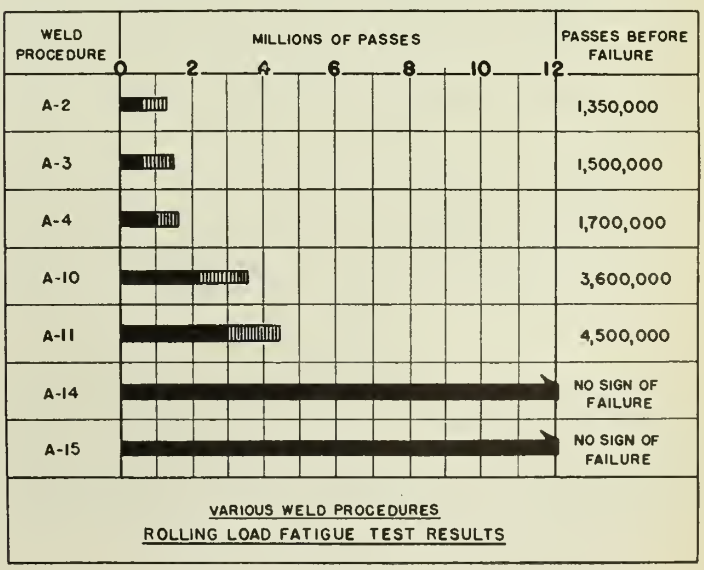

Fig. 10.

66-kv. Cable Operation in Montreal

Archie Benjamin, Jr.E.I.C.,

Montreal Light, Heat and Power Consolidated.

Paper presented before the Montreal Branch of The Engineering Institute of Canada, November 11th, 1937.

SUMMARY—This paper is a sequel to one which was delivered several years ago to the Montreal Branch. It describes the additional power facilities that have been provided for Montreal in the downtown area. The oil pressure systems and the methods of making joints in the cable are well illustrated and described. Defects in materials have developed from time to time and the paper explains how they have been overcome.

Some years ago a paper* was read before this branch of The Institute describing the installation in 1927 by the Montreal Light, Heat and Power Consolidated of 66-kv. cables to feed the new Vallee substation. By means of these cables one of the two 66-kv. overhead rings around the Island was looped into the substation. The installation at that time consisted of six single conductor cables in a specially-built duct line extending approximately 4,000 ft. from the overhead lines at Commissioners Street and St. Lawrence Boulevard to Vallee substation, just south of St. Catherine Street and west of Benoit Street.

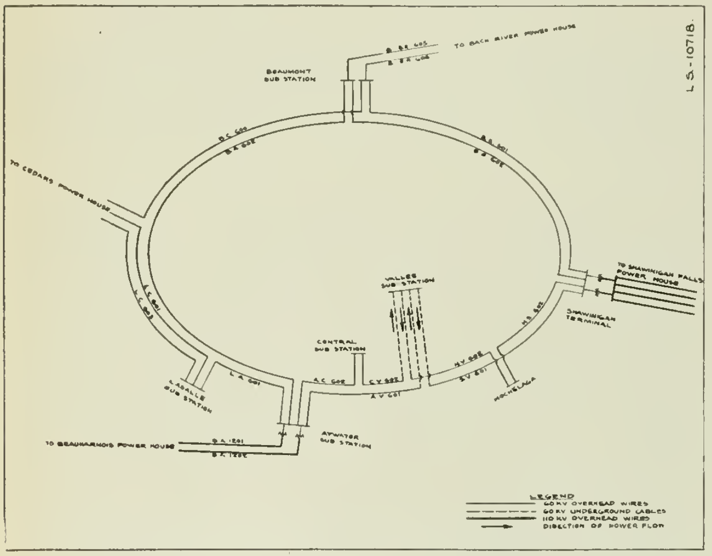

Fig. 1—Plan of Ring System at the Vallee Station.

In 1931 the capacity of Vallee substation was doubled and six additional single conductor cables were installed in another special duct line built along the same route and were connected to loop the other 66-kv. ring into the substation. A sketch of the ring system is shown in Fig. 1.

In 1937 one additional single-conductor cable was installed in the 1931 duct line to serve as a spare for any one of the other twelve cables. Figure 2 shows how the spare cable can be connected to any one of the twelve overhead wires by means of busses and jumpers at the Commissioners Street end of the line. A similar arrangement is provided at Vallee substation.

Thus there are now six cables in one duct line and seven cables in the other duct line, comprising four 3-phase circuits and one spare cable. The separation between the duct lines varies from 7 ft. to 45 ft. The general layout of the manholes and cables is shown in Fig. 3.

This paper will very briefly describe the duct lines, cables and accessories and outline the operating experience.

Duct Lines

Each duct line consists of ten fibre ducts 4½ in. inside diameter, 5 high, 2 wide encased in a concrete envelope. The distance between centre of ducts is from 7 to 8 in. The 1927 duct line has 12 manholes spaced from 235 to 430 ft. apart. The 1931 duct line has 10 manholes spaced from 220 to 495 ft. apart. The difference in elevation of the ducts between adjacent manholes varies from 1 ft. to 25 ft. The deepest manhole is about 16 ft. deep.

At the substation end of the duct lines the manholes are divided into 3 compartments. One of the manholes is approximately 40 ft. long, 12 ft. wide and 16 ft. deep, while the other is approximately 34 ft. long, 12 ft. wide and 13 ft. deep. The manholes at the Commissioners Street end are divided into 2 compartments and are approximately 38 ft. long, 10 ft. wide and 15 ft. deep. The other manholes are from 16 to 20 ft. long and 5 ft. wide at the centre.

Cables

The 1927 cables are 750,000 c.m. copper, 69 strands, hollow core, filled with a petrolatum base compound, 30/32 in. paper insulation, .003 in. metalized paper tape, and 9/64 in. lead sheath. The approximate outside diameter is 3.38 in. The end lengths of these cables have 10/64 in. lead sheath with ½ of 1 per cent. antimony. This reinforcement is to take care of the high static pressures due to the difference in elevation between the potheads and the manholes which is over 60 ft. at Vallee station and 75 ft. at the other end.

The 1931 and 1937 cables are 750,000 c.m. copper, 61 strands, solid core with a heavy oil base compound, 28/32 in. paper insulation; .003 in. metalized paper tape and 9/64 in. lead sheath. The approximate outside diameter is 3.1 in. The end lengths of these cables have .125 in. plain lead sheath, one layer of .008 in. paper, .005 in. phosphor-bronze tape, one layer of paper over that and .100 in. lead overall.

Since these cables are connected in series with the ring system, they are usually called on not only to feed Vallee substation but to transmit power east or west of

Fig. 2—Terminals at Commissioners Street.

*66-kv. Cables of Montreal Light, Heat and Power Consolidated, Humphreys Milliken, L. A. Kenyon, D. M. Simons. Engineering ournal, December 1928.

the substation. The ratings of the cables are: 350 amp. for the 1927 cables and 500 amp. for the other cables. The difference in these ratings is due to the fact that in the new cables sheath insulators prevent the flow of sheath currents.

Cable Terminals

The cable terminals are rated at 110 kv. The 1927 terminals have glass oil reservoirs mounted on them. The other terminals are fed by separate reservoirs. Figure 2 shows the terminals at Commissioners Street. The 1931 terminals at Vallee station are shown in Fig. 4.

in 1933 they were replaced by General Electric oil pressure bellows-type reservoirs. These reservoirs are mounted on the walls of the manholes and are connected by ⅜ in. outside diameter copper tubing to the joints—one reservoir for the three joints of each circuit. The rating of these reservoirs is a volume of 4 U.S. gal. with a corresponding pressure of 15 lb. The volume varies in a definite relationship with the pressure.

The reservoirs feeding the 1931 cables are Standard Underground type and are connected in the same manner as the others. These are also bellows-type and have the

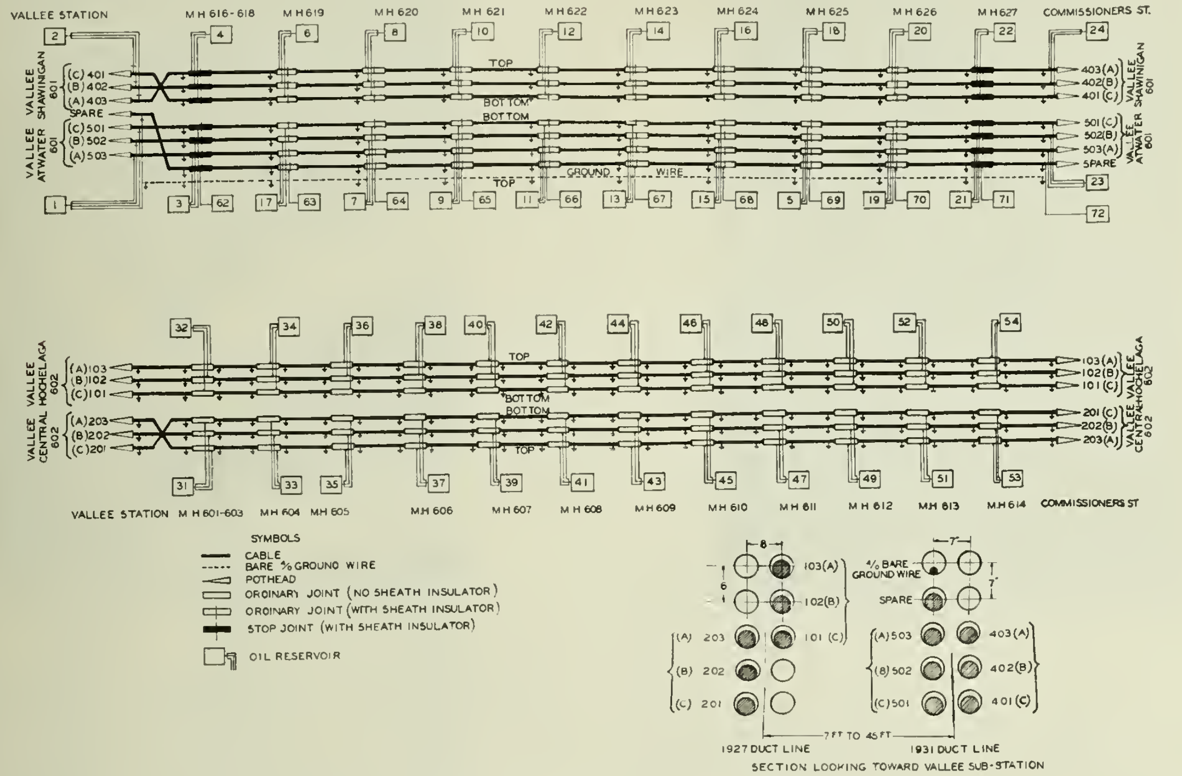

Fig. 3—General Layout of Manholes and Cables.

Joints

The joints on the 1927 cables are machine-wrapped as described in the previous paper. The replacement joints on these cables have been made by hand. There are two types of joints on the 1931 cables and the 1937 spare cable: ordinary and stop joints. The ordinary joints are all hand-wrapped with low loss black varnished cambric tape. The sleeves are equipped with sheath insulators and are grounded on one side of the joints only to prevent the flow of sheath currents.

In the manholes at each end of the duct line there are stop joints, connecting the reinforced riser cables with the ordinary cable. Figure 5 shows a stop joint being assembled. These joints are intended to prevent migration of the oil from the riser cables due to the head of oil. To prevent undue pressures from accumulating in the stop tubes of these joints the heavy oil in the riser cables had been bled by gravity until it was displaced by light oil. The normal pressures on these tubes are about 35 lb. to the sq. in., although over 45 lb. may be reached on the sudden application of the current. The joints are equipped with pressure gauges to indicate these pressures.

Reservoirs

The joints on the 1927 cables were originally equipped with sylphon tanks mounted directly on the joints. However, trouble was experienced with these sylphons and

same rating as the others. In addition to pressure gauge these reservoirs also have volume gauges. Thus a gas leak in the bellows of these reservoirs can be detected by a discrepancy between the relationship of volume and pressure from the normal. Figure 6 shows a Standard Underground pressure reservoir in one of the manholes.

The terminals on these 1931 cables are fed by feeder type reservoirs, mounted on the poles and on the wall of Vallee substation. The bellows of these reservoirs are exposed to the atmosphere and oil is fed into the terminals by gravity. One reservoir of 4 U.S. gal. capacity is connected to three terminals.

The 1937 spare cable has one General Electric pressure reservoir feeding each joint. These are of the same capacity as the others. The terminal on the pole is fed by a General Electric feeder type reservoir in which the active oil is contained in the bellows. The terminal at Vallee substation is connected to one of the existing reservoirs.

OPERATION

Oil Pressures

Thorough inspections of the cables and accessories are made every three months. The pressure gauges on the reservoirs are checked with a standard gauge. Reservoirs that are found with low pressures are pumped with oil until a pressure is reached that will be sufficient to ensure a positive oil pressure on the cable until the next

Fig. 4—1931 Terminals at Vallee Station.

Fig. 6—Standard Underground Pressure Reservoir in Manhole.

inspection. A pressure of 10 lb. usually is sufficient. Negative pressures in the reservoirs are undesirable due to the danger of the formation of voids in the cables and admitting air. However, in the spring care is taken that too much oil is not pumped so that the high summer temperatures will not cause excessive oil pressures. When high pressures are found they are reduced by draining oil from the reservoirs.

10-C transil oil is used in all the reservoirs and joints except at certain locations where migration of oil was experienced due to the difference in elevation of manholes—more than 20 ft. in one location. At these locations Sun XX heavy oil is used and our experience is that the migration is lessened.

All the oil used in the reservoirs is previously heated in an oven and tested for di-electric strength. The test required is over 30 kv. between 1 in. diameter discs spaced 1/10 in. apart.

In four years, from 1933 to 1936, a net amount of 182 U.S. gal. of oil was added to the 1927 cables and 135 gal. of oil to the 1931 cables. Assuming that the cables were well impregnated when installed, the possibility remains that the lead sheaths are stretched to make room for the extra oil. During the inspection of February of this year 108 U.S. gal. of 10-C oil and 25 gal. of heavy oil were pumped into the reservoirs to keep the pressures at 8 lb.

Fig. 5—Stop Joint Being Assembled.

Cable Defects

Some trouble has been experienced with the lead sheaths of the 1927 cables. Up to date there have been only two actual cables failures. However, the relay protection segregated the circuit from the system in each case without causing interruption of service.

The first failure was caused by accidentally driving a pick into a cable while excavating for a sewer connection. The second failure was apparently due to a break in the lead sheath as evidenced by oil emerging from the duct in the manhole some time before the failure. A few weeks later the cable broke down and it was difficult to ascertain the cause of the break.

In addition to the above failures there were eight stretches of the 1927 cable removed in anticipation of failure. In every case a break in the lead sheath was found. The first indications of these breaks were when oil was found emerging from the ducts into the manholes. This was usually accompanied by an abnormal decrease in pressure in the reservoir at the higher end of the suspected stretch.

Figure 7 shows a replacement cable being pulled up the pole at Commissioners Street. This cable is the hollow-core type with its regular sheath specially reinforced for this replacement by a bronze tape and outer lead sheath as on the 1931 cable end lengths. The wood block clamps holding the cable on the pole can be seen in the figure.

As this special cable is greater in diameter than the old cable, the grooves in the blocks on the pole had to be enlarged. As it was impossible to remove the inside halves of the blocks, a hot iron mandril was used on the pole to burn out the grooves to the proper diameter. Figure 8 shows a porcelain bushing being hoisted onto the pothead of a replacement cable at Commissioners Street.

Some of the breaks in the sheaths were apparently due to stretching of the lead. When the lead sheath was removed from this cable 4 in. on each side of the break, considerable oil was found between the paper insulation and the sheath. This piece of lead was cut into five equal strips and the thickness of lead measured around the circumference. These measurements indicated a stretching of the lead. The measured outside diameter of the cable at the break was 3.55 in. instead of the normal 3.38 in. All the defective stretches of cable on the 1927 system are now being replaced by solid core cable as installed in 1931.

The only defects experienced in connection with the 1931 cables were at the potheads on the pole. In two cases oil was found leaking from the duct in the manhole. Since these cables have their sheaths reinforced by phosphor-

Fig. 7—Replacement Cable Being Installed.

bronze tape and a second sheath it was thought improbable that both sheaths were broken. However, it was suspected that the wiped seal between the two lead sheaths inside the pothead might be broken and the oil from the pothead was allowed to pass between the two sheaths and out through a break in the thinner outside sheath. A wiped seal was therefore made between the two sheaths outside the potheads. This stopped the flow of oil from the duct and no further trouble was experienced.

Fig. 8—Porcelain Bushing Being Hoisted into Place.

Joint Defects

Leaks in the stop tubes of several stop-joints were found. This was remedied by replacing ⅛ in. thick vellumoid gaskets by 1/32 in. gaskets. These thinner gaskets have now been installed on all the stop joints and no further leaks found.

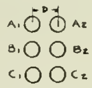

FIG 1
ARRANGEMENT OF CABLES

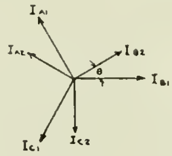

FIG 2.

INDUCED VOLTAGES ON CABLE SHEATHS – GROUNDED AT NOT MORE THAN ONE POINT.

CONSIDER SIX SINGLE PHASE CABLES ARRANGED AS SHOWN – (A_1, B_1, C_1) AND (A_2, B_2, C_2) ENERGIZED FROM TWO BALANCED THREE PHASE SYSTEMS WHICH MAY OR MAY NOT BE INTERCONNECTED. FIG 2 SHOWS THE VECTOR DIAGRAM OF THE TWO SYSTEMS. PHASE ROTATION IS ASSUMED TO BE A-B-C. PHASE B_1 IS TAKEN AS REFERENCE. θ IS THE PHASE ANGLE BETWEEN THE TWO SYSTEMS.

THE FOLLOWING RELATIONS HOLD:–

$$-je_{A1} = I_{A1}X_{A1A1} + I_{B1}X_{A1B1} + I_{C1}X_{A1C1} + I_{A2}X_{A1A2} + I_{B2}X_{A1B2} + I_{C2}X_{A1C2} \quad (1)$$

$$-je_{B1} = I_{A1}X_{B1A1} + I_{B1}X_{B1B1} + I_{C1}X_{B1C1} + I_{A2}X_{B1A2} + I_{B2}X_{B1B2} + I_{C2}X_{B1C2} \quad (2)$$

$$-je_{C1} = I_{A1}X_{C1A1} + I_{B1}X_{C1B1} + I_{C1}X_{C1C1} + I_{A2}X_{C1A2} + I_{B2}X_{C1B2} + I_{C2}X_{C1C2} \quad (3)$$

THREE SIMILAR EQUATIONS HOLD FOR e_{A2}, e_{B2}, AND e_{C2} RESPECTIVELY.

e_{A1} = INDUCED VOLTAGE TO GROUND ON CABLE SHEATH A_1.

X_{A1A1} = SELF-REACTANCE OF CABLE SHEATH A_1 = $K(\log P/R_m)$

X_{A1B1} = MUTUAL-REACTANCE BETWEEN CABLES A_1 AND B_1 = $K(\log P/D_{A1-B1})$

WHERE $K = 0.05292$ (FOR INDUCED VOLTS PER 1000 FEET)

R_m = MEAN RADIUS OF CABLE SHEATH.

$D_{A1\cdot B1}$ = SPACING BETWEEN CENTRES OF CABLES A_1 AND B_1.

P = DISTANCE FROM CENTRE OF CABLE TO A POINT AT INFINITY (IT CANCELS OUT IN THE FINAL RESULTS)

EQUATION (2) MAY BE WRITTEN AS FOLLOWS:–

$$-je_{B1} = I_{B1}\left(\epsilon^{j120}X_{B1A1} + \epsilon^{j0}X_{B1B1} + \epsilon^{j240}X_{B1C1}\right) + I_{B2}\left(\epsilon^{j(120+\theta)}X_{B1A2} + \epsilon^{j\theta}X_{B1B2} + \epsilon^{j(240+\theta)}X_{B1C2}\right)$$

IT IS EASY TO SHOW THAT

$$A\epsilon^{j120} + B\epsilon^{j0} + C\epsilon^{j240} = B - \tfrac{1}{2}(A+C) + j\tfrac{\sqrt{3}}{2}(A-C)$$

$$A\epsilon^{j(120+\theta)} + B\epsilon^{j\theta} + C\epsilon^{j(240+\theta)} = \left[B - \tfrac{1}{2}(A+C)\right]\cos\theta - \tfrac{\sqrt{3}}{2}(A-C)\sin\theta + j\left[\left\{B - \tfrac{1}{2}(A+C)\right\}\sin\theta + \tfrac{\sqrt{3}}{2}(A-C)\cos\theta\right]$$

USING THESE RELATIONS WE OBTAIN

$$-je_{B1} = I_{B1}\left[\left\{X_{B1B1} - \tfrac{1}{2}(X_{B1A1} + X_{B1C1})\right\} + j\tfrac{\sqrt{3}}{2}(X_{B1A1} - X_{B1C1})\right] + I_{B2}\left[\left\{X_{B1B2} - \tfrac{1}{2}(X_{B1B2} + X_{A1C2})\right\}\cos\theta - \tfrac{\sqrt{3}}{2}(X_{B1A1} - X_{B1C2})\sin\theta + j\left[\left\{X_{B1B2} - \tfrac{1}{2}(X_{B1A2} + X_{B1C2})\right\}\sin\theta + \tfrac{\sqrt{3}}{2}(X_{B1A2} - X_{B1C2})\cos\theta\right]\right]$$

FOR THE CONFIGURATION OF CABLES AS SHOWN ABOVE:–

$$-je_{B1} = 0.05292\left[I_{B1}\log\frac{D}{R_m} + I_{B2}(\cos\theta + j\sin\theta)\log\sqrt{2}\right] \text{ VOLTS PER 1000 FEET} \quad (2a)$$

$$-je_{A1} = 0.05292\left[-I_{B1}\left(\tfrac{1}{2}\log\frac{D}{2R_m} - j\tfrac{\sqrt{3}}{2}\log\frac{2D}{R_m}\right) + I_{B2}\left\{\left(\log\frac{\sqrt{5}}{\sqrt{2}}\cos\theta - \tfrac{\sqrt{3}}{2}\log\sqrt{5}\sin\theta\right) + j\left(\log\frac{\sqrt{5}}{\sqrt{2}}\sin\theta + \tfrac{\sqrt{3}}{2}\log\sqrt{5}\cos\theta\right)\right\}\right] \quad (1a)$$

$$-je_{C1} = 0.05292\left[-I_{B1}\left(\tfrac{1}{2}\log\frac{D}{2R_m} + j\tfrac{\sqrt{3}}{2}\log\frac{2D}{R_m}\right) + I_{B2}\left\{\left(\log\frac{\sqrt{5}}{\sqrt{2}}\cos\theta + \tfrac{\sqrt{3}}{2}\log\sqrt{5}\sin\theta\right) + j\left(\log\frac{\sqrt{5}}{\sqrt{2}}\sin\theta - \tfrac{\sqrt{3}}{2}\log\sqrt{5}\cos\theta\right)\right\}\right] \quad (3a)$$

EXPRESSIONS FOR THE INDUCED VOLTAGES ON THE OTHER CABLE SHEATHS MAY BE DERIVED IN A SIMILAR MANNER.

Fig. 9—Development of Formula Used in Configuration of Cables.

Induced Voltages on Sheaths of 66 kv. Cables

Test No.	Phase Amperes		Phase Angle between Current in Cables 401-2-3 and 501-2-3	Cable Tested	Phase	Length of Cable (Feet)	Induced Volts (Sheath to Ground)	
	Cables 401, 402, 403	Cables 501, 502, 503					Measured	Calculated
1	150	270	69 deg.	503	A	517	4.82	7.06
2	150	270	70 deg.	502	B	517	4.80	5.06
3	150	270	70 deg.	501	C	520	7.40	6.46
4	150	258	71 deg.	403	A	537	3.62	4.31
5	150	252	70 deg.	402	B	536	3.85	3.30
6	150	258	70 deg.	401	C	536	3.70	5.19

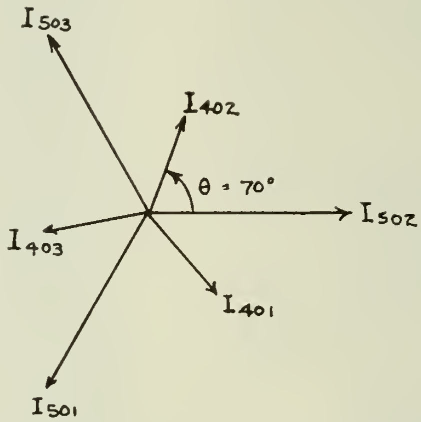

Fig. 10—Comparison Between Measured and Calculated Voltages.

Pothead Defects

Several oil leaks at the gaskets of the potheads were remedied by tightening the cap screws. Two porcelain bushings were cracked and had to be replaced.

Reservoir Defects

Trouble was experienced with the reservoirs on the 1931 cables. Leaks developed in the bellows of several reservoirs allowing gas to escape from them. These leaks were detected during the routine inspections and in most cases were repaired by soldering.

Induced Sheath Voltages

Some measurements were taken on all the insulated-sheath cables of the induced voltages built up between the ungrounded ends of the cable sheaths and ground. This was done with the twelve regular cables in service and the spare cable dead and grounded at both ends. Simultaneously a phase angle meter was used in Vallee substation to measure the angle between the currents in the insulated-sheath cables. The phase amperes were also noted. The configuration of the cables is shown in Fig. 3. Calculations have been made to check the voltage readings theoretically. Figure 9 shows the development of one of the formulae used. It is to be noted that the continuous-sheath cables in the other duct line have no appreciable effect on the induced voltages and they do not appear in the calculations. The reason for this is that because the distance between the cables in that duct line is very small compared to the distance between the two duct lines the mutual reactances are almost equal and their effects cancel each other.

Figure 10 shows a comparison between the measured voltages and the calculated voltages for the longest stretch of cables.

The induced voltages were also measured with the spare cable in service in place of cable 201 in the opposite duct line. The highest voltage measured was 8.50 volts in cable 501.

REQUEST FOR INFORMATION

To all members of The Engineering Institute of Canada

It is proposed to publish a membership list before the end of the year. In order that complete and up-to-date information may be available, will you kindly fill in this form and return it to Headquarters. The work is already under way; therefore a prompt response will be appreciated.

L. Austin Wright, *General Secretary*

Name in full..

Residence address..

Business address..

(*Underline the one to be used for mail*)

Membership classification in Institute..

Name of Employer..

Position occupied..

College, Degrees and year..

Military or Civil titles and honours..

Preventing Condensation in Insulated Structures

By T. S. Rogers, Architectural Record, March 1938

Abstracted for Engineering Journal by Douglas S. Laidlaw, A.M.E.I.C.

A small, but growing, number of buildings have been observed in recent years in which dampness has developed in walls, roofs, or attic spaces. Most of these have been insulated houses, and a few have been winter air-conditioned. The erroneous impression has spread that insulation "draws" water into walls and roofs.

Among the several million houses containing insulation, only a very few develop chronic dampness conditions, and, of these, most show only a staining of plaster, though some show the formation of frost and ice in concealed spaces, or dry rot and fungus growths in wood members. Two investigations of the problem have recently been made, and are reported in (1) "Condensation in Walls and Attics," U.S. Forest Products Laboratory Report (1937) by L. V. Teesdale, senior engineer, Forest Products Laboratory, Madison, Wisconsin; (2) "Condensation Within Walls" by Pro essor F. B. Rowley, A. B. Algren, and C. E. Lund, of the Engineering Experiment Station, University of Minnesota, presented at a meeting of the American Society of Heating and Ventilating Engineers, in January 1938. This article and the Time Saver Standard sheets summarize their findings for the benefit of the architectural profession.

It was found by the investigators that water vapour has a tendency to migrate from an area of higher to one of lower relative humidity, and that, if this tendency be restrained by the interposition of a vapour-tight membrane between them, condensation on the surface of that membrane will result only when that surface is at a temperature below the dew-point temperature of the air on the high-humidity side. Under winter conditions, it is common to find a higher relative humidity inside a house than outside it, and this condition has been intensified by the introduction of winter air-conditioning apparatus. Common forms of construction, used for many years, have not proved vapour-tight, even where, as was not always the case, they were wind-tight. The intensified interest in insulation and wind-tightness has produced many new types of construction, of which a large number have proved vapour-tight. Where the vapour-tight membrane has been placed in the cold portion of the wall or roof, condensation has resulted.

Three general types of construction are, therefore, found to be unfavourable to condensation: 1. Construction that is not wind-tight, as exemplified by many old or poorly constructed buildings. In this the vapour moves through cracks in the wall or around windows or doors. The maintainance of a high relative humidity inside such a building is impossible. 2. Construction that, while wind-tight, is not vapour tight, so that the vapour may pass, unhindered, to the outside. Unpainted plaster, plaster-boards, some ply-woods and fibre boards, ordinary rock wool insulation, and ordinary wood sheathing with building paper and siding, are of this character. 3 Construction containing a single, or multiple, vapour-tight membrane, so placed that its surface temperature will be above the dew-point temperature of the air inside the house. For this purpose, two coats of aluminium paint, reflective foil insulation, and heavy, built-up, waterproof building papers, when applied in effectively continuous layers, have been found to be very effective.

Condensation found in existing construction can be eliminated either by increasing the vapour-tightness of the inner portions of the wall or roof or by decreasing the vapour-tightness of the outer portions. The first method would usually be effected by the installation of a vapour-tight membrane on the inner surface, the second by ventilation of the concealed spaces to the outer air.

It has been found that it is not necessary to reverse the position of the vapour barrier in the walls or roofs of buildings equipped for summer air-conditioning, because the temperature of the air within the building only rarely falls below the dew-point temperature of the outer air, and such condensation as then occurs is readily dissipated.

The article is accompanied by simple diagrams explaining the principles involved, illustrations of the test equipment used, and diagrams showing methods of construction.

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."

VOLUME XXI SEPTEMBER, 1938 No. 9

War and the Engineer

War has become so much a matter of engineering that it is doubtful if any group of citizens is more interested or concerned about the present apparent trend of events, than the engineers. So much is written in newspapers and periodicals, so much discussion is taking place, that it is not possible to avoid the subject. It is true that we are told by visitors to England that in the press there, there is little war talk, and that the Canadian and American papers by their over emphasis seem to make war much more probable than it actually is. Nevertheless we cannot dismiss with a shrug the undisputed fact that all Europe is arming, and that England is well on in a programme to spend not less than seven and a half billion dollars as part of a programme to defend herself. Surely we cannot be accused of pessimism for thinking of these things under such conditions, and for wondering just what our part will be as individuals and as a nation.

With war only a possibility the only action that can take place is that of preparation. But preparation is a very broad term and involves much more than the recruiting and training of armies. Today a whole nation goes into battle—not just the soldiers. Therefore preparation concerns every citizen, and victory will probably go to that nation which has done this work the best.

We see the Mother Country making preparation on a scale that is staggering. Authoritative accounts of the plans and policies of the British government are a revelation of cool calculation, and firm determination. The whole fighting force is having its face "lifted" in no uncertain manner. Industry is in step with governmental plans, and the way this has been worked out is beyond the comprehension of other nations. Yet it all sounds so reasonable in England.

Canada's share in any Empire war is a subject upon which there is no unanimity of opinion, but whether we like it or not, Canada is making some preparation, and the nature and extent of that preparation should be interesting. Hence, we propose publishing from time to time as the information becomes available, short articles on the subject. The material already in hand deals with "industrial preparedness," and has particular significance for the engineer. It will appear in the October Journal.

Progress is Reported

The work of repairing and redecorating the Headquarters building is well under way. In fact by the time this report is read the staff should be back in possession of their quarters. For weeks possession seems to have been abandoned to the contractor and his hordes, and at times it looked as though it might never be regained. However, the dust has settled somewhat, scaffolding has been removed, tarpaulins have been lifted, and we have been allowed to gain a little of the lost territory.

Someone has said "You can't make an omelet without breaking eggs," from which it would appear that we must have a very large omelet under way. Work of this nature always brings a lot of confusion even in small doses, but when the entire building, both inside and out, is in process it becomes "confusion worse confounded." However, good progress is being made, and before long the objectionable features of such work will be removed and forgotten, and only the pleasant after effects will remain.

Members are urged to visit the "new" Headquarters, and see for themselves what has been taking place. It is expected that not only will the appearances be improved but the facilities also. You will be very welcome.

Presidential Visit to Western Branches

At the Council meeting on August 19th, President Challies outlined the tentative arrangements for his western trip. The itinerary is definitely decided upon but as each branch is in charge of its own arrangements and there has not yet been time to complete a programme, final details were still lacking. It was, however, announced that the visit to Regina would coincide with the annual open meeting of the Association of Professional Engineers of Saskatchewan, and that arrangements had been made that the two organizations would hold certain of their functions jointly.

At Vancouver, in addition to the branch activities, the party would participate in the Annual Western Meeting of the Canadian Institute of Mining and Metallurgy. The final programme of meetings and functions will be published just as soon as all details are determined, but in the meantime here is the itinerary.

Lv. Montreal	Monday	Oct. 24th
Ar. Ft. William	Tuesday	Oct. 25th
Lv. Ft. William	Wednesday	Oct. 26th
Ar. Winnipeg	Thursday	Oct. 27th
Lv. Winnipeg	Friday	Oct. 28th
Ar. Regina	Saturday	Oct. 29th
Lv. Regina	Sunday	Oct. 30th
Ar. Saskatoon	Monday	Oct. 31st
Lv. Saskatoon	Monday	Oct. 31st
Ar. Edmonton	Tuesday	Nov. 1st
Lv. Edmonton	Tuesday	Nov. 1st
Ar. Calgary	Wednesday	Nov. 2nd
Lv. Calgary	Thursday	Nov. 3rd
Ar. Lethbridge	Thursday	Nov. 3rd
Lv. Lethbridge	Thursday	Nov. 3rd
Ar. Calgary	Thursday	Nov. 3rd
Lv. Calgary	Thursday	Nov. 3rd
Ar. Vancouver	Friday	Nov. 4th
Lv. Vancouver	Friday	Nov. 4th
Ar. Victoria	Saturday	Nov. 5th
Lv. Victoria	Sunday	Nov. 6th
Ar. Vancouver	Monday	Nov. 7th

Remain in Vancouver until Friday, November 11th.

Hon. C. D. Howe Guest of Joint Meeting

Winnipeg engineers, to the number of two hundred, gathered at the Fort Garry hotel on Wednesday, August 3rd, to hear the Hon. C. D. Howe, Hon.M.E.I.C., speak on the Trans-Canada Air Lines. The occasion was a joint meeting of the Association of Professional Engineers of Manitoba and the Winnipeg Branch of The Engineering Institute of Canada.

Mr. Howe spoke very optimistically about the future of the Air Lines. He stated that the project would be a profitable aviation operation, and a great asset to the Post Office Department. He set October 1st as the probable date of inauguration of regular services. His confidence and enthusiasm were based partly on the very advantageous situation of the line, where the physical factors were favourable to successful operations. He referred particularly to the narrowness of the Rocky Mountains at the Crow's Nest Pass, and the absence of fog over the prairies and Northern Ontario.

He spoke of the advantages that an engineer has in dealing with such work as came into his department. He thought that such a post lent itself particularly to the qualifications of an engineer, and hoped and believed that for the future, engineers would continue to be placed in such positions.

The chairman of the meeting was E. P. Fetherstonhaugh, M.E.I.C., Dean of Engineering and Arthitecture at the University of Manitoba. P. Burke-Gaffney, President of the Association of Professional Engineers of Manitoba, introduced the guest of honour, and W. D. Hurst, A.M.E.I.C., chairman of the Winnipeg Branch of the E.I.C., offered the thanks of the meeting.

Changes in Service Involve Engineers

The recently announced promotions in the three branches of the Department of National Defence, affect several members of The Institute.

Air Commodore G. M. Croil, A.M.E.I.C., who is Senior Air Officer, becomes Air Vice-Marshal. A similar promotion goes to J. Lindsay Gordon, A.M.E.I.C., District Officer commanding Military District No. 10.

Group Captain E. W. Stedman, M.E.I.C., has been advanced to the rank of Air Commodore, and Wing Commander W. R. Kenny, A.M.E.I.C., has been made Group Captain.

It is also indicated that Major-General T. V. Anderson, A.M.E.I.C., is slated to succeed to the office of Chief of the General Staff.

Members of The Institute will be interested in these promotions, and will be pleased to know of the recognition that has come to their fellow members.

Fall Meeting of A.S.C.E.

Special invitations have been received by the President and Councillors and the General Secretary to attend the Fall Meeting of the American Society of Civil Engineers which is being held at Rochester, N.Y., on October 12th to 14th. Mr. Challies has already accepted the invitation, and will attend accompanied by Past-President J. M. R. Fairbairn, chairman of the Institute's Committee on International Relations, and the General Secretary. It is expected that several councillors will also be present. The meetings of the A.S.C.E. are always interesting and profitable, in addition to which visitors from Canada are made very welcome.

Erratum

We regret that in the August Journal on page 403, Dr. W. E. Cullen, was not given his correct title as President of the Institution of Chemical Engineers.

Joint Meeting at Sarnia

The London and Border Cities Branches are still busy on their plans for the big day on Saturday, September 24th. Considerable encouragement has come in the form of promised attendance from prominent members of many branches. Toronto, Hamilton, Niagara Peninsula, and the "Soo" will all be represented, along with a delegation from Headquarters.

In the morning there will be a trip of inspection of the Imperial Oil Refinery, and at one o'clock lunch at the golf club with an official of the Oil Company as speaker-guest. The afternoon starts out with an inspection of the new International Bridge, which in itself is an item of considerable interest. As you would expect, the day closes with a dinner. R. M. Smith, A.M.E.I.C., Deputy Minister of Highways, Province of Ontario, and President Challies will be the speakers, which seems to indicate that it will be a real occasion. Members from all branches will be very welcome.

OBITUARIES

John G. Sullivan, M.E.I.C.

With the death of John G. Sullivan in Winnipeg on August 7th, came to a close the career of one of the outstanding engineers of international reputation. Mr. Sullivan was born in the United States at Bushnell's Basin, N.Y., on January 11th, 1863, but lived in Canada almost continuously since 1893. In all that time he had been in the forefront of engineering progress and active in many projects having to do with the welfare of his community. He lived a full life and leaves behind him a country that is much better for his having been a citizen of it.

Shortly after graduating from Cornell University with the degree of C.E. in June 1888 he commenced railway work with the Great Northern Railway as rodman. He went to Washington Territory in the spring of 1889 and was engaged as instrumentman and assistant engineer, for the Spokane Falls and Northern Railway, until the fall of 1890 when he went to Seattle and was assistant engineer on the Pacific Extension of the Great Northern Railway.

He first came to Canada as assistant engineer on the Alberta Railway and Coal Company in July 1893. In 1894, all construction work having been stopped on account of a strike, he took a position as section foreman on the Northern Pacific Railway at Butte, Montana, which position he held for two or three months, after which he was engaged as locating engineer on the Butte Anaconda and Pacific Railway. In the spring of 1895 he began work as principal assistant engineer, on the Kaslo and Slocan Railway. The following year he became reconnaissance engineer for the Columbia and Western Railway, which subsequently became the property of the Canadian Pacific Railway.

From 1898 to 1900 he acted as principal assistant engineer on the construction of the Columbia and Western Railway and from 1900 to 1905 was division engineer of construction on the Canadian Pacific Railway; during this time he had entire charge of all surveys and construction on new lines built by the Canadian Pacific Railway, west of Fort William.

From 1905 to 1907 he was assistant chief engineer of the Panama Canal; his principal assignment being the excavation and disposition of waste from the Culebra Cut; but for three months while Mr. Stevens was in Washington, Mr. Sullivan was acting chief engineer in charge of all works. In the course of his duties on the Panama Canal, Mr. Sullivan designed details for the Lidgerwood Side Plow, which made the plow workable when operating flat cars with one solid side. As originally designed the plow would not work on a solid-side car in rock or boulders. His improvements increased the capacity of flat cars to 25 or 30 cubic yards, so that by reason of the long hauls involved, it was much more economical to use the plow and flat cars, than to use dump cars. The successful working of the improved plow and cars saved millions of dollars in the cost of canal excavation.

In 1907 Mr. Sullivan became manager of construction for the Eastern Lines of the Canadian Pacific Railway, and a year later was promoted to the position of assistant chief engineer for the Eastern Lines, with offices at Montreal. There being no chief engineer, he was in charge of the Engineering Department.

He was transferred in 1911 to the Western Lines of the Canadian Pacific Railway, as assistant chief engineer, with offices at Winnipeg. A few months later he was made chief engineer of the Western Lines, which position he held until 1915 when he was made chief engineer of the Canadian Pacific Railway. Although he resigned this appointment in 1918, he was retained as consulting engineer until 1927.

Beginning with the year 1911, there was a rapid growth of railways in the west; and during some of the years of Mr. Sullivan's tenure of office, as much as fifty million dollars per annum was spent for betterments and new lines under his direction. In the construction of the Connaught Tunnel, the plan of driving a centre heading was adopted. This was devised by Mr. Sullivan. With reference to this feature, the *Engineering News* of January 11th, 1917, made the following editorial comment:

> "A few months back, the completion of the Rogers Pass (Connaught) Tunnel, a sound-rock tunnel, signalized the brilliant success of a radically novel method of attack in rock. The system of blasting in rings from a central pilot tunnel, a bold innovation, was the key to success. Though centuries of prior art in rock tunnelling were available, sound engineering in this case lay, in abandonment of precedent."

In 1916 the Canadian Pacific Railway Company permitted him to act as a member of the special board of consulting engineers reporting on the design of the aqueduct for the Greater Winnipeg Water District. After retiring from the Canadian Pacific Railway he engaged in consulting work in Winnipeg, alone and later in partnership. For some years he was president of the firm of Sullivan, Kipp and Chace in that city.

Since 1918 he had varied experience, acting as arbitrator in labour disputes, as arbitrator between railways, and in an advisory capacity on engineering projects. Notes on some of this work are quoted below.

From 1919 to 1922 he was chairman of the Manitoba Drainage Commission, whose report was finally adopted by a committee of the local legislature, although not all of its recommendations were adopted by the government. In 1919 he reported to the Minister of Public Works of Manitoba on the economics of the proposed government electric power distribution system. During 1920 and 1921 he was retained by the Dominion Government as consulting engineer in the arbitration between the Government and the Grand Trunk Railway Company.

In 1922 he reported to the Premier of British Columbia on the physical and economic features of the Pacific Great Eastern Railway. In the following year he was a member of the commission appointed by the Government of Manitoba to study and report as to the policy the Government should adopt with regard to the Provincial Hydro System.

In 1924 he reported to the Southern Railway Company on the economics and revision of that company's line between Cincinnati and Chattanooga. The result of this report was a radical change of the policy of the Southern Railway in connection with the proposed plans for this line.

In the same year he reported to Price Brothers Company on the method to be adopted in protecting their paper mill plant at Kenogami from slides which threatened the plant. The protection works suggested by Mr. Sullivan were carried out.

He was appointed in 1925 as a member of a Board of Engineers to make a joint report to the Presidents of the Canadian Pacific and Canadian National Railways, on the railway situation in the Peace River country. The result of this report has undoubtedly saved the expenditure of several millions of dollars before the development of the country would justify such expenditure. In the same year he was retained by a firm of consulting engineers in London, England, who had charge of a private bill proposing a vehicular tunnel between Liverpool and Birkenhead, under the Mersey river, to give testimony before a Parliamentary Committee. The applicants were successful and the tunnel has been constructed.

In 1926 he was retained by the Denver and Salt Lake Railway Company to report and advise on the practicability of ventilating the Moffat Tunnel, to permit of the operation of steam locomotives. The tunnel having been ventilated in accordance with the plans proposed by Mr. Sullivan, steam locomotives are now being successfully operated through it.

He joined The Institute, then the Canadian Society of Civil Engineers, as a Member in 1900. He served on Council in 1910 and 1918, as Vice-President 1911-1913 and was President of The Institute in 1922. His interest in and services to the Winnipeg Branch were continuous. The Sir John Kennedy Medal for 1936 was presented to Mr. Sullivan. This gold medal established in commemoration of the great services rendered to the development of Canada, to engineering science and to the profession by the late Sir John Kennedy, Past-President of The Institute, is the highest honour which The Institute can bestow.

He is survived by two sons, Paul L. of Montreal and John T. of Temagami, Ont., and two daughters, Mrs. K. L. Puestow, Madison, Wis., and Mrs. John R. Lindsay, Winnipeg.

Walter Atkyns Ervine-Grim, M.E.I.C.

Members will learn with regret of the death of Captain Walter Atkyns Ervine-Grim, M.E.I.C., in Tampico, Mexico, on July 8th. Captain Ervine-Grim was born at Stratford, Ont., November 11th, 1880. His first engineering experience was gained with the Grand Trunk Pacific Railway on construction. In 1906 he became resident engineer with this company, then in 1907 he was transferred to their Mountain Division. After two years in this position he was again transferred to the Prairie Division. In 1912 he moved to Vancouver, B.C., as assistant engineer with the Western Canada Power Company.

Captain Ervine-Grim was on active service overseas from 1914 to 1919, being attached to the 16th Battalion of the Canadian Scottish from 1914 to 1917 and to the Canadian Engineers from 1917 to 1919. He enlisted as a private, was commissioned lieutenant in 1915 and was made a captain in 1917 when he was transferred to the Canadian Engineers.

In 1920 he went to Los Mochis, Mexico, as engineer in charge of standard gauge railways and irrigation system for the United Sugar Companies. After acting for some time as secretary of the Rockefeller Foundation Commission at Colima, Col., he was later connected with the Pan American Petroleum and Transport Company, Tampico, Mexico, and then with the Huasteca Petroleum Company of the same place. In 1928 he went to Maracaibo, Venezuela, S.A., with the Lugo Petroleum Corporation. In 1931 he returned to Tampico and was engaged in private practice as a consulting engineer at the time of his death.

Captain Ervine-Grim joined The Institute as an Associate Member in 1909, becoming a Member in 1919.

PERSONALS

W. S. Lea, M.E.I.C., **T. J. Lafreniere**, M.E.I.C., and **Ernest Gohier**, M.E.I.C., have been appointed by the Executive Committee of the city of Montreal as a committee of three to look into the project of building a new water intake at Ville LaSalle. The committee is to study both the urgency of the need of a new intake and the best method of constructing it.

Dr. H. G. Acres, M.E.I.C., Niagara Falls, Ont., has been appointed chief engineer of the Grand River Conservation Commission.

W. G. Murrin, M.E.I.C., president of the British Columbia Electric Railway Company Limited, has been receiving congratulations on the occasion of the completion of twenty-five years of service with that company.

G. E. Elkington, A.M.E.I.C., has been appointed general manager and president of the East Kootenay Power Company. He was formerly operating engineer.

Sir Alexander Gibb, G.B.E., C.B., LL.D. (Edin.), F.R.S. and Hon.M.E.I.C., Past-President, Institution of Civil Engineers, has recently had the honorary degree of LL.D. conferred upon him by the University of Edinburgh.

Frederick E. Bronson, M.E.I.C., has been elected president of the Ottawa Light, Heat and Power Company, Limited; the Ottawa Electric Company and the Ottawa Gas Company at a meeting of the directors of the three companies. He succeeds the late Hon. Thomas Ahearn.

A. E. K. Bunnell, M.E.I.C., is now president and general manager of Canadian Ventilating Shades Limited, Toronto.

T. M. Moran, A.M.E.I.C., Factory Manager of the Dominion Rubber Company, Limited, Montreal, will be one of the accredited delegates of The Institute attending the Seventh International Management Congress at Washington, September 19th to 23rd. Mrs. Moran will accompany him.

E. M. L. Burns, M.E.I.C., Works Manager of the Welland Plant, Canada Foundries and Forgings Limited, will be one of The Institute members attending the Seventh International Management Congress at Washington, September 19th to 23rd. Mrs. Burns will accompany him.

Secretary Emeritus **R. J. Durley** is now sufficiently recovered that he has been able to take a trip to the Maritimes. He will spend some time at Guysboro, N.S., after which he plans to visit in Sydney. From there he goes to Cambridge, Mass., to represent the Institution of Civil Engineers at the Fifth International Congress for Applied Mechanics on September 12th to 16th.

T. R. Durley, A.M.E.I.C., has been transferred to Montreal by the Canada Cement Company from Belleville, Ont., where he has been since 1935 at the Company's Plant No. 5. Since Mr. Durley's graduation from McGill University in 1928 he has been connected with the Canada Cement Company except for a few years spent with the General Electric Company at Schenectady and Philadelphia, and with the Canadian General Electric Company at Peterborough, Ont.

J. A. MacKenzie, A.M.E.I.C., division engineer, Trenton Division, Canadian Pacific Railways, has been promoted to the position of assistant engineer maintenance-of-way for eastern lines. He will be located at Toronto, Ont.

D. R. Smith, A.M.E.I.C., has been made Director of Works for the City of Saint John.

S. C. Carver, A.M.E.I.C., has been made assistant engineer, Public Works Department, Basutoland, South Africa. He has been in South Africa since March 1938, having been stationed at Mbabane, Swaziland, prior to his appointment at Maseru, Basutoland. He graduated from the University of British Columbia in 1929 and went to Glasgow, Scotland, where he was assistant designing engineer with Fleming Brothers, structural engineers.

David Hutchison, A.M.E.I.C., has been appointed manager of Mackenzie River Transport, Hudson Bay Company, and will be located in Winnipeg, Man. Prior to accepting this position he was construction superintendent of the Power Corporation of Canada, Montreal.

E. J. Davies, A.M.E.I.C., has accepted the position of principal of the Port Arthur Technical and Commercial High School, Port Arthur, Ont. He has been Director of Industrial Arts, Cornwall Collegiate Vocational School, Cornwall, Ont., for the past year.

W. U. Shaw, A.M.E.I.C., is now with the engineering division of the National Steel Car Corporation Limited, Malton, Ont. He was formerly chief engineer, Fairchild Aircraft Company, Longueuil, Que. Mr. Shaw is a graduate of Toronto University of the class of 1925.

William E. Ross, A.M.E.I.C., has been made manager of the apparatus sales department of the Canadian General Electric Company with headquarters at Toronto, Ont. Mr. Ross was formerly manager of the contract service department.

A. B. Sanborn, general manager and president of East Kootenay Power Company, has been elected president of the Northwestern Public Service Company.

Leo Hunt has recently been appointed lighting specialist of the Calgary Power Company.

Visitors to Headquarters

Leslie Gordon Jost, M.E.I.C., interrupted a nine thousand mile motor jaunt to visit The Institute in Montreal. He was on his way from Los Angeles to his old home at Guysboro, N.S., which he has not seen for twenty years. He has been in the structural steel business in Los Angeles for a great many years. He is enjoying the experience of looking up old friends and renewing acquaintanceships that have been neglected for years. His next points of call were Shawinigan Falls and Quebec. Address—8342 Kirkwood Drive, Los Angeles, Cal.

Councillor **R. A. Spencer**, A.M.E.I.C., Professor of Civil Engineering at the University of Saskatchewan, was in Montreal for the week of August 15th. He had conferences with the President and several councillors throughout the week and attended the Council meeting of August 19th, where the Saskatchewan agreement and other western topics were up for discussion. Montreal marks the easterly limit of his motor trip upon which he has been accompanied by Mrs. Spencer and his three children.

B. E. Bayne, A.M.E.I.C., councillor for Moncton, was in Montreal for the August council meeting, and spent Saturday morning at Headquarters discussing the branch programme for the coming season. He has some excellent ideas on this subject, which should be very valuable to the branch.

K. S. LeBaron, A.M.E.I.C., Councillor for the St. Maurice Valley Branch, was in Montreal on August 19th for the Council meeting.

Norman Marr, M.E.I.C., Chief Hydraulic Engineer, Dominion Water and Power Bureau, Department of Mines and Resources, Ottawa, dropped in on June 28th to talk about Institute affairs.

Robert F. Legget, M.Eng., A.M.E.I.C., recently appointed Assistant Professor of Civil Engineering at Toronto, has been in several times during the week of July 17th to consult the library. He was the luncheon guest of Councillor Fred Newell at the Mount Stephen Club on the 21st.

P. G. Gauthier, M.E.I.C., has been with the Ontario Paper Company Ltd. at Baie Comeau for two and a half years as townsite engineer. He recently returned to Montreal for his vacation, but will be back on the job again within a few weeks time.

Sidney Hogg, A.M.E.I.C., past chairman of the Saint John Branch, spent part of his vacation in Montreal which gave him an opportunity to drop in a few times at 2050 Mansfield Street and discuss Institute affairs. He is with the Saint John Drydock and Shipbuilding Co. Ltd.

A. Leslie Denton, Jr.E.I.C., was in Montreal for a few days in July. He has been with the Lamaque Mining Company, Limited, for five years where he is now instrumentman. Address—c/o Company, Bourlamaque, Que.

W. E. Weatherbie, Jr.E.I.C., was here on August 1st during his vacation. He is with the Department of Highways, N.S., and lives at Truro.

Recent Graduates in Engineering Additional List

Congratulations are in order to the following Associate Members, Juniors and Students who have completed their course.

Royal Military College

Prizes and Honours

Brown, M. C. Sutherland, Victoria, B.C.—Diploma; The Tommy Smart Cup.

Drury, Chipman Hazen, Montreal, Que.—Diploma; Honours; Sword of Honour for Conduct and Discipline; His Excellency The Governor-General's Silver Medal; Toronto Branch Trophy; First-Class Prize in Chemical Engineering; His Royal Highness The Prince of Wales Cup, and the Large Bexhill Cup.

Hyman, Ernest Roy, Winnipeg, Man.—Diploma; Honours; His Excellency The Governor-General's Gold Medal; First-Class Prize in Civil Engineering (including Mining).

Diplomas

Hall, Gordon Hudson, Peterborough, Ont.
Joyce, William Anderson, Kingston, Ont.
Lantier, Joseph Antoine Jacques Dunn, Kingston, Ont.
Mackenzie, Robert Kenneth, Kingston, Ont.
McNaughton, Andrew Robert Leslie, Ottawa, Ont.
Magee, Edward Desmond Boyd, Toronto, Ont.
Roy, Joseph Albert Maurice, Quebec, Que.
Spencer, George Hylton, Kingston, Ont.
Stephenson, John Gay, Windsor, Ont.
Thompstone, Robert Edward, Kingston, Ont.

ELECTIONS AND TRANSFERS

At the meeting of Council held on August 19th, 1938, the following elections and transfers were effected:

Member

RAYMENT, Arthur Charles, (Armstrong College), associate engineer, R. A. Rankin and Associates, Montreal, Que.

Associate Member

CONROD, Gerald Rhodes, B.Sc., (Dalhousie Univ.), wire and cable sales engr., Northern Electric Co. Ltd., Toronto, Ont.

Juniors

BARRETT, Michael Joseph, B.Eng. (Mech.), (N.S. Tech. Coll.), engrg. dept., Sun Life Assurance Company of Canada, Montreal, Que.

HORN James Gordon, B.Sc. (Elec.), (Univ. of Man.), student ap'tice, A. Reyrolle & Co., Hebburn-on-Tyne, England.

MITCHELL, David Alexander, B.A.Sc. (Elec.), (Univ. of Toronto), 29 St. Joseph Street, Toronto, Ont.

ROBINSON, Gordon Milford, B.A.Sc. (Civil), (Univ. of Toronto), 28 Scott St., Brampton, Ont.

SHERWOOD, Marvin Lorne, B.A.Sc. (Mech.), (Univ. of Toronto), district plant engr., The Barrett Co. Ltd., Montreal, Que.

Transferred from the class of Affiliate to that of Member

HARDING, Charles Percy, 69a St. Germain Blvd., St. Laurent, Que.

Transferred from the class of Student to that of Associate Member

INNES, Edward Patrick Nelles, B.Eng., (McGill Univ.), i/c engrg. dept., Canadian Canners Ltd., Hamilton, Ont.

Transferred from the class of Student to that of Junior

ARCHER, Maurice G., B.Eng. (Civil), (McGill Univ.), consltg. engr., Archer & Dufresne, Quebec, Que.

HAMILTON, William Garrison, B.Eng. (Mining), (McGill Univ.), Avon Gold Mines Ltd., Oldham, N.S.

PRESTON, William Walford, B.Sc. (Civil), (Queen's Univ.), struct'l. steel detailer, Hamilton Bridge Company, Hamilton, Ont.

ST. JACQUES, Gustave Fernand, B.A.Sc., C.E., (Ecole Polytechnique), Quebec Public Service Commn., Quebec, Que.

Students Admitted

BRANNEN, Arthur Douglas, B.Eng. (Civil), (N.S. Tech. Coll.), office engr., Engineering Service Co. Ltd., Halifax, N.S.

CONKLIN, Maurice William Murch, B.Eng. (Mech.), (Univ. of Sask.), junior engr., Algoma Steel Corporation, Sault Ste Marie, Ont.

CORBETT, Horace Kenneth, B.Sc. (Civil), (Univ. of N.B.), senior plant inspr., Milton Hersey Company, Fredericton, N.B.

MACKINNON, Donald Lauchlan, (Univ. of N.B.), asphalt paving inspr., Milton Hersey Company, Fredericton, N.B.

POLISKIN, Jacob, B.Sc. (Chem.), (Queen's Univ.), 691 George St., Sydney, N.S.

ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

American Standards Association: Year Book 1938.
Institution of Civil Engineers: List of Members, July 1938.

Reports, etc.

Canada Bureau of Mines: Investigations in Ore Dressing and Metallurgy, January to June, 1937.

Canada Mines and Geology Branch: Milling Plants in Canada, Pt. 1 Operators of Concentrating Mills Treating Metallic Ores.

Edison Electric Institute Electrical Equipment Committee, Apparatus and Design Division: Design of Switchhouses for Generating Stations and Transmission Substations.

Electrochemical Society: Anodic Behavior in Cyanide Copper Plating Baths; The Electrochemistry of Corrosion; A Theory of Cathodic Protection; The Effect of Pressure on the Passivity of Various Metals; Ethylene Diamine as an Ionizing Solvent; The Electrodeposition of Silver from Solutions of Silver Nitrate in the Presence of Addition Agents. (Preprints 74-1 to 74-6.)

India Forest Research Institute: Ascu—A Wood Preservative (Indian Forest Records, vol. 1, No. 6).

Institution of Civil Engineers: Kelvin Medal 1938, Report of the Proceedings at the Presentation on May 3rd, 1938.

International Joint Commission: Champlain Waterway; Richelieu River Remedial Works.

Ontario Department of Mines: Forty-Sixth Annual Report, 1937.

Ontario Hydro Electric Power Commission: List of Electrical Equipment, 4th ed. 1938.

U.S. Department of Commerce: List of Publications.

U.S. Department of the Interior: Geology and Fuel Resources of the Southern Part of the Oklahoma Coal Field, Pt. 3 Quinton-Scipio District; Preliminary Report on the Alunite Deposits of the Marysvale Region, Utah; Spirit Leveling in Vermont 1896 to 1935; Geophysical Abstracts 10, July-September 1937; Structure and Gas Possibilities of the Oriskany Sandstone in Steuben, Yates, and Parts of the Adjacent Counties New York. (Geological Survey Bulletin 874-C, 886-D, 888, 895-C, 899-A.

Technical Books, etc.

U.S. Works Progress Administration. **Bibliography of Aeronautics,** Pt. 2 Meteorology; Pt. 8 Autogiros, Pt. 9 Helicopters, Pt. 10 Cyclogiros, Gyroplanes; Pt. 12 Landing Gears; Pt. 13 Refueling in Flight, Pt. Tailless Airplanes, Pt. 15 Airplane Catapults, Pt. 16 Airplane Carriers; Vibration and Flutter of Aircraft Wings and Control Surfaces.

The Cracking Art in 1937. By G. Egloff, M. M. Doty and J. F. Jordan. Chicago, Universal Oil Products Co., 1938. 397 pp. 9 x 6 in., paper.

Direct-Current Machinery. By Thomas C. McFarland. Scranton, International Textbook Company, 1938. 439 pp., illus., diagrs. 5½ x 8½ in., lea., $4.00.

This book is primarily designed for use in courses on direct-current machinery by students majoring in electrical engineering.

Electrical Engineering Practice, Vol. 1. By J. W. Meares and R. E. Neale. 5th ed. London, Chapman and Hall, 1938. 780 pp., illus., plates, tab. 9 x 5½ in., cloth, 25s.

A practical treatise for electrical, civil, and mechanical engineers, which is the first of the three volumes in this series.

The Elements of Ferrous Metallurgy. By J. L. Rosenholtz and J. F. Oesterle. 2nd ed. New York, Wiley, 1938. 258 pp., illus., diagrs. 9 x 6 in., cloth, $3.00.

Northern Trails. By S. C. Ells, 263 Adelaide St. W., Toronto, Industrial and Educational Publishing Co. Ltd., 1938. 250 pp., illus., $2.00 (post paid). Available in October 1938.

Reports Wanted

Any members wishing to dispose of the following publications at $5.00 a copy should get in touch with the General Secretary.

International Waterways Commission, Compiled Reports, 1905-1913.

International Waterways Commission, Report on the Regulation of Lake Erie, 1910.

The Principles of **Motor Fuel Preparation and Application**, Vol. 1. By Alfred W. Nash and Donald A. Howes. 2nd ed. New York, Wiley, 1938, 628 pp., illus., plates, diagrs., tab. 10 x 6 in., cloth, $9.50.

Structural Design. By Carlton T. Bishop. New York, Wiley, 1938. 254 pp., illus. 9 x 6 in., cloth, $3.50.

Transformer Engineering. By L. F. Blume, G. Camilli, A. Boyajian, V. M. Montsinger. N.Y. Wiley, 1938. 496 pp., diagrs., charts. 9 x 6 in., cloth, $5.00.

Welding Handbook, 1938. New York, American Welding Society, 1938. 1,200 pp., illus., diagrs., tab. 9¼ x 6 in., cloth, $5.00 (to members), $6.00 (to non-members in U.S.A.), $6.50 (to non-members elsewhere).

BOOK REVIEW

The Engineering Catalogue

The 1938 edition of The Engineering Catalogue (formerly issued as the E.I.C. Engineering Catalogue) is now being distributed, and copies are available as before to any members of The Institute whose work involves the specifying or purchasing of equipment and materials. Requests for copies may be sent to the publisher or to the General Secretary of The Institute.

It will be recalled that arrangements were made earlier this year whereby the publication of the Catalogue would be transferred to N. E. D. Sheppard, A.M.E.I.C., with the assistance of the same organization as was previously responsible for its production. In doing this, Council felt confident that the standard of production which had characterized the Catalogue in the past would be maintained, and this confidence seems to have been fully justified by the volume which has recently been completed. Not only is the product of the same excellent quality, but there is a marked improvement in the copy supplied by advertisers and in the variety of products illustrated and described.

For the past five years the Catalogue has provided a valuable service to engineers and others engaged in related work throughout Canada. The convenient arrangement of its contents and the dependability of its data have earned for it undisputed recognition as a reference book for information about equipment and materials in this country.

Trade Literature*

Earth Moving.—Actual job data and photographs make up this booklet just released on mining subjects by R. G. LeTourneau Inc., Peoria, Ill.

Laboratory Pulverizing Mill.—Combustion Engineering Corporation, Ltd. (Office: Dominion Square Building, Montreal) have issued a 4-page illustrated bulletin announcing the new "Raymond Laboratory Mill," which has been recently developed and placed on the market by their Raymond Pulverizer Division. The new mill is of extremely small capacity and is designed for the laboratory pulverizing of non-abrasive products.

Switchgear.—Bepco Canada Limited (Office: 1050 Mountain St., Montreal) have published a 6-page illustrated leaflet, No. f. 985, describing Crompton Tested Switchgear.

Industrial and Scientific Instruments.—Frederick C. Baker and Co. (Office: 229 Yonge St., Toronto) have issued an 8-page condensed catalogue illustrating and describing the industrial and scientific instruments sold by them.

Oil Seal.—The Garlock Packing Co. of Canada Ltd. (Office: 620 Cathcart St., Montreal) have available for distribution an attractively prepared 16-page booklet, "The Garlock Split-Klozure," describing this new patented Oil Seal. As indicated by its name, the Split-Klozure is split, or cut open. It is applied by placing it around the shaft in somewhat the same manner as an ordinary packing ring, instead of sliding it over the end of the shaft as is necessary with solid oil seals of the conventional type. The booklet deals with the design, usage, installation, and sizes, and contains several pages of drawings showing the application of the Split-Klozure.

Nickel Cast Iron Data.—New data sheets, designed to assist the engineer or designer in the preparation of specifications for Grey Cast Iron, have been issued by International Nickel Co. Ltd. (Office: 25 King St. W., Toronto), and provide an easy guide to the selection of the proper castings for a wide range of applications. A.S.T.M. tables are given with examples of their use.

In an introductory note, it is pointed out that while strength is essential and high strength can be secured by alloys, the wider combination of properties available through their use is of even greater value in many cases. Machinability, wearing properties, density or freedom from porosity may be more important than tensile strength.

Instruments for Remote Control.—In a new bulletin, No. 506, published recently by The Bristol Co. of Canada Ltd. (Office: 64 Princess St., Toronto), there is a brief description of Bristol's Metameter System for Telemetering and Remote Automatic Control. This system is illustrated by photographs and chart records which give a few of the interesting facts regarding an installation of these instruments for the Remote Automatic Control of Gas Distribution Pressure. The instruments used, automatically maintain the pressure in a gas distribution system at a constant value, regardless of load variation.

Large Induction Motors.—An interesting illustrated bulletin, No. 1750, is being distributed by the English Electric Co. of Canada Ltd. (Office: St. Catharines, Ont.), describing in detail the company's larger induction motors, ranging in sizes from 75 hp. to 1,000 hp. in three different types, open, protected, and large fabricated frames. Constructional details are clearly illustrated by close-up views and cross-sections and particular emphasis is given to large wound rotor motors for hoist service.

Practical Low-Cost Homes.—An 8-page booklet entitled "Practical Low-Cost Homes" has been issued by Gypsum, Lime and Alabastine, Canada, Ltd. (Office: 50 Maitland St., Toronto). In it are described and illustrated the design and construction of an inexpensive home built at Beachville, Ont. for the company's workmen. This actual record of construction cost and the low maintenance expense should prove of interest to many who have to deal with this problem.

Millivoltmeter Pyrometers.—A complete line of Millivoltmeter Pyrometers is described in a new bulletin, No. 486, recently published by the Bristol Co. of Canada (Office: 64 Princess St., Toronto). In this publication, 12 pages of useful information are given regarding the construction and operation of Bristol's Millivoltmeter Pyrometers in all models—a type of Pyrometer built by this instrument manufacturer for some 40 years. Data concerning the available ranges and drilling dimensions are also included. Several scales are reproduced in actual size. This line of Millivoltmeter Pyrometers includes: Indicator Controllers, with enclosed mercury contacts or solid metal-to-metal contacts; single point indicators and multiple-point indicators with rotary switch. These operate with standard thermocouples or Bristol's Ardometer Radioation Pyrometer Unit.

Steel Scaffold.—Concrete and Building Specialties, Ltd. (Office: 1101 Yonge St., Toronto) are distributing a 12-page illustrated booklet describing "Safeway Steel Scaffold."

Pipe.—A small but interesting 16-page booklet entitled "The Story of a Pipe" has been published by Doulton and Co., Ltd., Royal Doulton Potteries, Lambeth, London, S.E.I. The "story" outlines the many processes necessary before raw clay is converted into glazed stoneware pipes. Messrs Doulton and Co. are represented in Canada by C. Kirkland McLeod, Ltd., Keefer Bldg., Montreal.

Less Water Yet More Placeability.—The Master Builders Co. Ltd. (Office: Toronto) have recently issued a 24-page book dealing with "Pozzolith," which they state is "a combination of a ferric alumino silicate with early effective pozzolanic properties and a cement plasticizing agent," and which they announce is now available in dry form for the first time.

Salt.—"Salt Stabilization, Principles and Practice" is the title of a new publication of the Canadian Industries Ltd., Montreal. It consists of 24 pages and in a well illustrated text deals with the important place that salt-soil stabilization is now taking in modern highway construction programmes.

Preventing Weld Spatter from Adhering to Metals.—A new material (Glyptal No. 1294) has been announced by Canadian General Electric Co. Limited (Office: Beaver Hall Hill, Montreal) for the prevention of the adhesion of weld spatter to metals which are to be welded. This material, which can be used without harm on any metal surface, including polished stainless steel, will not produce carbon to make the weld hard or brittle, nor will it reduce ductility. Likewise, it will not give off smoke to fog up the atmosphere and it will not form gas pockets or cause the weld to be porous.

Calrod Heating Units.—A new high-speed, high-heat Calrod heating unit has been developed by General Electric engineers for industrial applications that require temperatures as high as 1,500 deg. F. Among the uses of the product are applications in high-temperature air heating, industrial ovens with air temperatures up to 1,000 deg. F., hotplates, and various metal surfaces. The units are manufactured at the Ward Street Works of Canadian General Electric.

*Copies of these publications may be obtained by writing to the companies mentioned.

Meetings

American Society of Civil Engineers—Fall Meeting, October 12th-14th, 1938, at Rochester, N.Y.

American Society of Mechanical Engineers—Fall Meeting, October 5th, 6th and 7th, at Provience, R.I.

Canadian Chamber of Commerce—1938 Convention, September 28th-30th and October 1st, at the Seigniory Club, Montebello, P.Q.

The Canadian Institute of Mining and Metallurgy—Annual Western Meeting, November 9th, 10th, 11th, at Vancouver. H. Mortimer Lamb, Vancouver Secretary, British Columbia Division.

Dix-Huitième Congrès de Chimie Industrielle — Nancy, France, September 22nd to October 2nd.

The Engineering Institute of Canada—Annual General and Professional Meeting, February 20th-22nd, 1939, at Ottawa.

Fifth International Congress for Applied Mechanics—September 12th-16th, Harvard University and the Massachusetts Institute of Technology, Cambridge, Mass.

The Seventh **International Management Conference**—September 19th-23rd, 1938, at Washington, D.C.

The Iron and Steel Institute, and The Institute of Metals (London, England), Autumn Meeting, September 22nd Quebec; 23rd Shawinigan Falls; 24th and 25th Montreal; 26th Ottawa; 28th and 29th Toronto. Canadian Institute of Mining and Metallurgy are acting as hosts for Canadian visit.

Additional information about any of these functions may be secured from the General Secretary.

BOOK NOTES

The following notes on new books appear here through the courtesy of the Engineering Societies Library of New York. As yet, the books are not in The Institute Library, but inquiries will be welcomed at Headquarters, or may be sent direct to the publishers:

Aircraft Year Book for 1938. Ed. by H. Mingos. 20 ed. New York, Aeronautical Chamber of Commerce of America, 1938. 518 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $5.00.

This annual provides a record of developments in aviation during the past year, both at home and abroad. The work of the army and navy, the activities of the various Federal agencies and commercial firms are reviewed. Chapters are devoted to notable flights, to air lines, private flying, airports, to novelties and other fields of interest. The book includes tables of aircraft specifications, descriptions of aircraft and engine designs, a chronology of events and records, an aeronautical directory and statistics of the industry.

Business Correspondence and Office Management. By E. A. Duddy, L. E. Frailey and R. V. Cradit. Chicago, American Technical Society, 1938. 234 pp., illus., charts, tables, 9 x 6 in., cloth, $1.75.

The business letter, its importance, analysis of problems, letter form, and the various kinds of letters constitute the first section of this book. The second is devoted to the modern scientific technique of office management, including organization principles, filing methods, business machines, and other miscellaneous office equipment.

Civil Engineering To-Day. By E. Cressy. London and New York, Oxford University Press, 1938. 158 pp., illus., diagrs., maps, 9 x 6 in., cloth, $1.50.

This small volume provides a popular account of some outstanding modern bridges, tunnels, waterways, harbors, dams, power plants, water supplies, irrigation projects, etc., with brief outlines of the history of progress in these works. Excellent photographs add to the attractiveness of the book.

Elementary Practical Mechanics. By J. M. Jameson and C. W. Banks. 4 ed., New York, John Wiley & Sons, 1938. 363 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $2.75.

In revising this work, the editor has made a number of changes designed to make the arrangement more convenient and to bring the text up to date. A new chapter on heat has been added and the chapters on motion and on work and energy have been expanded. Numerous additions and many new problems are included throughout. The book is designed primarily for elementary technical and manual training schools, and as an introductory course in engineering colleges.

Elementary Practical Physics. By N. H. Black and H. N. Davis. New York, Macmillan Co., 1938. 710 pp., illus., diagrs., charts, tables, 9 x 5 in., cloth, $2.00.

A textbook for high-school students by two authorities in the field of physics. The subject is presented thoroughly, in simple language, and the significance of each principle is illustrated by applying it to familiar applications. Numerous diagrams and examples are included, and a large supply of problems and questions.

The Evolution of Railways. By C. E. Lee. London, Railway Gazette, 1937. 64 pp., illus., diagrs., 9 x 6 in., cloth, 2s. 6d.

A history of permanent way from its earliest evidences in antiquity to the late 19th century, with particular reference to its development for the British mining and metallurgical industries.

Great Britain. Dept. of Scientific and Industrial Research. **Building Research Board Report** for the Year 1937. London, His Majesty's Stationery Office, 1938. 172 pp., illus., diagrs., charts, tables, 10 x 6 in., paper, 3s. 6d. [obtainable from British Library of Information, 270 Madison Ave., New York, $1.10].

This report includes a very complete summary of the investigations carried on during the year upon a wide variety of subjects connected with building. The topics discussed include Materials, the Structures and strength of materials, and the Efficiency of buildings from the point of view of the user. A list of the reports and papers emanating from the Board and its staff during the year is included.

Great Britain. Mines Dept. **Coal Mines Act, 1911. General Regulations** as to the **Installation and Use of Electricity** with Explanatory Notes. London, His Majesty's Stationery Office, 1938. 59 pp., diagrs., 10 x 6 in., paper, 1s. [obtainable from British Library of Information, 270 Madison Ave., New York, $0.35].

Complete instructions as to the kind, care and treatment, installation, and application of materials and equipment for electrical purposes, as set forth under the "Coal Mines Act." Various special contingencies are covered in appendices, and the style of type used indicates whether the particular regulation is applicable above or below ground or both.

Illustrierte Technische Wörterbucher, Deutsch-Englisch-Französisch-Italienisch-Spanisch-Russisch. Bd. 1: Maschinenelemente —Machine Elements—Éléments des Machines—Elementi di Macchine —Organos de Mequinas—Detali Mashin. Ed. by W. Eppner. 3 ed. rev. and enl., Berlin, VDI-Verlag, 1937. 438 pp., diagrs., 10 x 7 in., cloth, 36 rm. (27 rm. in U.S.A.).

This dictionary provides definitions of words and phrases relating to the elements of machines. About five thousand terms are included, with the synonyms in English, French, German, Spanish, Italian and Russian. Illustrations are used to clarify meanings. This edition has been entirely rewritten, is greatly enlarged and is improved in format. It is an invaluable addition to the series in which it is included.

An Introductory Course in **Physical Chemistry.** By W. H. Rodebush and E. K. Rodebush. 2 ed., New York, D. Van Nostrand Co., 1938. 468 pp., illus., diagrs., charts, tables, 9 x 5 in., cloth, $3.75.

This book provides a one-year course, intended for college students who have had the usual training in chemistry, a course in college physics and some practice in the use of the calculus. The text aims to present fundamental principles clearly and precisely, and at the same time to stimulate interest in the subject. This new edition has been thoroughly revised.

La **Maison Insonore.** By V. Gavronsky, T. Kahan and M. Blumenthal. Paris, Dunod, 1938. 119 pp., illus., diagrs., charts, tables, 9 x 6 in., paper, 38 frs.

This volume is a translation of "Das laermfreie Wohnhaus," issued by the Anti-Noise Technical Commission of the Society of German Engineers. The book affords a popular, yet accurate, description of the effect of noise upon human beings, of methods of measuring noise and of practical methods of insulating buildings, machines, etc.

Radio, a Study of First Principles for Schools, Evening Classes and Home Study. By E. E. Burns. 3 ed., New York, D. Van Nostrand Co., 1938. 293 pp., illus., diagrs., charts, tables, 8 x 6 in., cloth, $2.00.

This book is based upon material used in teaching boys of sixteen to eighteen years of age. It aims to present the fundamental principles of electricity as applied in radio as simply and clearly as possible, as a basis for further theoretical and practical study. The new edition has been thoroughly revised. Obsolete matter has been replaced by new developments, including a chapter on television.

Solvents. A Series of Monographs on Applied Chemistry, Vol. 4. By T. H. Durrans, ed. by E. H. Tripp. 4th rev. and enl. ed., New York, D. Van Nostrand Co., 1938. 238 pp., diagrs., tables, cloth, $5.00.

This monograph is concerned with the technical application of solvents, especially in connection with the cellulose-lacquer industry, and attempts to present clearly and concisely the great mass of information scattered through the literature. Part one deals broadly and simply with such fundamentals as solvent action and power, plasticizing solvents, solvent balance, viscosity, vapor pressure and inflammability. Part two deals comprehensively with individual solvents. A list of trade names is appended.

Strength of Materials. By N. C. Riggs and M. M. Frocht. New York, Ronald Press Co., 1938. 432 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $3.75.

This book is intended for use in a first course in the subject and is designed for students with a knowledge of the calculus and the fundamentals of statics. Unusual features are a brief treatment of the theory and application of photoelasticity to the study of stresses, and the inclusion of curves giving the factors of stress concentration. The authors have endeavored to produce a unified, teachable text which stresses fundamental principles and illustrates the applications of the theory by numerous practical problems.

Symposium on Plastics. Rochester Regional Meeting, March 9, 1938. Phila., Pa., American Society for Testing Materials. 51 pp., illus., diagrs., charts, tables, 9 x 6 in., paper, $0.75; to members, $0.50.

BRANCH NEWS

Sault Ste. Marie Branch

N. C. Cowie, Jr.E.I.C., Secretary-Treasurer.

The young engineer and his needs, and the status of the engineering profession in Canada were discussed by J. B. Challies, M.E.I.C., President of The Engineering Institute of Canada, while addressing the members of the Sault Ste. Marie Branch of The Engineering Institute at a dinner meeting held at the Sault Ste. Marie Country Club on Wednesday, July 20th, 1938.

That engineers and the engineering profession had not advanced as it should was an opinion that has been expressed by some, Mr. Challies said, but he believed that good progress was and is being made by the profession in Canada. To illustrate this the speaker said that at Confederation in 1867 there was no engineering college or no professional faculty at any school then in existence in Canada. Today, however, there are 11 recognized engineering faculties in Canada and 3,517 students studying engineering courses. There was no professional engineering association of any kind in Canada 53 years ago. This was, the speaker said, because there were few if any professional engineers in Canada at that time. Last year The Engineering Institute of Canada celebrated the Semicentennial of its founding as the Canadian Society of Civil Engineers and was now honoured by other engineering and associated bodies throughout the world. In 1903, when the speaker entered the civil service, engineers filled jobs such as clerks and many outstanding engineering positions were not held by qualified engineers but by men who had little or no recognized engineering standing. At that time, Mr. Challies said, the engineer was not recognized in the federal civil service.

The credit for changing this situation belonged to Sir Wilfrid Laurier, the speaker said. He created the Civil Service Commission and set up the principle that men were to be advanced on merit and in so doing recognition of merit was to be made, university men were to be recruited and that the wishes of the politicians were to be ignored. One of the first steps of the Civil Service Commission was to recognize engineering as a profession and today no person can obtain an engineering position under the government unless he is fully qualified to hold it.

Fifteen years ago there was no professional engineers' association, and the founding of these associations in the various provinces was instituted and nurtured to a great extent by The Engineering Institute of Canada. Today these associations are endeavouring to protect the public from the unqualified and the charlatan as are the Bar and Medical Societies, for those other professions.

To summarize his remarks Mr. Challies expressed the opinion that engineering as a profession has not lagged behind the needs of the Dominion.

Speaking of The Engineering Institute of Canada, Mr. Challies said that this body was never in a better financial position. It had experienced growing pains, he said, but that was in itself evidence that The Institute was very much alive and expanding as the needs of the profession required it.

One of the real problems now confronting the engineering profession in Canada, and one that The Engineering Institute of Canada now had under consideration, was the needs of the young engineers and the young undergraduate engineers. In the past there has been a tendency to neglect this phase of the work, Mr. Challies said, but happily that day is rapidly passing. It is the aim of The Institute now to contact the younger men and by the co-operation of the older engineers to give them the advice, counsel and aid in their work that would be of very great assistance to them during the years following the completion of their university studies.

In order to assist in this work it was his opinion, Mr. Challies said, that engineers should first associate themselves with the professional engineers association and later affiliate with The Engineering Institute of Canada as they progressed in their profession. Membership in the elder parent engineering societies of Great Britain, the speaker felt, would be of value to the older members of the profession.

Mr. Challies was introduced to the meeting by John L. Lang, M.E.I.C., Councillor of the Sault Branch. The appointment of Mr. Challies as President of The Engineering Institute of Canada was no departure from the precedent of selecting outstanding men in their fields to lead The Institute, Mr. Lang said. Mr. Challies has had a long and distinguished career, first in the government service and later with the Shawinigan Water and Power Company of Montreal. He has built for himself a record as an outstanding engineer not only in Canada but throughout the world. Mr. Lang also mentioned the fact that in recognition of his accomplishments the University of Toronto would, this fall, confer on Mr. Challies the degree of Doctor of Engineering.

J. S. Macleod, A.M.E.I.C., chairman of the Sault Ste. Marie Branch, presided at the meeting. It was at his request that Mr. Lang introduced the speaker, and following Mr. Challies' address, Mr. Macleod had the pleasure of extending to the speaker the thanks of the meeting as expressed on a motion of Wm. Seymour, M.E.I.C., seconded by F. Smallwood, M.E.I.C.

The general meeting concluded a memorable day for the Sault Ste. Marie Branch of The Institute. Mr. Challies entertained the executive of the Branch at luncheon at noon. At this gathering many problems now before The Institute were explained and described by Mr. Challies. The remainder of Mr. Challies' visit to Sault Ste. Marie was spent in renewing and making acquaintance among the members of the Branch.

Saguenay Branch

Charles Miller, A.M.E.I.C., Secretary-Treasurer.
J. W. Ward, A.M.E.I.C., Branch News Editor.

The regular monthly meeting of the Saguenay Branch was held at the main office of the Aluminum Company of Canada, on June 22nd, 1938. Approximately 40 members and guests were present.

Mr. R. H. White, Manager and Vice-President of the Canadian Abrasives Company, Ltd., addressed the meeting on "Manufacture of Electric Furnace Abrasives." He gave an interesting history of the industry and described the development of the modern furnace.

Mr. White described the plant at Arvida. After the meeting an interesting discussion took place. Mr. Whitaker moved a vote of thanks.

A meeting of the executive of the Saguenay Branch was held immediately after the general meeting on June 22nd. The following members were present: Messrs. M. G. Saunders, Vice-Chairman; J. S. Fisher, M.E.I.C.; R. Rimmer, A.M.E.I.C.; A. C. Johnston, A.M.E.I.C.; Charles Miller, Secretary-Treasurer.

The minutes of the last executive meeting were read by the Secretary. Mr. Johnston moved and Mr. Rimmer seconded the motion that the minutes be adopted as read.

Mr. Fisher, chairman of the Annual Meeting committee, reported that they advised that the annual meeting be held in Arvida. The tentative date set was July 13th. The programme suggested was:—

2.00 p.m. Tour through plants of Aluminum Company and Canadian Abrasive Company.
Golf tournament.
7.30 p.m. Dinner at Staff House.

In line with Mr. Lawton's suggestion about the centenary celebrations in the Saguenay district, it was decided to have some of the older engineers in the district give a talk on early engineering in the Saguenay. The names of Messrs. Pelletier, Lavoie, Grenon and LaMothe were suggested.

The annual meeting of the Saguenay Branch was held at Arvida during the afternoon and evening of July 13th, 1938.

After a short business meeting and a highly instructive tour of the extensive additions to the Aluminum Company of Canada Ltd. works and the new plant of the Abrasive Company of Canada, some thirty-five members adjourned to the Saguenay Country Club. Golf and appropriate refreshments were provided.

Some forty members sat down to a most enjoyable dinner, the Branch Chairman, F. L. Lawton, M.E.I.C., presiding. Guests at the head table included Messrs R. E. Powell and O. M. Montgomery, President and Vice-President respectively of the Aluminum Company of Canada, Ltd., R. H. White, Vice-President and General Manager of the Abrasive Company of Canada, McNeely DuBose, General Superintendent of the Saguenay Power Company, and Major Flynn, General Superintendent of Price Bros. Company, Kenogami.

The toast "Our Guests" was proposed by James Shanly in characteristic style, while Major Flynn proposed "The Engineering Profession" in his own inimitable way.

This being the one hundredth year after the first settlers arrived in Grande Baie, the Chairman sketched briefly the early engineering developments in the "Kingdom of the Saguenay." G. F. Layne, A.M.E.I.C., one of the first branch chairmen very ably portrayed the part played by the "House of Price" in developing the paper industry. S. J. Fisher, M.E.I.C., dealt with the engineering problems met with in designing the very efficient and economical newsprint mill of the Lake St. John Power and Paper Company at Dolbeau.

A. W. Whitaker Jr., M.E.I.C., after remarking aluminum was discovered about the same time as the Saguenay was opened to development by the arrival of the first settlers, proceeded to discuss the engineering aspects of the Arvida works and the recent additions. Mr. R. H. White referred to the great promise the Saguenay held forth for the future, and to the need for the United States and Canada to work for peace and security in the world. Mr. McNeely DuBose, in telling of the early developments in hydro-electric power in the Saguenay, noted the first electric power for domestic use became available about 1895.

After paying tribute to Sir William Price as the "Father of Industrial Development" in the Saguenay, Mr. R. E. Powell very ably drew attention to the struggle between totalitarian and democratic states, and the necessity for the engineering profession, especially the younger men, to take a more definite interest in foreign trade and the political problems of our country.

The scrutineers' report on the election of officers was then given: Chairman, M. G. Saunders, A.M.E.I.C.; Vice-Chairman, Adam Cunningham, A.M.E.I.C.; Sec.-Treasurer, F. T. Boutilier, A.M.E.I.C.; Executive Committee, F. L. Lawton, M.E.I.C.; R. H. Rimmer, A.M.E.I.C.; A. B. Sinclair, A.M.E.I.C.; G. F. Layne, A.M.E.I.C.; Ex-Officio, A. C. Johnston, A.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.

Notices appearing in the Situations Wanted column will be discontinued after three insertions, and will be re-inserted after a lapse of one month, upon request.

All correspondence should be addressed to

The Employment Service Bureau, The Engineering Institute of Canada

2050 Mansfield Street, Montreal

Vacancies

ROYAL CANADIAN AIR FORCE

The following information has been sent to The Institute by the Department of National Defence "Air Force" which will be interesting to members who have any idea of following a career in the Royal Air Force or the Royal Canadian Air Force. A supply of pamphlets outlining the conditions of eligibility, method of selection, etc., together with application forms is at Headquarters for distribution to members.

There are a number of vacancies for appointments to Permanent General List Commissions in the Royal Canadian Air Force and one vacancy for appointment to a Permanent Commission in the General Duties Branch of the Royal Air Force.

The next Ab Initio Flying Training Course for candidates selected for Permanent General List Commissions in the Royal Canadian Air Force and in the General Duties Branch of the Royal Air Force will commence on November 1st, 1938, at R.C.A.F. Station, Trenton, Ont.

Candidates should be directed to submit their applications to the District Officer Commanding the Military District in which they are resident, prior to October 1st, 1938. Such applications should be accompanied by a Birth certificate, two certificates of moral character, and proof of graduation from the Royal Military College or University.

Situations Wanted

ENGINEER, A.M.E.I.C., Combustion specialist heat balance. Steam, Mechanical. Refrigeration. Office routine. Correspondence. Plant layout. Apply to Box No. 5-W.

ELECTRICAL ENGINEER, JR.E.I.C., B.SC.; age 31; at present employed, desires change in location. Experience includes; three summers experience in power conduit construction; two years in telephone engineering; four years experience in radio, both development engineering and production; two and one half years in a paper mill on electrical maintenance, with a short time in the cost accounting and draughting departments. Would be interested primarily in electrical maintenance. Apply to Box 12-W.

PAPER MILL ENGINEER: B.A., B.A.SC. Married. Age 34. A.M.E.I.C. Ten years experience in paper mill costs, maintenance, design and construction. Now employed as cost engineer in Southern States. Hard worker with excellent references. Available immediately. Apply to Box No. 150-W.

SALES ENGINEER REPRESENTATIVE. Mechanical graduate with fifteen years experience in Eastern Canada in sales and service of mechanical equipment; full details upon request to Box No. 161-W.

MECHANICAL ENGINEER, JR.E.I.C., with thorough training in England and wide experience for past eight and a half years in Canada, is seeking a permanent position as mechanical engineer in an industrial plant. Has had varied experience in mechanical engineering, heating, ventilating and power plant equipment. Excellent references. Apply to Box No. 270-W.

ENGINEER-DRAUGHTSMAN, experienced in design of machines for widely varied purposes and arrangement of motor drives. Accustomed to layout of small mill buildings, steel and timber. Good references. Present location Montreal. Apply to Box No. 329-W.

CIVIL ENGINEER, M.A.SC., A.M.E.I.C. eight years survey and municipal engineering experience, and three years draughting, detailing steel, concrete, and timber structures. Apply to Box No. 467-W.

PAPER MILL ENGINEER. If you are willing to pay around $5,000 per year for the services of an engineer, age 36, with twelve years experience in paper mill design, construction and operation, apply to Box No. 482-W.

CIVIL ENGINEER, B.SC. (McGill '20), A.M.E.I.C. Married. Twelve years experience in pulp and paper mill design, and six years general construction. Available immediately. Location immaterial. Apply to Box No. 547-W.

Situations Wanted

CIVIL ENGINEER, B.A.SC., A.M.E.I.C. Married. Experienced in engineering and architechtural design and in supervision, office management, etc., wants to round out experience in the contracting field. Ten years experience since graduation. Present location Toronto. Apply to Box No. 576-W.

ELECTRICAL ENGINEER, B.SC. E.E., Age 39. Married. Seven years experience in operation, maintenance and construction of hydro-electric plants, and sub-stations. Five years maintenance and installation of pulp and paper mill electric equipment. Reliable and sober, with ability to handle men. Best references. Any location, at once. Apply to Box No. 636-W.

ELECTRICAL AND CIVIL ENGINEER, B.SC. Elec. '29, B.SC. Civil '33. JR.E.I.C. Age 32. Experience includes four months with Can. Gen. Elec. Co., approximately three years in engineering office of large electrical manufacturing company in Montreal, the last six months of which were spent as commercial engineer, also experience in surveying and highway work. Year and a half employed in electrical repair. Best of references. Apply to Box No. 693-W.

CIVIL ENGINEER, B.A.SC. (Toronto '27), age 34, married. Five years railway and construction work as building inspector and instrumentman. Level engineer and on construction of a long timber flume for a pulp and paper mill. Field engineer for a sulphite company, in charge of the following mill buildings, acid, digester, blow pit, barker room, chip storage and acid towers. Available immediately. Apply to Box No. 714-W

ELECTRICAL ENGINEER, B.SC. '31 (U.N.B.), JR.E.I.C. Age 30 years. Single. Experience in electrical wiring, construction of concrete wharves, inspection of piling, rip rap, concrete reinforcing, forms, and dredging. Also junior engineer. Available at once. Apply to Box No. 722-W.

CIVIL ENGINEER, B.SC., M.SC., P.P.E.; Lieut. C.E., R.O. Sixteen years municipal, highway and construction. Five years overseas. Married. Read, write and talk French. Will go anywhere. Apply to Box No. 737-W.

MECHANICAL ENGINEER, JR.E.I.C. Technical Graduate. Bilingual. Married. Experience includes five years with firm of consulting engineers, design of steam boiler plants, mechanical equipment of buildings, heating, ventilating, air conditioning, plumbing, writing specifications, etc. Six years with large company on sales and design of power plant, steam specialties and heating equipment. Available on short notice. Apply to Box No. 850-W.

CONSTRUCTION ENGINEER, Grad. Toronto '07. Experience as resident engineer and superintendent on railroad, municipal, hydro-electric and industrial construction. Intimate with organizing, layout, survey, estimates and costs. Available immediately. Apply to Box No. 886-W.

CIVIL ENGINEER, B.SC. '29, JR.E.I.C., R.P.E.M. Age 31. Married. Experience includes railway and highway surveys and construction, land and mineral claim surveys, 4 years draughting, structural and hydraulic design, preparation of plans and estimates for hydro-electric development, sewage disposal project, water treatment plant, subway construction, buildings, etc. Experienced in reinforced concrete design including statically indeterminate frames. Also capable of preparing designs in steel and timber Desire permanent employment, preferably in structural design. Available immediately. Apply to Box No. 1023-W.

ELECTRICAL ENGINEER, B.SC. '29, age 30. Single. Eight and a half years experience on maintenance, on construction, floorman and operator on hydro-electric system. Desires construction, service, sales or research work. Any location. Excellent references. Apply to Box No. 1062-W.

ELECTRICAL ENGINEER AND GEOPHYSICIST. Age 41. 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. Experience 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.

Situations Wanted

ELECTRICAL ENGINEER, B.SC. '28. Two years student apprenticeship at Can. Westinghouse Co., including test and electrical machine design. Also about two years experience in operating dept. of large electrical power organization. Available on short notice. Apply to Box No. 660-W.

TECHNICALLY TRAINED EXECUTIVE. General experience administrative, organization and management in business and industrial fields, including; business, plant, property and estate management; plant maintenance, modernization, production and personnel; economic studies, company reorganizations and amalgamations, valuations; railroad, highway, hydro, pulp, newsprint, housing, industrial surveys, investigations and construction; B.Sc. degree in engineering, age 49, married, Canadian. Apply to Box No. 1175-W.

CHEMICAL ENGINEER, grad. McGill '34, experienced in meter repairs, control work; and also chemical laboratory experience. Apply to Box No. 1222-W.

CIVIL ENGINEER, B.A.SC. (Toronto '33), S.E.I.C., age 27. Married. Five years experience includes highway surveys, bituminous and concrete paving, steel and reinforced concrete building construction, instrument work, draughting, cost accounting and estimating and some experience as foreman. Available immediately. Apply to Box No. 1265-W.

FIELD ENGINEER AND DRAUGHTSMAN, A.M.E.I.C. Age 36. Married. Fifteen years experience in civil engineering, general draughting and instrument work. Experience covers office and layout work on construction of sewers, water mains, gas mains, (6" to 30" dia.) and transmission line structures; topographic and stadia surveys. Draughting covers general civil, reinforced concrete and steel design, mechanical detailing and arrangements, and mapping. Present location Montreal, but willing to locate anywhere. Available at once. Apply to Box No. 1326-W.

ENGINEER SUPERINTENDENT, A.M.E.I.C., R.P.E., Que. and Atla. Age 47. Twenty years experience as engineer and superintendent in charge of hydro-electric, industrial, railroad, and irrigation construction. Specialized in rock excavation and suction dredging. Intimate knowledge of costs, estimating and organizing. Available immediately. Apply to Box No. 1411-W.

CIVIL ENGINEER, graduate 1927, age 34 years, desires position as town engineer. Eight years municipal experience. Location immaterial. Apply to Box No. 1628-W.

CIVIL AND ELECTRICAL ENGINEER, JR.E.I.C. (Univ. of Man.). Married. Age 25. Good draughtsman. Four months draughting, one year instrumentman on highway location and construction, inspection and miscellaneous surveying and estimating. Six months as field engineer on pulp and paper mill construction. Prefer electrical or structural design. Available at once. Apply to Box No. 1633-W.

ELECTRICAL ENGINEER, B.SC. E.E. (Univ. of Man. '37). Age 24. Single. Experience in highway construction as inspector. Also experience in sales work and petroleum refining. Available on short notice. Apply to Box No. 1703-W.

CIVIL ENGINEER, B.SC. in C.E. '34. S.E.I.C. Age 27. Five years experience, including harbour construction, highway paving, one and a half years paper mill construction, instrument work, draughting, estimating, interested in design. Available on short notice. Apply to Box No. 1737-W.

CIVIL ENGINEER, B.A.SC. '33. O.L.S. Age 27. Married. One year and a half in charge of power plant construction. Four summers on land surveys and one summer on mine survey work. Also experience in draughting, electrical wiring, and highway engineering. Apply to Box No. 1757-W.

ELECTRICAL ENGINEER, B.E. in E.E., N.S. Tech. Coll. Single. Age 25. Experience in sales, electrical installation, and construction work. Available immediately. Will go anywhere. Apply to Box No. 1758-W.

CHEMICAL ENGINEER, graduate, Toronto '31. Seven years experience in paper mill, meter maintenance, control work and chemical laboratory. Speaking French and English. Location immaterial. Available at once. Apply to Box No. 1768-W.

CIVIL ENGINEER, B.A.SC., JR.E.I.C. (Toronto '35). Age 24. Experience in structural design, construction and surveying, including one year in South America. Details on request. Apply to Box No. 1784-W.

ELECTRICAL ENGINEER, JR.E.I.C. B.SC. Age 25. At present employed, but desiring change of location. Three years maintenance and test work, toll and automatic telephone equipment; two years sales engineering, telephone and electrical equipment. Prefer to remain in telephone field, but would be interested in any opportunities in electical engineering. Apply to Box No. 1817-W.

Preliminary Notice

of Applications for Admission and for Transfer

August 27th, 1938.

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 1938.

L. Austin Wright, General 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

BECKETT—RUSSELL MacDONALD, of 327 St. Mark St., Fort William, Ont., Born at Portage-du-Fort, Que., Feb. 26th, 1891; Educ., I.C.S.; With the H.E.P.C. of Ontario as follows: 1910-13, ap'tice, 1913-18, operation of power house, Cameron Falls, 1919-22, i/c elect'l. installns., Cameron Falls, and 1922-27, electrician; 1927-31, electrician, Mahon Electric Co., Fort William, Ont ; 1933-38, electrician, at Churchill, Man., for Dept. of Rlys. and Canals, and at present, electrician in charge at Port of Churchill, National Harbours Board.
References: K. A. Dunphy, S. E. Flook, J. N. Stanley, G. Kydd.

BURNETT—FRANCIS C.E., of 145 Percival Ave., Montreal West, Que., Born at Galashiels, Scotland, April 16th, 1878; Educ., Heriot Watt College, Edinburgh. Member, Inst. Elec. Engrs. (Great Britain); Three years in shops, Waverley Iron Works, Galashiels, and two years ap'tice, Waverley Electric Co. Ltd., Edinburgh; dftsman. and asst. to chief dftsman., Siemens Bros. & Co. Ltd., London (about 3 years); asst. engr., estimating, constrn., etc., Witting, Eborall & Co. Ltd., London; asst. engr., power and rly. work, Kincaid, Waller, Manville & Dawson, London, consltg. engrs.; 1907-10, asst. to chief engr., J. Kynoch, Can. Gen. Elec. Co. Ltd.; 1910-19, power engr. to Canada Cement Co. Ltd., i/c of all power, steam and electric, designed electric steel furnaces and other equipment for munitions work; 1920-29, in business on own behalf,iron foundry; 1929 to date, representing various British firms for engineering apparatus.
References: F. Newell, K. O. Whyte, R. N. Coke, C. K. McLeod, J. T. Farmer.

CLARKSON—ARTHUR GRANT, of 128 Upton Road, Sault Ste Marie, Ont., Born at Dixie, Ont., Nov. 7th, 1915; Educ., B.A.Sc. (Mech.), Univ. of Toronto, 1938; 1937, locomotive fitter's helper, and at present, junior dftsman., Algoma Steel Corporation Ltd., Sault Ste Marie, Ont.
References: C. Stenbol, F. Smallwood, A. E. Pickering, W. Seymour, W. S. Wilson.

CONNOR—WILLIAM ALEXANDER, Jr., of 209 Kingswood Road, Toronto 8, Ont., Born at Saint John, N.B., Feb. 21st, 1914; Educ., B.A.Sc., Univ. of Toronto, 1937; 1937, Trane Co. of Canada, Toronto, heating and ventilating engr.; at present, asst. to chief engr., Employers' Liability Ass. Corpn., Toronto, Ont.
References: E. A. Allcut, R. W. Angus, T. R. Loudon, R. C. Wiren, J. A. Aerberli.

EMERY—ROY WILLIAM, of 36 Leroy Ave., Toronto, Ont., Born at Hamilton, Ont., Dec. 8th, 1908; Educ., B.A.Sc. (Civil), Univ. of Toronto, 1932; R.P.E. of Ont.; 1929-30 (summer), detail dftsman., etc., Hamilton Bridge Co.; 1932 (summer), subforeman, Dominion Construction Co.; 1932-33, dftsman., Dominion Glass Co., Wallaceburg; 1934 (summer), design, estimate and constrn. of residence in Toronto (as genl. contractor and foreman in charge); 1935 (summer), flotation operator, Little Long Lac Gold Mines; 1935-37, struct'l. engr. in charge of surface surveys, bldg. design, estimating and inspn., incl. extensive mill additions, misc. mine structures and bldgs., sewerage, employees' houses and school. also part time underground surveying and special design work (winter months), Little Long Lac Gold Mines; 1937 to date, designer and dftsman., Toronto Iron Works. Estimates, design and details for struct'l. plate and pressure vessels, elevated ore bins, bunkers, stocks, water towers, storage tanks.
References: C. R. Young, R. E. Smythe, P. Ford-Smith, H. B. Stuart, F. L. Smith, R. O. Paulsen.

LAYTON—MICHAEL SHAKESPEAR, of Montreal, Que., Born at Bury St. Edmunds, England, May 7th, 1914; Educ., B.Sc., McGill Univ., 1935; 1935 to date, asst. chemist, designing electrodes for electric arc welding, Steel Company of Canada, Montreal, Que.
References: L. Jehu, Jr., R. E. Jamieson, F. Newell, C. R. Whittemore, R. S. Eadie, E. C. Kirkpatrick, W. M. Stobbart, P. E. Poitras.

LITZENBERGER—ALBERT JOSEPH HERMAN, of Yorkton, Sask., Born at Neudorf, Sask., May 29th, 1910; 1927-28, engrg. maths. and physics, Luther College, Regina; Private study; With the Dept. of Highways, Province of Sask., as follows; 1926-27, rodman, 1928, instr'man., 1929, instr'man i/c party, 1930, res. engr., constrn. and designing, 1931, instr'man. i/c of party, constrn. and dfting. design, 1935-36, asst. to district supt. on highway constrn. and mtce. in Yorkton Highways District, and from 1937 to date, district highways inspector, i/c of mtce. and constrn. engr. in Yorkton Highways District, market roads and bridge inspections.
References: H. S. Carpenter, H. R. Mackenzie, A. P. Linton, H. J. de Savigny, L. F. Creighton.

MANSEAU—GILBERT, of 2027 Grey Ave., Montreal, Que., Born at Montreal, March 12th, 1911; Educ., B.A.Sc., C.E., Ecole Polytechnique, Montreal, 1935; 1935-36, asst. to Henri Leblanc, C.E.; 1936, transit and level on canal survey for St. Lawrence Waterways Project, Dept. Public Works; at present, engr. for B. Trudel & Cie, Montreal, Que.
References: G. J. Papineau, J. H. Landry, A. Frigon, J. A. E. Gohier, S. A. Baulne.

SIBBALD—STANLEY W., of 676 Bay St., Sault Ste Marie, Ont., Born at Toronto, Ont., Oct. 8th, 1913; Educ., B.A.Sc. (chem.), Univ. of Toronto, 1937; at present, chemist, coke oven dept., Algoma Steel Corporation Ltd., Sault Ste Marie, Ont.
References: W. Seymour, C. Stenbol, W. S. Wilson, J. L. Lang, F. Smallwood.

TASCHEREAU—JOSEPH ROGER CHARLES, of Montreal, Que., Born at Quebec, Que., Nov. 4th, 1900; Educ., B.A.Sc., Ecole Polytechnique, Montreal, 1925. Post-graduate course at the Mass. Inst. Tech., 1925-26; R.P.E. of Que.; 1922 (summer), dftsman., Dept. Public Works, Quebec; 1924 (summer), asst. on transit and levels, field work, Duke Price Development; With the Shawinigan Water and Power Company as follows: 1926-28, dftsman., and field work, engrg. dept.; 1928-30, water resources dept., study of development of upper reaches of St. Maurice River; completed report on flow of river at different sites; 1930 (Feb.-Sept.), purchasing dept.; 1930-31, accounting dept.; April 1931, commercial and distribution dept., office work in general dealing with civil, electrical and hydraulic engrg., and from May 1937 to date, manager, contract division, commercial and distribution dept., dealing with rates in general, inspection of customers' installns., contracts in general.
References: P. S. Gregory, R. H. Mather, J. B. Challies, J. A. McCrory, H. Massue.

WING—ERNEST, of 118 Macaulay Ave., St. Lambert, Que., Born at Southampton, England, Aug. 21st, 1898; Educ., 1910-13, Ringsend Technical School. First Class British Board of Trade Cert.; 1913-16, ap'tice engr., Dublin Steam Trawling Co. Served with Army Service Corps, and completed ap'ticeship 1917-19, with Howden Engrg. Co., Glasgow; Marine engr., 1919-22, with Gow Harrison Co., Glasgow, and 1922-26, British Tanker Co., London, England; 1927-31, steam plant supt., St. Anne Paper Co., Beaupre, Que.; 1931-35, mech'l. supt., i/c of all mech. mtce. work, and 1935 to date, plant engr., i/c of design and installn. of all new equipment, also responsible for mtce. of all existing machinery, bldgs., etc., Canada and Dominion Sugar Co. Ltd., Montreal, Que.
References: R. A. Gurnham, R. H. Findlay, F. S. B. Heward, G. H. Midgley, W. G. Scott.

FOR TRANSFER FROM THE CLASS OF ASSOCIATE MEMBER TO THAT OF MEMBER

WHITMAN—KARL EWART, of Upper Vaughan, N.S., Born at Advocate Harbour, N.S., Aug. 6th, 1887; Educ., B.Sc. (Civil), N.S. Tech. Coll., 1914; R.P.E. of N.S. 1914-15, i/c erection of struct'l. steel, Toronto Structural Steel Co. Ltd.; 1918-19, instructor in engrg. subjects., Dept. of Soldiers' Civil Re-Establishment; 1913 (summer), res. engr. on constrn., Western Union Cable Co. Ltd.; 1916, asst. supt. of plant engaged in mfture of munitions, Standard Steel Constrn. Co. Ltd.; 1920-21, detailer and checker, Manitoba Bridge & Iron Works Ltd.; 1922, Dryden Paper Co. Ltd., investigation and constrn. of hydro-electric development and paper mill extension; 1923, res. engr. on power development, Avon River Power Co. Ltd.; 1924-25, design and constrn. of power development, N.S. Power Commn.; 1925-26, asst. professor of civil engrg., N.S. Technical College; 1926-28 and 1932-37, in private practice on struct'l. design and hydro-electric power investigation; 1928-32, hydraulic engr., and 1937 to date, chief designing engr., hydraulic and civil, Nova Scotia Power Commission, Halifax, N.S. (*A.M. 1919.*)

References: H. S. Johnston, D. Stairs, J. S. Wilson, O. Holden, C. A. Fowler, I. P. MacNab, F. L. West.

FOR TRANSFER FROM THE CLASS OF JUNIOR

JEPSEN—VIGGO, of Grand Mere, Que., Born at Gellerup, Denmark, March 22nd, 1904; Educ., 1923-27, day course, Horsens Technical School, Denmark; 1919-26 (summers), bldg. constrn., last year as supt.; 1927, engr. and dftsman., experimental office for artillery, Royal Danish Army; 1928-29, instr'man., 1929-30, asst. engr. on hydrographic surveys of St. Maurice River, 1930-31, layout engr. on constrn. of Rapide Blanc power development, Shawinigan Water & Power Company; 1931 (7 mos.), layout engr., John MacGregor Ltd., Montreal; 1931 (4 mos.), instr'man. i/c survey party, Shawinigan Engineering Co.; 1932-35, sales engr. for oil burning equipment, Jas. A. Ogilvy's Ltd.; 1936 (6 mos.), dftsman., for installn. of caustic treatment plant, Canadian Copper Refiners Ltd.; 1936 (3 mos.), designer for haul-up plant at St. Casimir, Que., Cons. Paper Corpn.; 1936 to date, chief dftsman., Laurentide Divn., Consolidated Paper Corpn., Grand Mere, Que. In charge of design for new and alteration to old equipment for paper mill. (*Jr. 1932.*)

References: F. W. Bradshaw, H. O. Keay, W. B. Scott, W. B. Scoular, H. G. Timmins, E. B. Wardle.

WARNOCK—ROBERT NICHOLSON, of Montreal, Que., Born at Montreal, April 19th, 1909; Educ., B.Sc. (Civil), McGill Univ., 1931. R.P.E. of Ont. and Que.; With Charles Warnock & Co. Ltd., Inspection Engineers, Montreal, as follows: 1930-32, inspection and office duties, 1932-36, secretary-treasurer, and 1936 to date, vice-president. (*St. 1931, Jr. 1936.*)

References: J. M. R. Fairbairn, J. E. Armstrong, R. B. Jones, W. A. Newman, C. B. Brown, W. A. Duff, J. A. Ellis.

FOR TRANSFER FROM THE CLASS OF STUDENT

BROWN—RALPH CUTHBERT CHISHOLM, of 699 Acacia Ave., Rockcliffe Park, Ottawa, Ont., Born at Ottawa, Nov. 8th, 1910; Educ., B.Sc. (Mech.), Queen's Univ., 1933; 1928-30 (summers), rodman, chainman, etc. during constrn. of Rockcliffe and Trenton Air Stations; 1931 (summer), machine shop work; 1937-38, technical asst., Fairchild Aircraft Limited; 1936-37, junior stressing and dfting., and Feb. 1938 to date, junior aeronautical engr., Dept. of National Defence, Ottawa, Ont. (*St. 1933.*)

References: E. W. Stedman, G. H. Ferguson, W. F. M. Bryce, H. S. Rees, G. E. Wait, C. M. Pitts.

TINKLER—HOWARD H., of 4140 St. Urbain St., Montreal, Que., Born at Montreal, April 18th, 1911; Educ., B.Eng., McGill Univ., 1933; Summers—1930, surveying party, Shawinigan Engrg. Co., 1931, operator, Canadien Theatre; May 1937 to date, asst. engr., Montreal Branch, Iron Fireman Mfg. Co. of Canada, Montreal, Que. (*St. 1933.*)

References: E. Brown, C. V. Christie, R. DeL. French, G. L. Wiggs, W. J. Armstrong, B. R. Perry.

TOY—EDWIN LEDENTU, of 108 Shanley St., Toronto, Ont., Born at St. George, N.B., Oct. 5th, 1909; Educ., B.Sc. (E.E.), Univ. of N.B., 1931; 1928-31 (summers), asst. to town electrn.; 1931-32, test course, Can. Gen. Elec. Co.; 1933-36, plant electrn., St. George Pulp & Paper Co. Ltd., St. George, N.B.; 1936 (Feb.-Sept.), plant electrn., Connors Bros. Ltd., Black's Harbour, N.B.; 1936-38, asst. foreman, test dept., Peterborough and from July 1938 to date, supervisor of test dept., Can. Gen. Elec. Co. Ltd., Davenport Works, Toronto. (*St. 1932.*)

References: L. DeW. Magie, W. T. Fanjoy, W. M. Cruthers, B. I. Burgess, C. E. Sisson.

WOOLSEY—JOHN TOWNLEY, Lieut., R.C.A., of Esquimalt, B.C., Born at Ottawa, Ont., Jan. 29th, 1911; Educ., Grad., R.M.C., 1933; 1933 to date, with the R.C.H.A. and the R.C.A., and at present, Regimental Officer, Royal Canadian Artillery, Work Point Barracks, Esquimalt, B.C. (*St. 1932.*)

References: H. L. Sherwood, J. H. McIntosh, L. F. Grant, H. H. Lawson, O. T. Macklem.

New and Revised Specifications

American Society of Mechanical Engineers: Power Test Code for Hydraulic Prime Movers.

American Standards Association: C39.1-1938 American Standard for Electrical Indicating Instruments.

Canadian Engineering Standards Association: S47T-1938 Standard Specification for Welded Steel Buildings, Welding by the Metallic Arc Process, Tentative Welding Qualification Code for Fabricators, Contractors, Supervisors and Welders; C22.2-No. 45-1938 Construction and Test of Rigid Steel Conduit; C22.2-No. 46-1938 Construction and Test of Electric Air-Heaters.

U.S. Department of Commerce National Bureau of Standards: Report of Vehicle-Scale Testing Service, November 1936-May 1938.

Canada a Sound Field for Investment

Freedom from labour troubles and natural business recovery have strengthened Canada's attraction for investors. The bulletin of the National Industrial Conference Board of New York points out the following highlights of the situation: Economic trends and conditions in Canada compare favorably with those of the United States without comparable governmental measures. Canada has higher relative production and employment figures; fewer strikes in relation to population; lower per capita relief expenditures and living costs and proportionally higher dividend payments. Gross governmental debts have increased 36 per cent in Canada and 115 per cent in the United States since 1929.

Setting Poles in Loose Soil, One Operation With Dynamite

Difficulty is often experienced in digging post holes in soft soil, sand or swamp land flooded with water. Often caissons are required to keep water and soil from filling up the pole hole which has been dug before the pole can be set.

In such situations considerable success has followed the practice of blasting the pole hole and setting the pole in one operation, according to A. E. Dyment, Manager, Technical Department, Explosives Division, Canadian Industries Limited. A hollow drill of about 1½ in. pipe is driven into the ground to the depth desired for the bottom of the pole. The soil is forced out through the lower end of the drill with a ram. A sand point on the end of the drill will help where the soil is such that it clogs the pipe, making ramming difficult. The pipe can be withdrawn leaving the sand point in the hole.

The charge of dynamite, primed preferably with an electric blasting cap, is pushed down through the pipe to the bottom and the pipe withdrawn. The pole is then raised above the surface directly over the dynamite and held in place by pike poles or rigged four ways, and the dynamite is detonated.

The explosion will create a pear-shaped pocket into which the pole will settle as the gases rush upward. The ground and water pressures press the soil back around the pole.

Some difficulty may be experienced in getting the pole to drop straight. It may be necessary to pull up the pole and blast another hole if the pole leans. The secret of settling the pole straight is in holding it straight above the ground by means of the pike poles or rigging. Care should be taken to see that the pole is exactly upright before the blast.

If the charge does not sink the pole far enough, the drill may be driven down along the pole and a second charge fired.

The amount of dynamite needed varies with the soil conditions encountered, but the following are suggested by experienced blasters who have done this work. In each case 40 per cent Polar dynamite is recommended: a 6 ft. to 7 ft. depth hole in swamp with muck underlying—2½ cartridges; a 5 ft. to 7 ft. hole in swamp with muck and rock underlying—3 cartridges; a 7 ft. to 7½ ft. hole in sand and water —3 cartridges; a 6 ft. to 7 ft. hole in coral rock—4 to 5 cartridges.

School Lighting

The American Standards Association has announced the completion of the new American Recommended Practice of School Lighting prepared under the leadership of the Illuminating Engineering Society and the American Institute of Architects.

The primary purpose of this "Recommended Practice" is to set forth standards of good illumination for the guidance of architects, engineers, school officials, and others interested in the conservation of children's eyes.

Scientific research by ophthalmologists, physicists, physiologists, and other experts has added materially to our knowledge of the relation between light and seeing. In line with these developments the new "Recommended Practice" suggests the minimum intensity for the general illumination of classrooms, studies, and offices at 15 foot-candles, a considerable increase over the minimum recommended in the code of 1932, which the present "Recommendations" supersede. However, in view of the fact that many school systems are today using much higher intensities with advantage, this estimate is conservative.

The new "Recommended Practice" is the work of a representative committee including eyesight specialists, physicians, research workers, public health officials, architects, and engineers. In its work the committee made use of actual tests and studies on lighting conditions. One such test involving two rooms of pupils of approximately equal age and intelligence proved that over a period of time children in the more adequately lighted room did better work than those in the other.

For sewing rooms, drafting rooms, art rooms and other rooms where fine detail work is to be done, intensities as high as 25 foot-candles on the work are recommended by the standard, while for locker rooms, corridors, and stairs, intensities as low as 4 foot-candles were deemed to be sufficient.

Not only the question of how much light, but what kind of light is taken up in the new "Recommended Practice." Such important factors to eye comfort as colour quality of light, light reflection from ceilings and walls, diffusion, distribution, and direction of lighting are considered. A section of particular interest to architects, engineers, and those responsible for the maintenance of school buildings discusses the wiring of school buildings and the capacity provisions which should be made in view of the trend toward higher illuminations.

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Snow Surveys

A New Medium for Forecasting Run-off

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Introduction

Over large portions of the temperate zones snow is the largest contributor to stream run-off. This is particularly true of mountainous and forested regions, such as the western portion of this continent. In the semi-arid southwestern states of the U.S.A. it is estimated that over 90 per cent of the run-off originates as snow in the Rockies and High Sierras. In British Columbia it has been found that 200 typical streams average 85 per cent of their run-off in the seven months March to September; moreover none of the 200 individually depart very far from this average. On many watersheds this 85 per cent is almost exclusively due to melting snows. Commencing in March or April, according to locality, the winter snows, melting in response to advancing spring, swell the streams till they reach their peaks some time in June and July, and then gradually recede.

Where storage is possible this great volume of snow-water is held over in reservoirs and lakes for power purposes, irrigation and domestic supply, as a reserve against the months of low flow.

Fig. 1—An Ideal Type of Forest Cover for Conserving Snow.

Snow itself is a variable element; it is elastic, and its density varies greatly. In its newly-fallen condition it has a range of density, so far as is known, of from 5 per cent to 18 per cent, whereas the meteorological services assume 10 per cent in reducing it to terms of water. At the end of winter the snow mantle has a far greater range of density, depending on altitude, exposure, depth, temperature, wind velocities, etc. In a single season the density of the snow on British Columbia Courses varied from 19.4 per cent to 71.1 per cent.

It is obvious, therefore, that only under favourable circumstances can meteorological records of snowfall serve as a criterion for estimating run-off, while depth alone as indicated by the snow stake is of little value. A scientific knowledge of the evolution of the snow-cover and its water content when melting begins is, therefore, of prime importance. Snow surveying, a young but healthy offspring of the science of hydrology, relates snow-cover to stream-flow, and thus makes it possible to forecast the latter from a knowledge of the former.

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History

Snow surveying had its genesis in Europe, but it was many years afterwards before its practical application was developed in the High Sierras of Nevada and California. On the 10,800-ft. summit of Mt. Rose Dr. J. E. Church, meteorologist of the Nevada Agricultural Experiment Station, established an observatory in 1904. In so doing he became the father of snow surveying, and remains its Dean today.

At Mt. Rose observatory every phase of the evolution of the snow pack and its melting were scientifically studied, and from this research certain fundamental relationships were isolated, studied, and finally put to practical use; the Nevada or percentage method of snow surveying was thus evolved.

As in most pioneering efforts recognition came slowly and grudgingly; but gradually one organization after another tried this new idea and found it worth while. These agencies were many and diverse; power companies, irrigation companies, cities, State Departments of water resources, etc. A fairly comprehensive, contiguous network now extends throughout the States of California, Oregon, Washington, Idaho, Montana, Wyoming, Colorado, Utah, Nevada and New Mexico, and portions of British Columbia and Alberta. There are also systems in Newfoundland, Quebec, and New York State, while in far-away Australia snow surveys are being tried out in the southern mountains of the Continent.

The earliest attempt at formal co-operation and standardization was through the medium of a Western Interstate Snow Survey Conference. This still functions and Mr. O. H. Hoover, Engineer-in-Charge, Dominion Water and Power Bureau, Calgary, and the writer were elected to its Executive Committee this year.

About 1934 the U.S. Department of Agriculture entered the picture as a more formal and authoritative coordinating agency, and the Bureau of Agricultural Engineering was entrusted with the work. They now receive and assemble all data, issue and supervise the distribution of new snow sampling equipment and provide for the systematic expansion of the various systems.

Scientific research into snow survey problems was early undertaken by the American Geophysical Union, through a Committee on the Hydrology of Snow, one of the standing committees of the Section of Hydrology. Of late years a meeting of the Snow Survey Conference is always included in the agenda of its Annual General Meeting and its Western Regional Meetings.

In 1934 snow surveys were initiated in B.C., by Major J. C. MacDonald, M.E.I.C., Comptroller of Water Rights, the writer being entrusted with their development.

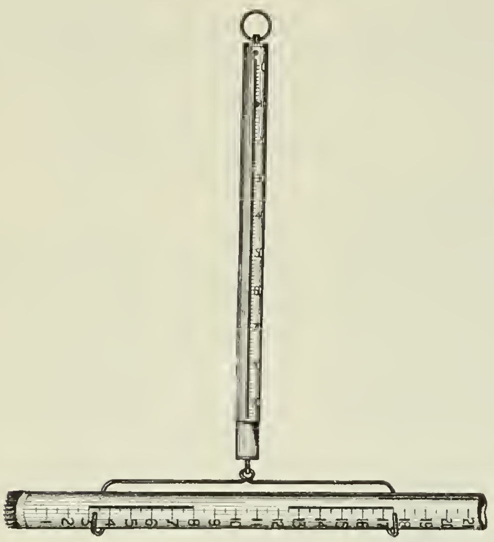

Fig. 2—Scales and Snow Sampler in Position for Weighing.

Fundamental Relationships

The fundamental facts upon which the Nevada, or percentage method of snow surveying are based are as follows*:

First: That over a given basin the relative snow cover was the same wherever measured, provided neither drifting nor melting had taken place. In other words, if the water content at some point was found to be, say, 75 per cent of normal, it would also be 75 per cent of normal at other points in the same basin within a very small margin of error, regardless of the depth of snow at either point.

Second: That the percentage of normal of the water content of the snow pack at the end of the snow-fall season agreed closely with the percentage of normal streamflow to be expected during the ensuing run-off months.

Distorting Factors

Certain factors may cause divergence between the snow water content and ensuing run-off. Those of sufficient magnitude to seriously affect the accuracy of forecasts are as follows:

(*a*) A normal relationship between snow and run-off is in some regions dependent on normal rainfall during the run-off period. If this rainfall is above normal the run-off is increased; if below normal run-off is decreased.

The magnitude of its effect is in general influenced by the ratio of early summer rains to snowfall. Where the ratio is large this factor will ordinarily produce a maximum effect.

It is the writer's opinion, however, that the possibilities of the distorting influence of this factor has been considerably over-rated. For instance, in the Canadian Columbia Basin, which includes parts of the Rocky and Selkirk mountain ranges, it had been supposed by experts that precipitation during run-off would be a seriously distorting factor. But in research studies† on the snowfall-run-off relationship over the period of record of 21 years, its effect was either entirely absent or quite negligible, nor has it shown any effect on the first three years of tentative forecasts.

Its lack of effect in this region is probably due to three causes:—

First: That most of the precipitation stations on which the supposition was based are located at valley points where the proportion of summer rains to winter snows happens to be much greater than in the surrounding higher elevations which produce the major portion of the run-off.

Second: That the summer rains while locally intense are much more spotted in occurrence than the major winter storms which produce the snowfall.

Third: That as summer temperatures throughout the region are high, and relative humidity low, the summer rains falling on increasingly large areas of snow-free ground as the season advances are almost entirely taken up by evaporation, soil absorption, plant use and transpiration.

Where precipitation during run-off is found to be a distorting factor, forecasts have to be corrected at the end of each month in light of the precipitation data received since the previous forecast.

(*b*) If the soil is deficient in moisture when melting begins, it is obvious that a certain proportion of the melting snow will be needed for re-priming before run-off can take place, and this represents a loss to run-off. The writer has termed this the "Soil Priming Factor," and the magnitude of its effect on run-off depends on the topography and geology of the region, and the yearly variation in autumn rains.

In the arid regions of Utah and Nevada where the snow falls on a dry soil in most years, it has been found that as much as 50 per cent of the snow cover is absorbed in re-priming the soil before any run-off occurs.

In the main Canadian Columbia and Kootenay basins this factor is apparently either negligible or relatively constant from year to year, thus exerting no distorting influence on the snow run-off ratio. This is probably partly due to the steep and rugged topography and the average shallowness of the earth mantle, and partly to autumn rains of sufficient intensity even in minimum years to prime the soil before the snow falls.

In the Okanagan Basin, on the other hand, a semi-arid region of more gentle contours and with deep deposits of glacial detritus and alluvials, the soil priming factor often exerts a marked influence on the snow run-off ratio.

In the Utah snow surveys, under the direction of Dean Clyde of Utah State Agricultural College, whose contributions to snow surveying are second only to those of Dr. Church, tests of soil moisture content are made at the time of snow sampling, and the average snow-water content weighted accordingly. This is probably the ideal method of approach.

Before undertaking this method for the Okanagan, however, with its additional expense for equipment and field work, the writer made a study of the relationship between autumn precipitation and the apparent effect of the Soil Priming Factor, as indicated by the frequent discordance between recorded snowfall and run-off. With fourteen years of precipitation data at three different stations to work with, a correction curve was developed; from this a coefficient is obtained which is applied to the snow-water content. Using this curve snowfall and run-off were brought into reasonable agreement for the fourteen years of record (11 years' precipitation data and 3 years' snow surveys were used).

Accuracy

Forecasts within an accuracy of even 10 per cent are usually of considerable value, but in most established

*Snow Surveys for the Purpose of Forecasting Streamflow by R. C. Farrow, Forestry Chronical, Vol. XIII, No. 1, February 1937.

†Snowfall and Run-off in the Canadian Columbia Basin: a Study to Determine the Ideal Location for Snow Survey Stations by R. C. Farrow, American Geophysical Union Transactions, 1937, pp. 632-644.

systems accuracies within 2 to 5 per cent are becoming more and more common.

The following gives the accuracy obtained in a group of 63 comparatively new courses in the U.S.A.:—

Accuracy within following percentages; based on normal run-off	No. of Forecasts
0 to 5 per cent	27
5 to 10 "	14
10 to 15 "	7
15 to 20 "	6
20 to 25 "	5

The accuracies so far obtained on British Columbia snow surveys are shown in the tabulation at the end of this article.

Snow Losses and Conservation

The higher altitudes of our mountain ranges, well above timber line, despite the heavy snowfall which they usually receive, appear to yield very little water to run-off; most of it is dissipated through evaporation both in winter and summer.

In winter the high winds which blow almost constantly about the bare peaks induce a high rate of evaporation even at low freezing temperatures.

The extent of this loss was examined at Mt. Rose Observatory. The acceleration in the rate of evaporation appeared to be roughly proportional to the increase in wind velocity. It was found that on the leeward slope, under an average wind velocity of 10.8 m.p.h. evaporation amounted to 7.17 in. (water content) per month, while on the windward slope under an average wind velocity of 30.6 m.p.h. evaporation reached 24.21 in. per month. At the higher velocities erosion began to take place forming cornices and sweeping the snow into crevasses and ravines.*

In summer the sun allies itself to the wind and further increases the rate of evaporation.

The writer's observations while engaged on work above timber line in the spring and summer led to the belief that very little run-off accrued from these high snowfields. Vast areas of snow even on the hottest days showed but meagre trickles from their fringes. Their yearly dissipation, therefore, appeared to be largely due to evaporation. Certain solar rays become very intense in the clear air at high altitudes, and the solar radiation itself is greatly magnified at the snow surface. The relative humidity is usually low and the ever prevalent winds keep the air in motion, so that conditions for a high evaporation rate are ideal.

Fig. 4—High Bare Slopes Which Appear to Yield Little to Run Off.

Last year Mr. F. E. Nathes of the U.S. Geological Survey made an exhaustive examination into the problem of how much of the high snow accrued as run-off. In a comprehensive paper† he laid his findings before the Western Regional Meeting of the American Geophysical Union in California in January 1938. His considered opinion, supported by a mass of data and photographs, was that very little water found its way to the streams from this source, and that the yearly dissipation of this high snow was due largely to evaporation.

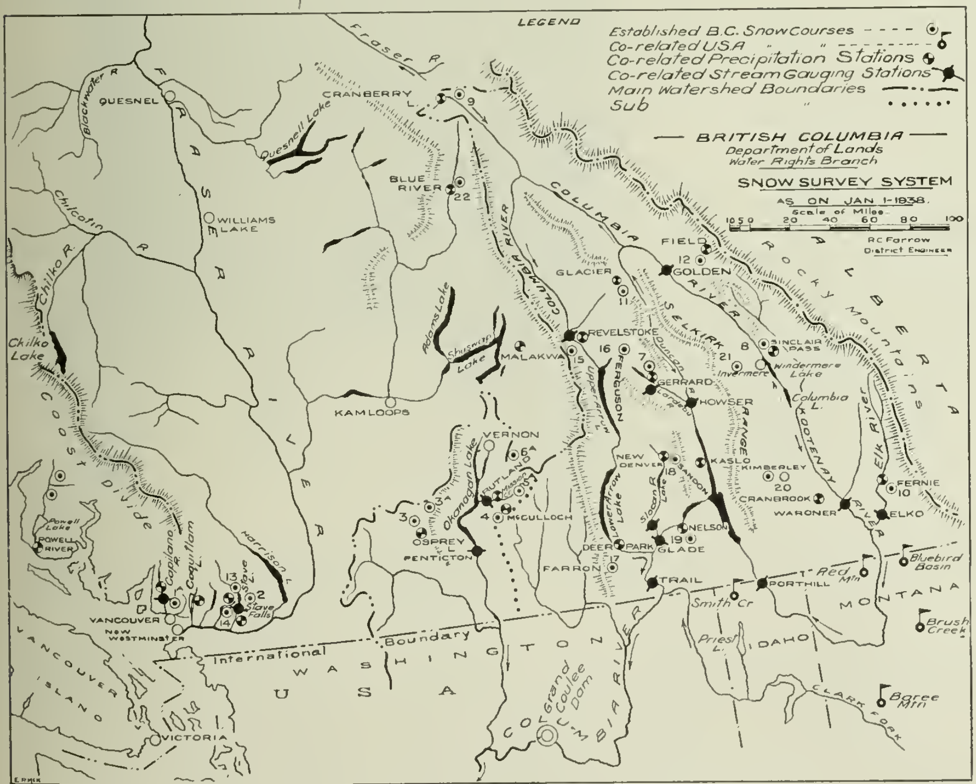

Fig. 3

On the other hand research has shown beyond refutation that forests are great conservers of snow; their effectiveness in gathering and retaining it is most marked as compared to bare open slopes. As an illustration, Dr. Church's studies on Mt. Rose disclosed the following conditions at the end of the snowfall season, the whole area under consideration having received the same snowfall. Depth of snow is in inches; water content in inches in brackets:

> "Unforested talus slopes 40.8 (18.4), distributed thus: cornice below Observatory 52.5 (25.1); windswept slope 8.1 (2.6); protected slope 78.1 (35.1); forested slope 88.6 (41.1)"

The conserving effect of forests undoubtedly far outweighs the losses in interception, plant use and transpiration.

*See Geographical Review, Dr. J. E. Church, Vol. XXIII, No. 4, October 1933.

†(Will be published in the "Transactions" 1938.)

Table I

Final Comparison for 20 Years 1915-1935, Run-off Columbia River at Revelstoke in Per Cent Departure from Snowfall at Glacier, Cranberry Lake, Revelstoke, and Malakwa, and Averages of Various Combinations

[Indications for averaged stations are: H_c = Glacier and Cranberry Lake; I_c = Glacier, Cranberry Lake, and Revelstoke; J = Glacier and Revelstoke; K_c = Glacier, Cranberry Lake, Revelstoke, and Malakwa; L = Glacier, Revelstoke, and Malakwa; M = Revelstoke and Malakwa; N = Glacier and Malakwa]

Precipitation-station or average	Per cent departure						No. of years in which per cent lies between					Total years
	Aggregate	Maximum	Minimum	Mean	Modal group	Median	0-10	10-15	15-20	20-25	25+	
Glacier	248.9	45.4	0.3	12.44	4 to 10 for 9	9.3	12	2	0	5	1	20
Cranberry Lake	455.7	61.5	0.7	22.80	0 to 6 for 5	21.7	5	3	1	3	8	20
Revelstoke	226.3	32.1	0.5	11.30	0 to 5 for 7	10.9	9	5	4	1	1	20
Malakwa	235.7	39.0	0.9	11.80	0 to 5 for 8	6.0	12	4	0	1	3	20
H_c	308.2	33.3	0.5	15.41	10 to 15 for 6	13.7	6	6	1	3	4	20
I_c	258.9	28.2	1.3	12.94	7 to 15 for 8	11.7	9	2	4	2	3	20
K_c	233.8	25.1	0.3	11.69	20 to 25 for 5	10.6	9	4	1	5	1	20
J	199.0	33.3	0.6	9.95	0 to 5 for 8	7.6	11	4	4	0	1	20
L	195.5	23.6	0.7	9.77	0 to 5 for 9	8.1	11	3	4	2	0	20
M	188.5	35.5	0.4	9.42	0 to 5 for 9	7.9	13	3	2	0	2	20
N	235.8	26.2	1.1	11.79	1 to 5 for 7	8.5	10	2	6	1	1	20

Note:—Suffix "c" (as in H_c) indicates that combination includes Cranberry Lake.

Inaugurating a Snow Survey System

As with many problems, while snow surveying is fundamentally simple, many complex problems arise in actual practice. Before attempting to lay out a system and locate snow courses, the climatology, topography, geology and hydrometric data of a basin should be studied. In particular, a complete study and analysis of the entire precipitation data for the region will often yield valuable information.

This was done by the writer for the Canadian Columbia Basin, with the result that a relationship was established between combinations of certain key precipitation stations and run-off at co-related gauging stations.*

While the relationship was not close enough to encourage the use of precipitation data alone for forecasting, except in the case of a few stations, it furnished a valuable guide in evaluating the probable effect of distorting factors, and served as a criterion for the location of snow courses. These were laid out adjacent to the precipitation stations but at higher elevations.

The type of final analysis used and the close agreement between the snowfall at certain precipitation stations and run-off are shown above (Table I).†

This method of approach assures a minimum number of courses to cover a given area. In the case of the Canadian Columbia Basin we have only 15 courses to represent 40,000 sq. mi. of watershed, and it is unlikely that many more will be necessary even in light of later experience.

In contrast, most of the U.S.A. systems were laid out by placing courses broadcast wherever they could conceivably be useful, very little attention being given to prior studies of precipitation; efforts were being concentrated on perfecting the technique of snow surveying itself. Many of the systems were laid out more or less under emergency conditions in order to obtain quick results and far more money was available for the work than we could ever hope to obtain.

It is now admitted that in many areas from 25 to 50 per cent of the courses could be dropped without affecting the accuracy of forecasts.

Snow Courses

A snow course is a permanently established line over which measurements of depth and water content are made at fixed observation points each year.

*Snowfall and Run-off in the Canadian Columbia Basin, American Geophysical Union Transactions 1937, pp. 632-644.

†Snowfall and Run-off in the Canadian Columbia Basin by R. C. Farrow, American Geophysical Union Transactions, 1937, p. 638.

In the earlier days of snow surveying it was thought necessary to have long courses with as many as 60 observation points, preferably 100 ft. apart. It soon became evident, however, that shorter courses were just as reliable, and as the records accumulated and were studied it appeared that 10 to 15 observation points, preferably about 100 ft. apart, were quite ample. The course should be high enough to be safe from premature melting, protected from drifting, and shaded to some extent from the sun's direct rays.

Fig. 5—Snow Sampling in the Southern Rockies, Kootenay River Drainage.

Snow Sampling

This is the operation of determining the depth and water content of the snow. Monthly samplings throughout the winter are useful for studying the evolution of the snowpack, and in some cases for preliminary forecasts where very close regulation of reservoirs is necessary. The important samplings for the main forecasts, however, are usually made about the end of March. The actual time is governed by the local conditions of snowfall and run-off.

The snow-surveying equipment now in general use, and standard with the U.S. Bureau of Agricultural Engineering (see Fig. 2), consists of jointed aluminum alloy tubes, slightly over 1½ inches in diameter; they are slotted in order that the rise of the snow-core can be noted, and are graduated in inches for measuring the depth. The bottom section is equipped with a steel saw-toothed cutter, for boring through ice and crusts. There is a spring balance and cradle for weighing the tube and snow-core. The throat diameter of the cutter is such that an ounce in weight is equivalent to one inch of water-content. A wrench is provided to assist in forcing the tube down, in deep and dense snow.

In sampling, the tube is forced down through the snow at each observation point on the course, and on being withdrawn retains a core of snow. Depth of snow is noted; and the difference in weight between the empty tube, and tube with snow-core represents the water content in inches. The average for all observation points is the water content for the course.

Forecasting

A preliminary normal of water content can be established in the following ways:

(*a*) By using the computed normal of run-off at the correlated stream gauging station.

(*b*) By using the normal of snowfall as recorded at a precipitation station, when close to the snow course, and when its data have been found to be reasonably well related to run-off.

(*c*) When neither run-off nor precipitation data are available, a number of years must elapse before an independent normal of water content can be built up.

Where several courses are to be related to a single stream gauging station, each course may be assigned a certain zone, or partial area of the whole tributary watershed; and an average water content for the whole, computed by weighting the water content of each individual course according to the percentage of the whole which it represents. This method is used with our Okanagan courses.

Where each course represents a large area, and such courses have been scientifically located on the basis of precipitation run-off studies, the average of the percentages of normal of these courses can usually be used for forecasting. This method is used in the Canadian Columbia Basin.

Correction for the Soil Priming Factor may be necessary; and in areas where precipitation during run-off can be a distorting factor, forecasts may have to be revised each month if this factor departs from normal. A systematic method of receiving, tabulating and analysing the snow-sampling data as soon as received has to be worked out.

Fig. 6—A Snow Course Site in the Selkirk Range, Columbia River Drainage.

Forecasts for major streams with established gauging stations are made in acre-feet; small streams having meagre or no stream-flow records at all are of necessity more general in nature and are usually expressed in per cent of normal or per cent of the previous year's run-off, if known.

B.C. Snow Survey Systems

The snow surveys inaugurated by the Water Rights Branch fall under three groups (see Map, Fig. II).

(1) Coastal, in the vicinity of Vancouver; with four courses. (In addition, the Powell River Co.—the largest pulp and paper concern in B.C.—have started their own system, with at present 2 courses.)

(2) Okanagan, with 6 courses.

(3) Columbia-Kootenay, with 15 courses, one being common with the Okanagan. In addition, 5 U.S.A. courses are used for the section of the Kootenay which flows through the States of Montana and Idaho.

This makes a total of 30 courses used in our forecasts.

As our snow surveys only date from 1934 and the systems outlined above were only rounded out last year, it will probably be several years before general public forecasts are ventured; but in the meantime the snow survey data are available to organizations having a technical staff capable of appreciating its short record limitations.

They are also transmitted to the U.S. Bureau of Agricultural Engineering, and U.S. Weather Bureau, and used in conjunction with their own data in their spring forecasts.

The results of our last year's tentative forecasts are as follows:—

Table II—British Columbia Snow Surveys Forecasts 1937

River		Snow Course Nos.	Per cent of Normal	R.O. in Ac. Ft.		Error in Per cent of Actual	Per Cent Error in 1936 Forecast
Name	at			Forecast	Actual		
Stave	Stave Falls	2, 13, 14	85.0	882,300	1,382,000	25.2	38.0
Columbia	Golden	8, 11, 12	74.1	1,551,000	1,529,000	1.4	11.5
Columbia	Revelstoke	8, 9, 11, 12	75.7	13,237,000	13,077,000	1.2	*
Columbia	Trail	8, 9, 11, 12	77.8	27,798,000	28,414,000	2.2	*
Kootenay	Wardner	8 and 10	79.9	2,997,800	2,804,700	6.9	5.8
Kootenay	Glade	7, 8, 10	79.6	11,721,400	11,781,000	0.5	*
Elk	Elko	8, 10	79.6	873,300	816,300	7.0	*
Lardeau	Gerrard	7	74.9	394,000	379,000	4.0	7.9
Duncan	Houser	7	74.3	1,311,000	1,404,000	6.6	6.8
Okanagan	Penticton	3, 3A, 4, 5A, 6A	101.6	305,400	328,400	7.0	7.8

*No forecast in 1936.

Industrial Preparedness in Canada for War

(Contributed)

Modern war demands a huge expenditure in money and material. The fighting forces must not only take the field equipped with every up to date device for making war, but in addition a continuous stream of equipment and munitions must be poured into the theatre of operations to replace expenditure in battle and wastage caused by enemy action. The great powers of the world to-day, therefore, base their war plans, not so much on the number of men that they can raise, as on the number which can be adequately equipped and maintained in the field. In other words, all are agreed that industry is one of the most decisive factors in modern war.

As the mechanical contrivances used in normal peace time pursuits are subject to improvement in design with mechanical progress, so too are the weapons of war. To depend on huge reserves built up in peace time is to invite obsolescence of equipment when an emergency arises. No country can afford to maintain in peace time sufficient manufacturing establishments to cope with the wastage of modern war. The mass production which is required must be undertaken by the whole industrial structure. Reserves built up in peace time can only hope to cover the interval between the rising of an emergency and the time when national industry can produce requirements on the scale required. The sooner industry can achieve this purpose after emergency, the smaller need be the size of reserves built up in peace, with a consequent saving in the financial burden placed on a country for defence purposes in normal times. This can only be achieved by industrial preparedness.

In their efforts to achieve industrial preparedness, nations have adopted methods which differ considerably depending on the extent to which the country is industrialized and the extent to which their industries are centrally controlled. Nevertheless similar general principles have been adopted on the basis that the essentials for a complete plan for mobilization of industry are as follows:

Firstly—Determination of material requirements.

Secondly—Plans for obtaining such requirements.

Thirdly—Determination of measures to be employed to ensure the proper co-ordination and use of the nation's resources.

Fourthly—Plans for the organization of administrative machinery to execute these control measures.

In any plan of industrial preparedness one cannot neglect the needs of the civilian population. These needs must necessarily be curtailed to some extent, but an underfed, under-privileged population at home will lose the will to continue the struggle resulting in collapse of the industrial machine so necessary to maintain the fighting machine.

It may be of interest to note at this point that the United States has given the question of industrial mobilization a very intensive study over the last fifteen years. As a result, a very elaborate and nation-wide system of industrial preparation for war has been built up under the direction of the Secretary of War. So much stress is laid on this phase of defensive preparation, that an Army Industrial College was established at Washington twelve years ago for the purpose of training certain selected Army and Naval officers in "planning procurement" and industrial mobilization. In addition further officers are trained for the purpose in the Harvard Business School of Administration. Great Britain has been intensively studying the question of supply in war since 1924, and very recently a new department under the Minister for Co-ordination of Defence has been established as its designation implies, for the purpose, of ensuring the co-ordination of the nation's industrial efforts and resources, in the development of the present extensive defence programme.

The Canadian Situation

In the autumn of 1936, the Minister of National Defence, the Honourable Ian MacKenzie, caused a joint Navy, Army and Air Supply Committee to be set up within his Department for the purpose of investigating emergency supply. This committee immediately commenced a survey of commercial undertakings in Canada with a view to ascertaining what facilities existed in the country for the production of war stores in an emergency. To date 800 plants have been surveyed, and individual records completed, setting forth the existing facilities possessed by each for the production of war stores. In its work of investigation, the committee has received valuable assistance from other government departments—the National Research Council, the Department of Mines and Resources, the Dominion Bureau of Statistics, the Department of Transport, and that of Trade and Commerce. Perhaps one of the most outstanding features of the whole investigation has been the loyal spirit of co-operation which industrialists and manufacturers have shown the committee during its investigations. Trade information of a confidential nature has in many cases been given which under other circumstances would not have been divulged. But for the interest shown by the private manufacturer, the committee would not to-day be in the position of having such complete records on individual plants.

As soon as the present survey is completed, and it is very much in the nature of a preliminary survey, there will be information at the disposal of the Department of National Defence which will permit a fairly accurate gauge of the existing facilities possessed by Canadian industry for the production of war stores. From the information available, a preliminary allocation can be made which will permit more detailed investigation of plants selected for the production of specific war stores best suited to the facilities which they possess. Finally, a plan can be drawn up which will allocate production to industry in an emergency based on probable requirements. Such a plan will go far toward cutting down the time that manufacturers will be given an opportunity to consider and study production methods of the store which they will be called on to produce in an emergency.

The production of war stores by Canadian industry may be broadly classified as:

Firstly—Those which are of ordinary commercial pattern or an adaptation of such to military use.

Secondly—Those which have no commercial equivalent and are of special design and methods of manufacture.

To obtain military stores falling under the first category presents little difficulty in peace or war. Those under the second may, however, prove difficult since this classification includes most of the lethal armament—guns, bombs, torpedoes, shells, service aircraft, tracked vehicles, etc. To date, the preliminary survey has divulged that there is little reason to doubt that Canadian industry would be capable of supplying the bulk of our armament requirements. We must realize that the demand created by the peace time needs of the defence forces of Canada would hardly warrant entering production of certain items of special manufacture unless we are prepared to accept very high production costs, or unless a demand develops from other markets.

Amongst other factors in the preparation of a plan of industrial preparedness are those appertaining to raw material supply and labour. The former may well prove a bottleneck in emergency production, thus all available sources of supply must be explored. Where a possibility of shortage of raw material may occur, arrangements must be made to build up reserve stocks. In some cases the difficulty may be overcome by changes in specification which will permit substitution of a material more readily available. The labour problem cannot be over-emphasized. Shortage of skilled mechanics may be a retarding factor in reaching emergency output. The solution of this problem appears to be one which the industrialist and labour unions must solve in co-operation with each other. The enlistment of skilled mechanics into the defence forces during an emergency will have to be carefully scrutinized.

The role which our national industry will play in an emergency needs no further emphasis. The ability of Canadian industry to produce the requirements of the defence forces will measure the success of any defensive precautions of a naval, military or air force nature which may be devised. Finally, it must be borne in mind that other nations have been engaged in planning for "Industrial Mobilization" over a period of twenty years. Owing to constantly changing circumstances, their plans can never be wholly complete but must be subject to periodic revision. We should bear in mind then, that such planning takes time and much careful investigation. It is not a matter which can be rushed at boldly and completed over night, but one which takes form gradually.

The Relation of Cost to the Speed of Rail Transport

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NOTE.—The author has specialized on the economics of railroad operation. From the date of his graduation at Cornell, where he majored in transportation, up to the present time he has worked with the railroads of the States and South America, lectured in the universities, sat on commissions and research boards, and generally investigated and studied transportation problems, until to-day he is recognized as one of the experts on this subject in the United States.

In view of the importance which is attached to-day to the speed of transport, and which is evidenced by the insistance of shippers on reducing the time consumed in transit of goods, the following analysis of the relation between the cost and the speed attained in the movement of tonnage freight by railroad may be of some interest. It must be pointed out in the beginning, however, that the analysis presented here deals only with the movement of commodities over the road, and does not include consideration of the costs of terminal handling, or those incident to collection and delivery service where that is provided by the railroads. Such terminal costs are independent of the speed of actual movement, and represent constants to be added to the cost of the run.

An analysis of the sort contemplated here must be based on certain assumptions in order to simplify the problem as well as to help bring out more clearly the effect of the particular factor being studied, in this case the speed of movement. Accordingly, it is assumed that the locomotive is operating under full load; that the cars in the train are loaded to capacity; and, in developing the characteristics of the locomotive tractive effort for different speeds, the movement takes place over straight, level track. These assumptions represent the ideal, rather than the normal situation, perhaps; but conform to standard practice in this type of analysis, whereby any deviation from these assumed conditions would constitute a particular situation for which allowance could be made more readily. The analysis must also be based on a particular stage of technological development. Further technological advance may modify the data presented here so as to change the result numerically. This is almost certain to be the case. But the underlying relationships involved in the present study are well established.

Movement of Commodities

In developing a cost curve of speed the element of size, or carrying capacity, in this case the train load, will not be held strictly constant, but will be allowed to vary with variations in the speed as it does in actual operation. The elements of cost include wages, fuel and locomotive supplies, maintenance, and other customary charges. A preponderating proportion of these cost factors are independent of the speed of movement. Wages and fuel are the principal variables. But wages are in part on an hourly basis, with mileage allowances added. Moreover, on the assumption made here, namely, that the locomotive is working to capacity at all speeds, there would be practically no variation in the rate of fuel consumption. It is possible, therefore, to take a cost per train-hour on the road which is constant for all practical purposes. Then, by relating variations in locomotive tractive effort and train resistances for different speeds, an allowable weight of train can be developed for any given speed.* The corresponding cost per ton-mile of transportation produced is computed from this data. From this relationship developed between cost and speed, it is possible to discover the speed for which the unit cost is a minimum. The rate of movement so determined represents the most economical speed, where the agency of transport alone is considered. These computations have been made for three types of steam locomotives now in use, hauling trains of 50-ton capacity cars.† If the capacity of the cars were increased the tendency would be to reduce the train resistances and thus to increase the "economic" speed.‡

The results of these computations have been plotted on the chart (Fig. 1) for the three locomotives, the cost per ton-mile being plotted against speed. Certain facts which are revealed by this chart deserve some attention. In the first place, there is a clearly defined point of minimum cost per ton-mile for each of these locomotives. Secondly, it is seen that not only does the cost increase rapidly as the speed is increased beyond the optimum (the minimum points of the respective curves), but also that the cost increases equally rapidly as the speed is reduced below this point. Data are not available for the higher ranges of speed, but the curves, as plotted suggest symmetry about the minimum points, and have the general appearance of parabolas. This indicates that the cost does not vary directly with the speed, but with some higher power. This is in line with the relationship which obtains in marine transport. The curve, M-M_2, giving the speed-cost relationships for a mountain type locomotive, rep-

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* The train resistances at different speeds used in the present analysis are derived from the findings of the Engineering Department of the University of Illinois, Bulletin No. 39, Vol. VI, pp. 31-33, as modified by findings more recently of one of the large railway supply companies.

Variations in locomotive tractive effort have been taken directly from drawbar-pull curves developed through tests conducted by one of the large railway systems.

† For detailed computations, see Appendix.

‡ This effect would also be produced at the higher speeds by streamlining.

resenting the most recent development in steam locomotive design, indicates a substantial increase in the range of speeds for which operating costs are reasonably low. This is of considerable importance from the economic standpoint, as will be shown shortly. It should be noted that the points of minimum cost obtained here are at speeds considerably in excess of that formerly claimed by writers on this subject as the most efficient speed for tonnage freight trains.* In view of this fact it may be well to examine the effect of variations in speed on the volume of transportation produced over some measurable period of time.

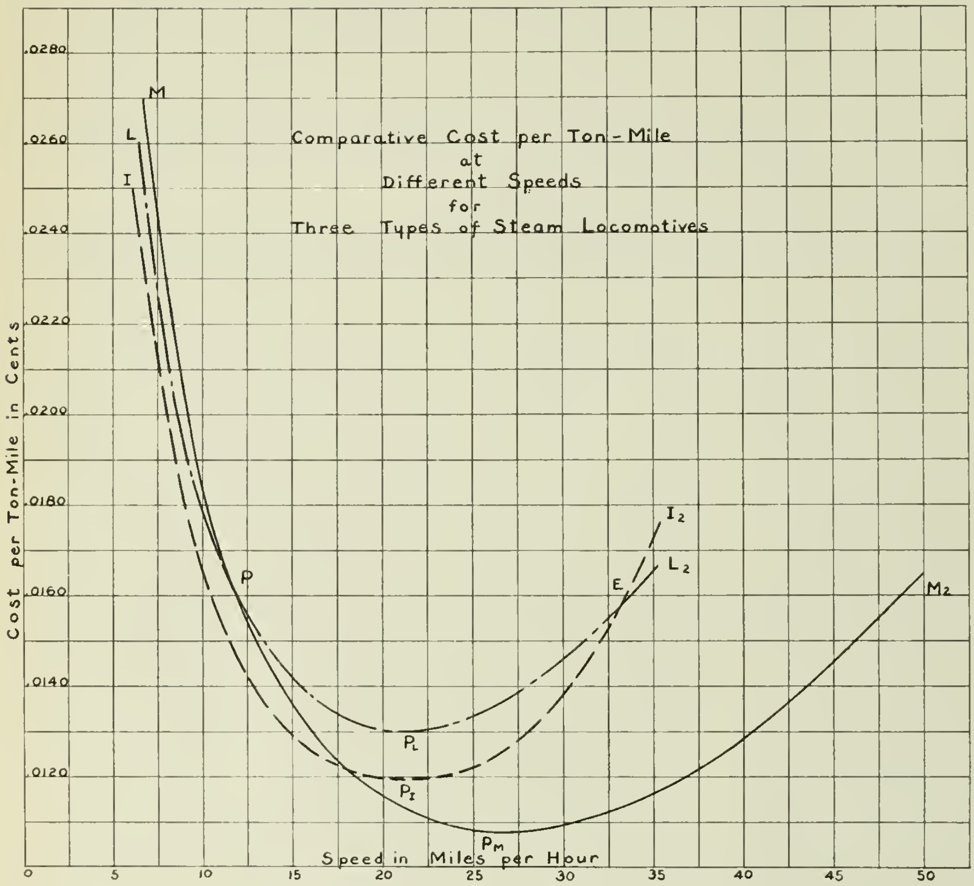


Fig. 1.

It is possible to approach closely actual conditions by taking the figures for allowable weight of train at different speeds for one or more of the locomotives studied, using the actual variations in tractive effort and train resistances developed by test. The locomotive which is most efficient at a speed of approximately 25 mi. per hr. is capable of hauling a train of 6,000 tons at that speed, and will produce 150,000 ton-miles per hour. In an eight-hour day this would mean a production of 1,200,000 ton-miles. The same locomotive can haul a train of approximately 8,300 tons at a speed of 12.5 mi. per hr.; but the ton-miles produced per hour will be only 104,000; and in an eight-hour day, would be only 832,000 ton-miles, or a decrease of over 40 per cent in ton-miles produced per hour and per day. Moreover, the cost has increased proportionately. The cost per ton-mile at a speed of 12.5 mi. per hr. is 143 per cent of the cost at a speed of 25 mi. per hr. The argument advanced on practical grounds for the former low rate of movement has been based on the contention that divisional operation required yarding of trains at the end of a 100-mile haul, on the average, for change of crews. This has been about the average length of a division, and could be covered in eight hours at a speed of 12.5 mi. per hr. Any higher speed, which would reduce the time consumed in completing this run, it has been contended, would not effect any savings in wages, since eight hours represents the minimum day's pay, and the increased speed would call for a lighter train load, and so reduce the ton-miles produced per eight-hour day, and, therefore, per man-hour. The answer to this argument has been that, even if crews are changed at the division termini, the trains do not have to be yarded at these intermediate points, but may be run through to ultimate destination intact in many cases

The result has been the development of inter-divisional runs, which have materially improved the over-all speed of freight movement. The distance limits imposed by former operating methods have thus been done away with, as well as a considerable amount of unnecessary yarding of trains. Crews may be changed at division points (though this is not always done), but the locomotive and train are moved straight through for distances up to 500, and even 1,000 miles, or more, without yarding.† It can now be fairly said that managements have definitely broken away from the former policy of moving the greatest possible tonnage per train at what might almost be termed the slowest possible speed, to a policy of getting freight over the road at much faster rates. For the consummation of this achievement they (and the shipping public) have largely to thank the competition of the motor trucks.

But, as the cost of moving commodities increases as the speed is reduced below the economic or most efficient level, so also does it increase if the attempt is made to improve the rate of movement without due consideration being given to volume; that is, if the attempt is made to produce miles per hour without regard to tons. Thus, if the speed of the locomotive we have been considering is increased from 25 mi. per hr. to 35 mi. per hr., the locomotive-miles, or train-miles produced in eight hours will increase from 200 to 280, or by 40 per cent. But, at this speed the locomotive can haul only about 4,000 tons, as opposed to 6,000 tons at a speed of 25 mi. per hr. Therefore, although the train-miles have been increased by 40 per cent, the ton-miles, i.e. the actual transportation of goods, has been reduced from 150,000 to 140,000 ton-miles per hour, or a reduction of about 7 per cent; and the unit cost has increased by a similar proportion.

There is, thus, apparent validity to the theory of an optimum, or economic speed for tonnage freight at any given stage of technological development. An examination of the cost curves developed for the three types of locomotives studied here indicates, moreover, that with tech-

* Byers, M. L., Economics of Railway Operation, 1907, pp. 499-505.
Haines, H. S., Efficient Railway Operation, 1919, p. 361.
Droege, J. A., Freight Terminals and Trains, 1912, pp. 168-171.

† Freight trains are run through to-day from Denver, Colorado, to Ogden, Utah, on the Union Pacific, a distance of 577 miles; from Saint Paul, Minnesota, to Minot, North Dakota, on the Great Northern, a run of 526 miles; and from Los Angeles, California, to El Paso, Texas, on the Southern Pacific, a distance of 815 miles, without yarding.

nological advance the slope of the positive section of the cost curve tends to be reduced. The slope of the curve, P_m-M_2, is less than that of either curve, P_1-L, or P_I-I. This has considerable significance, for it indicates that with continued improvement in motive power the decrease in tractive effort as the speed is increased tends to be less rapid for a given locomotive. This, in turn, permits a greater allowable weight of train for the higher speeds, thus reducing the cost per ton-mile. It may, therefore, be possible to increase the speed of movement via rail by further considerable increments without materially increasing unit costs.

It should be noted also that, in the case of the latest type of locomotive tested by the above analysis (curve M-M_2), not only is the most efficient speed considerably greater than for the other two types, but, in addition, the unit cost at the "economic" or optimum speed is considerably lower. This latest type can be operated at 40 mi. per hr. with the same unit cost (per ton-mile) as that obtained for the other types at their respective optimum speeds of 20-21 mi. per hr.

If these curves are considered in the light of cost curves, then, down to the minimum points on the respective curves speed is supplied on the basis of increasing returns. If, however, rates are stabilized on the basis of costs determined from operation at some lower speed, such as that represented by the common point, P, an inducement will be presented to the carriers to offer faster schedules to shippers without any increase in rates. In fact, a substantial increase in speed can be effected with the same motive power (the difference between 12 and 32 mi. per hr. or 20 mi. per hr.) before unit costs will again come up to the same figure as for a speed of 12 mi. per hr. And, at the higher speed the optimum operation of the more efficient locomotive has been only slightly exceeded. With this locomotive trains could be run at any speed between 12 mi. per hr. and approximately 45 mi. per hr. at a net gain to the carrier. This is a steam locomotive with a characteristic diminishing tractive effort as the speed is increased. While accurate information concerning the characteristics of the tractive effort of electric locomotives is at present rather meagre, it can definitely be stated that there is a lower rate of decrease in tractive effort as the speed is increased than for steam locomotives, i.e., the tractive effort of electric locomotives remains more nearly constant for a higher range of speeds. The effect of this would be, obviously, to make possible very substantial further increases in the speed of trains without any appreciable increase in operating costs, except as wages are affected; for, the allowable weight of trains being greater, the cost per ton-mile would tend to be lower. Maintenance charges would tend to increase with higher speeds, though not in the same proportion. Another factor is the possible legal limit to the length of trains. If the length, and therefore the weight, of trains were restricted, unit operating costs would be affected, although the speed of operation itself were not.

The value of high speed to the users of transportation may be sufficiently great to warrant a speed considerably higher than the optimum operation developed by the above method, at a correspondingly higher cost. The true "equilibrium" speed in the economic sense is reached when any further increase can be secured only at a cost beyond that which the traffic will bear. What this true equilibrium speed will be at any time will depend in part upon the type of industrial organization which has been developed to most effectively meet current trade customs. These trade customs will determine the standards of service demanded. The speed of transport is a vital factor in securing whatever distributive service is obtained.

APPENDIX

Computations Involved in the Development of an Economic, or Optimum Speed for Rail Freight Transport

A basic cost per train-hour of $14.50 was taken for the Mikado locomotive (curve L), which is composed of direct operating expenses only, and includes the wages of a full crew, locomotive expenses, including the cost of fuel, oil, supplies, maintenance charges, etc.; but does not include overhead, fixed capital charges, and the like. The cost per train-hour for the other two locomotives (curves I and M on the chart) is proportioned to their respective capital costs relative to that of the Mikado type locomotive.

The relative capital costs, using the Mikado as base (100 per cent), are 104.4 per cent for the Decapod, type I, and 109.2 per cent for the Mountain type, M. These figures are derived from the actual prices paid for the locomotives used in this analysis. The respective costs per train-hour are:

Cost per train-hour, type L engine—100.0 per cent—$14.50
" " " " I " —104.4 " — 15.14
" " " " M " —109.2 " — 15.83

To vary the cost per train-hour according to the capital costs of the respective locomotives seemed justified, partly by the lack of detailed operating cost data for each locomotive, and partly by the fact that wages could not properly be held strictly constant because of the custom of paying the engine crew higher rates on larger locomotives than on smaller, though this practice varies somewhat among the different railroads because of differences in design.

In the following tabulations the computations involved are: Column 4 equals column 2 divided by column 3; column 6 equals column 1 multiplied by column 5; column 7 is based on the assumed costs per train-hour given above for the three types of locomotives respectively. All unit costs are given in cents, except as indicated.

Table I
Cost per Ton-Mile* for Various Speeds
Mountain Type Locomotive

Speed	Tractive Effort	Train Resistance	Allowable weight of Train		Ton-mile	Cost per Ton-mile	
m.p.h.	Per cent	Per cent	Per cent	Tons	Per hour	Cents	Per cent
7	105.4	91.9	114.8	9120	63,850	.0248	187.8
8	105.0	92.4	113.6	9080	72,600	.0218	165.0
9	104.4	93.3	112.0	8960	80,700	.0196	148.4
10	103.8	94.5	109.9	8790	87,900	.0180	136.3
11	103.2	97.0	106.4	8515	93,700	.0169	128.0
12	102.6	98.3	104.3	8345	100,000	.0158	119.6
13	101.7	99.2	102.4	8200	106,600	.0148	112.0
14	100.8	99.9	101.0	8080	113,000	.0142	107.5
15	100.0	100.0	100.0	8000	120,000	.0132	100.0
16	99.1	102.6	96.8	7745	123,800	.0128	97.0
17	97.9	105.3	93.0	7440	126,400	.0125	94.7
18	96.9	106.8	90.7	7255	130,600	.0121	91.6
19	95.9	108.1	88.8	7100	134,900	.0117	88.6
20	94.7	109.4	86.6	6925	138,500	.0114	86.4
21	93.6	110.8	84.5	6760	142,000	.0112	84.8
22	92.2	113.3	81.4	6510	143,200	.0111	84.0
23	91.0	116.1	78.3	6260	144,000	.0110	83.4
24	89.6	118.0	76.0	6080	145,900	.0109	82.6
25	88.0	119.0	73.9	5910	147,700	.0107	81.0
26	86.2	121.6	71.0	5680	147,700	.0107	81.0
27	84.5	124.3	67.9	5430	146,600	.0108	81.8
28	82.8	127.0	65.1	5210	145,800	.0109	82.6
29	81.3	129.7	62.6	5010	145,200	.0109	82.6
30	79.8	132.3	60.2	4815	144,400	.0110	83.4
31	77.9	135.1	57.6	4610	143,000	.0111	84.0
32	76.3	137.7	55.4	4490	142,000	.0112	84.8
33	74.4	140.5	53.0	4240	140,000	.0113	85.6

*Assumed cost per train-hour—$15.83.
Calculations made by slide rule.

Table II
Cost per Ton-Mile* for Various Speeds
Decapod Type Locomotive (50 per cent cut-off)

Speed	Tractive Effort	Train Resistance	Allowable weight of Train		Ton-mile	Cost per Ton-mile	
m.p.h.	Per cent	Per cent	Per cent	Tons	Per hour	Mills	Per cent
7	116.0	91.9	126.0	10070	70,490	0.215	170.3
8	114.4	92.4	124.0	9920	79,360	0.191	151.3
9	112.2	93.3	120.4	9632	86,688	0.175	138.6
10	110.3	94.5	116.9	9352	93,520	0.162	128.5
11	107.0	97.0	110.3	8824	97,064	0.156	123.7
12	106.2	98.3	108.0	8640	103,680	0.146	116.1
13	104.4	99.2	105.4	8432	109,616	0.138	109.4
14	102.1	99.9	102.2	8176	114,464	0.132	105.0
15	100.0	100.0	100.0	8000	120,000	0.126	100.0
16	97.5	102.6	95.0	7600	121,600	0.124	98.8
17	95.0	105.3	90.2	7216	122,672	0.123	97.8
18	92.3	106.8	86.5	6920	124,560	0.122	96.4
19	89.3	108.1	82.6	6608	125,552	0.121	95.7
20	86.5	109.4	79.0	6320	126,400	0.120	95.0
21	83.3	110.8	75.2	6016	126,336	0.120	95.1
22	81.0	113.3	71.4	5712	125,664	0.121	95.7
23	78.5	116.1	67.6	5408	124,384	0.122	96.6
24	75.8	118.0	64.2	5136	123,264	0.123	97.3
25	73.2	119.0	61.5	4920	123,000	0.124	97.6
26	70.5	121.6	58.0	4640	120,640	0.126	99.4
27	67.8	124.3	54.5	4360	117,720	0.129	102.1
28	65.0	127.0	51.2	4058	114,688	0.132	104.8
29	62.3	129.7	48.1	3848	111,592	0.137	107.5
30	60.0	132.3	45.4	3632	108,960	0.140	111.0
31	56.8	135.1	42.1	3368	104,408	0.145	114.8
32	53.7	137.7	39.0	3120	99,840	0.152	120.0
33	50.5	140.5	35.9	2872	94,776	0.160	126.7

*Assumed cost per train-hour—$15.14.
Calculations made by slide rule.

Table III
Cost per Ton-Mile* for Various Speeds
Mikado Type Locomotive

Speed	Tractive Effort	Train Resistance	Allowable weight of Train		Ton-mile	Cost per Ton-mile	
m.p.h.	Per cent	Per cent	Per cent	Tons	Per hour	Cents	Per cent
7	116.4	91.9	126.7	8860	62,100	.0234	169.4
8	115.7	92.4	125.2	8760	70,100	.0207	150.0
9	114.2	93.3	122.4	8565	77,100	.0188	136.2
10	112.1	94.5	118.6	8300	83,000	.0175	126.8
11	109.9	97.0	113.3	7930	87,250	.0166	120.2
12	107.4	98.3	109.3	7650	91,800	.0158	114.3
13	104.9	99.2	105.7	7390	96,000	.0151	109.3
14	102.5	99.9	102.6	7175	100,400	.0144	104.4
15	100.0	100.0	100.0	7000	105,000	.0138	100.0
16	97.4	102.6	94.6	6630	106,000	.0137	99.3
17	94.8	105.3	90.0	6300	107,100	.0135	97.9
18	92.4	106.8	86.5	6060	109,100	.0133	96.4
19	89.6	108.1	83.0	5810	110,300	.0131	95.0
20	86.4	109.4	78.9	5525	110,400	.0131	95.0
21	83.8	110.8	75.6	5290	111,100	.0130	94.2
22	81.2	113.3	71.6	5015	111,000	.0131	95.0
23	78.5	116.1	67.6	4735	108,800	.0133	96.4
24	76.2	118.0	64.7	4530	108,700	.0133	96.4
25	73.8	119.0	62.0	4340	108,300	.0134	97.1
26	71.3	121.6	58.6	4105	106,700	.0136	98.5
27	69.0	124.3	55.5	3883	104,800	.0138	100.0
28	66.7	127.0	52.5	3676	102,900	.0141	102.2
29	64.3	129.7	49.6	3475	100,700	.0144	104.3
30	62.2	132.3	47.0	3290	98,900	.0147	106.4
31	60.2	135.1	44.6	3126	97,000	.0150	108.6
32	57.9	137.7	42.1	2947	94,300	.0154	111.4
33	56.0	140.5	39.6	2787	92,000	.0158	114.4

*Assumed cost per train-hour—$14.50.
Calculations made by slide rule.

The Concrete Gang

P. B. Motley, M.E.I.C.

This little sketch was inspired by the operation of "the gang" laying new road and sidewalk in front of the author's home. It gives a somewhat different view of the labourer and artisan than that usually held by the engineer. It just shows you what perspective will do.

These men are counterfeiting nature. The work of centuries is being done in a day for the service and convenience of man! There are not many of them—probably twenty-five in all—and they are like a ship's crew, of all ages and nationalities.

Here is a man with a battered Borsalino, that he has riddled with holes. His mates say, "he's air conditioned!" Then there's Fatty, who's not yet thirty, and weighs two hundred and fifty pounds! His job is to hang onto a rock drill because, they say, he doesn't feel the vibration. There's also Mike, the big Ukrainian with a chest like a grizzly bear, and a hand as big as a Virginia ham! In the dinner hour, he amuses himself and the boys, by carrying one of his pals around on one arm.

"Come on now ye little troglodites," shouts the foreman, a restless man, who always seems to be going somewhere or wigwagging his arms to a truckdriver over there! He carries a plan in his hand, but he does more than that. He's the "Headman" and a thinker; he lays out the work according to the engineer's plans, sees the mix is right and the materials correct as to quality and quantity—and he's a financier; he makes out the payrolls at the end of the day! Important man this!

Now they're off, and at it. This is a rush job and several hundred feet must be poured by night so that it may have Sunday to harden. "Come on now you —." It is rumoured that if he did not speak in these affectionate terms, the boys would think he was getting swelled head or "high hat," or was losing interest in them. "Hurry up there you'se barrow men. Where's the guy with the 'blasted' hose?"

The mixer, which looks for all the world like a simple dairy churn, with much clatter, spues out the sludge from its insides, and all the Joes and Mikes and Fattys and Rodrigues fall upon it with shovels and big spreading rakes, and wheelbarrows, transporting it by much push and pull and vocal effort to the farthest corners of the work, as happy as mudlarks—which they actually are, in their long boots, verily wading in the wet concrete, like boys in spring puddles; with this difference—it's stone they are making!

There are some men ahead working on the wooden forms which give the proper curves to the curbs and walks. One of them has his mouth full of nails. He is an artist in his way. He has a hammer in his hand, sometimes a foot rule, that simplest of engineering instruments of precision, that critic and criterion of the work, which he silently uses from time to time—as a sculptor does in his studio.

"Come on now boys" again shouts the foreman who is afraid of the weather and wants to get this run finished before rain or nightfall. He knows the value of time and team work—and so do these big bespattered grey men. They have their officers and obey them, just as on shipboard on the main yard on a pitch dark night, or in front line trenches in the face of the enemy. No man tries to fool his fellows—while he may at times try to fool the boss.

At last, with continuous din from the machinery and shouting from the men, at seventeen minutes after quitting time, the work is finished. It's done. The long boots are washed at the water pipe as are faces and hands, for these soiled bronzed Adonises, when off the job, are quite fastidious about their appearance, and they are proud of their work—it's permanent!

Consider those other fellows, who expose themselves to a course of technical instruction for a period of years, at the end of which they get a piece of sheepskin which lets them into *their* little union whereupon they become "specialists"! These men too are specialists—union and all. Hats off to the men of the "Concrete Gang."

Recent Developments of the Gas Industry in Canada

John Keillor,
Gas Engineer, British Columbia Electric Railway Company, Vancouver, B.C.

Presented at the International Engineering Congress, Glasgow, June 21st-24th, 1938.

SUMMARY.—This paper was written in compliance with a specific request which The Institute received from the London Executive Committee of the International Engineering Congress in Glasgow. It deals with the sales of gas, existing and recommended standards, new methods of manufacture, gas burning appliances, and in particular the fields in Alberta. It describes the largest underground storage holder in the British Empire situated in Southern Alberta and a unique method of transporting gas across a three hundred foot lift bridge.

The Decline in Gas Sales in Canada

Perhaps the most outstanding fact about the gas industry in Canada is that the combined sales of manufactured and natural gas in 1937 were less by over 3 billion cu. ft. than in 1930. The decline in manufactured gas sales being greater in proportion than that of natural gas.

The gas industry in Canada is taking cognizance of its position following a period of recession—six consecutive years (1930-1936) of decline in gas output due to new and intensive forms of competition—low priced fuel oil, Diesel oil, electricity and sawdust. The remarkable improvement in the design of appliances for using the various grades of oil, electricity, sawdust, etc., has enabled the new competition to successfully invade homes and industrial plants throughout the Dominion, making serious inroads into domestic, commercial and industrial gas sales. An amazing increase has taken place in recent years in the use of these cheap competitive fuels to the exclusion of gas.

Gas sales began to decline and the need for new construction fell off. Only two new coal gas plants have been built in Canada since 1930, a chamber oven plant in Vancouver, B.C., and a continuous vertical retort plant in Guelph, Ontario.

Following are the changes in million cu. ft. sales of manufactured and natural gas in Canada in recent years:

Manufactured Gas	M. cu. ft.	Therms
Year 1930-31 to March 31st	18,266,000	89,503,400
" 1936-37 "	16,577,000	81,227,300

Average calorific value of manufactured gas 490 B.t.u.'s per cu. ft.

Natural Gas	M. cu. ft.	Therms
Year 1929-30 to March 31st	31,881,000	369,819,600
" 1936-37 "	30,291,000	351,375,600

Average calorific value of natural gas 1,160 B.t.u.'s per cu. ft.

	Therms
Combined sales of the two gases, year 1936-37	432,602,900

Total manufactured gas sales are down 9½ per cent from 1930-31
Total natural gas sales are down 5 per cent from 1929-30

The losses are principally due to cheap fuel and Diesel oil and electrical competition in the domestic and industrial markets. These forms of intensive competition are common to most cities in both Canada and the United States.

It is interesting to note that while sales of both manufactured and natural gas in the United States declined in about the same ratio as they did in Canada between 1930-1933, combined losses in the United States have since been more than recovered, while manufactured gas sales in Canada are still down 9½ per cent and natural gas down 5 per cent as compared with 1930. The writer is hopeful this unsatisfactory situation may soon be remedied in Canada.

Four year's figures taken from American Gas Association returns illustrate the remarkable recovery and trend of the business in the United States.

Percentages of Increase in M. cu. ft. Sales, 1937 over 1933

	House Heating	Industrial	Domestic	Total
Manufactured Gas				
Change in M. cu. ft. output	+127.8%	+65.2%	−12.8%	+13.5%
Natural Gas				
Change in M. cu. ft. output	—	+73.0%	*+21.6%	+55.1%

*Include house heating.

There are no similar figures available in Canada to show plus or minus sales in the three main branches of the business, but it is well known that the recovery in United States total sales is due to the rapid increase in sales for "space heating" and "industrial" purposes.

Only a few of the companies in Canada are as yet actively promoting the sale of gas for "space heating." Those who do are recording increases in total cubic feet sales. Those who don't show gas sales are languishing or further declining.

Gas Standards

Canada has a "uniform" or minimum 450 B.t.u. standard governing the quality of manufactured gas sold throughout the Dominion.

Throughout Canada gas is still made to the same "uniform" standard regardless of the varying qualities of coal or oil available for gas and coke making, geographical location, vulnerability of companies to competition of foreign fuels or manufacturing economies.

A committee of the Canadian Gas Association realizing that Canada's regulations are now out of date recently brought the matter to the attention of the Association and that body is now studying more recent British, American and Australian regulations with a view to modernization of the regulations in this country.

There are as yet no gas companies in Canada selling gas on a "therm" or other heat unit basis. No companies making gas under the "Declared" C.V. System.

There are no companies manufacturing gas of lower than 460 B.t.u.'s but opinion is gaining favour that it would be well for the industry and the gas consuming public if the "uniform" standard were abandoned in the Dominion as it was in Great Britain and the British system of requiring each gas company to "declare" the quality of gas it is best equipped to make and sell from available raw materials adopted. The gas to be sold on a "therm" or other heat unit basis. The writer believes that the

Fig. 1—Hydro Electrolytic Gas Plant, Top View of Battery of Cells.

"Declared" C.V. System is the fairest and most scientific formula for manufactured gas company operations yet devised and if adopted in Canada will give gas companies freedom to make the kind or composition of gas that will enable them in most districts to give consumers a better product than they get now—at the burner point a high flame temperature gas at a lower price. This should be the aim of every gas company in these days of keen competition among fuels.

More attention is being given to constancy of specific gravity, combustion characteristics, flame temperature, the composition of gases, etc. It is becoming recognized in Canada as elsewhere that calorific value alone is an indeterminate measure of value of gas. If the industry in Canada would increase the efficiency of manufacture, reduce manufacturing costs, attain greater efficiency in the use of gas and make progress in the future the writer believes that one of the first steps toward the accomplishment of these objectives should be the revision of the Canadian gas regulations. In the meantime present Government regulations prevent gas companies adopting more efficient methods of manufacture and sale, made possible in other countries by more flexible regulations.

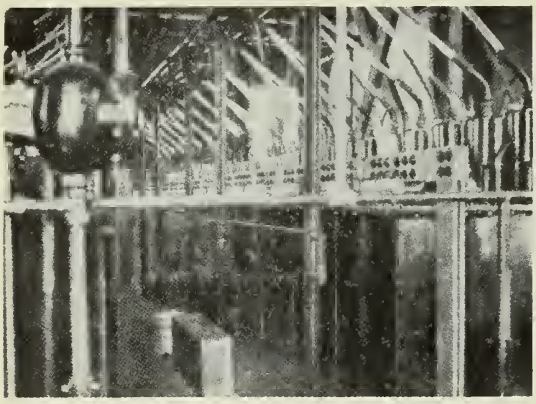


Fig. 2—View Between Battery of Cells.

Recent Gas Engineering Developments

Several new and interesting engineering developments have taken place in Canada in recent years. These the writer will endeavour to describe briefly, quoting from papers written on the respective developments.

Mixing Gas Electrically—Complete Gasification of Coal with Oxygen

A recent Toronto experiment conducted by A. T. Stuart, Director, Gas Department, Hydro-Electric Power Commission of Ontario, shows how complete gasification of coal or coke, etc., can be accomplished in the generator designed by Mr. Stuart in collaboration with American engineers, using oxygen produced from water by electrolysis.

Excerpts from description of the process by Mr. Stuart follow:—

"For many years it has been known and realized by experts in all parts of the world that the solution of the problem of the economical and complete conversion of coal into gas will depend upon large supplies of cheap oxygen.

When we consider the manufacture of domestic gas, it becomes apparent that air may not be the logical source for oxygen. If we use air oxygen we produce a gas abnormally high in carbon monoxide and higher in gravity than the gas now in city mains. If however we use water instead of air as the source of oxygen we restore the balance and can produce gas almost identical with the gas now in city mains.

The Hydro-Electric Power Commission of Ontario may therefore claim to be among the first to demonstrate on a commercial scale how coal can be completely gasified by means of electricity for the manufacture of gas similar in composition, heat value and gravity to that now being distributed in city mains.

This plant is capable of producing some 2,000 cu. ft. of oxygen and 4,000 cu. ft. of hydrogen per hour. (Figures 1, 2, and 3.) A standard type of gas producer having stationary grates was installed for operation with oxygen and steam.

Although it is a simple matter to carburet these gases to present standards, and although costs would still be less than competitive methods, the lowest possible costs would be reached if 333 B.t.u. gas could be sold on a therm basis."

The Three Stage or "Triple" Process of Manufacturing—Coal Gas, Blue Gas and Carburetted Water Gas Simultaneously

There has recently been developed in the gas works of the British Columbia Electric Power and Gas Company, Vancouver, B.C., a process for the manufacture in intermittent chamber ovens of coal gas, blue gas and carburetted water gas simultaneously. This process has certain economic advantages compared with manufacturing coal gas and blue gas in intermittent chambers or continuous vertical retorts, and carburetted water gas in a separate water gas plant.

The three stage process makes possible control of coke production, reduces the cost of making mixed gases and increases the gas production capacity of the ovens in Vancouver, 25 per cent. It is described in a paper read by Mr. J. Kirkhope, Vancouver, B.C., before the Canadian Gas Association, July 1936, excerpts from which follow:—

"In the ordinary two stage process of making gas by the carbonization of coal in the intermittent ovens it is well known practice to admit steam to the bottom of the ovens when the carbonizing period is complete, this practice serving the purpose of utilizing some of the coke for making blue gas and thus increasing the total make of gas per ton of coal carbonized.

At the completion of coal gas and blue gas manufacture in the ovens, i.e., at the end of the second stage, there is, of course, still left in the resultant coke a large amount of available sensible heat which, however, cannot be employed for further blue gas production without lowering the calorific value of the mixed gas.

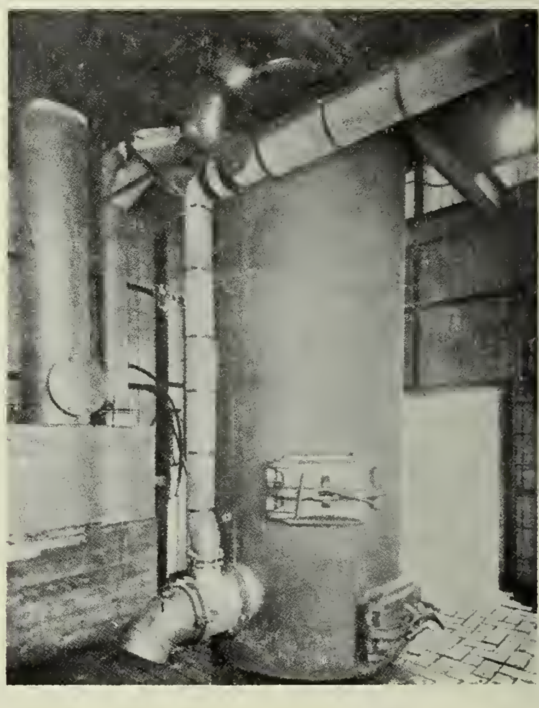


Fig. 3—Gas Producer Installation.

If, however mixed gas of the same calorific value is required, enrichment of the surplus blue gas is necessary. This enrichment was accomplished at Vancouver by the admission of liquid hydrocarbons to the ovens at the top simultaneously with the admission of steam at the bottom. The liquid hydrocarbons sprayed on top of the hot coke in the chambers at regulated temperatures causes cracking of the hydrocarbons to take place, with consequent formation of a permanent gas of high calorific value, which gas mixes with the water gas resulting from the prolonged reaction of the steam with the hot coke. The resultant mixture of water gas and cracked gas can, within certain limits, be made to any desired calorific value between that of either constituent, by adjustment of the proportions of steam and hydrocarbon liquid admitted to the chamber.

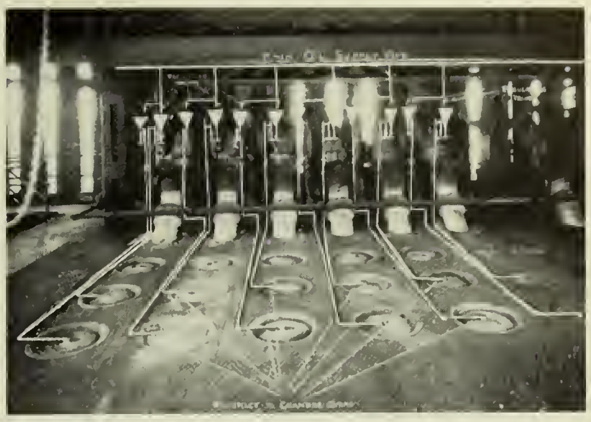


Fig. 5—Equipment for Oiling Oven Charges, Vancouver Plant.

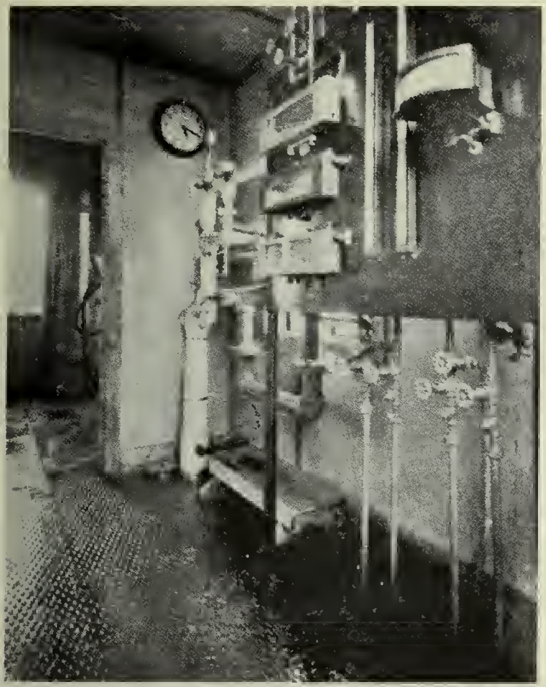


Fig. 4—Recording Instrument Rooms.

Each of the thirty-six ovens in Vancouver is equipped with two funnels and U-sealed delivery lines and the oil discharges into the ovens through nipples in two of the three charging port lids. Either one or both can be used to suit the proportions of oil gas wanted in the mixture. (Fig. 5.)

In a modern gas producing plant of the intermittent oven type the "Triple Process" of making coal gas, water gas and carburetted water gas can thus be carried on simultaneously, thereby controlling the coke output in a manner hitherto not attempted. The coke residue is still of good marketable quality.

In the case of the results obtained without oiling, i.e., making coal and blue gas only, the points lie fairly close to the curve "*A*." When the "Triple Process" is in use, the results obtained when using twenty to twenty-five gallons of oil per ton of coal carbonized are shown plotted, and fall on, or close to, curve "*B*" (different curves are obtained for different oil consumptions).

When using the "Triple Process," the make of coal gas, blue gas and carburetted water gas usually averages 25,000 cu. ft. (117.5 therms) per ton of coal and oil used and on occasion 30,000 cu. ft. (141 therms) has been exceeded. Thus the third step in the process-making carburetted water gas increases the yield of gas per ton of coal and oil used, so that coke production can be controlled at will and without utilizing the auxiliary water gas plant, except when the output exceeds the capacity of the chamber oven plant."

A Unique Natural Gas Engineering Development— Production of Natural Gas in Turner Valley and Recharging a Depleted Natural Gas Field at Bow Island, Alberta

The largest gas producing plant in the Empire is the Turner Valley Natural Gas Wells, Alberta. They are producing more therms annually (880,000,000) than all the gas companies in London, Glasgow, Edinburgh, Manchester, Liverpool, Birmingham, put together. And no gigantic coal gas, water gas or complete gasification plants on ground level are required to produce this enormous therm output. The natural gas has a C.V. of 1,160 B.t.u.'s per cu. ft. after it has been stripped of its gasoline content.

At the present rate of proration approximately 208 million cu. ft. of natural gas (2,412,800 therms) is being produced daily in the Turner Valley field. Of this amount 9 million cu. ft. (104,400 therms) is being used in field boilers and for heating purposes in the field proper while between 30 and 50 million cu. ft. daily is being consumed through the pipe line system of the Canadian Western Natural Gas, Light, Heat and Power Company, Ltd., Calgary, depending on weather conditions. The balance, an average of 160 million cu. ft. (1,856,000 therms) is blown to the atmosphere and wasted daily after the wet gas has been treated in separators and stripped of its gasoline content.

Storage of Natural Gas in the Bow Island Field

Southern Alberta also possesses the largest underground gas storage holder in the Empire. There is now stored in the Bow Island field 10 billion cu. ft. of natural gas which has all been pumped from the Turner Valley field into the near depleted wells at Bow Island (160 miles distant) there to be conserved. Pumped underground against outlet pressures on compressors from 297 lb. to 566 lb., the filling of of this great underground holder has been going on for 7 years.

Repressuring near depleted wells and storing quantities of natural gas underground at increasing pressures is a remarkable piece of natural gas engineering. It is a successful attempt to conserve at least a small part of the enormous surplus gas now going to waste in the Turner Valley.

The writer is indebted to Mr. P. D. Mellon, General Superintendent and Chief Engineer of the Calgary Company, for this up to date information re Turner Valley operations and for the following details of the operation.

Report on Storage of Turner Valley Gas in Bow Island Field, form Commencement of Operations August 4th, 1930 to July 31st, 1937

Gas stored August 1st, 1935 to July 31st, 1937....	1,352,444 M. cu. ft.
Previously stored..............................	8,631,869 "
Total to date..............................	9,984,313 M. cu. ft.

Individual Well Storage

No. 4.................	1,550,298 M. cu. ft.
" 7.................	946,783 "
" 8.................	3,773,784 "
" 11.................	766,593 "
" 12.................	1,545,714 "
" 14.................	937,932 "
" 22.................	463,209 "
Total..............	9,984,313 M. cu. ft.

Average rock pressure of field after being shut in 11 days....	542 lb.
Average rock pressure before commencement of storage operations, August 4th, 1930..........................	248.7 "
Increase in average rock pressure since commencement of storage operations..............................	293.3 "
Increase in average rock pressure in last 12 months.........	25 "
Increase in average rock pressure in previous year..........	21 "
Increase in average rock pressure per 1 billion cu. ft. stored since commencement of storage operations.............	29.4 "

Outlet pressure on compressors, August 4th, 1930..........	297 lb.
" " " " July 31st, 1931............	415 "
" " " " July 31st, 1932............	428 "
" " " " July 31st, 1933............	467 "
" " " " July 31st, 1934............	500 "
" " " " July 31st, 1935............	524 "
" " " " July 31st, 1936............	544 "
" " " " July 31st, 1937............	566 "

Automatic High Pressure Valves on a 300-ft. Lift Bridge—The Only Installation Extant

An interesting development in Gas Distribution Engineering was described in a paper read before the Pacific Coast Gas Association, Seattle, Washington, August 1937 by Mr. F. E. Reed, British Columbia Electric Power and Gas Company, Vancouver, B.C., the designer of the automatic valves. A short time ago the company extended its distribution system to the north shore of the harbour in Vancouver and it became necessary to either lay a high pressure submarine main under heavy tidal water or devise a means of getting the gas across a lift bridge. How this was done is described in the paper referred to, excerpts from which follow:—

Fig. 6—Second Narrows Bridge, Vancouver, B.C., Carrying Gas Mains.

"At the point where the bridge (Fig. 6) is built there is a tidal current which runs at times as fast as 10 knots according to the variation of the tides.

At first the possibility of laying an under-water gas main at a location a short distance from the bridge where the City Water Department has several cast iron water mains was considered. These water mains are 1½ in. thick, 18 in. in dia. and weighing over 450 lb. per ft. and on information obtained we were advised that the effect of the silt and sand deposited from the creeks, passing back and forth with the tidal current over these pipes, had been known to wear sections of them through within a very short period, also some of them had been broken by vessels dragging their anchors, etc.

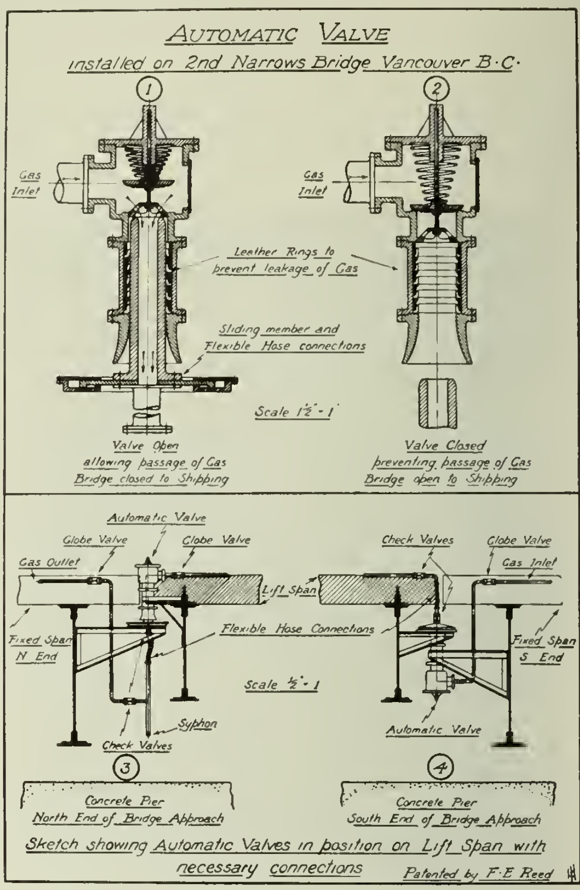


Fig. 7—Operation of Automatic Valves on Second Narrows Bridge, Vancouver, B.C.

Finally after very careful consideration and in view of the physical difficulties and high capital and depreciation costs of a submerged gas main it was decided to install on the bridge and lifting span section two automatic joints and valves.

This is the first and only installation of its kind in the world to be used by a gas company in the transmission of its product. On each end of the 300 ft. lift span was installed an automatic joint. When the bridge span lifts for the passage of a vessel the joints come apart and the gas supply to North Vancouver is automatically cut off. This does not affect the supply to the consumer for the demand is taken care of by storage of gas in a Hortonsphere holder on the North Vancouver side. When the lift span is brought down to the traffic level the joints automatically couple themselves, opening valves and permitting gas to flow from the city plant to the North Vancouver shore. The valves were placed in operation in 1934 and to date they have worked without giving the slightest trouble and requiring very little attention.

Figure 7 explains the operation of these valves. This drawing has been divided into four sections, 1, 2, 3 and 4 and by referring to Fig. 7 (1) you will see how the two halves of the joint are joined together when the bridge is in position and the gas is passing through our main."

Certification and Approval of Gas Burning Appliances

The writer is indebted to Mr. George Allen, Secretary, Canadian Gas Association, Toronto, for the following information:—

The gas industry in Canada has for twelve years been keenly interested in the certification and approval of gas burning appliances, so that users of gas service may be supplied with equipment that is at once safe, efficient and durable. The Canadian Gas Association has taken keen interest in the activities of the Testing Laboratories of the American Gas Association and has adopted the standards of gas appliance manufacture laid down by the Approval Requirements Committee of that organization. Most of the gas appliance manufacturers of Canada have fallen in line with this excellent movement, and are doing all they can to bring up the quality of their products to a standard that promises well for the gas industry in this country.

The certifying and approving of gas appliances, especially those that fit into domestic service, has done much to increase the efficiency in use of both manufactured and natural gas and improve customer satisfaction. The central testing laboratory located at Cleveland, Ohio, and the branch located in Los Angeles, California, has tested and approved nearly 6,000 individual gas appliances made by manufacturers in Canada and the United States. In addition, about 23,000 other appliances have also been approved by visual inspection only based on their similarity to those previously tested. At the present time the laboratories are certifying equipment for nearly 300 manufacturers located throughout the United States and Canada. The value of the property and physical equipment of the laboratories amounts to about $250,000.

The Seal of Approval of the Canadian or the American Gas Association shown on a gas appliance, appurtenance, device or accessory, is a guarantee to the public of compliance with basic national requirements for safety, and any such equipment that cannot meet these requirements is not fit to be used, and all practical means should be employed to prevent its sale and use.

Monel Metal Tanks

Of the many new types of appliances approved, special mention might be made of the recent use in Canada of monel metal tanks in automatic gas water heaters, increasing numbers of which are being sold. Where they have been in use for three years or more it is found that customers get a supply of hot water absolutely free of rust or discoloration. This confirms the belief that monel metal tanks will outlast other makes of tanks so far as internal corrosive action of the water is concerned, but it is not known yet what effect the products of combustion of various gases are going to have on the exterior of the tanks. This will take some years to find out.

Aviation Radio

A. K. Bayley,

Assistant Radio Electrical Engineer, Department of Transport, Aviation Radio Branch, Ottawa, Ont.

Presented before the Lethbridge Branch of The Engineering Institute of Canada on January 22nd, 1938.

SUMMARY.—The value of communication in transportation cannot be overestimated. In the field of aviation this value is greatly enhanced, but the means of establishing the communication is much more complicated than in other forms of travel. The author describes the different systems and equipment that are now in use in Canada.

There are many angles from which a subject so complex as aviation radio might be approached. Indeed, within the prescribed limitations, it is possible to cover only a small portion of the subject. In preparing this material an endeavour has been made to deal with the features that would have the most interest of a general nature.

The history of transportation shows the development of its dependence upon communications from the early days of slow motion travel to this day of speed. This dependence has steadily grown until to-day it is evident that our transportation systems could not operate without it. Trains, boats, busses, and air lines would be at a standstill if they did not have efficient methods of maintaining contacts with other moving vehicles and with the stationary points on land. Hence we see that the first work of a communication system is to establish safety in transportation. With that most modern of all conveyances the aeroplane, it is more than ever important, and it is the object of this paper to outline the needs of this form of rapid transportation and to describe the equipment and the methods that apply to this modern method of communication.

This field divides into two parts:

1. The facilities for rapid inter-communication between ground stations and between these ground stations and the planes.

2. The facilities for guiding planes in their flights between the various terminus points and for assisting them in landing when the visibility is poor.

1. In dealing with the first requirement, it has become standard practice to include a teletype circuit which connects all stations along the airway. Weather reports are normally sent along these circuits in order to render the radio facilities available for plant to ground communication at all times. It is obvious therefore, that as far as the dispatching of weather reports from one ground station to another, the radio is only used as a standby in the event of trouble on the teletype lines.

The radio communication system is, however, used for service or routine messages between the terminus points of the system. These messages include such things as the times of arrival and departure of planes and in fact all the normal routine details of concern to a transportation system. This radio set is also used for the purpose of assisting in the landing of planes when visibility is poor. Even under good conditions the station contacts the plane immediately before it lands, giving last minute reports on details that might affect the landing.

This ground equipment serves another important service. The operator of the ground station keeps constant watch on the communication frequency. The plane is required to report at fixed times each hour. In the event of a plane failing to report on one of these allotted times, immediate investigation is made as to its location. Therefore a continued check is maintained from the time the plane leaves one terminus until it arrives at the next.

To fulfil the requirements imposed on the terminus ground station these stations must be equipped with:

a. A transmitter of sufficient power to ensure an uninterrupted communication service between any three adjacent ground stations and constant communication with planes flying between any two adjacent ground stations.

b. A receiver capable of receiving the messages directed to the ground stations from either adjacent ground stations or planes.

The planes must be equipped with:

a. A transmitter of sufficient power to ensure reliable communication with the two terminus ground stations between which it is flying.

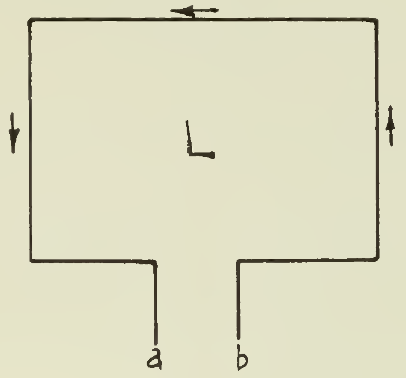


Fig. 1.

b. A receiver capable of receiving signals from the adjacent ground stations between which the plane is flying.

Due to the present popularity of multiband broadcast receivers, nearly everyone has at one time or another heard the type of message that is directed both from the aviation ground stations and the planes themselves, thus this section is concluded with a brief outline of the factors which determine the type of equipment used in this branch of the Aviation Radio Service.

Obviously the power required for the ground transmitters is determined by the distance between the terminus points where these stations are located, but what about the plane transmitters? Every pound of weight added to the equipment carried by the plane means one pound less "pay load." It is a well known fact that the more power required, the larger and heavier is the equipment necessary to deliver that power to the transmitter for its operation. The problem of seelcting the plane transmitter then resolves itself into selecting the transmitter of the least

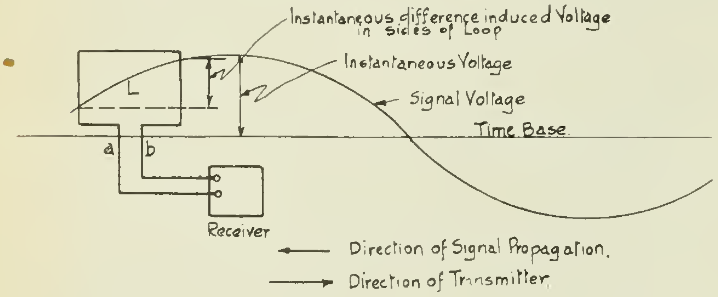


Fig-2

bulk, requiring the least power to operate it, which will still fulfil the communication requirements. The answer to the problem is apparent, namely short wave transmitters. The bulk of this transmitter and the power required to operate it are appreciably less than those transmitting long waves for the distances over which communication between ground and plane must be maintained. Obviously the answer to the plane transmitter problem dictates the type of transmitting equipment to be used on the ground since it is not economical to install separate equipment for each of the two services required of the ground station.

Since the selection of receivers is tied with the solution of the transmitter problem it will suffice to say that short wave receivers are less bulky than those for long wave operation.

2. The discussion of the radio equipment necessary to guide planes from one point to another, logically falls into two subsections: in other words, there are two methods which may be used to guide planes by radio signals.

a. The first method involves the installation of a direction finding receiver, in each plane. By the reception of signals from ordinary broadcast stations or stations specially constructed for this service, the operator in the plane can determine his position by triangulation. The ground station transmitters for this service do not have to be specially adapted for the service. By using direction finding equipment, the pilot may tune his direction finder on a station located near his destination airport and fly directly towards it. This system is used extensively in Europe and also for trans-oceanic flying where it is not possible to install transmitters of a better type. On this continent this system has so far been used only to supplement that which is described later.

Numerous commercial direction finders for this type of service are available but all of them are based upon a property peculiar to loop type antennae. Since a review of all the various types available would be a discourse of

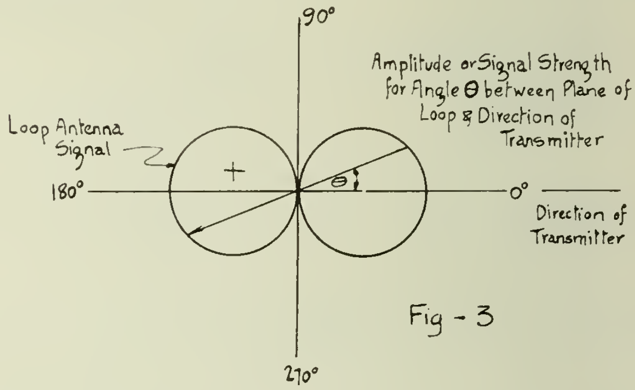


Fig - 3

great length in itself, the writer will deal only with this common property.

Before the efficient household broadcast receiver deteriorated into a piece of furniture, loop type aerials were mounted on the receiver so that its directional properties could be used to help us select the station we wished to listen to. This deterioration along with interference difficulties involved in the use of such an aerial have caused it to vanish from the household field. Let us observe this directional property peculiar to this type of antenna in a general way in order to establish a basis for the discussion of the system described later.

Let us represent the loop aerial diagramatically as L (see Fig. 1). If this loop were connected to a battery with its positive terminal connected to b and its negative to a, the current around the loop would conventionally be in the direction of the arrows. In other words, the current would flow upwards in one vertical side of the loop, and downwards on the other. If an alternating voltage were connected to a and b the current would continually change its direction, but at any given instant the currents in the two vertical sides of the loop would still be in opposite directions. These currents are said to be 180 deg. out of phase. Let us now disconnect the battery from the loop and connect a and b to the input terminals of a receiver (see Fig. 2). The radio signal received is in itself an alternating voltage travelling through space as shown in the diagram. The dimensions of the loop are chosen so that they are small compared with the wave length of the signal. Therefore, with the loop placed in the position shown, there will be a difference in the voltages induced in the two vertical sides of the loop which will send a current around the loop. The currents in the two vertical

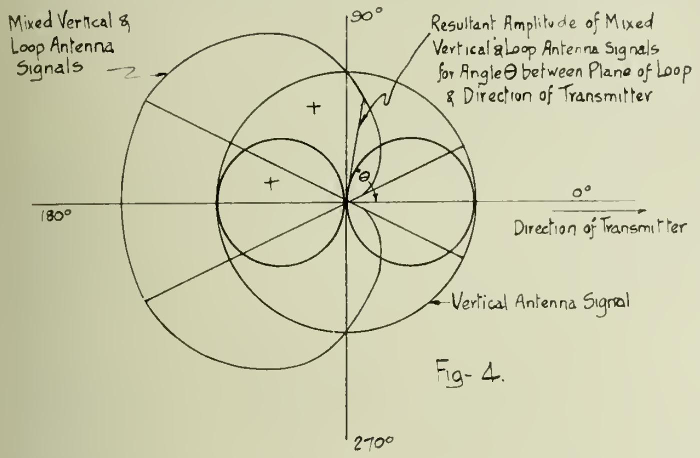


Fig- 4.

sides will still be 180 deg. out of phase at all times. We might add that this voltage appears at the terminals of the loop *a* and *b*, and is fed to the reciever input.

Let us now rotate the loop so that its plane makes an angle of 90 deg. with the direction of the transmitter. Here we see that no difference of voltage is set up in the vertical sides of the loop and hence, no voltage appears at *a* and *b*. Therefore, if we plotted the polar diagram of the signals received at any instant as we rotated the loop through 360 deg. we would get a diagram known as the "figure of eight" (see Fig. 3). In this and following figures the representation of the loops of the figure of eight diagrams as circles is not strictly correct, but for the purposes of this discussion the figures illustrate the general theory involved. In other words, we get a maximum signal from the transmitter with the loop at 0 and 180 deg. but a zero signal at 90 and 270 deg. It is obvious from the shape of the curve that the minimum signal is more distinct than the maximum, so that it is used to give the directional indication. It should be noted from Fig. 3 that at any instant the signals for the loop in any two positions 180 deg. apart (other than 90 and 270 deg.) will be 180 deg. out of phase. To remove the ambiguity of the directions, a vertical antenna signal is introduced which cancels out one side of our figure eight pattern. The signal received in the vertical antenna is in phase or 180 deg. out of phase with the loop signal at any instant depending on the angular position of the loop. The proper relationship of vertical and loop antenna signals is determined by the adjustments made during calibration of the direction finder. It is obvious, however, that the amplitude of the signal from the vertical antenna must equal the maximum amplitude received by the loop (i.e. in its 0 and 180 deg. positions). See Fig. 4. This latter adjustment is called the determination of "sense." The actual direction in degrees is found by the former adjustment as difficulties involved in the adjustment for sense make absolute accuracy very difficult to obtain. In other words the sense adjustment is only used to determine which of two bearings 180 deg. apart is the correct bearing or direction of the transmitter.

Hence we see that if a plane were to have a loop mounted rigidly at right angles to its length, it would be possible for the pilot to fly towards the station in question by flying in the direction necessary to maintain minimum signal in his receiver. The disadvantage of such a system is of course the fact that the plane may fly a curved path due to wind drift, taking if off the straight line course between two points.

b. The other alternative method of guiding planes by radio is to use equipment popularly called a radio beacon, more accurately named radio range. In the original set-up the directional property of loop antenna was again used to produce a group of four directional signals which combine to yield four distinguishable courses which can be recognized by the pilots of the planes utilizing an ordinary receiver without automatic volume control. Two loop aerials were erected at right angles to each other and fed with signals from a goniometer unit. By use of a keying mechanism the signal was alternately fed to each of the loops producing first one figure of eight pattern then another at right angles to the first (Fig. 5). The field or signal pattern of the tramsitted signal is exactly similar when the loop is used as a transmitting antenna to the case in Fig. 3, when the loop is used as a transmitting antenna. It is obvious from the diagram that planes flying along the directions at 45 deg. to the two loops will receive signals of equal strength from both figure of eight patterns. In order to distinguish one signal from the other the 0-180 deg. loop was keyed with the letter A (· – in code), and the other loop with the letter N (– · in code.) The signals are so interlocked that when the plane flies on course, a steady signal is heard in the receiver. That is, the dot of the A fills up the space between the dash and the dot of the N and the dash of the A fills up the space between the N's and vice-versa. If the plane flies to either side of the course either an A or an N is heard in the receiver.

It is obvious that the courses that are required may not be 45 deg. to the loop directions. Let us rotate the goniometer primary into the 45 deg. position and find where the courses will lie. It is evident that when the keyer is in the A position, the output of the transmitter is divided equally between the two loops. Similarly, the

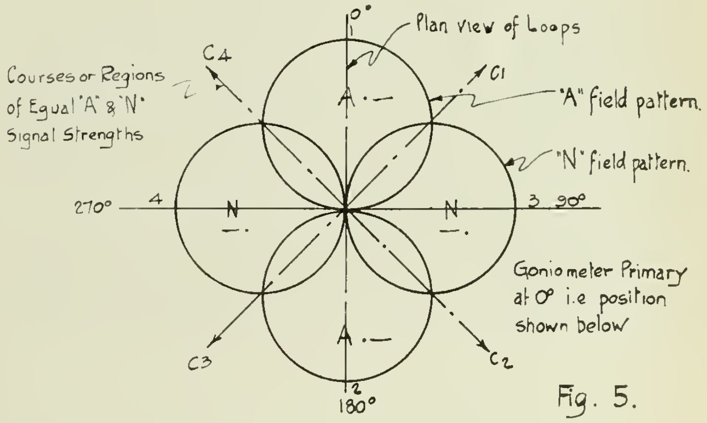
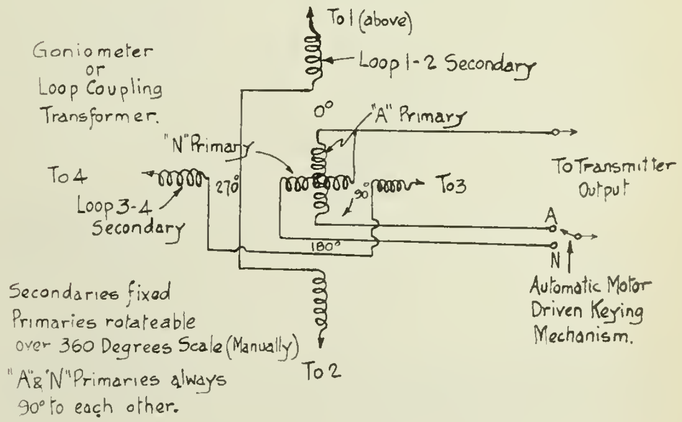


Fig. 5.



power in the N position is divided equally between the two loops. This produces two figure of eight patterns as shown, and we see that our courses are now 0-180 deg. and 90-270 deg. See Fig. 6. Thus by rotating the goniometer primary from 0 to 45 deg. the courses have also swung around through 45 deg. If we continued to turn the

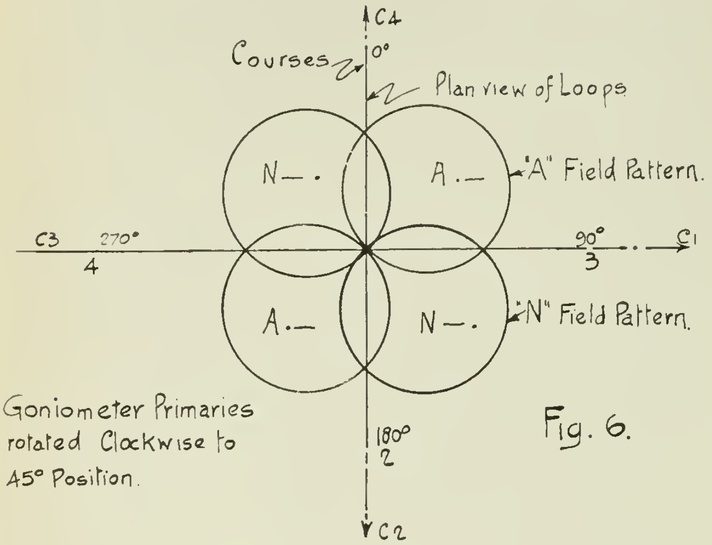


Fig. 6.

goniometer through the entire 360 deg. we would see that the courses rotated 45 deg. ahead of the goniometer setting. It must be noted that the four courses still remain 90 deg. apart.

Again it is obvious that the required courses from a given range station may not be all disposed 90 deg. apart. Let us leave the goniometer at 45 deg. and introduce a resistance in series with the N side of the keying system. A voltage drop occurs accross this resistance, hence the voltage which is delivered to the N primary will be less than that delivered to the A primary of the goniometer. This means that the N figure of eight pattern will be reduced in size. See Fig. 7. Here we see that our courses have been moved from their 90 deg. relationship, but reciprocal or opposite courses still remain 180 deg. apart. This process is called course squeezing. Even this adjustment may not fill the requirements, so some means must be used to bend the reciprocal courses away from their 180 deg. relationship.

With the loop beacon this can be done by introducing a vertical aerial into the centre of the system and distorting the figure of eight patterns in the same manner that sense

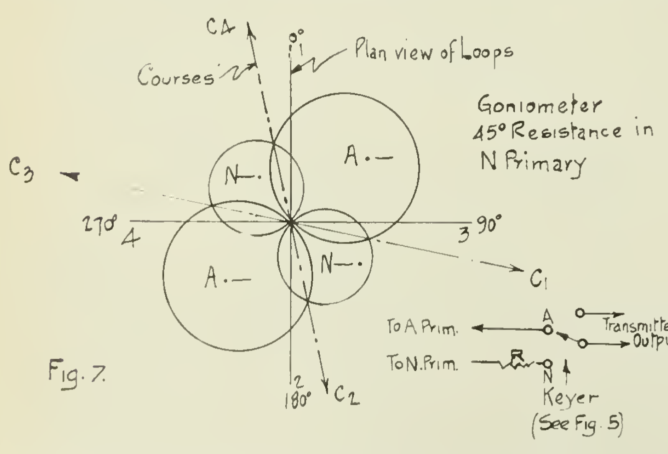


Fig. 7.

was obtained for direction finding, not carrying the process far enough to completely cancel out one loop of each diagram. The resulting field patterns will take on the approximate shape shown in Fig. 8, with the goniometer at 45 deg. Here we see that we have changed the angle between the east and west courses from 90 deg.

As this adjustment is very difficult, as was the case of our sense adjustment, for direction finding, the designers of such installations concentrated their attention on modifying the system to make course bending easier to achieve.

Also the loop aerial system is subject to errors due to a condition known as "night effect." The ability to obtain accurate and stable courses depends entirely upon the reception of what is known as the horizontal ground wave which is sent out by the vertical sides of the loops. The signal transmitted by the horizontal sides of the loop is called the vertical signal or wave. This vertical wave is reflected by the hypothetical Heaviside layer and when it comes back to the earth, it has usually been bent in both horizontal and vertical planes. If this vertical signal is strong at the receiving station then it will mix with the horizontal signal and produce errors. This effect is most noticeable between the hours of 8.00 p.m. and 8.00 a.m. and is therefore given the name "night effect."

As this effect was also apparent in direction finding, a designer by the name of Adcock decided to eliminate the horizontal sides of the loops. At the time Adcock designed his new system, receivers were not developed to a state of high sensitivity and since the new system of aerials was less efficient in picking up signals, it was discarded temporarily. However, with the advent of supersensitive

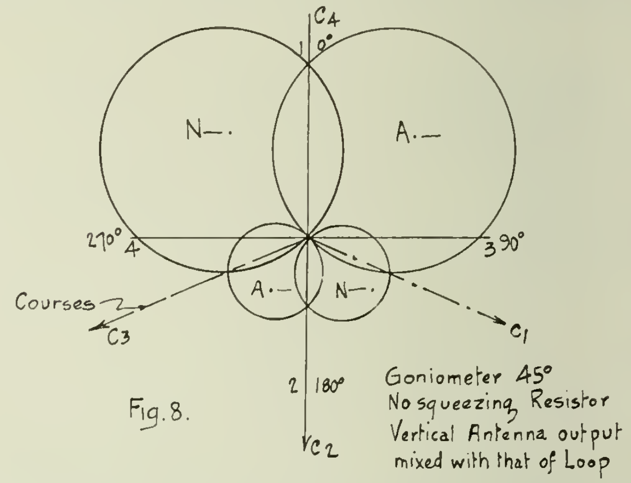


Fig. 8.

receivers, the Adcock aerial system again came to the fore and is now being used in aviation direction finding work from the ground for the purpose of locating planes in flight. This same aerial system has been applied to radio ranges to eliminate the undesirable night effect and coincidentally affords a more readily controllable method of course bending.

In this system, four vertical antennae or towers are erected which represent the four vertical sides of two loop aerials (Fig. 9). They are connected in the initial set up so that the currents in each of the opposite pairs are 180 deg. apart. We have seen that this was the condition in the loop aerial. The towers, therefore, are connected so that they are, in effect, exactly similar to two loop aerials placed at right angles. As the vertical signal radiated from such a system has been reduced almost to zero, the undesirable night effect is reduced from a possible ±45 deg. error to perhaps a ±10 deg. error.

Rotation of all the courses together is obtained by rotating the goniometer as before. Course squeezing is also obtained as before by inserting resistance in either the A or the N primary circuit. Coincidentally however, with the reduction of night effect we now have an easier method of controlling and adjusting the course bends.

In the loop system the currents in the vertical sides of the loops were always 180 deg. out of phase, now that towers are used we may chnage this condition. Changing the phase relationship between opposite towers has a similar effect to the introduction of a signal from a vertical aerial in the case of the loops.

This phase adjustment is obtained by the introduction of an artificial transmission line as well as the physical line to each of the towers. By adjusting the electrical length of this line we can change the phase relationship between the currents fed to the diagonally opposite towers. As it is possible to calculate the phase adjustment necessary between the opposite towers to give the desired bends in the courses, the system lends itself more readily to the efficient alignment of courses. Admittedly, the calculations from theory only give the engineer a place to start, having then to juggle the courses to compensate for the difference between theory and practice, but this is better than having to start off the adjustment by trial and error, as is the case with loop type installations.

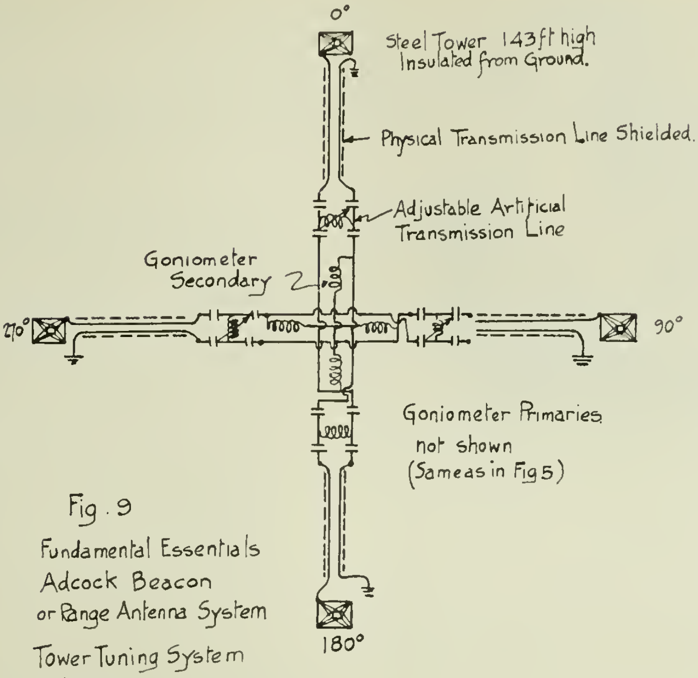


Fig. 9
Fundamental Essentials
Adcock Beacon
or Range Antenna System
Tower Tuning System
not shown.

It is interesting to follow the method by which a pilot may locate himself when after being lost with no range signal for a period he suddenly picks up a range signal. The identification signal which is given over each pair of loops in turn every 30 seconds tells him the station he is listening to. Looking on his chart he determines the line bisecting the angle enclosed between the courses bordering the A or N quadrant, whichever he happens to be in. He then adjusts the receiver to minimum volume and flies the bearing of this bisector. If he is flying towards the station the signal becomes louder. If he is flying away from the station the signal fades out. He therefore knows the direction that he must fly to pick up one of the courses.

A few words as to how the range may be used as an assistance to landing might also be in order. Directly above the station there occurs what is known as the cone of silence. This is a conically shaped region directly above the centre of the range station inside whose bounds the signal is reduced almost to zero. The pilot flying over the cone then locates himself even though it is impossible to see the ground. The range is usually located three miles from the airport with one of its courses lined up with the emergency runway of the field. He then knows that he is three miles from the field, his altimeter tells him his altitude and he has a course to guide him to the runway. Therefore, when he comes down out of the overcast, the runway is right in front of him.

There are two incorrect but popular conceptions regarding the operation of range stations, namely:—

1. That a radio beam similar to that emitted by a searchlight exists in the direction of each course. As indicated in Fig. 5, the courses are marked by regions of equal signal strength from two distinct field patterns set up alternatively around the range station.

2. That each course may be adjusted independently to its correct location. A study of Figs. 6, 7, and 8 indicate that each adjustment affects at least two courses, and when the goniometer is in other positions than 45 deg., all courses are affected by every adjustment. Hence the process of course alignment is one requiring considerable patience and time in order to obtain a set of specified courses.

Many other radio aids to airway navigation at present being developed are rapidly nearing perfection. Among these are: radio markers, to yield additional position checks along the airway routes; radio blind landing systems, to make landing under zero ceiling conditions entirely safe; and ultra-high frequency radio equipment to cope with the ever-present interference problem. Indeed, the complete removal of all skepticism as to the safety of air transportation, depends to a large extent on these new developments.

The National Housing Act 1938

by Horace L. Seymour, M.E.I.C.

SUMMARY.—The recently passed National Housing Act is of importance to all parts of Canada. The working of it is rather complicated, but the author explains it in such a way that it can be understood. He also points out the difficulties that will attend the operation of it, and suggests considerations that will facilitate its usefulness.

Early this year the writer received a letter from the Secretary of The Engineering Institute of Canada asking him to represent The Institute at a meeting which was being called in Ottawa by the National Housing and Planning Association for the purpose of urging the Dominion Government to extend existing federal legislation so that it would more adequately provide for low-rent housing projects.

At the meeting (held May 11th) were many business men, engineers, architects and members of parliament. Among those taking part in the speeches and discussions were Dr. S. H. Prince of the Nova Scotia Housing Commission, Professor at Dalhousie University, Halifax; P. E. Nobbs, chairman of the Housing Committee of the Civic Improvement League, and Professor of Architecture at McGill University, de Gaspe Beaubien, M.E.I.C., of the Montreal Housing Committee, and George S. Mooney, of the Montreal Metropolitan Commission, Secretary of the National Housing and Planning Association, all from Montreal; Captain G. H. Rochester, First Vice-President of the Ontario Command of the Canadian Legion, Dr. T. H. Leggett, President, and Horace L. Seymour, M.E.I.C., Secretary, of the Ottawa Housing and Planning Association, all of Ottawa. Members of parliament were from all parties, and all took an active part in the meeting. Twenty-four national organizations sponsored the gathering, and three others, including The Engineering Institute of Canada, had official observers.

The main resolution of the meeting was presented to the Hon. C. A. Dunning, Minister of Finance, on the morning of May 12th, by a committee of twelve representatives of national organizations, who resided in Ottawa or remained there for this purpose. The Minister of Finance pointed out the need for co-operation by provinces as well as by municipalities if national housing legislation were to be successful. In spite of difficulties he indicated the possibility of legislation along the lines requested and the impression gained was that such legislation was already in draft form.

On June 28th, 1938, the National Housing Act was passed, the preamble reading:

WHEREAS *The Dominion Housing Act, 1935*, has encouraged the building of houses by persons with moderate incomes but the facilities of the Act have not been largely used by persons with small incomes or by persons living in small or remote communities; and Whereas, it is desirable to stimulate the construction of houses to be owned by persons with small incomes and by persons living in remote or small communities; and Whereas, as a result of the low level of building activity during the recent depression, the employability and efficiency of the urban population may be adversely affected by reason of congestion in potential slum areas and of overcrowding in housing accommodation which falls short of minimum standards of health and amenity; and Whereas, such decline of employability and efficiency may retard the full employment of the working population living under such conditions; and Whereas, the task of providing adequate housing accommodation at rentals within the capacity of low income groups to pay is, in its aspects of public health, morals and minimum living conditions, primarily a responsibility of the provinces and municipalities; and Whereas, nevertheless, it is in the national interest that a limited experiment in low-rental housing should be undertaken now, creating needed employment and directing public attention to the importance of housing problems generally, and providing a basis of experience on which the provinces and municipalities may follow sound and proven policies in the future; and Whereas, high real estate taxes have been a factor retarding the construction of new houses and it is therefore desirable to encourage prospective home owners to construct houses for their own occupation by paying a proportion of the municipal taxes on such houses for a limited period.

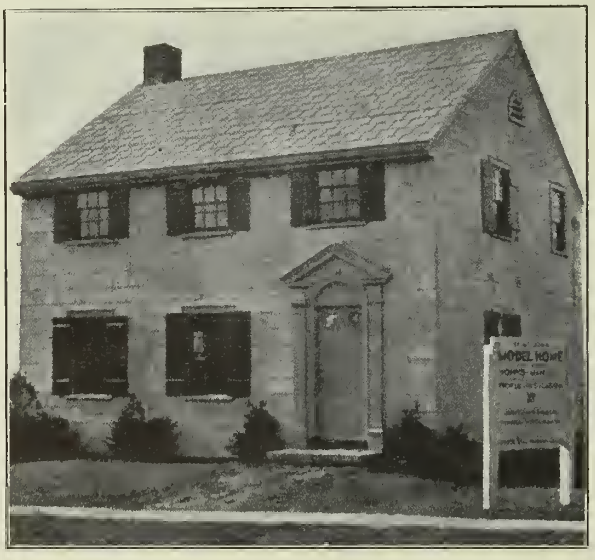


Fig. 1—First House Built in Saint John, N.B., under Dominion Housing Act.

General satisfaction has been expressed that the Act provides the machinery for a more active home building programme. It is felt that for real success co-operation and active interest are required not only by those interested in the building trades and industries, but also by provinces, municipalities, lending institutions, housing authorities, and corporations and individuals.

The Act provides, essentially, cheap money. It follows modern European housing policy and practice, a study of which indicates that the actual building of houses by national governments has been generally discontinued and that subsidies to stimulate house production have been generally abandoned. Now the most widely adopted form of assistance is the extension of government credit through loans or guarantees.

The National Housing Act—Part I

The new Act is divided into three parts.

Part I is an extension of the provisions of the Dominion Housing Act 1935, under which up to May 31st, 1938, the financing of 4,249 family housing units had involved aggregate loans of $17,350,000. This represents an average loan of $4,083 or an average cost for each home, including house, land and other incidental expenses of over $5,000, although the number of smaller loans is increasing.

The National Housing Act provides for a total federal expenditure of $20,000,000 under this part of the Act but of this amount about $4,500,000 has already been spent as the Dominion's share of the $17,350,000, the balance being provided by approved lending institutions—Insurance and Trust Companies.

Under Part I of the Act the Federal Government plans, therefore, to spend a further $15,500,000 as its part of loans for individual home ownership. This represents a possible expenditure of $75,000,000 in home construction in the next few years.

Under the Dominion Housing Act, not only has it been impossible to obtain loans in "small or remote" communities, but certain sections of the Dominion have been served only with apparent reluctance on the part of the lending institutions, which naturally were not anxious to set up new offices where a large volume of business was not expected or where the areas in which homes were to be built were not adequately planned or where there were no zoning regulations to protect the investments during the life of the housing loans. For example, in the City of Saint John and vicinity no loans were made for many months and it required considerable negotiation and the assurance of a Zoning By-law (as prepared by the Saint John Town Planning Commission and now passed for the City and district) to encourage the granting of loans.

Figure 1 shows the first house built in Saint John, N.B., under the provisions of the Dominion Housing Act 1935. It cost well over $5,000 and cannot be considered in the low-cost class. Part I of the new Act encourages lending institutions to finance homes costing $4,000 or under even if to be built in small or remote communities, but the intending owner is still required to make a 20 per cent down payment.

The ten winning designs in the Minimum Cost House Competition, conducted by the Federal Housing Administration, were made public in February 1938. Figure 2 shows one of the designs with a modernistic touch. It was submitted by Mr. A. H. Tremblay, M.I.R.A.C., of Quebec City. It was hoped that these houses, exclusive of land or other charges, were to cost not more than $3,000. Working

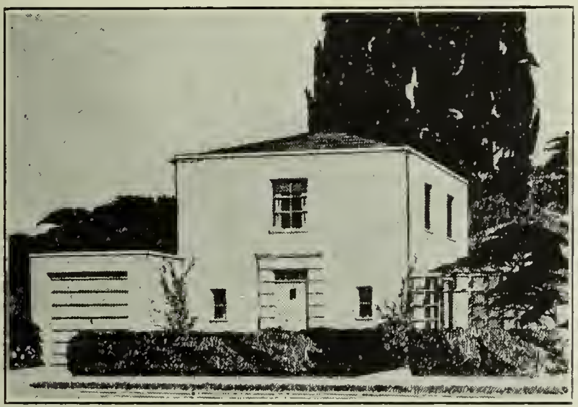


Fig. 2—One of the Prize-winning Designs in the Minimum Cost House Competition.

drawings of the ten designs have been purchased by the Federal Government from the architects, and for any one design four sets of blue prints together with four Dominion Housing Memorandum Specifications (to be filled in by the owner and builder) may be purchased from the Housing Administration, Department of Finance, Ottawa, for the sum of $10. With this information the individual can secure an estimate or preferably a tender from a reliable builder.

Three bedrooms on the top storey are provided in the home illustrated in Fig. 2. The dimensions of the house are 20 ft. by 24 ft. with a height from cellar floor to roof of 26 ft. This gives a volume of 12,480 ft. To build this house for $3,000 would mean a cost of only about 24 cents per cubic foot. This is only approximate but your architect or builder will no doubt tell you how difficult it is to build up to the Housing Administration standards at, or near, this figure—even if building materials are now to be exempt from the 8 per cent sales tax.

Fig. 3—Another Prize-winning Design—Architects Greensides and Langley, Toronto.

In the preamble to the National Housing Act it is stated that "it is desirable to stimulate the construction of houses to be owned by persons with small incomes." And it is provided in the Act that if a home can be built for $2,500 or under, then the down payment can be reduced from 20 per cent to 10 per cent. The terms in all cases are for a maximum 20 year repayment with equal monthly installments requiring both loan and interest at 5 per cent at the end of that period. (The portion of the loan granted by the Federal Government is at 3 per cent interest and by the lending institution at about 5½ per cent interest.)

It is claimed that one of the obstacles to the full application of the Dominion Housing Act has been the down payment of 20 per cent of the total cost of the property; that only a very few have that 20 per cent and that the depression of recent years has depleted the savings of many prudent and thrifty families, though such families are still good "risks."

But who can build the $2,500 home and pay only 10 per cent instead of the 20 per cent down payment required for homes of greater cost? The possibility of a farmer with his own labour constructing the $2,500 home is admitted but doubt is expressed of the possibility of building the low-cost home at that figure in urban or suburban areas in any province in Canada with the possible exception of British Columbia. It is felt that in any event only by the building of a great many homes standardized in nearly all particulars and on a well planned site can the necessary benefits of mass production and reduced cost of utilities be obtained to keep costs of home building at the $2,500 level. Prefabrication of standardized parts or even prefabricated rooms may help. While in the United States costs of prefabricated houses have generally exceeded those of ordinary construction, there still seems a reasonable hope of help from this source.

The National Housing Act—Part II

Part II of the National Housing Act involves new principles for federal relationship to low-cost, low-rental homes. The Government is prepared to grant loans up to $30,000,000, pro rata, to urban population, for low-rental housing projects in urban communities. This should represent over $35,000,000 in developments which on account of the low costs involved will probably be of the apartment or multiple dwelling type rather than single family homes.

Under the provisions of the National Housing Act low-rental projects may be undertaken by the municipality or by a limited-dividend housing corporation A municipality can obtain a 90 per cent loan from the Federal Government but must also obtain a provincial guarantee for such loan. For this and other reasons it seems likely that the limited-dividend corporation (composed of public spirited citizens) must be depended on for effective action. While it can obtain only an 80 per cent loan from the Federal Government yet a provincial guarantee is not required.

According to the provisions of the Act, a family ordinarily eligible for a low-rental home must not have a total *family income* of over five times the economic rental, which is approximately 12 per cent of the cost of a housing unit (to average not more than $3,000). Therefore the family income must ordinarily not exceed $1,800 per annum. The maximum rental must ordinarily not exceed one-fifth the total family income or $30 per month (*for the maximum income*). There will be but few maximum incomes, it is believed. Interest centres in minimum rentals, which must be sufficient for all carrying charges, and which, including allowances for management and repairs, maintenance and vacancies, might still amount to but $14 to $15 per month for a $2,400 apartment (which it is maintained can be built). The rental provides for a 5 per cent return on capital invested by the limited-dividend corporation and in case any higher rents were charged the difference only increases the semi-annual payment to the Federal Government.

A Federal Housing Development New York City, United States.

Co-operative Apartments in Stockholm Sweden.

A Housing Scheme in Folkestone, England.
Fig. 4—Group and Low-cost Housing in other Countries.

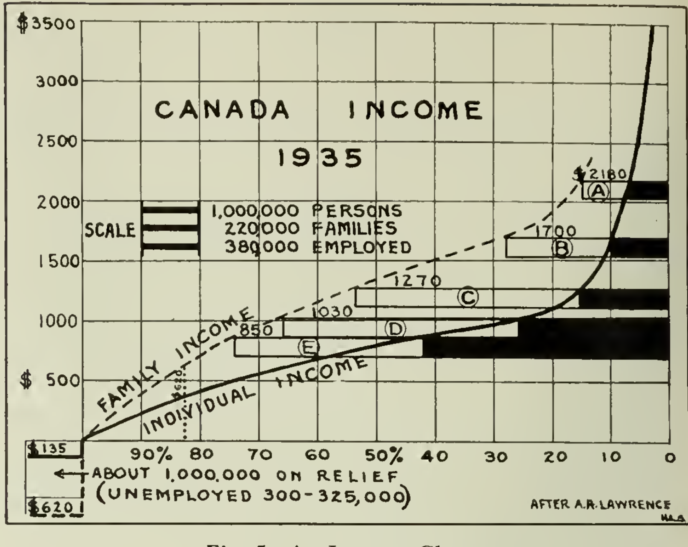


Fig. 5—An Income Chart.

It might be explained that the low rental is made possible by the low interest rate (1¾ per cent per annum payable half yearly in the case of a limited-dividend corporation), charged by the Federal Government to be repaid over 35 years, and to the low taxes (generally involving the consent of the province as well) which the municipality must agree shall not exceed 1 per cent of the cost of construction and to the exemption of the limited-dividend corporation from income tax by the municipality.

The area in which a housing project is being developed must be adequately planned and the zoning regulations must be sufficient to secure the investment and the loan during its life. Adequate municipal services must be available or be supplied forthwith.

THE NATIONAL HOUSING ACT—PART III

Part III of the National Act deals in tax assistance for homes costing $4,000 or under when built before the end of 1940 by the owner for his own occupation in any municipality that agrees, if it owns lots suitable for residential purpose, to offer to sell a reasonable number at not more than $50 per lot (or at the lowest amount it may be otherwise authorized to dispose of such lots). Under such conditions, taxes due to the building of the house only will be paid by the Federal Government as follows: 100 per cent the first year taxes are levied, 50 per cent the second year and 25 per cent the third and final year for such tax assistance.

The Minister of Finance, admitting the impossibility of accurate prediction, makes the assumption that in the next three years $100,000,000 of new houses may be eligible for this tax subsidy. Assuming the average tax levy to be 2½ per cent of the cost, the Federal Government would then spend nearly $5,000,000 in tax assistance in the next three years. Many of the houses built with tax assistance will no doubt also be constructed under the provisions of Part I of the Act and they should not be counted twice in making an estimate of the amount of building that may be expected under the provisions of the new National Housing Act.

With the full co-operation of all concerned, homes built under the provisions of Part I of the Act, that are not eligible for tax assistance, are estimated at 1,000 per year; low-rental housing units are estimated at 3,000 per year as built under the provisions of Part II of the Act, and some 10,000 family units per year under the tax assistance provided by Part III of the Act. If this be considered a generous estimate it is still only about half the accommodation required for the 30,000 families that, it is estimated, are added each year to our population. Can unassisted building take care of the balance and also relieve present housing shortage that is apparent in the "doubling-up" of families and the many obsolescent homes that should be extensively repaired or demolished?

In exploring the ways in which the National Housing Act can be most effective it seems of advantage to relate housing costs to incomes. A generous allowance for monthly commitments in the case of purchase or for monthly rental in the case of lease is from 30 per cent of monthly income in the higher income brackets reducing to 20 per cent in the lower incomes. In the case of purchase the monthly payments include interest and principal reduction over 20 years, taxes, insurance, maintenance, water and local improvements and generally amount to 11 per cent to 12 per cent of the total cost of the home or about 1 per cent a month.

Figure 5 shows a chart that has been prepared to indicate the relation between income and the cost of a home it can afford. Group A (representing 7 per cent of the individuals in Canada gainfully employed) are those of the income group that, it was estimated, might build with the interest rates and other conditions that prevailed before the passage of the Dominion Housing Act 1935. For homes costing $4,000 to $5,000 and requiring monthly payments of $40 or so, Group B takes in the gainfully employed that receive a yearly income of $1,700 or more. This group takes in only 10 per cent of individuals gainfully employed (including those in group A) but is the group that might be counted on to have saved the necessary 20 per cent down payment as required by the Act. Group C with individuals receiving at least $1,270 per year, includes those who might finance the $3,000 home if they had the necessary 20 per cent for a down payment, either in land, in cash or partly of both. But it would appear that very few receiving less than $1,700 per year have managed to keep or to save that necessary 20 per cent.

Group D includes all individuals who might afford to build the $2,500 home, on which only a 10 per cent down payment need be made. Even if the $2,500 home can be built, it should be noted that Group D includes less than 30 per cent of all individuals gainfully employed. If family incomes could be considered, Group D would be greatly increased but for purchase over a long period it is considered wise to depend on individual incomes.

Family incomes may be considered in the case of rentals and are specifically referred to in the National Housing Act. Allowing 20 per cent of the family income for rent, it takes an income of $850 per year to provide a rental of $14 per month, just the very minimum rental that seems possible for a family of any size under the provisions of Part II of the Act. It would seem that families of lower income could not be accommodated by the low-rent provisions of the Act unless a voluntary rent-reduction fund, as mentioned in the Act, is subscribed to by the province and/or municipality. Of the gainfully employed in Canada more than 55 per cent receive less than $850 per year. Family incomes increase this percentage to a great degree but there are still, it is estimated, at least 25 per cent of our Canadian families (some 2,500,000 persons) with an income below $850 per year. And then there was that 1,000,000 on relief (fortunately now a diminishing number) or some 200,000 or more families receiving as much as $14,000,000 from government sources in one year for rent accommodation, and as a rule the very poorest accommodation.

Without large direct subsidies, it would appear impossible to help the lowest income groups. But if without further subsidy, those of higher income groups can be induced to build then the employment provided, both

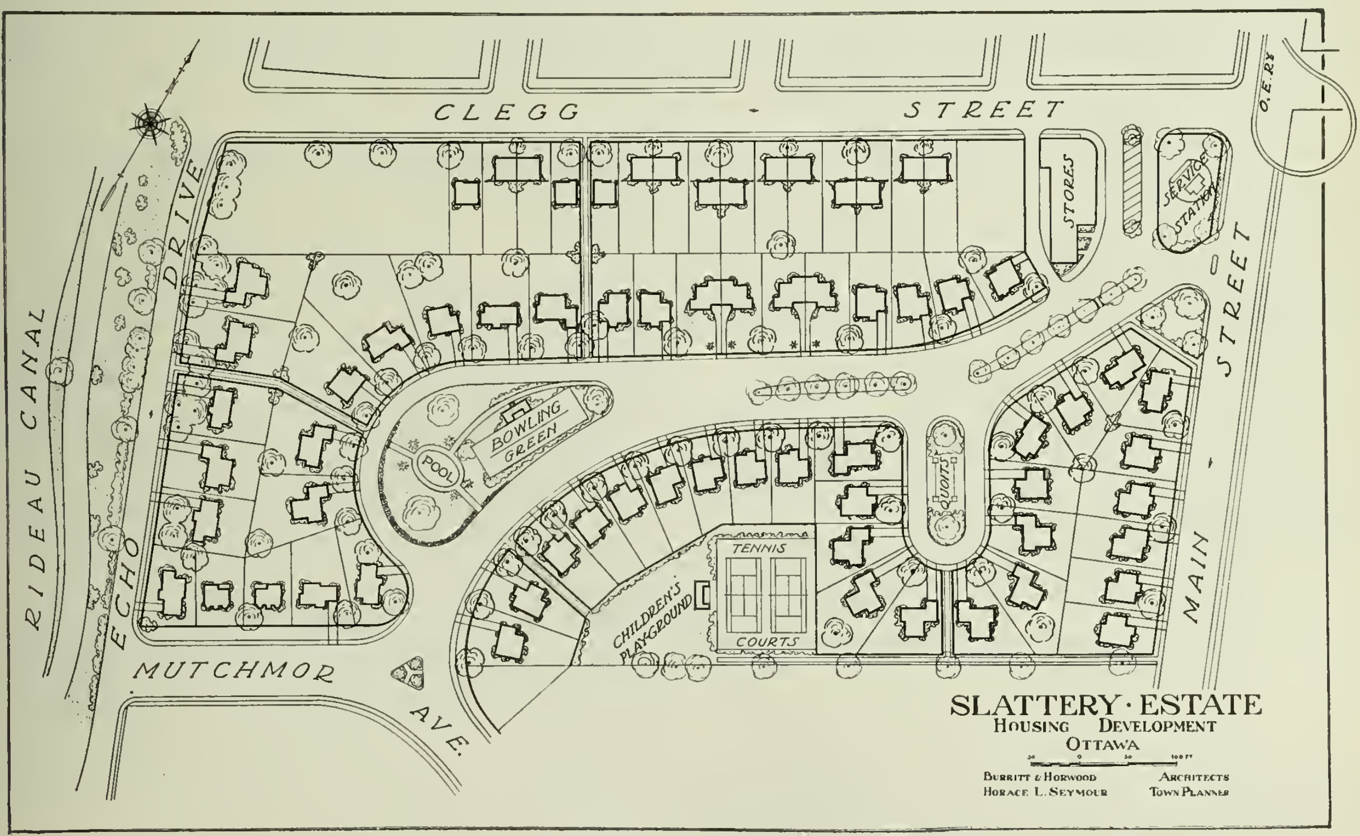


Fig. 6—A Proposed Subdivision Illustrating Modern Design.

Fig. 6 illustrates some features of modern subdivision design; the long block for this motor age but with footpaths for pedestrians; the cul-de-sac or one-way street for greater safety and privacy; the small interior block playground; wider lots or a double building line for narrow lots; the provision of community services; and a greater consideration for the amenities and the appearance of the subdivision as a whole.

directly and indirectly, should help those in the lowest income groups. It would seem that it is for the homes costing between $2,500 and $4,000 that assistance might be given to provide the intending owner with at least half of the 20 per cent down payment which he is required to make but for the lack of which he cannot build. The experience of other countries indicates how this might be accomplished without subsidy.

The Building Societies of Great Britain, the Building and Loan Associations of the United States and the Housing Co-operatives of other countries, it is believed, are the kind of organizations necessary to further the housing programme now begun by the Federal Government. In Great Britain the building society idea started over 100 years ago in the smallest way. Now building societies there have tremendous assets. Over half the mortgages in England and Wales are held by them and it is estimated by informed observers that from 80 per cent to 90 per cent of all new mortgage money comes from these societies engaged in a co-operative form of private enterprise. There are some 3,500,000 members in Great Britain. In the United States there are 7,000,000 members of building and loan associations which take a prominent part in the building programme of their country.

For reasons that cannot be detailed in this article, federal and most provincial legislation and practice in Canada is not particularly favourable to the building society or the housing co-operative form of home building assistance. This should be and is being remedied. Small housing co-operatives are now operating in the province of Nova Scotia. The Minister of Finance has urged the assistance of localized institutions. He has stated, for example, that a Credit Union having sufficient assets, being empowered to do this kind of thing by the legislation creating it, and having the ability to do the job, might be considered as a lending institution.

In the Dominion Housing Act of 1935 and the regulations thereunder, and in the National Housing Act of 1938, that amends and amplifies the earlier legislation, the need and advantage of houses thoughtfully planned are fully recognized. Of equal importance is the emphasis placed in the new Act and in statements of Federal Housing Administration authorities on the adequate planning of areas where individual homes or low-rental housing projects are to be built, and for zoning regulations and building codes that will protect the communities (where the housing units are constructed) against the intrusion of undesirable structures or a type of development that might destroy property values of the individual.

In conclusion, let it be emphasized that the National Housing Act 1938 is merely permissive; it does not provide, as has been done in some other countries, for actual construction of low-cost housing or for slum clearance by a national or central authority. The initiative must come from individuals and all others interested.

When the National Housing Act was introduced in the House of Commons, the Minister of Finance pointed out that prior to May 31st of this year only 4,249 family housing units had been financed under the Dominion Housing Act of 1935. The average loan was $4,083 per family unit (80 per cent or less of the total cost). This is too few homes at too great a cost.

An endeavour has been made to provide under the National Housing for income groups that, up to the present, have not been able to build or rent reasonable accommodation. As explained in this article, low-interest long-term money is made available under certain conditions and other inducements offered, but active leadership must come from the provinces, municipalities, the trades and the labour unions, public spirited groups and individuals.

The National Housing and Planning Association and its affiliating branches are endeavouring to assist through educational means. Included in the membership of such groups are members of The Engineering Institute. Many more may welcome the opportunity to take an active part in the programme of education which should precede actual construction if we are to have successful operation and maintenance of low housing projects.

Seventh International Management Congress

T. M. Moran, A.M.E.I.C.,

Chairman, Industrial Management Section, Montreal Branch and Institute Delegate to this Congress.

The Seventh International Management Congress took place in the building of the United States Chamber of Commerce in Washington, D.C., U.S.A., from September 19th to 23rd, 1938.

Sponsoring Organizations

The Congress was held under the auspices of the International Committee of Scientific Management, an organization which represents seventeen countries, and which in the past twelve years has held congresses in a number of European capitals.

The President of the International Committee is:—

The Rt. Hon. Viscount Leverhulme
(Governor of Lever Bros. and Unilever, Ltd.)

The incoming President of the International Committee is:—

William L. Batt,
President, S. K. F. Industries, Inc.

The Congress was organized by the National Management Council of the United States in collaboration with other scientific, professional and industrial associations. Through its membership of the International Committee of Scientific Management, the National Management Council represents internationally those societies in the United States which are concerned with various aspects of management.

Ministerial Support

While it is not the practice of the Government of the United States officially to sponsor any undertaking of the type of the present Congress, the Cabinet Heads and the Government Departments in the spheres of public interest touched upon by the Congress were good enough to indicate their hearty approval of the Congress and its objectives and their willingness to do everything within their power to make its session successful.

To this end Secretary Cordell Hull of the Department of State and Secretary Roper of the Department of Commerce officiated respectively at the opening and closing sessions of the Congress.

Co-operation of the United States Chamber of Commerce

The Congress was fortunate in securing the cordial and hearty co-operation of the United States Chamber of Commerce, which placed its handsome and dignified building in Washington, and its office staff, at the disposal of the Congress for the duration of its sessions. All sessions, accordingly, were held in the Chamber of Commerce building, which was admirably adapted for this purpose.

Objectives and Programme

A free, open and factual discussion, from a world-wide point of view, of the problems and achievements of management in agriculture, industry and the home, is the primary and general objective of the Congress. To this end it set out:—

1. To provide a forum for the interchange of management experience in order to increase the efficiency of production and consumption of all forms of goods and services.
2. To appraise the present situation and probable future course of management in its broader social and economic aspects.
3. To provide an authoritative and public reminder, to management itself and to the world it serves, of the fact that the only type of management worthy of the name is that which contributes to the welfare of mankind.

The Congress falls into two main divisions:—

General Sessions

The General or Plenary sessions were devoted to the theme: "Social and Economic Aspects of Management," and were addressed by distinguished leaders of thought and action from both sides of the Atlantic, chosen as being best qualified to speak with authority upon the vexed questions of management's responsibilities to society as a whole—for example the influence of technological progress; the problems of incentive and security, and of free enterprise versus social control; the interrelations of worker and owner, and of both with the public, and the responsibilities of management to all three.

Technical Sessions

At these sessions the theme "Recent Developments in Management" were discussed on the basis of over 250 papers, which were submitted from some twenty countries. These papers cover a very wide range of topics, the conditions governing the contribution of papers being such as to permit of the treatment of any technical aspect of management provided that the problem dealt with represents a "recent development in management" in the author's country, which for the purposes of the Congress has been taken to mean a development which has either manifested itself or has made definite progress since the international management congress held in London in 1935.

Administration:

Fundamentals of a Public Relations Programme for Business—Arthur W. Page (U.S.A.).

Financial World Criteria for Business Enterprises—Sidney J. Weinberg (U.S.A.).

The Constituents and Functions of the Administrative Group—Henry P. Kendall (U.S.A.).

Developments and Trends in Administrative Management—Dr. H. Pasdermadjian (France).

Essential Information for Effective Business Administration—Harry A. Bullis (U.S.A.).

Statistics and Graphical Control as an Aid to Commercial Management—L. C. Vervooren (Holland).

Control of Business Through an Integrated Corporate Budget—Henry C. Perry (U.S.A.).

Der Aufbau Wirtschaftlicher Funktionen Als Organisations-Grundsatz — Ein Gemeinschaft-licher-Beitrag (Deutschland).

Decentralizing The Operating Organization—Edgar W. Smith (U.S.A.).

Facilitating Co-ordination in Business Establishments—Walter D. Fuller (U.S.A.).

Relationship Between Headquarters' Departments and the Operating Groups of Imperial Chemical Industries, Ltd.—H. J. Mitchell (Great Britain).

Note sur la Technique du Travail en Commission—Jean Coutrot (France).

Opportunities for Executive Development and Advancement—Robert R. West (U.S.A.).

A Modern Executive Training Programme at the Top—Lawrence A. Appley (U.S.A.).

L'Ecole Superieure des Messageries Hachette—Paul Hemmerdinger (France).

Executive Compensation and Incentives in the Business World—Morris E. Leeds (U.S.A.).

The Control of Office Work—Gordon A. Hardwick (U.S.A.).

Maintaining A Responsive Office Staff—I. J. Berni (U.S.A.).

Il Macchinismo Nel Lavoro Di Ufficio Di Fronte Ai Postulati Ed Alla Disciplina Del Corporativismo Fascista—Giuseppe Landi (Italia).

Adapting Office Procedures and Facilities to Administrative Requirements—Harry L. Wylie (U.S.A.).

Organization and Recording of Remittance and Payment Transactions in a Banking Institution—Francizek Jazwinski (Poland).

Organization Scientifique du Travail de Bureau dans les Grands Ateliers des Chemins de fer du P.O.—Midi—les Chemins de Fer du P.O.—Midi (France).

Office Management: Recent Developments in Office Technique—H. Keegstra (Holland).

How to Study Office Machines—R. W. Starreveld (Holland).

Criteri di Classificazione Della Materia Inerente L'Organizzazione Scientifica Del Lavoro—Ente Nazionale Italiano per l'Organizzazione Scientifica del Lavoro (Italia).

L'Organizzazione del Servizio di Documentazione dell' E.N.I.O.S.—Ente Nazionale Italiano per l'Organizzazione Scientifica del Lavoro (Italia).

Administrative and Financial Controls for Public Bodies—Edwin O. Griffenhagen (U.S.A.).

Public Personnel Administration—Leonard D. White (U.S.A.).

A Few Measures of Rationalization Introduced at the Royal Hungarian Post Office—Akos Tersztyanszky de Nadas (Hungary).

Assessment of Qualifications for Promotion in the British Civil Service—A. L. N. D. Houghton (Great Britain).

A Government Department Adopts a Commercial Viewpoint—Harold Whitehead (Great Britain).

These papers will be available to members of The Engineering Institute. Please send your requests direct to Mr. L. Austin Wright, General Secretary.

The writer would like to take advantage of this occasion to advise the Members of The Engineering Institute of Canada of a dinner that was given by Washington engineers to our General Secretary. Forty prominent engineers of various groups attended. This expression of good will is a real reminder of our status in the Engineering Profession and of our splendid relationship with our American neighbours.

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."

VOLUME XXI OCTOBER, 1938 No. 10

The New Era

Saskatchewan Shows the Way

One of the most significant events in the annals of the engineering profession in Canada will be the signing of the co-operative agreement between The Engineering Institute and the Association of Professional Engineers of Saskatchewan, which is to take place in the capital city of Saskatchewan on Saturday evening, October 29th. It is fitting that Council should arrange that the President and the General-Secretary, with the chairman of the Council's Committee on Professional Interests, should journey from Headquarters to Regina to complete the historic document. The popularity of the movement, both within and without The Institute, for a closer working arrangement with the Associations is manifest everywhere. At the recent joint dinner of the London and Border Cities branches in Sarnia, there was a notably enthusiastic response from the entire company to the gracefully worded wish of the engineer-mayor of Sarnia for an early and satisfactory conclusion to the negotiations for an entente cordiale between The Institute and the Associations.

It is both a happy circumstance and a good omen that the first agreement has been approved of so wholeheartedly. It is doubtful if a more decisive vote has ever been recorded on any issue in The Institute. From coast to coast the councillors voted unanimously in favour of the agreement, and in Saskatchewan the corporate membership did not record a single negative ballot. The Association membership gave similar approval, and all but two members voted in favour of the progressive movement. Under such preponderantly favourable support the signing ceremonies at Regina at the end of October take on an added importance.

The committees of both organizations are to be congratulated. After the long period of negotiations, it must bring them much satisfaction to see their efforts crowned with achievement. Engineers everywhere owe them a debt of gratitude for their courage, perseverance and acumen in bringing to consummation the much talked of ideal of co-operation.

To Saskatchewan goes the honour of blazing the trail that leads to the goal desired by the great majority of professional engineers—COMMON MEMBERSHIP between The Engineering Institute of Canada and the Provincial Professional Associations.

"Paul Sise and Company"

It was interesting news to all Canadians to read of the appointment of a group of men to take charge of the construction in Canada of bombing planes for the British Air Ministry, but it was particularly interesting to members of The Institute because the man who heads up that group is an engineer and a Member of this organization. The project is a combination of engineering, industry and finance and it seems only right that an engineer should be at the head of it.

General satisfaction has been expressed at the personnel of the group. The "Montreal Gazette" aptly refers to it as "Paul Sise and Company," and speaks in no uncertain terms of praise for the group and for the individuals that constitute it. We quote. "This is not the official title of the new Canadian organization, but it stands for what is, perhaps, individually and collectively the ablest group of industrialists and financiers ever associated in any one undertaking in the long history of Canadian business. The British authorities who are sponsoring the enterprise have been exceedingly fortunate in enlisting the services of Mr. Paul F. Sise and in having him supported by a Board composed of men who are without exception leaders in industry and finance, whose reputations are of the highest and whose business experience has been comprehensive and successful."

There is no one who will be pleased that it has become desirable or necessary to start Canadian industry on the production of war materials or equipment, but we can all be thankful that this unhappy business is in the hands of such competent citizens as Mr. Sise and those who are serving with him.

Journal Cover Design Competition

The Publication Committee reports that it has been very gratified with the result of the competition for a design for a new cover for The Engineering Journal, and has decided to award the prize of $25.00 for the best design to John G. Hall, M.E.I.C., Montreal.

There was an excellent response to the competition, 29 different designs, obviously the result of much thought and study, were submitted by the following 20 members:—

H. W. Buzzell, A.M.E.I.C.	Lachine
John G. Hall, M.E.I.C.	Montreal
James Dick, A.M.E.I.C.	Ottawa
R. H. Vaughan, A.M.E.I.C.	Victoria Island, B.C.
Adam Hay, M.E.I.C.	Toronto
M. Wolff, A.M.E.I.C.	Westmount
F. E. Palmer, Jr.E.I.C.	Montreal
W. G. Mitchell, M.E.I.C.	Montreal
E. L. Miles, M.E.I.C.	Charlottetown
M. D. McFarlane, A.M.E.I.C.	Hollywood, Cal.
Robert W. Allen, M.E.I.C.	Regina
Gordon R. MacLeod, S.E.I.C.	Montreal
A. S. Wootton, M.E.I.C.	Vancouver
J. P. Svarich, Jr.E.I.C.	Edmonton
K. G. Cameron, A.M.E.I.C.	Hampstead
M. H. Marshall, M.E.I.C.	Regina
M. I. Bubbis, S.E.I.C.	Winnipeg
J. M. Cameron, S.E.I.C.	Niagara Falls
J. Stuart Neil, A.M.E.I.C.	Calgary
R. H. Cratchley, A.M.E.I.C.	Ottawa

The Committee has decided that it will not recommend the adoption of any one of the designs submitted, but rather that the principal features of the present cover design should be adhered to. There were so many good features in the designs submitted, that it may be found possible to use some of them without losing the advantages of the present design and colour scheme, which have done such good service for so many years.

Industrial Management Under the Microscope

When fifteen hundred well established business executives get their heads together to discuss their management problems and their findings, and when this number includes psychologists, engineers, scientists, financiers, accountants and statisticians, you can expect that there will be some substantial contributions made to the field of industrial management. This is exactly what has been happening at the Seventh Industrial Management Congress at Washington, D.C., during the week of September nineteenth. Over three hundred of these executives came from countries other than the United States. Twenty-three different nations were represented, and the phases of the subject discussed seemed almost as many as the number of delegates.

The Institute's interest in this subject comes through its Industrial Management Group. Today so many engineers are progressing right through the engineering phases of industry to managerial positions that it has seemed appropriate to many that some time and study should be given by engineering organizations to management problems. This development is already well established to the south of us and it appears that the beginning which has been made by The Institute may be enlarged to interest many more members and many more branches.

Industrial management, industrial administration, scientific management—call it what you will—is of vital importance to engineers. It is inconceivable that an engineer can go very far in his profession without meeting management problems of administration, of production, of distribution, and of personnel, and these problems are not best solved by cut and try methods. The best brains of business have been working on them for years, and working largely in a scientific manner, and although all problems are far from a permanent solution, great progress has been made.

It was the aim of The Institute's representatives at the Congress to discuss with similar English and American organizations which have already made gigantic strides in this study, the possibility of closer affiliation. Canadians are just beginners in this field of learning and from the point of view of organization have almost nothing to offer. It appears that The Institute is well qualified to give substantial leadership, and to render a real service to engineers. It is encouraging to know that the advances which were made to these other bodies were well received and that tentative proposals for co-operation have already been made. Beyond a doubt a sound basis for future progress has been laid by the negotiations which took place at the Congress.

Kingston Plans to Honour Dr. Malcolm

Negotiations have just been completed whereby Dr. W. L. Malcolm, M.E.I.C., formerly Professor of Municipal Engineering at Queen's University, and now Dean of the School of Engineering at Cornell University, will be feted by the Kingston Branch on Saturday, October 22nd. The occasion is to mark the branch's appreciation of Dr. Malcolm's new appointment, and to give the officers, councillors and other members an opportunity to join with them in doing honour to him.

Details of the arrangements have not been completed at the time of going to press, but Councillor Grant of Kingston states that officers and members from Headquarters and from branches will be very welcome. President Challies has already accepted the invitation, and it is expected that many councillors from the Montreal district and from Ontario will also be present.

Dean McKiel, of Sackville, has wired to say that he expects to be able to join in the well deserved tribute to Dr. Malcolm.

Saskatchewan Agreement

Results of Ballots

Ballot of Council

Number of ballots received	36
Number of ballots marked "yes" favourable to proposed agreement	36

* * *

Ballot of Corporate Members Resident in Saskatchewan

In accordance with our acceptance as scrutineers of the ballot recently taken under Section 76 of our By-laws, on the vote by the Saskatchewan Branch, the undersigned two scrutineers are pleased to submit their report.

We have received sixty-one ballots from the secretary of the Saskatchewan Branch covering the vote by the members of the Branch, returnable Saturday noon, September 24th. From an examination of the ballots in question we find as follows:

Total ballots received	61
Number of ballots marked "yes" favourable to proposed agreement	60
Number of ballots marked "no" opposed to proposed agreement	nil
Number of ballots spoiled	1

Yours truly,
H. S. Carpenter, M.E.I.C.
D. A. R. McCannell, M.E.I.C.
Scrutineers.

* * *

Ballot of Members of the Association of Professional Engineers of Saskatchewan

Total ballots received	70
Number of ballots marked "yes" favourable to proposed agreement	68
Number of ballots marked "no" opposed to proposed agreement	2
Number of ballots spoiled	nil

Hamilton Prepares for President's Visit

Arrangements are well underway at Hamilton for the celebration on Friday, October 14th, at which time President Challies is the guest of the Branch. The principal event is the reception and dinner at the Connaught hotel at six o'clock at which function the President will speak on Institute activities, and on the general situation in Canada in the engineering profession. Mr. W. J. McCulloch, editor of the "Hamilton Spectator," will also speak, and his subject will be "World Affairs." The General Secretary, L. Austin Wright, will accompany President Challies.

Other events for earlier in the day include the following:

During the afternoon the following Industrial Plants will be visited:—

The Steel Company of Canada Limited; New Blooming Mill, operated by a 7,000 h.p. motor.

Dominion Foundries and Steel Limited; New Tin Mill and the only Plate Mill in Canada.

The Canadian Westinghouse Co. Ltd. will be open for those interested in the manufacture of electrical apparatus.

Those who wish to visit any of these plants will proceed to the main offices of the plant desired at *2 o'clock p.m.*

The Branch is putting forth a real effort to make this an interesting occasion. They expect representation from sister organizations, visitors from other branches, and a large turnout of Hamilton members. On the notice that was received at Journal headquarters we notice that "tickets may be obtained from the Chairman of the Branch, and the Secretary-Treasurer, or members of the executive. An early application for tickets will be greatly appreciated."

The Blue Water International Bridge Connecting Port Huron, Mich., with Point Edward, Ont.

Joint Meeting is a Great Success

Border Cities and London Provide Interesting Day

Saturday, September 24th, in Sarnia, was surely a big day in the affairs of The Engineering Institute. From ten thirty in the morning until ten thirty at night it was just one thing after another, culminating in a bang-up dinner at the Vendome hotel. There were approximately one hundred and twenty-five who shared in the pleasures and the privileges of the programme, and not one but voted the whole affair a great success.

It is hard to tell who deserves the most credit for the arrangements, but it was evident that many capable people co-operated to produce the result. A. O. Wolff, of London, was master of ceremonies for the day, and a fine job he made of it. Councillors Vance and Chambers, Harry F. Bennett, E. M. Krebser, J. F. Bridge and D. S. Scrymgeour were conspicuous throughout the day, carrying on the staff work. Even "Scoop" MacLean, the photographer, excelled himself, and gave many examples of the dangers to which newspaper camera men are exposed!

The first item on the programme was a tour through the Imperial Oil Refinery, which is the largest and most complete of its kind in Canada. C. E. Carson, superintendent of the plant, opened the proceedings with a description of the layout and the operation of the refinery. He gave a very complete picture of the five hundred acre development in a very short time, and started the various parties out on the tour under the care of nine excellent guides.

We were permitted to look into the sanctums of the research department, and the testing department, to see the rows of test tubes and retorts and bottles and ovens, and queer shaped pipes. Outside we gazed on high at the tops of the huge vertical cylinders, row on row, and wondered how the oil could find its way through such a labyrinth of pipes and passages from one cylinder to the other, as the guide assured us it did. And yet they called it "crude." Occasionally we could peep through a small glass and see a white fluid bubbling merrily out of one pipe and into another. "Gasoline," the guide said, and we gazed in awe at such quantities of the precious fluid. Strange how difficult it is to keep the old flivver's tank full when there are such copious quantities running around like that. We dealt in such terms as fractions, cracking, viscosity, flash point, volatility, and so on, and really had a good time. We proved that you don't have to be a chemist to be interested in the breaking down of plain crude oil into the myriad of useful products that help to make life more pleasant and more luxurious. On the other hand, the oil company proved that the manufacture of these products for our convenience is far from simple—that not only brains and ingenuity are required, but enormous quantities of capital as well.

The programme for the afternoon was an inspection of the brand new Blue Water International Bridge across the St. Clair River of which Messrs Monsarrat and Pratley were the designing engineers for the Ontario Government on the Ontario approach and were associate engineers with Messrs Modjeski and Masters who in turn are the designing engineers for the Michigan State Bridge Commission. Forty cars made up the caravan, and led by Lieut.-Col. C. K. S. Macdonnell, A.M.E.I.C., resident engineer, Department of Highways of Ontario, first drove down on the Canadian shore under the bridge, to have a look from the ground up. Then the line was reformed and the procession returned to the Canadian approach and drove over the deck to the centre span, where an inspection was made from the top down. The international boundary line is nicely indicated by two bronze plates on the guard rails. A new material for marking the lanes on the roadway has been used, and it is expected will give unusual satisfaction, both from the point of view of utility and of maintenance.

At the invitation of the Sarnia Bridge Company the entire company continued to Port Huron and reassembled in the quarters of that city's leading hotel, where a brief talk was given by John R. Giese, resident engineer for Modjeski and Masters, consulting engineers, on the design and construction of the new structure. Refreshments were served by our hosts, and were much appreciated by the entire "entourage." When you stop to think of it, this bridge inspection privilege was something very unusual. Somebody deserves a lot of credit for getting it through. When you realize that the bridge is not yet open to the public, and remember the complications that usually develop when crossing the border, you begin to appreciate that somebody must have done a powerful lot of arranging in order that we could be granted access to the new highway and permitted to pass back and forth almost as though there were no border line. Incidentally, it was a wonderful gesture of hospitality and cordiality on the part of the U.S. officials.

The festivities were concluded by a dinner presided over by A. O. Wolff, chairman of the London Branch, and graced by the presence of President Challies, R. M. Smith, Deputy Minister of Highways for Ontario, Fred Pelling, Mayor of Sarnia, Mr. Stinson, Secretary of the Michigan State Bridge Commission, George Guthrie, M.L.A., John R. Giese, of Modjeski and Masters. There were visitors from other branches such as Toronto and Niagara Falls, but the two whose visit was most appreciated were John L. Lang and John S. Macleod, councillor and chairman respectively of the Soo branch. They made the trip by motor especially to attend the meeting. There were also present E. V. Buchanan, of London, vice-president of The Institute for Ontario, E. M. Krebser, chairman, and W. C. Miller, past-chairman of the Border Cities Branch, Councillor W. E. Bonn, and General Secretary L. Austin Wright.

The principal speakers were Mr. Smith and Mr. Challies. Mr. Smith gave a very interesting account of his trip to Europe to examine the new highways, and showed some excellent lantern slides of roads over there as well as in Ontario. The Ontario ones did not seem to suffer by the comparison. Mr. Smith made his talk very interesting, and his contribution was more appreciated because it is seldom that The Institute gets such talks on roads from such authoritative persons. It would be nice if we could have more talks and papers on this highway situation.

Mr. Challies dwelt on the values of such structures as the new bridge, as factors in maintaining peace between nations. He stated "It is a noteworthy fact that from the Atlantic to the Pacific, most of the strategic points from a military standpoint are marked only by important works such as bridges, tunnels, hydro-electric developments, navigation dams, canals, locks, etc. The genius of the engineering profession of neither country has been used to conceive and construct works of defence or offence along their common boundary."

He pointed out the fine work which was being done by the International Joint Commission in promoting concord and co-operation respecting boundary waters between the United States and Canada, and commented on the fact that all this had been done by them without any "fanfare of publicity." In describing the character of the Commission he said "There is nothing else quite like it; nor has there been in the past. Three Americans and three Canadians sit, not as national sections more or less competitive, but as one judicial body determined to give the best possible judgment with the utmost impartiality to the settlement of boundary water questions that arise sometimes on one side of the boundary and sometimes on the other. It is significant of the sympathtic attitude of Canadians and Americans toward each other and toward their common problems that in every case dealt with by the Commission since its organization, the decision has been unanimous. This is because each of the six commissioners realizes that while he is a citizen of but one nation, he is constituted a judge for both."

The gathering broke up about ten thirty with many handshakes and promises of getting together more frequently in the future, which is not a bad idea. Meetings such as this are not only pleasant but they are profitable, and the success of this one would seem to offer sufficient encouragement to other branches that they would be tempted to follow suit.

On the International Boundary Line

Left to right: J. M. May, superintendent of plaza construction at Point Edward; L. B. Henderson, engineer Michigan Highways Dept.; B. L. Irwin, engineer Dept. of Highways for Ontario; John Giese, resident engineer in charge of bridge construction; W. C. Stinson, manager of bridge; J. B. Challies, M.E.I.C., Montreal; E. V. Buchanan, M.E.I.C., London, Ont.; James Vance, A.M.E.I.C., Woodstock, Ont.; John A. Baird, M.E.I.C., Ont. Dept. of Highways resident engineer; Col. C. K. S. MacDonell, A.M.E.I.C., district engineer, Dept. of Highways of Ontario; William A. Guthrie, M.P.P., West Lambton; A. O. Wolff, M.E.I.C., London.

Washington Engineers Honour E.I.C.

An indication of the high regard in which The Engineering Institute is held in the United States and of the friendly relationships which exist between all engineering bodies was given on Wednesday, September 21st, when forty of the leading engineers of Washington gathered at the Cosmos Club, with the General Secretary, Austin Wright, as their honoured guest. The occasion was a luncheon in the private dining room of the club. The chairman was Col. D. H. Sawyer, Director of Space Control, Procurement Division, and the prime mover was John C. Hoyt, Consulting Engineer, U.S. Geological Survey, who is well known in the capital of Canada for his advice and assistance to members of the Canadian Government Service who were responsible for instituting the Hydrometric Survey of Canada.

The chairman made most kindly references to Canadians and to Canadian institutions, with special reference to The Engineering Institute, and emphasized the fact that the Secretary was a most welcome visitor to the capital. He asked that the compliments of the gathering, which represented many branches of engineering, be presented to the Council of The Institute at the first opportunity, and charged the Secretary with delivering the message.

The Secretary spoke on the excellent international relationships that exist between engineers and engineering organizations, and thanked the Washingtonians for this luncheon which was just another indication of this helpful friendliness. In response to an inquiry he also spoke at length on the relationship between The Institute and the various provincial professional associations. The situation in the States is much more complicated than in Canada, and the meeting was very much interested in knowing the progress which The Institute was making in the solution of it.

(*Please turn to page 487*)

List of Nominees for Officers

The report of the Nominating Committee was presented to and accepted by Council at the meeting held on September 9th, 1938. It is published herewith for the information of all corporate members as provided by Sections 68 and 74 of the By-laws.

List of Nominees for Officers for 1939 as Proposed by the Nominating Committee

President:	H. W. McKiel, M.E.I.C.	Sackville, N.B.
Vice-Presidents:		
*Zone "A" (Western Provinces)	A. L. Carruthers, M.E.I.C.	Victoria
	H. N. Macpherson, M.E.I.C.	Vancouver
	P. M. Sauder, M.E.I.C.	Lethbridge
*Zone "C" (Province of Quebec)	W. G. Mitchell, M.E.I.C.	Montreal
	F. Newell, M.E.I.C.	Montreal
Councillors:		
†Halifax Branch	J. R. Kaye, A.M.E.I.C.	Halifax
	Ira P. MacNab, M.E.I.C.	Halifax
†Saint John Branch	S. Hogg, A.M.E.I.C.	Saint John
†Saguenay Branch	A. C. Johnston, A.M.E.I.C.	Arvida
†St. Maurice Valley Branch	E. B. Wardle, M.E.I.C.	Grand Mere
‡Montreal Branch	E. Gohier, M.E.I.C.	Montreal
	H. Massue, M.E.I.C.	Montreal
	B. R. Perry, M.E.I.C.	Montreal
†Ottawa Branch	W. F. M. Bryce, A.M.E.I.C.	Ottawa
†Kingston Branch	L. F. Grant, M.E.I.C.	Kingston
†Toronto Branch	A. U. Sanderson, A.M.E.I.C.	Toronto
†London Branch	J. A. Vance, A.M.E.I.C.	Woodstock
†Border Cities Branch	T. H. Jenkins, A.M.E.I.C.	Windsor
†Lakehead Branch	P. E. Doncaster, M.E.I.C.	Fort William
†Saskatchewan Branch	A. P. Linton, M.E.I.C.	Regina
†Edmonton Branch	W. R. Mount, M.E.I.C.	Edmonton
†Vancouver Branch	J. Robertson, M.E.I.C.	Vancouver

*One Vice-President to be elected for two years.
†One councillor to be elected for two 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 General Secretary on or before the first day of December, shall be accepted by the Council and shall be placed on the officers' ballot."

English Engineer Visits E.I.C.

Dr. A. P. M. Fleming, C.B.E., M.Sc., is the President Designate of the Institution of Electrical Engineers (London, England), and it was in that capacity that he visited The Engineering Institute of Canada in Montreal on September 1st. The Institute received him at an informal luncheon in the University Club, with President Challies presiding, and with twenty-two past-presidents, officers and councillors in attendance. Dr. Fleming is Director of Metropolitan-Vickers Electrical Company Limited, and is in charge of their departments of research and education

In a world that is all "cockeyed," said Dr. Fleming, it would be a great help if the logical thinking of engineers could replace the irrational ideas and actions of the great majority of people who hold public office. Engineers are specially trained and experienced for such work, and their participation in it would result in a reduction of to-day's hysteria and irrationalism in world affairs. He urged that the profession give serious thought to the idea of taking on added responsibilities of this type.

As one would expect, Dr. Fleming touched on research work. He said he thought that one of the chief factors in keeping England "in the running" in world competition was the tremendous development which had taken place in research. New materials, new methods and new uses had been found that made possible tremendous advancement in industry. He also stated that the new practices in selecting and training personnel had contributed to the success of industrial England to an extent that exceeded their expectations.

Dr. Fleming has visited frequently in Russia, Germany, and Italy. He had had plenty of opportunity to observe the effects of the new forms of government, and deplored the great loss of freedom of thought and action. He spoke of the "ruthless efficiency" of these countries "that was bought at too high a price," and by comparison referred to his own country where they were enjoying the results of voluntary co-operation and "freedom for action."

Many questions were asked on the European situation, and the speaker gave very illuminating responses. It was interesting to hear him say that he thought the Russian policy in theory was very sound and dead right. In spite of the restrictions placed on the citizenry they enjoyed a much more liberal administration. He also spoke at length on the development of munition manufacture in England and described the government's policy of encouraging established industries to become experienced in these new lines so that tremendous facilities and experienced personnel would be available in the event of war. The government frequently supplied the machinery and let the contract on a percentage basis through the experimental period. The manufacturers had responded in a remarkable manner.

In conclusion he referred to the bonds that held The Engineering Institute of Canada close to the English Engineering Institutions—the common ground of education and vocation, a common nationality and language, sympathy, understanding and wholesome friendliness. From the Institution of Electrical Engineers be brought warm greetings, and for The Engineering Institute of Canada he wished "abiding prosperity."

Ecole Polytechnique Makes Appointment

With the appointment of Maurice Danloux-Dusmesnils, a graduate of the Ecole des Mines de Paris, as professor of geology and mineralogy to replace the late Prof. Adhemar Mailhiot, the Ecole Polytechnique intends to turn out a greater number of competent mining engineers.

Armand Circe, director of the Ecole Polytechnique, pointed out that Professor Danloux-Dumesnils is one of the world's leading authorities on mining. He is a graduate of the Ecole des Mines de Paris and has been engaged as mining expert in a number of countries where expert opinion was imperative.

Mr. Circe referred to the possibility of the establishment of a sixth year at the institution which would enable the school to prepare students fully for the mining industry and possibly award them diplomas.

Headquarter's Renovation Now Complete

Since The Institute moved into the present quarters twenty-five years ago, the building has never been redecorated and only sufficient maintenance has been expended to keep it in the minimum of good repair, with the result that appearances had become shabby and repairs were badly needed. This spring it was decided that something would have to be done about it, and arrangements were made by the House Committee to let the whole undertaking to one contractor, and to accomplish as much as could be done within the financial limitations that had to apply.

The work has been under way for a month and a half, but at long last is complete. The money has been carefully spent, and while a larger sum could have been required to do a complete job, the present expenditure seems to have brought about a complete transformation.

The chief items of renovation are:

A new roof surface over the front portion of the building. Redecorating of the lecture hall, including new curtains at the rear of the platform, and drapes for the windows and new light control. Redecorating the reading room, hallways, council room, secretary's office and the general office. The latter has been re-arranged to give a more convenient and efficient layout. The secretary's office has been greatly improved by the addition of new drapes and lighting fixtures and a badly needed carpet.

Larger and more efficient radiators have been installed in the secretary's office, council room, reading room, and the lower hallway. Metal weather stripping has been placed around all windows, and the frames have been caulked with mastic.

All outside woodwork and ironwork has been repainted.

In general, the interior of the building has been greatly improved and it is felt that it is more in keeping with the handsome war memorial that it houses. The exterior not only looks better but is again in condition to resist the rigour of the weather.

Members are invited to visit the Headquarters. It is hoped they will make full use of the building and avail themselves of the facilities offered. Out of town members will be particularly welcome, and are urged to make this their headquarters while in Montreal.

J. B. D'Aeth, M.E.I.C.,
Chairman House Committee

Institute Delegates Report on International Engineering Congress, Glasgow

Engineering Institute of Canada,
2050 Mansfield Street,
Montreal, Que.

Gentlemen:

You will no doubt be interested to hear that having had the honour to be appointed an official delegate of The Engineering Institute of Canada, I attended the International Engineering Congress at the Empire Exhibition, Glasgow, from June 21st to 24th inclusive.

On the morning of the 21st, I met my compatriot, Mr. E. V. Buchanan (Vice-President, E.I.C.), at the Exhibition and together we attended several of the Technical Sessions Meetings on June 21st and 22nd. We also were guests at Lord and Lady Weir's dinner to the official delegates and later at the civic reception given to the Congress by the Rt. Hon. the Lord Provost and Corporation of Glasgow.

The last two days of the Congress were devoted to most enjoyable road, rail and sailing trips and visits to Scottish works. The Congress concluded on the evening of June 24th with a very pleasant reception and conversazione in the Palace of Art of the Empire Exhibition given by the President and Council of the Institution of Engineers and Shipbuilders in Scotland.

Very cordial welcomes and excellent addresses were given to the delegates and members of the Congress by Lords Weir and Elgin and by Rt. Hon. John Colville, M.P., Secretary of State for Scotland.

The technical papers submitted to the Congress were all by distinguished authors and were of a very high order throughout. To me they were most interesting and instructive.

The Empire Exhibition is a very fine one, well planned and on a magnificent scale. A conspicuous and worthy feature is the fine Canadian Pavilion on Dominions Avenue with its numerous and very interesting exhibits. It was pleasing to note that the men of the R.C.M.P. on duty there were so popular with the throngs of visitors.

I am glad to take this opportunity to express to you my high appreciation of the Congress in general and of the cordiality of the welcome and the splendid hospitality extended to the delegates and also for the honour and privilege of having been able to attend the Congress as one of your two delegates.

Yours faithfully,
James McGregor, M.E.I.C.

Gleniffer,
Thorn Road,
Bearsden, Glasgow, Scotland.

Engineering Institute of Canada,
2050 Mansfield Street,
Montreal, Que.

Gentlemen:

At the Council meeting of The Institute held in London in January of this year the writer was appointed The Institute's delegate to the International Engineering Congress in Glasgow in June and also to the International Electrotechnical Commission Plenary meeting held in Torquay and London from June 22 to July 1. The other Institute delegate to the Glasgow Congress was Major J. McGregor, D.S.O., A.M.E.I.C., who is now resident in Glasgow. The other Canadian delegates to the Electrotechnical Commission meeting were Alexander J. Grant, A.M.E.I.C., representing the National Research Council, Ottawa, and H. Lebouteux of the Aluminum Company, resident in London.

The International Engineering Congress at Glasgow was managed by the staff of the Institution of Engineers and Shipbuilders in Scotland and was very well organized. The headquarters for the technical sessions were in the Concert Hall at the Empire Exhibition grounds. The Rt. Hon. Viscount Weir, P.C., G.C.B. was the President of the Congress. I was shown every courtesy on my arrival and was immediately invited, along with my wife, to lunch with Viscount and Viscountess Weir, together with one of the German and one of the American delegates and their wives. Viscount Weir opened the Congress in an address of welcome in which he deplored the preparations for war and that the engineers' knowledge was being made use of for purposes of destruction, when so much more good could be brought to humanity by the efforts of the engineers in peace purposes.

I attended the following technical sessions:

"The Building of Ships—A British Survey," by Sir James Lithgow, Bt., M.C., D.L.

"Municipal and Industrial Planning,"—by A. Lilienberg, Esq. (Sweden).

"Technical and Economic Developments in Electrical Engineering," by S. B. Donkin, Esq.

"International Air Transport,"—by the Rt. Hon. Lord Sempill, A.F.C.

"Recent Developments of the Gas Industry in Canada," by J. Keillor, Esq. (Canada).

The last paper was the only Canadian paper, and in Mr. Keillor's absence, was presented by his nephew, who is an engineer in the gas industry in Greenock. A great many visits to works were arranged from which the delegates could make their choice. I visited the works of John Brown and Company at Clyde Bank where the "Queen Elizabeth" is being built, and Bruce, Peebles and Company, Limited, electrical manufacturers in Edinburgh. An excellent dinner was given to all delegates and their ladies by the President, the Rt. Hon. Viscount Weir and Viscountess Weir. The interesting feature of this banquet was that there were no speeches, except a vote of thanks proposed by the President of the Société des Ingenieurs Civils de France, and replied to briefly by the President. Beautiful souvenirs were presented to the ladies by Viscountess Weir. The delegates were also the guests of the Corporation of the City of Glasgow at the municipal buildings and were received by the Rt. Hon. The Lord Provost, Sir John A. Stewart.

No doubt the International Engineering Congress was organized with the aid of Engineering Institutions of Great Britain to attract engineers from all parts of the world to the Empire Exhibition in Glasgow. This report would not be complete without some reference to the Exhibition itself. Having had the privilege of visiting the British Empire Exhibition at Wembley in 1925 and the North East Coast Exhibition at Newcastle in 1929, I feel that the Glasgow show far surpasses both of these in every way.

It is natural, in an exhibition held in Glasgow that the Engineering Pavilion should be the most extensive. One of the delegates remarked that an Empire exhibition should feature engineering, as the real builders of Empire were the engineers. In this building there is literally everything in engineering, an epitome of the world of engineering.

Things of interest to engineers are not confined to the Engineering Pavilion. In the United Kingdom Pavilion, for instance, there are a working model of a coal mine, a blast furnace, a fully equipped bridge of a battleship and a mechanical man.

The predominating feature of the Exhibition for miles around is the modernistic observation tower, rising 300 feet above the crest of the hill in the centre of the grounds. For the structural engineer, this tower is undoubtedly of much interest. I was told that the maximum downward pressure on any one leg is 700 tons, while the overturning pull due to wind pressure and the unbalanced balconies that could be developed in any one leg is 400 tons.

The fountains and water displays are of great magnitude, novelty and variety. The use of special nozzles to aerate the water, giving it a sparkling white appearance, is an entirely novel device. The grading of the height of the jets, the carefully planned parabolas, and the skilful use of floodlighting all contribute to marvellous effects.

The Canadian Pavilion is the largest in Dominions Avenue and is a strikingly designed building. The engineering feats for which successive generations of Canadian engineers have been responsible are represented in pictures and dioramas from the Welland Canal to the construction of bridges like that at Quebec. The murals depicting Canadian life in ultra-modernistic, or almost sur-realist type are a mistake. It should have been evident to the designers that the vast majority of exhibition visitors are realists and take everything literally. These murals constantly created much mirth.

Following the International Congress in Glasgow, I proceeded to Torquay and arrived at the International Electrotechnical Commission meeting two days late, as the two conferences overlapped.

The meetings in Torquay were of an entirely different nature from those in Glasgow. The Glasgow Congress consisted of the delivery of papers of a very general nature and without discussion. At Torquay, on the other hand, the delegates were assigned to advisory committees and engaged in long discussions of a technical nature.

The International Electrotechnical Commission was the outcome of the St. Louis Electrical Congress held in the United States thirty-two years ago. A paper at that Congress on the Rating of Electrical Machinery given by Colonel Crompton led directly to the formation of this commission. It appeared that there were considerable discrepancies between the laws relating to electric units or their interpretation in various countries and that there was a great need of securing practical uniformity. Other questions bearing on nomenclature and the determination of units and standards were also raised on which it seemed desirable to have international agreement. After two years of study, Government delegates and those from various national engineering societies organized the I.E.C. in England in 1906.

All nations, large and small, have equal voice and freedom in the work of the I.E.C. Twenty-seven countries are now affiliated with the I.E.C. and in each of these countries, either through the leading electrical association or through the Government, where there is no such institution, there is found an electrotechnical committee representative of all the electrical interests of the country.

I attended the meetings of the committees on switchgear, transformers and overhead lines. The divergent practices in the rating of transformers in different countries was a problem which engaged the attention of the committee and some progress was made to reach uniformity.

One or two of the discussions at the conference have been simply indicated above, as it would be out of place here to attempt to report on the work of the numerous committees. One of the impressions gained by me at this conference was the loss of time due to the difficulties of language. Every remark made by a delegate had to be translated from English to French or vice versa. There were also unnecessary delays caused by apparently stubborn opinions based chiefly, I fear, on national pride. These differences, of course, are natural but, it would appear to me that more preparation should be done prior to these Plenary sessions by committees of action and thus speed up the work of the Plenary meetings.

Approximately 350 delegates in addition to about 100 ladies, representing twenty-two countries were present. The programme included a great many social functions which my wife and I enjoyed greatly. We are now in a position to instruct the members of The Engineering Institute and their ladies in the latest English dances, namely, the Lambeth Walk and the Palais Glide. The high spot, however, in entertainment was the banquet in London arranged by the British Standards Institution in the Guild Hall, where the delegates had for the guest of honour His Royal Highness the Duke of Kent, and were received by the Lord Mayor and his Sheriffs. It was a thrill which will be long remembered to dine in this old building, which has been the centre of the Corporation's social life since the year 1191. I had the pleasure of sitting opposite Sir Charles Bressey, Chief Engineer of the Department of Transport, who has just completed a 40,000 word report on the traffic problem in the City of London. His almost fantastic proposals, such as elevated and sunken main thoroughfares, three storey parking spaces on Trafalgar Square, etc. are most interesting.

While in London, I made an official visit to the headquarters of the Institution of Electrical Engineers, the Institution of Civil Engineers and the Institution of Mechanical Engineers, to pay the respects of our Institute. I also had the pleasure of attending the Dominion Day reception at Canada House and paid the respects of the President of The Engineering Institute to Mr. Vincent Massey, our High Commissioner in London. Along with my family, I had the great privilege of attending a garden party at Buckingham Palace and having tea in the Palace with His Majesty the King and Queen Mary, Queen Elizabeth being absent on account of the recent death of her mother.

There are many impressions which one could give on a trip of this kind, but space will not permit extending this report further.

Yours very truly,

E. V. Buchanan, M.E.I.C.

London, Ont.

Meetings of Council

A meeting of Council was held in Montreal on August 19th, 1938, at eight o'clock p.m., with President J. B. Challies in the chair, and eleven other members of Council present.

A resolution was passed recording the regret of Council at the death of Past-President J. G. Sullivan.

On behalf of the Publication Committee, Mr. Busfield reported that twenty-nine designs had been submitted for The Journal cover competition, and also that twenty-five members of The Institute had agreed to become Advisory Members of the Publication Committee to act in a technical advisory capacity to the editor of The Journal.

The President referred to the report on membership classification which had been prepared by Professor Spencer's committee. It was agreed that the report, with the memorandum and a questionnaire from Council, be sent to all branch executive committees for an expression of opinion.

There was a long discussion on the relationship of The Institute to the engineering students. It was felt that there should be some further service rendered to this basic group. In view of the Secretary's pending visit to Washington to gather information on this subject, further discussion was postponed until the next meeting.

Councillor Newell reported on the Saskatchewan agreement, and asked Council to authorize the submission of the agreement to councillors and corporate members resident in Saskatchewan in accordance with By-law 76. This was agreed to, the following scrutineers being appointed: Vice-President H. S. Carpenter, M.E.I.C., Councillor R. A. Spencer, A.M.E.I.C., and Past-Councillor D. A. R. McCannel, M.E.I.C.

At the request of the Association of Professional Engineers of Nova Scotia consideration was given to the passing of an amendment to By-law 76 that would facilitate the consummation of a co-operative agreement between the Nova Scotia Association and The Institute. This was agreed to.

The President's visit to the western branches was described and the itinerary submitted. The party will consist of President and Mrs. Challies, Councillor and Mrs. Newell, and the General Secretary. From Winnipeg to Calgary they will be accompanied by Mr. Gaherty, chairman of the Committee on Western Water Problems. In Regina the visit will coincide with the Semi-Annual Meeting of the Association of Professional Engineers of Saskatchewan, and in Vancouver with the Western Fall Meeting of the Canadian Institute of Mining and Metallurgy.

The President reported on the progress which had been made with the arrangements for the Annual Meeting which takes place in Ottawa on Monday, Tuesday and Wednesday, February 20th, 21st and 22nd, 1939. A number of distinguished guests have been invited.

An invitation had been received from the American Society of Civil Engineers to join with them in a meeting which is being arranged in New York in September 1939 with the Institution of Civil Engineers. The suggestion was accepted and a committee consisting of the President, Past-President Fairbairn and the General Secretary was appointed to discuss arrangements with the officers of the American Society of Civil Engineers.

After a long discussion and a report from the Treasurer, Mr. deGaspe Beaubien, it was decided to accept the invitation of L'Institut Scientifique d'Etudes des Communications et des Transports to appoint two members of the executive to their Committee of Honour. The President and Mr. Beaubien were made appointees.

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

Elections		*Transfers*	
Member	1	Student to Associate Member	1
Associate Member	1	Student to Junior	4
Juniors	5	Affiliate to Member	1
Students admitted	4		

The Council rose at eleven fifteen p.m.

* * *

A meeting of Council was held at Headquarters on September 9th, 1938, at eight o'clock p.m., with President Challies in the chair, and nine other members of Council present.

The President commented on the presence of Vice-President R. L. Dunsmore, of Halifax, and thanked him for representing The Institute at the meeting of the Mining Society of Nova Scotia in Sydney, and presenting the Leonard Medal to T. L. McCall, M.E.I.C., on that occasion.

Past-Councillor R. E. Smythe, Director and Secretary of the Technical Service Council, was present by invitation. He had come to Montreal for the purpose of discussing with the General Secretary and other councillors who were particularly interested, the possibility of improving the employment services of The Institute and the Council by closer co-operation.

Consideration was given to a letter from the Secretary of the American Society of Mechanical Engineers dealing with the joint meeting of that body and the Institution of Mechanical Engineers in New York in September 1939. It was suggested by the A.S.M.E. that The Institute might co-operate with them at a joint meeting in Niagara Falls or Toronto during the tour which followed the meeting in New York. The President pointed out the difficulty of co-operating satisfactorily with both the A.S.C.E., which had previously invited The Institute to co-operate with them, and with the A.S.M.E., and it was left with the committee previously appointed to discuss this with the officers of both societies so that arrangements could be worked out to the best advantage.

The ballot of Council on the Saskatchewan agreement was reported upon, and it was noted that out of thirty-six ballots received not one negative vote was recorded.

Mr. D'Aeth reported for the Library and House Committee that the work on the Headquarters building was practically completed, and he wished to invite members of Council and members of The Institute in general to visit the building and see the changes for themselves.

The report of the Nominating Committee, under the chairmanship of Harry F. Bennett, M.E.I.C., for the officers for 1939, was received and accepted.

A recommendation from E. P. Muntz, M.E.I.C., Council's representative on the National Construction Council of Canada, that the proposed amendment to the by-laws of the Construction Council be supported, was agreed to, and the Secretary was directed to inform Mr. Muntz that Council approved of his recommendation.

As replies had not been received from all the branches on the proposed re-organization of Council, which was submitted to them in June, it was decided to extend the period for replies until October 1st.

Four resignations were accepted; two Life Memberships were granted; the names of two members were removed from the list, and two special cases were considered, and decisions reached in accordance with their merits.

On the recommendation of the Finance Committee, Council decided to recommend an amendment to By-law 35 so that the fee charged to new members for fractional portions of the year would be based on the actual number of months contained in the unexpired portion of the year. It was also decided to propose and sponsor an amendment to By-law 32 fixing the entrance fees as $10.00 for Members, Associate Members, and Affiliates, and $5.00 for Juniors. This rate was established by a resolution of Council on December 17th, 1937, and confirmed at the last Annual Meeting, and the amendment is proposed for the simple purpose of recording the resolution in the by-laws.

The President drew Council's attention to the proposal of the Kingston Branch to have a special gathering in Kingston to honour Dr. W. L. Malcolm, M.E.I.C., who had been appointed recently Dean of the School of Engineering at Cornell University. As the President wished to be present at such a function, and as many councillors also wished to attend, the Secretary was instructed to submit two dates to Councillor Grant in the hope that either one would be acceptable to Dr. Malcolm and the branch. It was hoped that a date could be agreed upon that would be suitable for a Council meeting. (The second date, namely, October 22nd, has since been agreed upon, which makes it impossible to hold the proposed Council meeting in Kingston).

It was reported that the secretary of the Peterborough Branch had invited the President and the General Secretary to be their guests on the occasion of their Annual Dinner. Councillor Bonn stated that as this was always an important gathering, it would be well if a date could be found that would permit many councillors, as well as the President and Secretary to attend. The Secretary was instructed to recommend Saturday, November 26th, as a suitable date, and to express the hope that this would be satisfactory to the Peterborough Branch. It was also proposed that Council hold its November meeting in Peterborough at the same time, subject, of course, to the approval of the branch executive.

The American Society of Heating and Ventilating Engineers had invited The Institute to participate with them in a special meeting which they were holding on October 6th in Montreal. At this meeting it was expected that all the officers of the Society would be present. Council expressed its appreciation of the invitation and approved of it. As the co-operation would have to come principally from the Montreal Branch the matter was referred to them, with the request that they co-operate if it could be arranged.

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

Elections		*Transfers*	
Member	1	Associate Member to Member	4
Associate Members	4	Junior to Associate Member	2
Junior	1	Student to Associate Member	1
Student admitted	1	Student to Junior	5

It was decided that the next regular meeting of Council would be held in Montreal on Friday, October 7th, 1938.

The Council rose at eleven o'clock p.m.

E.I.C. Transactions Wanted

The Library needs the following number of The Institute Transactions:

Canadian Society of Civil Engineers, Vol. 25, pt. 1, 1911.

It would be appreciated if any member wishing to dispose of this number would communicate with the General Secretary. Single copies are worth $1.50.

Reports Wanted

Any members wishing to dispose of the following publications at $5.00 a copy should get in touch with the General Secretary.

International Waterways Commission, Compiled Reports, 1905-1913.

International Waterways Commission, Report on the Regulation of Lake Erie, 1910.

OBITUARIES

Marshall Willard Hopkins, M.E.I.C.

Word has recently been received of the death of Marshall Willard Hopkins, a Life Member of The Institute, at his home in St. Paul, Alta. Mr. Hopkins was born at Stoney Creek, Ont. on May 24th, 1861. He was graduated from McGill University in Civil Engineering with honours in 1888. Prior to his graduation and for a year after he was assistant engineer of the Montreal Sanitary Association. His first railway experience was obtained as early as 1890 when he was given charge of a twelve mile section of railway construction on the Charleston, Cincinnati and Chicago Railway, South Carolina. The next year he was associated with Stewart Noble on the reconnaissance of the Danville and East Tennessee Railway. In 1892 he returned to Canada and took up private practice as consulting engineer in Hamilton, Ont. He became consulting engineer for the municipalities of Hamilton, Barton, Saltfleet, North Grimsby, South Grimsby and Grimsby. He then became connected with the Hamilton, Grimsby and Beamsville Electric Railway and later with the Niagara Central Railway for which he made a preliminary survey from Hamilton to St. Catharines and Thorold. As well as engaging in railway work Mr. Hopkins made reports on the water supply of Hamilton and nearby towns, drew up surveys and plans of streets for the Hamilton Street Railway Company, located the Radial Electric Railway across Burlington Beach, Hamilton, and made surveys as chief engineer for the location of the International Radial Railway Company from Hamilton to Guelph.

In 1897 he moved to Rat Portage, Ont., where he practised mining engineering and land surveying for a considerable time. In 1904 he went to St. Paul, Alta. After surveying a great tract of the Peace River country for the Dominion Lands Department he did considerable surveying for the municipal districts. In 1923 after his retirement from the government service he wrote a mathematical book "Chance and Error." This book has been used in several universities.

Mr. Hopkins joined The Institute in 1887 as a Student, becoming an Associate Member in 1891 and a full Member in 1901. In 1925 he was made a Life Member.

Stewart Robertson McDougall, A.M.E.I.C.

Members will learn with regret of the death of Stewart Robertson McDougall, A.M.E.I.C., in Montreal, September 3rd. He was born at New Westminster, B.C., on April 10th, 1900. In 1922 he received the degree of B.A.Sc. in chemical engineering from the University of British Columbia and in the following year the degree of M.A.Sc. from the same University. During the year 1922-23 he was instructor in advanced analytical chemistry. He continued his studies at the University the following year, 1923-24, having obtained a Dominion Research Council Bursary. He came to Montreal in 1924 to attend McGill on a Dominion Research Council Studentship. The next year he entered the employ of the Northern Electric Company as chemical engineer and for ten years held various positions as development engineer. Since 1935 he had been acting in an advisory capacity in the Operating Department of the Cable Division of the company.

Mr. McDougall joined The Institute as a Student in 1920, becoming an Associate Member in 1927.

Charles Cathmer Ross, M.E.I.C.

Members of The Institute will regret to learn of the sudden death of Charles Cathmer Ross, M.E.I.C., in Vancouver, B.C., on September 12th. Mr. Ross, formerly Minister of Lands and Mines in the Alberta Government, was spending a holiday in Vancouver with Mrs. Ross. He was born at Ottawa, Ont., on June 14th, 1884. He attended Lisgar Collegiate there prior to entering McGill

University. In 1909 he graduated from the University with the degree of B.Sc. (civil) and following graduation was with the International Boundary Survey and subsequently with the Hydrographic Survey.

From 1911 until 1913 Mr. Ross was in private practice, contracting. In 1916 he went to Calgary, where he made his home until his death. As senior mining inspector and later as supervisory engineer for the Department of the Interior, he accomplished noteworthy results in the evolution and harmonious operation of the regulations for the development of the mineral resources of the prairie provinces. In 1928 he was chosen to organize the administrative machinery necessary to perfect a similar satisfactory service in northern Manitoba and northern Saskatchewan and in the Northwest Territories. In 1931 he left the Government service and engaged in the development of oil and gas and mining as a consultant. In 1935 he was appointed Minister of Lands and Mines in the Alberta Government, a position which he held until 1937.

Mr. Ross joined The Institute as a Member in 1925 and was always active in Calgary Branch affairs.

Edward James Turley, A.M.E.I.C.

We regret to have to record the death of Edward James Turley, A.M.E.I.C., on August 23rd in Montreal. He was born at Frankfort, Ont., on March 15th, 1884, and attended Trenton High School prior to entering McGill University. He graduated from the University in 1906 with the degree of B.Sc. in mechanical engineering. After graduation he entered the Montreal Locomotive Works where he remained for two years. He was then appointed factory engineer of the Northern Electric and Manufacturing Company. In 1910 he became associated with the Montreal Light Heat and Power Company as mechanical superintendent. After three years in the company he was made superintendent of general shops, the position which he held until his death.

Mr. Turley joined The Institute as a Student in 1906, becoming an Associate Member in 1913.

PERSONALS

Dr. T. H. Hogg, M.E.I.C., has completed twenty-five years of service to the Hydro-Electric Power Commission of Ontario. To mark the occasion and to acknowledge his attainment to the chairmanship, the staff of the Commission, on September 16th, 1938, paid tribute by the presentation of an illuminated address expressing the warm feeling and good wishes of the staff throughout the Province. The address recalled the fact that Dr. Hogg was associated with the first hydraulic plant constructed by the Commission, and expressed confidence in the administration of the Chairman in the future.

As a more tangible evidence of the staff's good wishes, Dr. Hogg was presented with four covered serving dishes of fine old English sterling, made by Paul Storr in 1822.

Because of the large numbers in attendance it was necessary to make the presentation from the steps of the west door of the Commission's head office building. The presentation was made by Mr. C. F. Publow, President of the Ontario Hydro-Electric Club.

Edgar T. J. Brandon, A.M.E.I.C., chief electrical engineer of the Hydro-Electric Power Commission of Ontario, has retired from active duties. On April 25th, 1938, Mr. Brandon completed thirty years of service with the Commission and it is a matter of regret that, owing to ill-health, he finds himself unable to carry out his active executive duties. However, as he will be retained upon a consulting basis, his services will continue to be available to the Commission. Mr. Brandon will be succeeded by Mr. Arthur H. Hull who has been appointed acting electrical engineer.

Archie B. Crealock, M.E.I.C., is now in the hospital suffering from pneumonia. The last report before going to press was that the doctor was well satisfied with his progress and expected he would be able to leave hospital in about two weeks time.

P. L. Pratley, M.E.I.C., of Monserrat and Pratley, is in hospital in Montreal for observation and treatment, but expects to be back in his office within a few days.

J. Hoogstraten, A.M.E.I.C., lecturer in civil engineering at the University of Manitoba, Winnipeg, Man., attended the University of Michigan this summer, taking graduate work in rigid frames and advanced fluid mechanics in preparation for a M.Sc. degree.

Harold G. Mosley, Jr.E.I.C., is now chief surveyor of the Cumberland Railway and Coal Company (a subsidiary of the Dominion Coal Company), at Springhill, N.S. He held the same position with the Dominion Coal Company at Glace Bay prior to his being transferred to Springhill.

A. B. Dove, A.M.E.I.C., is now in Montreal in the engineering department of the Steel Company of Canada. Mr. Dove is a graduate of Queen's University of the class of 1932 in chemical engineering. After graduation he entered the Steel Company of Canada, Hamilton, Ont., as chemical engineer. He later become assistant superintendent as well and held these positions until his transfer to Montreal. While in Hamilton he was active in Branch affairs, serving on the executive in 1937.

J. B. Hamilton, A.M.E.I.C., has been appointed manager of Western Securities Limited, 200 Lancaster Building, Calgary. This company is interested in the McCanachie Air Transport Limited and in the development of 104,000 acres of Pouce oil lands and generally in royalties in the Turner Valley oil fields. Prior to accepting this position he was sales manager of the International Bitumen Company Limited.

Charles D. Woolward, A.M.E.I.C., has accepted a position with Anglin-Norcross Limited, Montreal. He was formerly steel designer with the Canadian Industries Limited, Montreal.

Louis Trudel, S.E.I.C., has been appointed production engineer with the Marine Industries Limited in Sorel, Que. He has previously been with the Southern Canada Power Company Limited and with the Provincial Electricity Board. He will be greatly missed from his executive position as Vice-Chairman of the Junior Section of the Montreal Branch.

Douglas S. Laidlaw, A.M.E.I.C., is now associated with Chapman and Oxley, architects, Toronto. For the past four years he has been in the firm of Catto and Catto, architects, Toronto. Previous to going to Toronto, Mr. Laidlaw was located in Montreal for two years. He obtained his degree of B.A.Sc. from Toronto University in 1928.

Ralph G. Johnstone, A.M.E.I.C., has been promoted to the position of production manager of the E. B. Eddy Company, Hull, Que. He has been with the company since 1931 and for a year has been assistant production manager.

W. Sidney Kidd, A.M.E.I.C., is now managing director of the E. B. Eddy Company, Hull, Que. He has been connected with the company since 1926 and has held the positions of assistant chief engineer, mechanical superintendent and production manager.

W. A. Dawson, A.M.E.I.C., has been appointed plant manager of the E. Long Limited, Engineering Works, Orillia, Ont. He was graduated from Queen's University, after which he was associated with the Ford Motor Co. of Canada for eleven years, first as mechanical draftsman and later as chief in charge of machine and tool design. In 1935 and 1936 he was connected with the Algoma Steel Corporation, Sault Ste. Marie, Ont. as assistant superintendent of shops and foundry. Last September he returned to Windsor as plant engineer of the new motor plant of the Chrysler Corporation of Canada.

W. W. Preston, Jr.E.I.C., has accepted a position on the staff of the University of Alberta. He is a graduate of Queen's University 1935, and prior to his present appointment has been in Hamilton with the Hamilton Bridge Works Company Limited. He has been assistant secretary and branch news editor of the Hamilton Branch.

R. DeL. French, M.E.I.C., has started on a series of weekly radio broadcasts dealing with his favourite hobby, postage stamps, Friday nights, 7 p.m., station CFCF, Montreal.

D. H. McDonald, A.M.E.I.C., has been transferred to London, Ont., as senior assistant engineer in the Department of Public Works there. He has been lately in Ottawa with the Department as chief, Engineers Branch.

Visitors to Headquarters

H. F. Bennett, M.E.I.C., visited Headquarters September 29th on his way through Montreal to Saint John, N.B., to attend the funeral of his father.

Norman Hall, M.E.I.C., professor of mechanical engineering of the University of Manitoba, was at Headquarters September 22nd when in Montreal to visit his brother John Hall, M.E.I.C., assistant to the vice-president of Combustion Engineering Corporation.

Dean Mackenzie, of Saskatoon, visited Headquarters on August 27th, when he had an opportunity of discussing Institute developments with President Challies and Councillor Newell.

G. B. Moxon. A.M.E.I.C., of the Aluminum Company of Canada at Arvida, paid a visit to Headquarters recently.

C.P.R. Appointments

Recently changes have been announced by the Canadian Pacific Railway that affect several members of The Institute. They are as follows: **Lieut.-Col. Blair Ripley,** M.E.I.C., district engineer, Toronto, Ont., was appointed engineer, maintenance of way, eastern lines, Toronto; **J. H. Forbes,** A.M.E.I.C., assistant district engineer, Montreal became assistant right-of-way agent, Montreal; **W. C. E. Robinson,** A.M.E.I.C., division engineer, Laurentian division, Montreal, is now division engineer, London, Ont.; **James Edward Beatty,** M.E.I.C., engineer maintenance of way, eastern lines, Toronto, retired; **T. B. Ballantyne,** A.M.E.I.C., assistant district engineer, Toronto, was made district engineer; **A. O. Wolff,** M.E.I.C., division engineer, London, Ont. is now assistant district engineer, Toronto, and **L. M. Duclos,** A.M.E.I.C., assistant engineer, North Bay, became division engineer, Sudbury, Ont.

Cotton in Roads

Cotton fabric woven with a coarse mesh is being used at Burnley (Lancashire), Eng. as a road-building material. Concrete is laid in the usual way to a depth of five inches. The cotton, looking like a fish net, is then placed on top, separating the foundation layer from the concrete surface, which is three inches thick. In consequence, when re-surfacing is necessary, it is a simple matter to remove only the top layer, leaving the bottom layer undisturbed. The cost of the material, which is manufactured at a Burnley mill, is about twopence a yard.

MEETINGS

American Society of Civil Engineers—Fall Meeting, October 12th-14th, 1938, at Rochester, N.Y.

American Society of Heating and Ventilating Engineers—Annual Meeting, January 23rd to 26th, 1939, William Penn Hotel, Pittsburgh, Pa.

Canadian Construction Association—January 10th-12th, at Winnipeg, Man.

The Canadian Institute of Mining and Metallurgy—Annual Western Meeting, November 9th, 10th, 11th, at Vancouver. H. Mortimer Lamb, Vancouver Secretary, British Columbia Division.

Canadian Institute on Sewage and Sanitation—October 20th-21st, at the Royal York Hotel, Toronto. Secretary, Dr. A. E. Berry, M.E.I.C., Ontario Department of Health, Parliament Buildings, Toronto, Ont.

The Engineering Institute of Canada—Annual General and Professional Meeting, February 20th-22nd, 1939, at Ottawa.

E.I.C. Kingston Branch—Complimentary Dinner to Dr. Malcolm, October 22nd, 1938.

E.I.C. Peterborough Branch—Annual Banquet in the evening and Special Meeting of Council in the afternoon, November 26th.

Thirteenth Exposition of Power and Mechanical Engineering—December 5th to 10th, 1938, Grand Central Palace, New York.

Twelfth National Asphalt Conference—February 20th to 24th, 1939, Biltmore Hotel, Los Angeles, Calif.

Additional information about any of these functions may be secured from the General Secretary.

ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

Institution of Mechanical Engineers: Proceedings, Vol. 138, January-April 1938.

Institution of Mining and Metallurgy: Transactions, Vol. 46, 1936-37.

North East Coast Institution of Engineers and Shipbuilders: List of Members, July 31st, 1938.

Reports, etc.

British Columbia Dept. of Lands: Water Powers, Fraser River. 1938.

Canada Bureau of Mines: Comparative Pulverized Fuel Boiler Tests on British Columbia and Alberta Coals and on Ontario Lignite by C. E. Baltzer and E. S. Mallock.

Connecticut Society of Civil Engineers: Annual Report 1938.

Edison Electric Institute: Transmission and Distribution Committee, Transmission Group: Lightning Proof Transmission Lines. July 1938.

International Boundary Commission: Joint Report upon the Survey and Demarcation of the Boundary between the United States and Canada from the Gulf of Georgia to the Northwesternmost Point of Lake of the Woods. 1937.

Manitoba Economic Survey Board: Mineral Resources of Manitoba. 1938.

Ohio State University: Soil Mechanics Applied to Highway Engineering in Ohio. (Engineering Experiment Station Bulletin No. 99.)

U.S. Bureau of Mines: Minerals Yearbook, 1938, Review of 1937; Copper Mining in North America (Bulletin 405); Methods for the Detection and Determination of Carbon Monoxide, Flotation for Recovery of Scheelite from Slimed Material, Notes on the Sampling and Analysis of Coal (Technical Papers 582, 585, 586).

U.S. Geological Survey: Geology and Ore Deposits of the Southwestern Arkansas Quicksilver District, Metalliferous Mineral Deposits of the Cascade Range in Oregon, Subsurface Geology and Oil and Gas Resources of Osage County, Oklahoma (Bulletin 886-C, 893, 900-A); Species and Genera of Tertiary Noetinae, Pliocene Diatoms from the Kettleman Hills, California, Lower Pliocene Mollusks and Echinoids from the Los Angeles Basin, California (Professional Paper 189-A, 189-C, 190); Geology and Ground-Water Resources of the Valley of Gila River and San Simon Creek, Arizona, Surface Water Supply of the United States 1936 Pt. 10 the Great Basin, Drought of 1936 with Discussion on the Significance of Drought in Relation to Climate (Water-Supply Paper 796-F, 810, 820).

U.S. Public Health Service: Planning the Organization and Conduct of Stream Pollution Surveys.

University of Illinois: The Friction of Railway Brake Shoes at High Speed and High Pressure, Fatigue Tests of Riveted Joints, Solutions for Certain Rectangular Slabs Continuous Over Flexible Supports, A Distribution Procedure for the Analysis of Slabs Continuous Over Flexible Beams, Fourth Progress Report of the Joint Investigation of Fissures in Railroad Rails (Bulletin Vol. 35, Nos. 72, 79, 81, 84, 93).

Technical Books, etc.

American Men of Science. Ed. by J. McKeen Cattell and Jaques Catell. 6th ed. New York, Science Press, 1938. 1608 pp. 10¼ x 7½ in., cloth, $8.00.

Engineering Mechanics. By Seibert Fiarman and Chester S. Cutshall. New York, Wiley, 1938. 267 pp., diagrs., 9¼ x 6 in., cloth, $2.75.

Estimates and Costs of Construction. By Frank W. Stubbs. New York, Wiley, 1938. 234 pp., front., illus., plates, diagrs., charts, 9¼ x 6 in., cloth, $3.00.

(*Continued from page 479*)

Among those present were Major R. S. Buck, M.E.I.C., of Niagara Bridge fame; Major William Bowie, formerly Chief, Division of Geodesy, U.S. Coast Surveys; John F. Coleman, Reconstruction Finance Corporation, Past-President of the Engineering Council and of Am.Soc.C.E., and Honorary Member, Am.Soc.C.E.; Roy W. Crum, Director, Highway Research, National Research Council; Com. C. L. Garner, Chief, Division of Geodesy, U.S. Coast and Geodetic Survey; J. L. Harrington, Consulting Engineer, Kansas City, formerly President, Am.Soc.M.E.; W. W. Horner, Professor of Municipal and Sanitary Engineering, Washington University, Past-Director, Am.Soc. C.E.; E. W. James, Chief, Division of Highway Transportation, Bureau of Public Roads; Gen. R. C. Marshall, Consulting Engineer, formerly head of Construction Division, during World War; William McClellan, President, Potomac Electric Power Company, President, Engineering Council; O. C. Merrill, Director, World Power Conference; T. W. Norcross, Chief Engineer, U.S. Forest Service; Gov. Thomas Riggs, U.S. Commissioner, Alaska Boundary Commission, formerly Governor of Alaska; O. G. Taylor, Chief Engineer, U.S. Park Service; Gen. M. C. Tyler, Assistant to Chief of Engineers in charge of civilian activities; E. F. Wendt, Consulting Engineer, Past-President, Institute of Consulting Engineers, formerly Interstate Commerce Commission, and Capt. Paul C. Whitney, Chief, Division of Tides and Currents, U.S. Coast and Geodetic Survey.

BOOK NOTES

The following notes on new books appear here through the courtesy of the Engineering Societies Library of New York. As yet, the books are not in The Institute Library, but inquiries will be welcomed at Headquarters, or may be sent direct to the publishers:

British Non-Ferrous Metals Research Association, Research Reports, Association Series, No. 472, May, 1938. **Nickel Silver:** a Survey of Published Information by T. F. Pearson, London, The Association, Regnart Bldgs., Euston St., London, N.W.1. 36 pp., tables, 10 x 6 in., paper, 3s.

This survey presents a very compact account of the available information. After a short introductory section, the specifications for nickel-silver alloys issued in various countries are discussed. Following sections discuss the mechanical and physical properties of the alloys, the technique of melting and casting them, sands and sand mouldings, the effect of impurities, methods of working the alloys and the effect of annealing. There is a select bibliography.

Concentration des Minérals par Flotation, Exposé Théorique et Pratique. By H. Havre. Paris and Liége, Librairie Polytechnique Ch. Béranger, 1938. 461 pp., illus., diagrs., charts, tables, 10 x 6 in., cloth, 190 frs.

The concentration of minerals by flotation is covered in detail. The opening chapters discuss the various important methods with or without agitation or agents. Following this come descriptions of machinery and equipment used, then practical information concerning the treatment of sulphides, oxides, native metals and non-metallic minerals, concluding with process control and cost and equipment estimating.

Demonstration Experiments in Physics, ed. by R. M. Sutton, prepared under the auspices of the American Association of Physics Teachers. New York and London, McGraw-Hill Book Co., 1938. 545 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $4.50.

This is a collection of nearly twelve hundred lecture experiments for the use of high school and college teachers of physics and general science. The book was prepared under the auspices of the American Association of Physics Teachers, and includes contributions from two hundred physicists. The descriptions of experiments are direct and emphasis has been placed upon simplicity of apparatus and procedure.

Group Purchase of Medical Care by Industrial Employees. By L. Brown. Princeton, N.J., Princeton University, 1938. 10 x 7 in., paper, $1.00.

The problem of medical care is presented and the developments in this line within industry are discussed. A limited number of representative group purchase plans are analyzed and summarized, including the attitude of organized medicine toward such plans. A selected bibliography is appended.

REQUEST FOR INFORMATION

To all members of The Engineering Institute of Canada

It is proposed to publish a membership list before the end of the year. In order that complete and up-to-date information may be available, will you kindly fill in this form and return it to Headquarters. The work is already under way; therefore a prompt response will be appreciated.

L. AUSTIN WRIGHT, *General Secretary*

Name in full..

Residence address..

Business address..

(*Underline the one to be used for mail*)

Membership classification in Institute...

Name of Employer..

Position occupied..

College, Degrees and year..

Military or Civil titles and honours..

BRANCH NEWS

Niagara Peninsula Branch

G. E. Griffiths, A.M.E.I.C., Secretary-Treasurer.
J. G. Welsh, A.M.E.I.C., Branch News Editor.

EXECUTIVE 1938-1939

Chairman—C. G. Moon, A.M.E.I.C., 66 Yates Street, St. Catharines, Ontario.
Vice-Chairman—A. W. F. McQueen, A.M.E.I.C., H. G. Acres and Company, Ferry Street, Niagara Falls, Ont.
Secretary-Treasurer—G. E. Griffiths, A.M.E.I.C., Box 385, Thorold, Ontario.
Branch News Editor—J. G. Welsh, A.M.E.I.C., 83 Niagara Street, Fort Erie, Ontario.

ELECTED EXECUTIVE

District No. 1—St. Catharines—
C. G. Moon, A.M.E.I.C., 66 Yates Street, St. Catharines, Ontario.
A. L. McPhail, A.M.E.I.C., 52 York Street, St. Catharines, Ontario.
M. H. Jones, A.M.E.I.C., Ontario Paper Company, Thorold, Ontario.
District No. 2—Niagara Falls—
A. W. F. McQueen, A.M.E.I.C., H. G. Acres and Company, Ferry Street, Niagara Falls, Ont.
C. G. Cline, A.M.E.I.C., Ontario Power Plant, Box 237, Niagara Falls, Ontario.
D. W. Bracken, A.M.E.I.C., 1975 Drummond Road, Niagara Falls, Ontario.
District No. 3—Thorold, Port Colborne, Welland and Fort Erie—
C. H. Burns, M.E.I.C., 105 Dorothy St., Welland, Ontario.
P. E. Buss, A.M.E.I.C., Spun Rock Wool, Box 40, Thorold, Ontario.
E. C. Little A.M.E.I.C., Welland Ship Canal Office, Humberstone.

COMMITTEES

Programme—C. G. Moon, A. W. F. McQueen, G. E. Griffiths.
By-Laws—W. Jackson, M.E.I.C.
Publicity—J. G. Welsh.
Visitors and Social—Chairman, M. B. Atkinson, M.E.I.C. with H. M. King, M.E.I.C., and C. H. Burns.

DISTRICT REPRESENTATIVES

Port Colborne—G. N. Geale, A.M.E.I.C., Welland Ship Canal, Humberstone, Ontario.
Welland—V. S. Dyson, 229 Maple Ave., Welland, Ontario.
Fort Erie—L. J. Russell, JR.E.I.C., c/o Horton Steel, Box 471, Fort Erie, N. Ontario.
Thorold—P. E. Buss, A.M.E.I.C., Spun Rock Wool, Box 40, Thorold, Ontario.
St. Catharines—D. D. Hall, A.M.E.I.C., c/o Dominion National Gas Company, Ltd., St. Catharines, Ontario.
Niagara Falls—M. F. Ker, A.M.E.I.C., 2057 Drummond Road, Niagara Falls, Ontario.

Saguenay Branch

F. T. Boutilier, A.M.E.I.C., Secretary-Treasurer.
J. W. Ward, A.M.E.I.C., Branch News Editor.

SECRETARY'S REPORT FOR YEAR ENDING JUNE 30TH, 1938

Mr. Chairman and Gentlemen:

I take pleasure in bringing to your attention the activities of this branch of The Institute during the past year. This was very active during the last season, having held eight general meetings.

Our last annual meeting was held at Dolbeau, on July 30th. After luncheon at the Dolbeau Inn, the members made an inspection tour of Lake St. John Power and Paper Co.'s papermill and the Trappist Brothers' limestone quarry.

On October 15th, Mr. McNeely DuBose, General Superintendent of the Saguenay Power Co. Ltd., delivered a very interesting address on the "Costs of Power." The costs involved in building hydro-electric plants were described in detail as well as the various methods of setting rates.

On February 11th, T. M. Moran, A.M.E.I.C., Chairman of the Industrial Management Section of the Montreal Branch, gave an instructive paper on the "Technical Men in Industry."

On February 25th, Mr. Frank Calder of the Aluminum Co. of Canada, Limited addressed the Saguenay Branch on "Paper Unloading Facilities at Port Alfred." This paper proved to be very interesting and was well illustrated by slides.

On March 25th, N. D. Paine, A.M.E.I.C., General Electrical Superintendent of Price Brothers & Company, Ltd., gave an illustrated address on "Operating Experience with Wood Pole Transmission Lines in the Saguenay District." F. L. Lawton, M.E.I.C., Chief Engineer of the Saguenay Power Co. Ltd., gave a similar address "Operating Experience with Steel Tower Transmission Lines in the Saguenay District." His address, illustrated with a number of slides, covered general features and insulation levels of three double circuit steel-tower lines in the Saguenay district.

On May 4th, G. E. LaMothe, A.M.E.I.C., Logging Division Engineer of Price Bros. & Co. Ltd., gave a timely address on "Wood Preservation," before a well attended meeting. After the meeting two talkies were shown, "Structural Shapes" and "Golden Gate Bridge."

On May 13th, Mr. A. Leuthold, Engineer of the Brown Boveri Company, Switzerland, delivered a very interesting illustrated paper on "Latest Application of Grid Controlled Mutators" just after the installation of the mercury arc rectifier station at the Aluminum Company's platt.

Mr. R. H. White, Manager and Vice-President of the Canadian Abrasives Company, Ltd., addressed the meeting on "Manufacture of Electric Furnace Abrasives." He gave an interesting history of the industry and described the development of the modern furnace.

During the past year the membership increased from 53 to 60, which is a result of the excellent work of the Membership Committee. The membership now stands at four members, 35 associate members, 7 junior members, 12 student members and 2 affiliate members.

CHARLES MILLER, A.M.E.I.C.,
Secretary-Treasurer.

Vancouver Branch

T. V. Berry, A.M.E.I.C., Secretary-Treasurer.
J. B. Barclay, A.M.E.I.C., Branch News Editor.

A joint dinner under the auspices of the Engineering Bureau, Vancouver Board of Trade, and The Engineering Institute of Canada, Vancouver Branch, was held in the Georgia hotel on September 13th, 1938, with A. S. Wootton, M.E.I.C., chairman of the Engineering Bureau, in the chair. Fifty members of these two organizations sat down to dinner.

The guest speaker was P. L. Pratley, M.E.I.C., who delivered a paper on "The Collapse of the Niagara Arch Bridge."

In an interesting address illustrated by lantern slides and film, Mr. Pratley described the unusual meteorlogical conditions over Lake Erie in the two or three days previous to the collapse of the bridge, which served to force unusual quantities of ice over Niagara Falls, the enormous lateral pressure of which on the lower chord members of the arch brought about its final demolition on January 28th, 1938.

A vote of thanks to the speaker was proposed by C. E. Webb, M.E.I.C., vice-chairman of the Vancouver Branch, Engineering Institute of Canada.

Electrodynamic Ammeter as Standard of Current at High Frequencies

A jewel-bearing oscillating-ring electrodynamic ammeter was described recently to the members of the New York section of the Institute of Radio Engineering in a paper presented by Harry R. Meahl of General Electric's General Engineering Laboratory. The author explained his method for calibrating this instrument, and showed it to be a standard of currents above one ampere, at high frequencies.

Past investigators of high-frequency phenomena have wondered why some practical standard of current at high frequencies was not found long ago. The reason is that many efforts were made to use the heating effect of the current, and only a few to use the energy in the magnetic field. Even on direct current, an instrument using the heating effect of the current is not a standard, because of the difficulty of accurately calculating its characteristics. The performance of the electrodynamic ammeter can be accurately calculated from measurements of length, mass and time, giving a standard of current at high frequency. This instrument is used with currents from 3 to 6 amperes over the 5 to 42 megacycle frequency range with an accuracy of plus or minus one per cent.

Atom Faces Disintegration

The mighty atom is going to have things happen to it, judging by reports emanating from Harvard University. It appears that a number of eminent professors have concentrated their united efforts upon the construction of a cyclotron atom-smasher, one of the largest machines of its kind in the world. This machine is expected to generate atom-smashing projectiles of 8,000,000-volt energy and above, permitting the most precise measurements ever made of the forces released by atomic disintegration. The third such machine for which General Electric has furnished parts, it is expected to be in operation this summer. Two years ago, it is recalled, two coils were made for a unit at the University of Rochester and an oscillator was made for another cyclotron at Princeton University. The pole cores of the Harvard cyclotron, it has been learned, are two times greater in diameter than those of the machine at Rochester, and will give four times as much magnetic flux. One interesting and possibly very valuable application of the cyclotron is the production of radio-active material having some advantages which radium does not possess. Such material has been produced by bombarding common salt, or metallic sodium, by the high speed ions, and has been successfully used in treating cancer in rats. By producing a substitute for that rare and exceedingly costly metal, radium, the cyclotron may provide another means for combating cancer, supplementing the powerful weapon now used, the X-ray tube.

Preliminary Notice

of Applications for Admission and for Transfer

September 25th, 1938.

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 1938.

L. Austin Wright, General Secretary.

*The professional requirements are as follows:—

A Member shall be at least thirty-five years of age, and sball 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 cbarge.

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, whicb 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. Tbe 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 hranch 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 bas beld 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 bas 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 tbe profession, in which case be 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 tbe extension of this age limit.

An Affiliate shall be one wbo 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 tbat candidates give tbe names of certain members as reference does not necessarily mean that their applications are endorsed by such members.

FOR ADMISSION

CARSON—CECIL EDWARD, of 315 London Road, Sarnia, Ont., Born at Westmount, Que., Dec. 17th, 1900; Educ., B.Sc. (Chem.), McGill Univ., 1922; With the Imperial Oil Limited as follows: 1923-29, asst. chemist, and 1929-33, technical asst. to refinery supt., Montreal East; 1933-34, refinery supt., Regina, and 1934 to date, gen. supt., Sarnia, Ont.

References: T. Montgomery, F. C. Mechin, R. L. Dunsmore, E. R. Smallhorn, V. A. McKillop.

CAWLEY—HUGH ROSE, of Melville, Sask., Born at Glasgow, Scotland, Feb. 20th, 1909; Educ., B.Sc. (Mech.), Univ. of Sask., 1938; With the C.N.R. as follows: 1926-28, general shopwork, 1928-34, machinist ap'tice, 1934-38 (summers), machinist; June 1938 to date, asst. locomotive foreman, Melville, Sask.

References: C. J. Mackenzie, I. M. Fraser, R. A. Spencer, A. M. Macgillivray, J. J. White.

DOBSON—FRANKLIN ALVER, of 223 S. Archibald St., Fort William, Ont., Born at Stanstead, Que., Dec. 29th, 1908; Educ., B.Sc., Queen's Univ., 1932. Two years post-graduate study in aeronautics, Goettingen, Germany; 1935-36, dftsman., Fleet Aircraft of Canada, Fort Erie, Ont.; 1936-37, dftsman., Fairchild Aircraft of Canada, Longueuil, Que.; 1937, stress analyst, Waco Aircraft Co., Troy, N.Y.; 1937-38, project engr., and at present, re earch engr., Canadian Car and Foundry Co., Fort William, Ont.

References: D. Boyd, G. R. Duncan, P. E. Doncaster, H. Os, L. T. Rutledge, D. S. Ellis, A. Jackson, D. M. Jemmett.

DuBOSE—McNEELY, of Arvida, Que., Born at Ashville, N.C., Jan. 9th, 1892; Educ., B.E. and E.E., North Carolina State College, 1912. R.P.E. of Que.; 1912-18, with the following companies: Appalachian Power Company, Isthmian Canal Commission, Riegos y fuerza Ebro (Spain), Catawba Valley Co., Tallassee Power Company, U.S.A. Engineers; 1919-25, supt., Tallassee Power Company; 1925-26, supt., Aluminum Co. of Canada Ltd.; 1926-38, gen. supt., Saguenay Power Co. Ltd., also vice-president and director, Saguenay Electric Co., Saguenay Transmission Co. Ltd., Alma & Jonquiere Ry. Co. (Member, A.I.E.E.).

References: J. B. Challies, P. S. Gregory, J. Morse, J. W. McCammon, O. O. Lefebvre, J. A. McCrory.

HAMILTON—HAROLD PERCY, of Island Falls, Sask., Born at Regina, Sask., June 6th, 1912; Educ., B.A.Sc., Univ. of Toronto, 1934; 1932 (summer), electrn's and mechanic's helper; 1935-36, rodman and dftsman., Prairie Farm Rehabilitation, Swift Current, Sask.; 1936-37, operator, and 1937 to date, acting as dftsman and asst. engr. on design of structures for a storage reservoir, Churchill River Power Company.

References: J. B. D'Aeth, J. J. White, P. C. Perry, B. Russell, C. J. McGavin, D. A. R. McCannel, R. W. Jickling.

LORIMER—WILLIAM CLARENCE, of Kerrobert, Sask., Born at Manor, Sask., Dec. 27th, 1907; Educ., B.Sc. (Mech.), Univ. of Sask., 1929; 1929, dftsman., City of Regina; With Canadian Utilities Limited as follows: 1929-30, dftsman., instrument work, inspection, 1930-31, field inspr., 1931-32, res. engr., 1937 to date, plant operator and part time lineman.

References: C. J. Mackenzie, R. W. Allen, J. W. D. Farrell, J. J. White, W. E. Lovell.

SPENCE—HOWARD CLEMENT, of Ste 11A, Guelph Apts., Winnipeg, Man., Born at Winnipeg, April 13th, 1909; Educ., B.Sc. (Civil), Univ. of Man., 1934; 1926-27 (intermittent), constrn. and location surveys for C.P.R. and C.N.R.; 1928-35, 1 year, foreman and surveyor, 3 years, asst. field mgr., 2 years, acting field mgr., 2 years, field mgr., Winnipeg Anti-Mosquito Campaign. Full time employment during vacations with part time duties during academic years, incl. estimating, directing and reporting of all control measures (larvicides, drainage, etc.); 1935 to date, in Highway Traffic and Taxicab Office, Municipal and Public Utility Board, Province of Manitoba, 1½ years, inspr., 2 years, secretary. Work involves licensing and regulation of trucks, buses and taxicabs, incl. investigations relative to awarding of certs. of "public convenience and necessity," arrangement of bus and truck schedules, provisions for safety, use of downtown streets in urban districts by trucks and buses from country points, supervision of stations and terminals, tariff for passengers, freight and express traffic, etc.

References: J. Hoogstraten, D. M. Stephens, A. J. Taunton, A. E. Macdonald, G. H. Herriot.

TAYLOR—FRANK BUTLER, of 4384 Draper Ave., Montreal, Que., Born at Liverpool, England, March 18th, 1903; Educ., 1919-24, Liverpool Technical School. 1919-24, five years ap'ticeship, Marine Engrg., steam and Diesel, Cammell, Laird & Co., Birkenhead, England. British Board of Trade Chief Engr's Cert. for steam and motor vessels; 1924-28, engr. officer on British steamships; Since 1928 has specialized solely in study of high powered Diesel engines as applied to marine propulsion; With the Imperial Oil Shipping Company as follows: 1928, second engr. of motor tankers of 4,000 h.p., since 1932, chief engr. of motorships of over 6,000 h.p., several months during 1936 and 1937, and at present, marine supt., at Montreal.

References: F. C. Mechin, G. Agar, R. C. Flitton, P. F. Stokes, R. C. Simon.

WILLIAMS—CHARLES GUNNING, of 417 Rosemary Road, Toronto, Ont., Born at London, Ont., March 16th, 1882; Educ., B.A.Sc., Univ. of Toronto, 1905; 1913-28, with Hollinger Consolidated Gold Mines, 12 years as gen. supt.; 1929, private consltg. practice; 1934, general secretary, Canadian Metal Mining Association; 1936, general consltg. practice; at present, professor of mining engineering, University of Toronto, Toronto, Ont.

References: C. H. Mitchell, R. W. Angus, C. R. Young, H. E. T. Haultain, W. S. Wilson.

FOR TRANSFER FROM THE CLASS OF ASSOCIATE MEMBER TO THAT OF MEMBER

MacKENZIE—GORDON LESLIE, of 2230 Elphinstone St., Regina, Sask.; Educ., B.Sc. (Civil), Queen's Univ., 1919; D.L.S., S.L.S., R.P.E. of Sask.; 1913-19, Dom. Govt. surveys with the Dept. of Indian Affairs; 1920-34, with Underwood & McLellan, consltg. engrs., Saskatoon, in responsible charge of surveys for, design of, and constrn. of municipal engrg. works in Saskatchewan; 1934-37, Dominion Public Works, on Outlook Bridge, Prince Albert, retaining wall and other misc. works; 1937 to date, office and designing engr., water development, Prairie Farm Rehabilitation, Dominion Dept. of Agriculture, 1937 i/c design and constrn. water conservation projects in Manitoba, 1938, office design and specifications on large projects. (*St. 1919, Jr. 1922, A.M. 1922.*)

References: F. G. Goodspeed, A. M. Kirkpatrick, A. J. Taunton, B. Russell, J. J. White, C. J. McGavin.

WATSON—McCLELLAND BARRY, of Toronto, Ont., Born at Toronto, Jan. 22nd, 1889; Educ., B.A.Sc., C.E., M.E., Univ. of Toronto, 1910; R.P.E. of Ont.; 1911-12, res. engr., waterworks and sewage systems, design and supervision of installns., Chipman and Power; 1912-13, chief asst. to mech'l. engr., Toronto Power Company; 1913-14, chief dftsman., Ontario Dept. of Highways; 1919-27, director, dept. of engineering, Central Technical Scbool, Toronto; 1927-31, partner, Angus &

Watson, consltg. mech'l. engrs.; July 1931 to date, private consltg. practice, also Director, Dept. of Military Studies, University of Toronto. (*Jr. 1914, A.M. 1919.*)
References: C. H. Mitchell, R. W. Angus, J. R. Cockburn, W. E. P. Duncan, W. S. Wilson, C. R. Young, T. R. Loudon, E. G. T. Taylor.

FOR TRANSFER FROM THE CLASS OF JUNIOR

RICE—WALTER LESLIE, of Toronto, Ont., Born at Hinckley, Leicestershire, England, March 6th, 1904; Educ., Toronto Technical Schools and private study. Passed E.I.C. exams. for admission as Junior, Nov. 1933. Passed E.I.C. exams. under Schedule "C" for admission as Associate Member, Nov. 1936; With the City of Toronto as follows: 1926-28, rodman, chainman and acting instr'man. on gen. sewer constrn.; 1928-30, dfting. and assisting with design of sewer constrn.; 1930, instr'man., St. Clair Reservoir constrn.; 1930-31, instr'man., and acting res. engr., filtered water tunnel; 1931 to date, dftsman., work includes dfting and assisting with the design of steel and concrete water mains, chambers, etc., specializing in reinforced concrete design; checking contractor's drawings; misc. surveying, dfting and field work covering Toronto waterworks extension projects and present water supply system. (*Jr. 1933.*)
References: G. G. Powell, A. U. Sanderson, G. Phelps, J. M. Walker, W. L. Shelden, H. J. Ross.

VINCENT—PAUL EMILE ALBERT, of Quebec, Que., Born at Montreal, Dec. 8th, 1906; Educ., B.A.Sc., C.E., Ecole Polytechnique, Montreal, 1934; 1927 (summer), asst. junior engr., Wayagamack Pulp and Paper Co. Ltd.; 1929-31, with Heroux & Robert Ltd., general contractors, May 1930 to Sept. 1931, asst. engr. i/c constrn.; Session 1934-35, asst. professor, elect'l. laboratory, Ecole Polytechnique; 1935 (summer), asst. on constrn., Aluminum Co. of Canada Ltd.; 1935-37, asst., water levels investigation, Marine Dept., Ottawa; 1937 (Apr.-June), i/c field party, Quebec Roads Dept.; June 1937 to date, district engr., roads and bridges divn., Colonization Dept., Quebec, Que. (*St. 1934, Jr. 1935.*)
References: A. I. Cunningham, C. G. Cline, A. Frigon, A. Gratton, A. B. Normandin, A. O. Dufresne.

FOR TRANSFER FROM THE CLASS OF STUDENT

BEIQUE—HENRI F., of 9 Belvedere, Quebec, Que., Born at Montreal, May 5th, 1911; Educ., B.Eng. (Elec.), McGill Univ., 1936; 1932, 1934, 1935 (summers), Quebec Streams Commission and Shawinigan Water and Power Co.; 1936-37, Shawinigan Water and Power Co., and 1937 to date, engr., Quebec Power Company, Quebec, Que. (*St. 1936.*)
References: O. O. Lefebvre, P. A. Beique, G. R. Hale.

COUSINEAU—LOUIS PHILIPPE, of Sorel, Que., Born at Montreal, May 9th, 1909; Educ., B.A.Sc., C.E., Ecole Polytechnique, Montreal, 1936. 1936-37, Ecole Supérieure de Soudure Autogène, Paris, France, welding engr.; 1929-35 (summers), surveying, Quebec Streams Commn.; 1937 (summer), Société L'Air Liquide, Paris; 1936 (summer), constrn. work, Chantiers Manseau; 1936-38, Chantiers Manseau and Marine Industries Ltd.; at present, welding supt., Marine Industries Limited, Sorel, Que. (*St. 1934*)
References: O. O. Lefebvre, A. Frigon, A. Cousineau, C. E. Frost, L. Trudel.

STEVENSON—CHARLES LESTER, of Arvida, Que., Born at Waltham, Mass., June 5th, 1911; Educ., B.Sc. (Civil), Univ. of N.B., 1934; 1930-31 (5 mos.), dftsman., etc., N.B. Highways Dept.; 1931 (5 mos.), instrument man, Northern Construction Co., Montreal; 1933 (4 mos.), materials checker, E. G. M. Cape Co., Montreal; 1934 (4 mos.), 1935-36 (10 mos.), asst. to res. engr., City of Saint John, N.B.; 1936 (9 mos.), instrumentman, Ontario Paper Company, Baie Comeau, Que.; 1937, constrn. engr., A. F. Byers & Co., Montreal, and Can. Engrg. and Contracting Co., Hamilton, Ont.; 1938 (9 mos.), plant engr., i/c of installn. of plant equipment, further constrn. on plant, and constrn. of houses, for the Abrasive Company of Canada, Arvida, Que. (*St. 1934.*)
References: J. Stephens, D. R. Smith, E. V. Gage, E. P. Muntz, W. J. Thomson, C. M. Miller, J. B. Stirling.

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.

Notices appearing in the Situations Wanted column will be discontinued after three insertions, and will be re-inserted after a lapse of one month, upon request.

All correspondence should be addressed to

The Employment Service Bureau, The Engineering Institute of Canada
2050 Mansfield Street, Montreal

Situations Wanted

ENGINEER, A.M.E.I.C., Combustion specialist heat balance. Steam, Mechanical. Refrigeration. Office routine. Correspondence. Plant layout. Apply to Box No. 5-W.

ELECTRICAL ENGINEER, JR.E.I.C., B.SC.; age 31; at present employed, desires change in location. Experience includes; three summers experience in power conduit construction; two years in telephone engineering; four years experience in radio, both development engineering and production; two and one half years in a paper mill on electrical maintenance, with a short time in the cost accounting and draughting departments. Would be interested primarily in electrical maintenance. Apply to Box 12-W.

PAPER MILL ENGINEER: B.A., B.A.SC. Married. Age 34. A.M.E.I.C. Ten years experience in paper mill costs, maintenance, design and construction. Now employed as cost engineer in Southern States. Hard worker with excellent references. Available immediately. Apply to Box No. 150-W.

SALES ENGINEER REPRESENTATIVE. Mechanical graduate with fifteen years experience in Eastern Canada in sales and service of mechanical equipment; full details upon request to Box No. 161-W.

ENGINEER-DRAUGHTSMAN, experienced in design of machines for widely varied purposes and arrangement of motor drives. Accustomed to layout of small mill buildings, steel and timber. Good references. Present location Montreal. Apply to Box No. 329-W.

CIVIL ENGINEER, M.A.SC., A.M.E.I.C. eight years survey and municipal engineering experience, and three years draughting, detailing steel, concrete, and timber structures. Apply to Box No. 467-W.

CIVIL ENGINEER, B.SC. (McGill '20), A.M.E.I.C. Married. Twelve years experience in pulp and paper mill design, and six years general construction. Available immediately. Location immaterial. Apply to Box No. 547-W.

ELECTRICAL ENGINEER, B.SC. E.E., Age 39. Married. Seven years experience in operation, maintenance and construction of hydro-electric plants, and sub-stations. Five years maintenance and installation of pulp and paper mill electric equipment. Reliable and sober, with ability to handle men. Best references. Any location, at once. Apply to Box No. 636-W.

Situations Wanted

ELECTRICAL ENGINEER, B.SC. '28. Two years student apprenticeship at Can. Westinghouse Co., including test and electrical machine design. Also about two years experience in operating dept. of large electrical power organization. Available on short notice. Apply to Box No. 660-W.

CIVIL ENGINEER, B.A.SC. (Toronto '27), age 34, married. Five years railway and construction work as building inspector and instrumentman. Level engineer and on construction of a long timber flume for a pulp and paper mill. Field engineer for a sulphite company, in charge of the following mill buildings, acid, digester, blow pit, barker room, chip storage and acid towers. Available immediately. Apply to Box No. 714-W

ELECTRICAL ENGINEER, B.SC. '31 (U.N.B.), JR.E.I.C. Age 30 years. Single. Experience in electrical wiring, construction of concrete wharves, inspection of piling, rip rap, concrete reinforcing, forms, and dredging. Also junior engineer. Available at once. Apply to Box No. 722-W

CIVIL ENGINEER, B.SC., M.SC., P.P.E.; Lieut. C.E., R.O. Sixteen years municipal, highway and construction. Five years overseas. Married. Read, write and talk French. Will go anywhere. Apply to Box No. 737-W.

CIVIL ENGINEER, B.SC. '29, JR.E.I.C., R.P.E.M. Age 31. Married. Experience includes railway and highway surveys and construction, land and mineral claim surveys, 4 years draughting, structural and hydraulic design, preparation of plans and estimates for hydro-electric development, sewage disposal project, water treatment plant, subway construction, buildings, etc. Experienced in reinforced concrete design including statically indeterminate frames. Also capable of preparing designs in steel and timber Desire permanent employment, preferably in structural design. Available immediately. Apply to Box No. 1023-W.

ELECTRICAL ENGINEER, B.SC. '29, age 30. Single. Eight and a half years experience on maintenance, on construction, floorman and operator on hydro-electric system. Desires construction, service, sales or research work. Any location. Excellent references. Apply to Box No. 1062-W.

ELECTRICAL ENGINEER AND GEOPHYSICIST. Age 41. 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. Experience 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.

Situations Wanted

TECHNICALLY TRAINED EXECUTIVE. General experience administrative, organization and management in business and industrial fields, including; business, plant, property and estate management; plant maintenance, modernization, production and personnel; economic studies, company reorganizations and amalgamations, valuations; railroad, highway, hydro, pulp, newsprint, housing, industrial surveys, investigations and construction; B.Sc. degree in engineering, age 49, married, Canadian. Apply to Box No. 1175-W.

CHEMICAL ENGINEER, grad. McGill '34, experienced in meter repairs, control work; and also chemical laboratory experience. Apply to Box No. 1222-W.

ELECTRICAL ENGINEER, B.SC. '31. Age 35. Experience in oil field work and railways construction survey. Two years on installation and maintenance of mine equipment, and two years industrial plant engineering on design and layout of equipment. Available immediately. Will go anywhere. Apply to Box No. 1249-W.

FIELD ENGINEER AND DRAUGHTSMAN, A.M.E.I.C. Age 36. Married. Fifteen years experience in civil engineering, general draughting and instrument work. Experience covers office and layout work on construction of sewers, water mains, gas mains, (6″ to 30″ dia.) and transmission line structures; topographic and stadia surveys. Draughting covers general civil, reinforced concrete and steel design, mechanical detailing and arrangements, and mapping. Present location Montreal, but willing to locate anywhere. Available at once. Apply to Box No. 1326-W.

CIVIL AND ELECTRICAL ENGINEER, JR.E.I.C. (Univ. of Man.). Married. Age 25. Good draughtsman. Four months draughting, one year instrumentman on highway location and construction, inspection and miscellaneous surveying and estimating. Six months as field engineer on pulp and paper mill construction. Prefer electrical or structural design. Available at once. Apply to Box No. 1633-W.

CIVIL ENGINEER, B.SC. in C.E. '34. S.E.I.C. Age 27. Five years experience, including harbour construction, highway paving, one and a half years paper mill construction, instrument work, draughting, estimating, interested in design. Available on short notice. Apply to Box No. 1737-W.

CHEMICAL ENGINEER, graduate, Toronto '31. Seven years experience in paper mill, meter maintenance, control work and chemical laboratory. Speaking French and English. Location immaterial. Available at once. Apply to Box No. 1768-W.

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Advanced Practices in the Use of Automatic Oxy-Acetylene Cutting Machines

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Paper presented before the Hamilton Branch of The Engineering Institute of Canada, December 14th, 1937.

SUMMARY.—Flame cutting, particularly with the aid of automatic machines, has now become a most valuable workshop process. The paper gives guidance as to its limitations and possibilities, and information as to the technique needed for successful operation.

Oxy-acetylene cutting of ferrous metals is a process of preheating the material to be cut to its kindling or ignition temperature and rapidly oxidizing it by means of a closely regulated jet or stream of oxygen issued from a special tool called a cutting blowpipe or cutting torch.

In the case of plain carbon steel, the metal is preheated to a bright red colour in daylight, reached between 1,400 and 1,600 deg. F., approximately. Only the metal within the direct path of the oxygen jet is acted upon, to form a narrow cut or kerf, as it is usually called, having uniformly smooth and parallel walls. Under skilled workmanship, such as produced by mechanically-guided blowpipes, the tolerances of cutting as to squareness and longitudinal alignment of the cut surface may range from a few thousandths of an inch for the thin materials, 2 in. and under, with proportional tolerances for the thicker materials ranging to 26 in. in thickness under present practices. Thus, a very accurate and economical means of shaping steel products is provided.

The faces or walls of the cut, in the commonly used steels, are not injured by the cutting operation. On the contrary, their strength and toughness, if of plain low carbon steel, are slightly improved. The heat effect upon the metal induced by normal cutting operations penetrates about 1/10 in. below the cut surface. Oxy-acetylene preheating flames are used to heat the metal to kindling temperature. These usually surround the cutting jet of oxygen and vary in number and size with the composition and thickness of the metal and the condition of its surface.

Oxy-acetylene cutting is primarily a chemical process based on the remarkable chemical affinity of oxygen for ferrous metals when at and above kindling temperatures. When commercially pure oxygen is brought into contact with most steels or iron, at kindling point, a very active chemical reaction between them results. The commercial process, viz. controlled linear cutting, is obtained through close regulation of the gases supplied and the rate of progression of the cutting.

In addition to the chemical reaction, there is a noticeable and very helpful mechanical eroding effect produced by the kinetic energy of the cutting oxygen stream which washes away some of the metal in unconsumed or metallic form.

Chemistry of Oxy-Acetylene Cutting

Oxidation of Ferrous Metals—The iron oxide formed in oxy-acetylene cutting is black or magnetic iron oxide, identical in composition with hammer scale or magnetite ore. Its chemical formula is Fe_3O_4. It contains a smaller proportion of oxygen than rust or red iron oxide, Fe_2O_3. The complete chemical equation for the oxidation reaction in gas cutting is:

3 Fe	+ 2 O_2	=	Fe_3O_4
3 Mols*	+ 2 Mols	=	1 Mol + 26,691 calories.
Iron	Oxygen		Black Iron Oxide

From these data it can readily be determined that theoretically one cu. ft. oxygen will oxidize 0.217 lb. or 0.761 cu. in. of pure iron. However, as already mentioned, the iron removed from the kerf in actual gas cutting is not entirely consumed by the oxygen. Due to the eroding effect of the cutting oxygen stream, about 30 to 40 per cent of the metal is washed out of the cut as unconsumed or metallic iron.

In practice, therefore, one cu. ft. oxygen may actually remove one cu. in. of iron or more.

Assuming 65 per cent of the iron to be oxidized to magnetite (Fe_3O_4) the heat generated by the reaction in the cut will be 1,865 B.t.u. per lb., or 531.7 B.t.u. per cu. in. of metal removed from the kerf. This is at least twice as much heat as is supplied by the preheating flames of the oxy-acetylene blowpipe in ordinary light cutting, and the ratio increases rapidly with the thickness.

Theoretically again, the heat thus generated by the oxidation of the iron is more than ample to maintain the metal being cut at a kindling temperature. This is actually the case for certain classes of work. However, for machine cutting on commercial plate, the heat lost in the oxides and metal blown out of the kerf, by conductance into the adjacent metal, and by radiation, is such a large proportion of the total generated that preheating flames are essential in maintaining the cut as well as in starting it.

The function of acetylene in oxy-acetylene cutting is, of course, that of the fuel gas required to supply sufficient heat on combustion to bring the steel to its ignition point and to maintain sufficient heat to allow the cutting operation to be carried on continuously. Acetylene is unquestionably the most satisfactory fuel gas. Acetylene with oxygen gives the highest flame temperature, by a wide margin, of any known fuel gas. It requires a minimum of oxygen for complete combustion and its heating efficiency remains high at elevated temperatures.

Nozzle Design

Oxy-acetylene blowpipes utilize the Bunsen principle of premixing gases prior to combustion. This principle in

*A 'Mol' is a mass equal to the molecular weight in grams.

itself produces a much better and shorter flame than when fuel gases are simply allowed to flow out into the air and burn without premixing.

The cutting blowpipe nozzles of various manufacture show considerable variation depending on the type of service for which each is designed. Even for automatic machine cutting a varied selection of nozzles is available. The variations are essentially in the size, shape, number and grouping of the preheating orifices, as shown in Fig. 1.

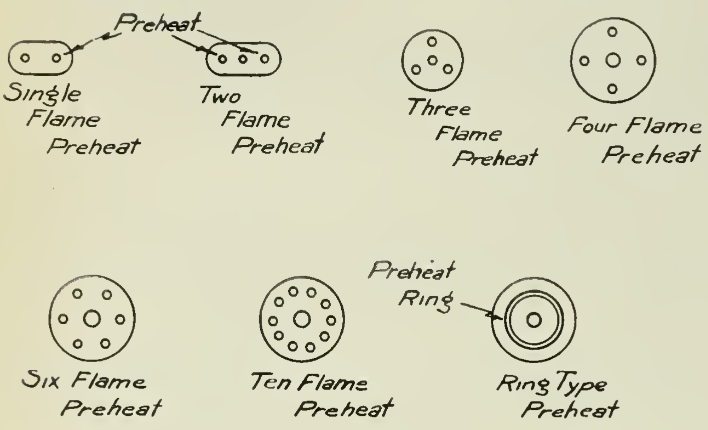

Fig. 1—Typical Grouping of Preheating Flames for Cutting Nozzles.

The simplest type of cutting nozzle has a single preheating flame ahead of the cutting oxygen orifice. This may be satisfactory for cutting thin material in one direction only. Other nozzles provide two preheating flames for two-directional cutting. The most common nozzle used in this country has four preheating flames equally spaced about the centre cutting orifice.

For intricate shape machine cutting, a cutting nozzle having a minimum of six preheating flames should be provided to give approximate uniform preheating in front of the cutting jet of oxygen no matter in which direction the blowpipe is travelling.

Effect of Flame Cutting on Steel

For some reason or other the flame-cut edge has at times been regarded with suspicion where certain further operations are to follow, such as mechanical caulking, holes in which tubes are to be rolled or rivets driven and where fusion welding is to be applied. It is doubtful whether there is any real reason for this suspicion which is believed to be due to an unfortunate use of terms wherein this process has been referred to as a "burning" operation. This may, perhaps, have led to the inference that the highly heated oxidation process has had some injurious effect upon the edges of the kerf, such as cracking, or that the structure of the steel adjacent to the kerf has been damaged.

It is well known that certain of the mechanical methods of severing metals have injurious effects upon the condition of the severed edges. Examples are shearing and friction sawing. Also, machining can, under conditions of heavy cuts and high cutting speeds, create effects that are akin to shearing. In such cases it has been customary to require that the damaged surface be removed by machining, chipping or grinding before supplementary operations are applied thereto, and it is undoubtedly this practice that has been carried over bodily into codes and specifications to apply to flame-cut surfaces.

There are, however, no data to show that a clean smooth flame-cut is detrimental for any of the above uses, as long as the steel contains less than 0.35 per cent of carbon and is of the non-alloy variety.

Comparison of Flame Cutting with Mechanical Methods

Numerous investigations have been made to determine the effect of the cutting flame on the physical properties of flame-cut surfaces of plain low carbon steel and sufficient data are on record to show that the effect is negligible. Neither tension tests of specimens with flame-cut edges nor bend test specimens with the flame-cut edge on the outer or stretched surface show materially different results from those having machined edges. In the case of the bend test specimen, the increased force necessary to bend and elongate the flame-cut surface indicates that the flame cutting has introduced a tough layer adjacent to the surface.

As compared to sheared surfaces or those resulting from friction sawing, the flame-cut edge has much to recommend it. Both the shear and friction saw inflict a certain amount of punishment on the surface of the metal. The shear tears the metal adjacent to the edge and causes more or less flow in the direction of the path of shear, and often results in the formation of incipient cracks. The friction saw causes a high degree of localized heating and always considerable flow of metal at the edge. The resulting hardening and deformation may be damaging to the surface for subsequent operations.

Recent tests of flame-cut edges of plain low carbon structural steel with regard to hardness, microstructure, resistance to impact and ductility, have shown that there need be little hesitation in using flame-cut surfaces for almost any type or character of mechanical treatment or service. With properly controlled technique the disturbance of the hardness and structure of plain low carbon structural steel plate is less severe in flame cutting than in either shearing or friction sawing and ductility, as determined by the cold-bend test, is less seriously affected by flame cutting than by either shearing or friction sawing.

This statement is based on recent investigations of this subject, particularly those of J. H. Zimmerman, of the Massachusetts Institute of Technology.* The appearance of the surfaces resulting from the various processes examined by Mr. Zimmerman is shown in Fig. 2, taken from one of his papers.

Preheating and Post Annealing

When higher carbon steels or alloy steels are flame-cut, troostite or even martensite may be produced. Steels having these structures may not be ductile enough to withstand the stresses set up. As the steel is heated, it expands, but it is restrained by the adjoining cold metal

Fig. 2—Appearance of Cut Surfaces Resulting from the Five Cutting Procedures Under Test (from Top to Bottom: Machined, Sheared, Friction Sawed, Hand-Torch Cut, and Machine-Flame Cut).

*See Mechanical Engineering July 1935, pp. 423-427, and June 1936, pp. 363-368.

and the action called "upsetting" results. Then when cooling down occurs, contraction of the upset metal may produce severe stresses, and in some cases the ductility near the cut edge will not be sufficient to prevent cracking. But it has been found by experience that, in general, if the high carbon or alloy steels are preheated to a temperature of the order of 500 to 600 deg. F., the cracking will not occur. The reason, of course, is that first the difference in expansion between the metal heated during cutting and the adjoining metal is less, with resulting great reduction in the stresses set up during the subsequent cooling, and second, since the difference in temperatures is less, the cooling goes on more slowly and the formation of the undesirable troostite and martensite is prevented.

These precautions in cutting apply to some of the newer structural steels such as the so-called structural silicon steels which have come into prominence in recent years. The several grades have a tendency toward air-hardening under the action of ordinary flame cutting practices and call for consideration of the recommendations given above.

Flame Softening

Due to the increasing general use of high strength structural steels just mentioned, the necessity arose for a rapid method of satisfactorily cutting with the oxy-acetylene process and at the same time maintaining the desirable physical properties at the cut edge. To this end a procedure called "flame softening" has recently been developed. Certain aspects of these processes of flame softening are covered by patents and patents pending; however, the processes are to be made available to the fabricating industry through reasonable licensing agreements.

Flame softening is a localized heat-treatment carried out after or simultaneously with the cutting operation. For certain types of work it is accomplished by mounting a bank of oxy-acetylene flames on the cutting machine either to precede or follow the cutting blowpipe.

A chart showing the effect of "flame softening" in connection with oxy-acetylene cutting of a number of different steels is given in Fig. 3, by permission of the Linde Air Products Co.

Warping

Whenever metal is heated it expands, the amount having a direct relation to the increase in temperature. If uniformly heated, the forces set up by the expansion are

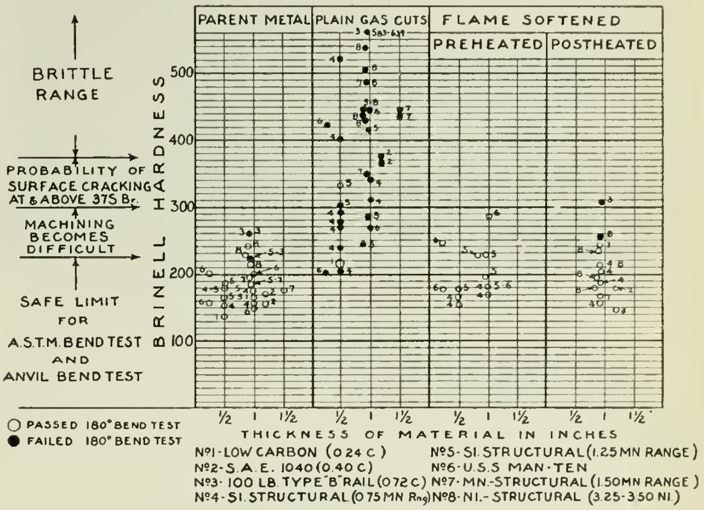

Fig. 3—Chart Showing Effect or "Flame Softening" in Flame Cutting Various Steels.

likewise uniform throughout the part, which, if lying flat or fully supported and free to expand or contract, will, after uniform cooling, resume its original state as to dimensions and alignment. If, however, a part is locally heated, there is likelihood of warpage of the part unless:

1. Its cross-sectional engineering properties are sufficient to resist the forces which such local heat sets up, or

Table I

Machine Flame Cutting Table for ⅛-In. to 20-In. Thickness for Mild Steel—Not Preheated—Type No. 1 Cutting Only‡

Thickness of steel, inches	Diameter of cutting orifice, inches	Oxygen pressure, lb. per sq. in.	Cutting speed, in. per min.†	Gas Consumptions* Per Hour Oxygen, cu. ft.	Gas Consumptions* Per Hour Acetylene cu. ft.	Gas Consumptions* Per Linear Foot† Oxygen, cu. ft.	Gas Consumptions* Per Linear Foot† Acetylene, cu. ft.
⅛	0.0250-0.0400	15- 23	22-32	40- 55	7- 9	0.34- 0.36	0.05- 0.06
¼	0.0310-0.0595	11- 35	20-28	45- 93	8-11	0.45- 0.66	0.08- 0.08
⅜	0.0310-0.0595	17- 40	19-26	82-115	9-12	0.86- 0.89	0.09- 0.09
½	0.0310-0.0595	20- 55	17-24	105-125	10-13	1.04- 1.24	0.11- 0.12
¾	0.0380-0.0595	24- 50	15-22	117-159	12-15	1.45- 1.56	0.14- 0.16
1	0.0465-0.0595	28- 55	14-19	130-174	13-16	1.83- 1.86	0.17- 0.19
1½	0.0670-0.0810	- 55	12-15	-240	14-18	3.20-	0.23- 0.24
2	0.0670-0.0810	22- 60	10-14	185-260	16-20	3.70- 3.72	0.29- 0.32
3	0.0810-0.0860	33- 50	8-11	240-332	18-23	6.00- 6.04	0.42- 0.45
4	0.0810-0.0860	42- 60	6.5- 9	293-384	21-26	8.53- 9.02	0.58- 0.65
5	0.0810-0.0860	53- 65	5.5- 7.5	347-411	23-29	10.97- 12.62	0.77- 0.84
6	0.0980-0.0995	45- 65	4.5- 6.5	400-490	26-32	15.10- 17.78	0.98- 1.16
8	0.0980-0.0995	60- 90	3.7- 4.9	505-625	31-39	25.52- 27.30	1.59- 1.68
10	0.0995-0.1100	75- 90	2.9- 4.0	610-750	37-45	37.50- 42.10	2.25- 2.55
12	0.0110-0.1200	69-105	2.4- 3.5	720-880	42-52	49.70- 60.00	2.97- 3.50
14	0.0110-0.1200	-105	2.0- 3.2	830-1045	48-59	65.20- 83.00	3.69- 4.80
16	0.1285-0.1600	-110	1.8- 3.0	935-1360	57-70	90.60-104.00	4.67- 6.33
18	0.1495-0.1600	-120	1.7- 3.0	1045-1680	65-83	112.10-123.00	5.53- 7.65
20	0.1610-0.2000	-135	1.5- 3.0	1155-2050	75-99	136.70-154.00	6.60-10.00

*As the pressure of acetylene for the preheating flames is more a function of blowpipe or torch design than of the thickness of the part being cut, the pressure data, therefore, have been omitted from this table. For acetylene pressure data, see cutting apparatus manufacturers' charts.

†Lowest speeds and highest gas consumptions per linear foot are for inexperienced operators, short cuts, dirty or poor material. Highest speeds and lowest gas consumptions per linear foot are for experienced operators, long cuts and clean and good material.

‡The apparent inconsistencies which will be noted in some of the columns in the table are due to the fact that there does not exist a straight-line relationship between the elements of pressure, speed and orifice sizes for the range of apparatus data from which this table was devised.

2. The part is fixed in position by clamps or weights during the cutting operation and the subsequent cooling of the part to room temperature, or
3. The cutting is performed simultaneously or in rapid succession about the neutral axis of the part, thus equalizing the forces about said axis, in turn, reducing their effect (physically) on the part to zero.

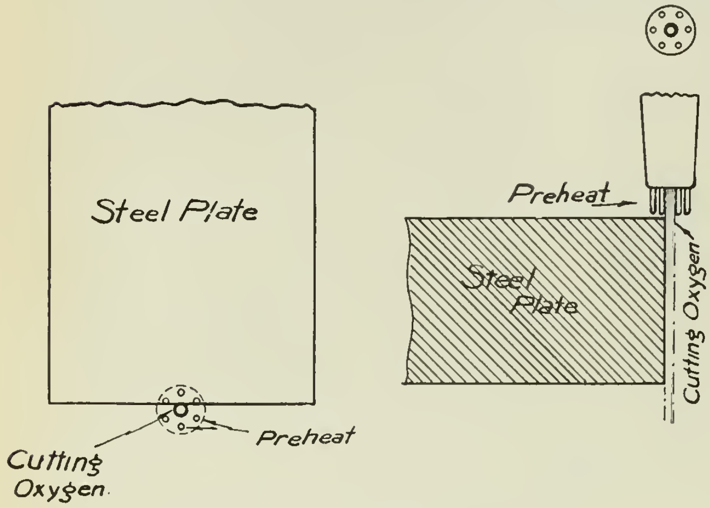

Fig. 4—Correct Starting Procedure.

Experience has shown that at and above ½ in. thickness there is little tendency for a part to warp if not unduly narrow. Many simple operations, such as cutting off rods or bars, structural shapes, rail, piping and similar lengthy materials, do not involve the matter of warpage.

In splitting narrow materials, such as flat bar stock and structural I-beams and channels, the practice of so-called "skip-cutting" has proved to be satisfactory to prevent warpage. In this method, the cut is made to skip at intervals depending upon the narrowness of the material, leaving a series of uncut sections along the line of cut, each about ½ in. to 1 in. long. These uncut ligaments hold the material in line until cooled, whereupon they are cut through to separate the parts.

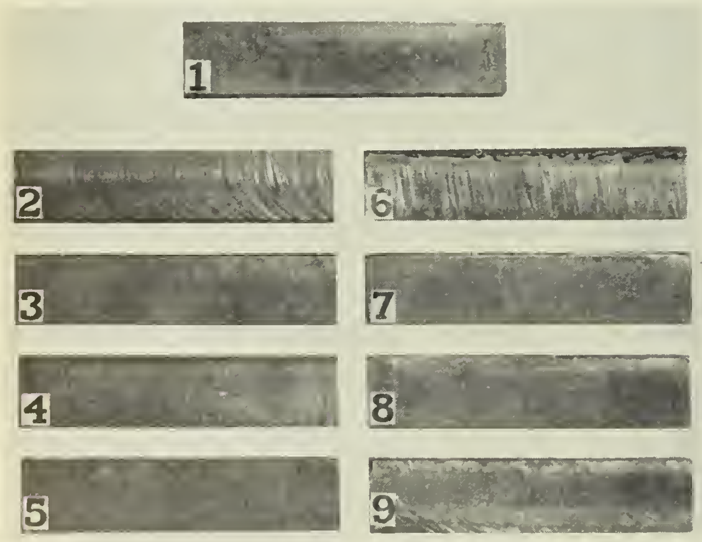

Fig. 5 Cut Surfaces Resulting from Correct and Incorrect Technique.

1. Effect of correct cutting technique. 2. Blowpipe advanced along line of cut too quickly. 3. Blowpipe advanced along line of cut too slowly. 4. Cutting oxygen pressure too high. 5. Cutting oxygen pressure too low. 6. Excessive preheat flames used. 7. Blowpipe nozzle adjusted too close to surface of plate. 8. Blowpipe nozzle adjusted too far from surface of plate. 9. Shows the effect of a dirty blowpipe nozzle cutting oxygen orifice.

In cases where great accuracy is demanded in the overall dimensions of the cut parts, account must be taken of the dimensional changes which are produced by the heat of cutting. The intense heat along the line of cut develops expansion immediately ahead and astern of the point of cutting (more particularly astern) and upon cooling to room temperature the surface will have shrunk slightly which will affect the overall dimensions unless a correction factor has been applied in making the cutting layout.

Cutting Technique

In automatic oxy-acetylene machine cutting the human element and other variable factors are greatly reduced as compared with cutting with a hand-operated blowpipe. However, the proper cutting speed, oxygen pressure, and nozzle size must be selected in accordance with the plate thickness being cut. For this purpose the equipment manufacturer's charts should be consulted. A typical example of such a pressure speed chart is shown on page 495, taken from a booklet "Oxy-Acetylene Cutting," published by the International Acetylene Association. Such charts give the proper cutting nozzle, gas pressures and cutting speeds for a given thickness of material. The gas consumption per hour or per linear foot of cutting is often included. The only remaining factors affecting the quality of the cut obtained are the mechanical condition of the cutting equipment, the adjustment of the preheating flames, and the technique used to start the cut. This latter item is quite important. The correct starting procedure is shown in Fig. 4.

The quality and accuracy of the work is largely dependent on correct adjustment of pressures and speeds, and on the proper technique as regards the preheating flame or flames. This is illustrated in Fig. 5, showing the cut surfaces resulting from various incorrect practices (samples 2 to 9) as compared with the result of correct technique (in sample 1).

Oxy-Acetylene Cutting Machines

From crude beginnings, oxy-acetylene cutting machines have been improved to the point where they are now comparable with machine tools. 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 usual purposes little or no finishing is required. Oxy-acetylene cutting machines now available include manual or motor-driven, partly or almost fully automatic, portable or stationary, having various capacities suitable for practically all classes of work of almost any size or thickness.

Some machines are equipped with two, or as many as six cutting blowpipes, centrally controlled and guided, and will flame-cut a like number of identical shapes simultaneously, thereby effecting marked economies where high production rates are essential. Still other types of machines crawl around pipes, making one or two square or bevelled cuts as desired. Nearly every conceivable requirement is covered by the wide assortment of machines now manufactured.

Special Machine Flame Cutting

In addition to the types of machine flame cutting already discussed, there exists quite a wide field of special applications for the process. This field includes cutting of pieces which are not flat, cutting in different planes or at different levels and angles on the same piece, cutting sections of variable thickness and similar work. For example, digester shell plates are dished and formed like orange peelings, although of uniform thickness. They may be machine flame-cut or trimmed to size, with bevelled edges for caulking where desired, very satisfactorily and economically. Severing of I-beams and other structural shapes or rails requires positioning of the blowpipe to cut at different heights and angles.

Stack Flame Cutting

In addition to cuts made through single thickness of material, flame cutting is utilized in some cases for cutting through several thicknesses simultaneously. This operation is known as "stack flame cutting." While this is a relatively new development and therefore not widely applied as yet, it may be utilized with success and economy under certain conditions of material, thickness, quality of cut, tolerances and cost of setting up the work. The plates in the stack should be clean and flat, with edges in alignment where the cut is started. Their number should vary with thickness of individual plates, to keep stack thickness constant. They should be clamped together as nearly as possible along the line of cut. In stack flame cutting very thin plates, a "waster plate" having sufficient rigidity to lie flat while the cut is being made, is usually clamped on to prevent the top thin plate from buckling. It serves also to maintain ignition in the cut by its own combustion, thereby facilitating the speed of cutting in this kind of work.

Precision Machine Cutting

The degree of precision attained in modern precision machine flame cutting practices is within several thousandths of an inch in material up to 2 in. thickness; that is, the cut surfaces are true as to cross-sectional squareness to

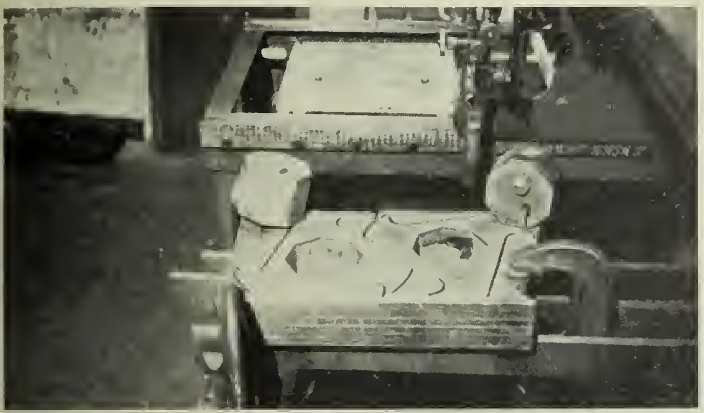

Fig. 6—Close-up Showing Templet and Stack of Plate with two Sets of Parts Completely Cut.

within this amount. Longitudinally, the degree of precision depends upon the trueness of the guide rails of the cutting machine, the clearance of operating mechanism and the regularity of the propelling unit, similarly as with machine tools. The more recent straight line and shape cutting machines are constructed so as to maintain very close traverse alignment; however, much depends upon the sensitivity of the tracing mechanism, which, if not carefully adjusted as to grip and speed, will defeat the precision of the cutting machines beyond this point. With regular forward movement of the torch and with proper preheating, there may be obtained precision tolerances in plain carbon steel ranging from 3/1000 of an inch for material 1 in. thick to 3/100 for material 6 in. thick. Such close tolerances however are not always commercially obtainable.

Applications of Automatic Cutting

The automatic oxy-acetylene cutting process is extensively used in steel mills and steel jobbing warehouses for

Fig. 7—Completed Stack of Circles Showing High Quality of Cut, on Strip Material.

the cutting of steel plate and structural shapes to size. In numerous industries it is used for the fabrication of machine bases and frames from assemblies of flame-cut steel plates and shapes.

This process of fabrication is also particularly suitable for all manner of jigs and fixtures. The construction time is reduced and the materials may be used repeatedly where alterations or completely new fixtures replace old ones.

In other industries the process is used for the rapid fabrication of innumerable small tool parts such as cams, lever arms, sprockets, etc. In this field parts may be cut in three different planes, eliminating or reducing machining to a minimum.

Stripper, trimmer, moulding and backing-up dies are cut on automatic machines in a fraction of the time formerly required to shape by ordinary machining methods.

Some typical examples of finished work, showing what can be accomplished by machine flame cutting, are given in Figs. 6 and 7. It would be impossible to list all the many and varied applications of automatic cutting, since they embrace almost every industry. Wherever plain carbon and low alloy steels are to be cut accurately to size, automatic oxy-acetylene cutting may well be considered for it combines accuracy, speed and economy, probably the three essentials in modern industry.

References

1. "Oxy-Acetylene Cutting," from the 1937 Report of The Oxy-Acetylene Committee of the International Acetylene Association, 30 East 42nd St. New York City.

2. "Cutting and Tempering of Structural Steels," paper by H. H. Moss, presented to the International Acetylene Association November 10, 1937.

3. "Flame Cutting Steel Plate," by J. H. Zimmerman, Massachusetts Institute of Technology, Mechanical Engineering, June 1936, p. 363.

4. "Cutting Structural Steel," by J. H. Zimmerman, Massachusetts Institute of Technology, Mechanical Engineering, July 1935, p. 423-7.

5. "Working Data on the Cutting of Steel by the Oxygen Jet," by N. Daniel, B.Sc., A.I.C., and C. E. Durant, A.M.I.P.E. Paper presented at a meeting of the Institute of Welding, London, England, February 10, 1937. Welding Industry, February 1937 issue.

6. "Cutting with Oxygen," by Dr. Adolf Krebs and Carlos Krebs.

The Measurement of Canada's Water Resources

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It is safe to say that to most people water, as a provision of nature, is as commonly taken for granted as the air they breathe. They fail to appreciate that, unlike air which is universal, *water is a resource* which is available in ever varying quantities. Actually, it is the most vital of all natural resources. Without water there is desert and life is impossible.

The primary source of the water supply is precipitation occurring in the form of rain and snow. Its benefit to any country depends upon its volume and upon its seasonal and territorial distribution. This all-governing precipitation is not subject to any human control. Nevertheless man has to act interminably in order that he may on the one hand enjoy this natural resource and on the other prevent it from doing harm.

Rain is partly dissipated by evaporation, is absorbed and used to promote plant growth, is absorbed in the ground to maintain groundwater supplies which may later be made use of from springs or wells, or flows off to enter the creeks and rivers and maintain what is known as surface run-off.

It is this surface run-off which is available for measurement, regulation, control, and conservation, in order that, as a resource, it may be harnessed for effective service to mankind to provide navigation, power, irrigation, and water supply generally, and in order that its capacity for doing damage may be minimized by the construction of culverts, bridges, flood protection works, and drainage projects.

As already stated water as a resource has largely been taken for granted. It is only when there is a deficiency, as in recent years in the drought areas of Canada and the United States, that the complete dependence of mankind upon its water supply is widely appreciated; or when there is an excess as instanced by disastrous floods such as occurred in 1937 on the Mississippi and Ohio rivers in the United States, that the almost immeasurable possibilities of destruction by water, arising from uncontrolled stream flow, are nationally realized.

Canada has been particularly blessed by Providence in her water resources. Consider only the power phase. *Power* is the basic tool of modern industry. *Low-cost* power is the key to industrial supremacy. *Water-power* is Canada's basic power tool. A few startling facts may be mentioned. Ninety-eight per cent of all the power developed for sale in Canada is hydro power and it represents a capital investment of $1,600,000,000 in its development and distribution—the largest single industry of the Dominion.

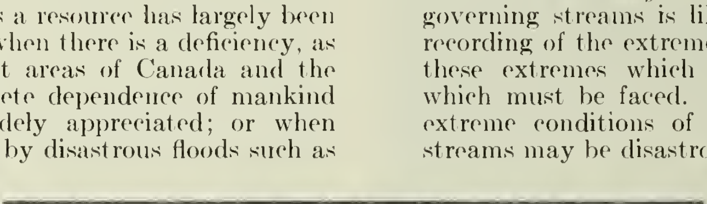

Fig. 1—Birchbank Cable Station, June 25, 1937. Water Elevation 1370.33.

Much has been written and spoken of Canada's lakes and rivers, of her navigable waterways, and of her immense water-power resources. Few have considered what lies behind the regulation, the control and the conservation of this resource to ensure its effective utilization in the service of the public.

The natural resources of land, forest, and mine are carefully measured, appraised and recorded in our national balance sheet. Our water resources are similarly measured by stream flow and water level records. Unfortunately the flow of streams is as variable as the precipitation which produces it. It varies from day to day, from month to month, from season to season, from year to year, and from cycle to cycle. In Canada, also, the winter accumulations of snow and ice interject further complications in the records. There are, furthermore, changing natural conditions of flow resultant from drainage of surface and subsurface waters, from deforestation and from agricultural development. A dependable record and knowledge of our water resources therefore necessarily involves much more than intermittent or casual measurement. Basic principles govern:—

Records of flow *over a long period* of time are essential to a thoroughly reliable appraisement of our surface water supply and of all that is dependent thereon. Data covering one or two years are useful but entirely inconclusive. If the period is one of twenty years or upwards the data are of proportionately greater value and, by allowing reasonable factors of safety, works can be constructed with the expectation that they will be adequate for the purposes for which they are designed. Longer term records are of the utmost value and lead to economy in that the factors of safety required can be more closely approximated.

The *continuity* of records in representative or governing streams is likewise essential to ensure the recording of the extremes of high and low flow as it is these extremes which constitute critical conditions which must be faced. Failure to secure a record of extreme conditions of high or of low flow in such streams may be disastrous.

A further basic factor underlying the analysis and appraisement of our water resources is the necessity of planning the measurements and studies upon *watershed* bases. Surface run-off is essentially a watershed resource, governed by the topographical conditions prescribed by nature rather than by artificial geographical boundaries. The interrelationship of the main stream and the tributaries, and the relationship of the natural and artificial reservoir sites to hydro power, navigation, or irrigation possibilities, or to possible locations of regulation or control, all enter into the planning of the measurement stations.

In a country of the wide extent of Canada *co-operation* among many interests and jurisdictions to ensure the maximum availability, conservation, and utilization of this resource is essential.

In Canada, the systematic measurement of stream flow was only commenced about thirty years ago. The Dominion Government's activities in hydrometric work were first undertaken in areas where deficient rainfall rendered irrigation necessary and where, in the interests of administration, it became essential to determine the amount of water in these areas available for this purpose. A short time later the question of water available for the production of hydro-electric power became active and hydrometric

Fig. 2—Birchbank Gauge House, Looking Upstream, June 25, 1937.

work was extended. In due course the value of systematic, reliable and uniform stream flow data became apparent to all administrators both Federal and Provincial with the result that a Hydrometric Service, Dominion wide in its scope, was established and is still maintained under the Department of Mines and Resources of the Federal Government. This service is maintained in close co-operation with the Provinces and with many municipal and corporate bodies concerned with water utilization. Six district offices are located in the major drainages of the Dominion, measurements are made of the various rivers and continuous water level records secured. These are assembled, compiled and published biennially, on a watershed basis, and are thus readily available to all interested in water questions.

At the present time there are about 570 gauging stations in Canada established upon rivers and lakes of importance in connection with international, navigation, water-power and water-supply or water-control problems generally. There are other stations (about 1,800 in number) at which records have been secured for a certain length of time but which have been discontinued. A considerable number of these were on small irrigation streams or irrigation ditches where the information secured was sufficient for the purpose required. In addition to these, a large number of miscellaneous measurements have been secured on remote streams which are visited by engineers for the purpose of investigation but where observations could not be maintained due to the absence of suitable observers.

Co-operative agreements with the Provinces ensure the entire absence of duplication of effort or expenditure as between the Dominion and the Provinces.

They provide for:—

(*a*) The complete standardization from coast to coast—
of methods of measurements;
of computation and analysis of water resource records;
of methods of water and water power study; and
of publication of run-off records and of water power resources data—all upon a uniform, dependable, watershed basis.

(*b*) The making of these data available—
to Dominion, Provincial and Municipal administrative officers; and
to all public and private bodies who are interested in water administration or utilization for purposes of the development of power, navigation, drainage, irrigation and for water supply projects and undertakings generally.

It is of interest to note that the National Resources Committee of the United States published a report in September 1936, prepared by a special Committee dealing with hydrological data and the deficiencies therein. This report contains many arresting statements which cannot be extensively quoted herein. A number of instances are given of losses in the United States running into many millions of dollars which would have been avoided if adequate stream-flow data had been available, and, in urging a programme for the correction of glaring deficiencies in knowledge of water resources, the report states:—"There is every reason to suppose that these small expenditures, systematically and scientifically made, would save the country many millions of dollars and perhaps many human lives during the coming generation."

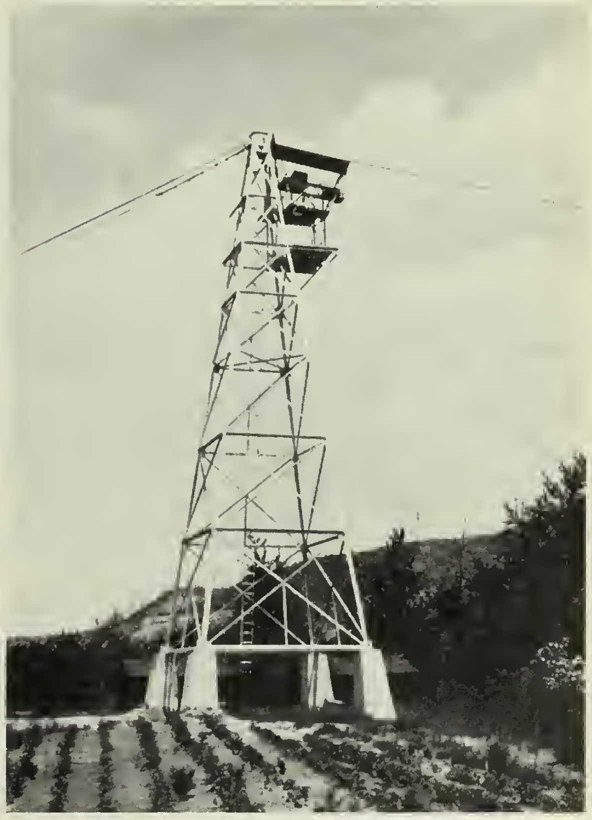

Fig. 3—Birchbank Tower, Right Bank, June 25, 1937.

Canada's water supply constitutes one of her greatest natural resources, in some respects her greatest. It is only with definite knowledge as to its volume, distribution, availability and usability that a full measure of regulation and control can be exercised, and its full weight applied to the development of her resources of land, mine, and forest, and the full value of these resources realized.

Safety in Industry

With Particular Reference to Ontario

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Paper presented before the Niagara Peninsula Branch of The Engineering Institute of Canada, at Niagara Falls, November 9th, 1937.

Accident prevention is like everything else, effort must be put forth if reasonable results are to be obtained. It has been said that the Safety movement is tied up in "the three E's"—Engineering, Education and Enforcement. Rules and regulations are of no use unless there is enforcement; for example, much of the problem of traffic control is tied up with that word "enforcement." If you have a community where the police force is not supported by public opinion, there is little encouragement for its members to carry out arrests or to endeavour to bring offenders to book. Enforcement is vital.

Safety education is a broad general term that may include instruction in safe work methods, it may include all that goes under the term "supervision"; it may take in good plant housekeeping, provision for first aid and so on. The basic idea of the middle of these three E's is good, it is necessary and it will produce worthwhile results.

Before dealing with the first of the three E's, Engineering, it is desirable to note the way in which the matter of Workmen's Compensation has been handled in Ontario.

Ontario's Law

The late Sir William Ralph Meredith, Chief Justice of Ontario, was appointed by the Government to make a report on the laws relating to the liability of employers. His report resulted in the Workmen's Compensation Act of the province, which became effective on the first of January, 1915, and has served as a model for all compensation laws in Canada. Such acts are now in effect in all provinces except Prince Edward Island. They have relieved industry of litigation in dealing with accidents to employees and have made for promptness and certainty of payment to injured workers without unduly burdening the employer.

Compensation Benefits

Under the Ontario Act compensation is paid for accidents and specified industrial diseases arising out of, and in the course of, employment, except only when the disability lasts less than seven days or where the accident is attributable solely to the serious and wilful misconduct of the worker; even this latter circumstance is not considered when the accident results in death or serious disablement. In death cases the widow, if any, receives a payment of $40 a month for life or until re-marriage, and there is an allowance of $10 per month for each child under sixteen; the total paid, however, not to exceed two-thirds of the average earnings of the worker. In non-fatal cases the injured worker is entitled under the Act to two-thirds of his average earnings up to $2,000 per annum. If the injury is a permanent disability, compensation is paid in the form of a pension, the Pension Fund being referred to sometimes as a reserve fund, and the claim is made that the Workmen's Compensation Board has built up a large reserve fund of millions of dollars. The Pension Fund is a fund to take care of pensions that have been awarded for accidents that have already happened and is in no sense a reserve fund.

Particular attention is called to the fact that The Workmen's Compensation Board pays for accidents arising out of and in the course of employment. Periodically accidents are reported to the Board and in certain cases the information submitted discloses the fact that the accident was really not due to the injured man carrying out some duty or function in connection with his employment. Such cases are extremely difficult to deal with, because, of necessity, there must be sympathy for the man who has suffered a serious injury. On the other hand, it must always be remembered that The Workmen's Compensation Board is administering an Act and must be guided by that Act.

Medical Aid and Hospital Services

Under the Workmen's Compensation Act, medical aid and hospital services are absolutely unlimited. The Workmen's Compensation Board provides that employer and employee have an equal right in the selection of a doctor and that if the employer and employee cannot agree on the medical man, the Board will appoint one to look after the injury. Too much care cannot be exercised in the selection of a competent medical man to handle compensation cases. The average employer wants to be quite certain that the injured man is receiving all possible care and that he will be returned to work as soon as fit.

Employers in Schedule 1, which includes approximately 22,000 firms under compensation, pay on the collective basis, while employers in Schedule 2, which includes the steam and electric railways, municipalities, school boards, telephone and telegraph companies, etc., as well as Crown cases, pay on an individual basis. (This applies also in the Province of Quebec.) That is to say, if an employee of a telephone company is injured and the total cost of that accident is $5,000, the telephone company employing the man pays that amount to the Compensation Board, plus administration expenses.

The Workmen's Compensation Board provides the employer with certain forms whereupon to report accidents that may happen. The employer gives certain information, such as the name and address of the worker, his age, his allegiance, whether he speaks English or not, and then a brief description of how the accident happened, including date, time, place and the nature of the injury. Similar reports are received from the injured worker, or his dependents, and from the medical man handling the case. It will readily be seen that if the report of the employer, the injured worker and the doctor all agree, there is comparatively little reason for the Compensation Board conducting any further investigation.

Accident Prevention Work

When the Workmen's Compensation Act was being framed, employers asked that they be given some authority to carry on accident prevention work patterned in part on the German plan. It is under Section 114 of the Workmen's Compensation Act that the Industrial Accident Prevention Associations are set up and function. The funds for the operation of the various accident prevention associations are supplied by the Workmen's Compensation Board under the authority of that Section of the Act and are charged against the accident fund of the class; it being generally understood that it is better and cheaper to prevent accidents than to compensate for them.

Accidents

Injuries are usually the result of what we term "accidents." These accidents result from (*a*) inadequate safe practices, (*b*) improper training, (*c*) poor supervision or (*d*) improperly guarded machines and equipment. There have been 58,225 accidents reported to the 31st of October, in 1937, including 301 fatal cases. These represent a great loss to the community and much suffering to injured workers or their dependents. The work of the Industrial Accident Prevention Associations is an effort, on the part of industry, through the authority given in the Workmen's Compensation Act, to cut down these losses, and to reduce this cost. The organization consists of most of the manufacturing classes, and represents something over two-thirds of the total payroll in Schedule 1, under the Act, or, approximately $290,000,000 of payroll. The Directors are representative of the various classes of industry included in the membership, and are elected each year at the Annual Meeting. The Annual Meeting in 1937 was held in Toronto, and during the two days of the Safety Convention held at that time, there was a total registration of 1,800 persons from more than 100 towns and cities.

Roughly, the work of the organization is divided into three phases; first, the inspection services; second, the distribution of safety literature and other material, and last, the general services which include the dissemination of certain forms of information, together with the cost ratio cards received from The Workmen's Compensation Board.

Getting Results

Speaking at a Safety Convention of the Industrial Accident Prevention Associations, Sir Edward Beatty, President of the C.P.R., said:—"In summing up the results of our experience, I think it can be said that the most effective measures, for accident prevention in shops, are the careful supervision of shop practices, the education of the men in the principles of safety, and the responsibility of the immediate officer in charge, for the efficiency of the men under him."

The representative of another large employing group, Mr. H. G. Hilton, Vice-President and Works Manager of the Steel Company of Canada Limited, at Hamilton, said:—"Whatever measure of success we have achieved in accident prevention has been due to the policy of holding superintendents and foremen responsible for safety just as they are held responsible for quality, costs and other routine operations and impressing upon them the fact that a poor accident record will reflect unfavourably upon them just as the case would be if their quality or costs should be unsatisfactory."

Back of the ideas expressed by Beatty and Hilton must, of course, be certain engineering principles, and the following is a quotation from an address by Dr. L. W. Chaney, of the Bureau of Labour Statistics at Washington, in which he dealt with engineering revision: "The foregoing analysis proves quite conclusively that (1) Education and the development of interest among the men will come near to eliminating minor injury. (2) Adequate 'engineering revision' will reduce serious injuries to an as yet undetermined degree. The degree of such reduction is largely conditioned on what shall be regarded as 'adequate.' It is certainly possible to imagine structures and apparatus so strong, so well designed, so intelligently operated, that failure and consequent death will be the rare exception. The possibilities of improvement from an engineering standpoint are almost limitless."

Dr. Chaney's analysis was tied in with the experience of certain of the large iron and steel industries, and it is interesting, for example, to note that under his heading of "Death and Major Mutilation," out of 68 cases, it was calculated that 39 were preventable by engineering revision, 10 by care of the worker and 19 were classed as a trade risk, giving 57 per cent of the fatalities and major injuries as preventable by engineering revision.

Engineers and Industrial Hazards

If the engineer has been rightly described as "the pathfinder of civilization," and as one who "reduces effort, eliminates waste and increases production," it would seem that every engineer should take a practical interest in accident prevention and, at the same time, do something about it in the sphere in which his activities are cast, whether that be civil, electrical, mechanical, or any other type of engineering. Chaney said "The possibilities of improvement from an engineering standpoint are almost limitless." The problem, therefore, becomes largely one for engineering thought and action. All mechanical and physical hazards should be adequately and substantially guarded. Adequate ventilation should be provided, special emphasis being laid on this phase in the dusty industries, and adequate lighting should be available. These matters involve engineering questions to which every engineer can devote a certain amount of attention. The engineer in an industry who takes an intelligent interest in his accident prevention problems must, among other things, become a human engineer, because employees should be assigned to jobs for which they are temperamentally and physically suited and a periodic check of their work and their work practices should be made to see that the job is done in a safe and satisfactory manner. The engineer can make a systematic check of records to determine whether any department or any individual is showing a high frequency rate, and steps then can be taken to adjust such conditions when found. Periodic check over of tools, equipment and plant lay-out becomes an engineering problem, particularly when the elimination of hazardous conditions is included.

Dust offers a serious hazard in certain lines of industry. All dusts are harmful when taken into the human system in quantity, and some dusts are dangerous through the probability of development of industrial diseases such as silicosis and pneumoconiosis. A clean plant is not a dusty plant and the place to trap dust is at the source. The use of respirators and masks may be necessary in some lines of work but regardless of everything else, every effort should be made to keep the dust out of the air. Ventilation and exhaust systems should be installed under the direction of a competent engineer, as they require work of a type that does not fall within the province of a tinsmith or an ordinary mechanic.

Danger Signals

The following points should be looked into by those who investigate accident causes:—

1. Lack of physical and mechanical safeguards.
2. Slack supervision.
3. Insufficient first aid.
4. High accident frequency.
5. Too many medical aid cases.
6. Too many doctors.
7. Compensation awards in excess of assessments levied by the Compensation Board.
8. Medical aid costs too high in relation to awards.
9. Lack of compensation cost and accident records.
10. Accident reports to the Compensation Board signed by a junior clerk.
11. Failure to follow up cases after the injury.
12. The plant manager who does not know what awards have been made for injuries to his people, but who says "the Company has paid the Board plenty," and who really knows nothing about it.

The Workmen's Compensation Act has been a model for all the other provinces. It has insured prompt and certain payment to the injured worker and has not laid an unfair burden on industry. In the 22 years, 1915 to 1936, inclusive, the total benefits awarded by the Workmen's Compensation Board amounted to $116,136,634.61, while the total number of accidents reported to the Board in the same 22 years was 1,182,741, including 8,492 death cases. This made an average of $98.19 per case reported in the twenty-two years.

Safeguarding Machinery

The first requisite for a machine ever since man first began to make them was that it should turn out the work a little quicker, easier, and cheaper than could be done by hand. The designer of the machine probably had these points in mind but the safety of the operator was a subsequent development brought about by two things in industry, namely, the demand for workmen's compensation, and ordinary humanity. Engineers, therefore, have a responsibility to design tools with a wide factor of safety for the protection of the operator, as it has been shown that properly guarded equipment will make production easier, cheaper and quicker.

Summary

It should always be remembered that the Workmen's Compensation Act in Ontario gives protection not only to the worker and to the employer, but to the public as well. For this reason, the Act itself should have the support of all thinking citizens. The organized effort for accident prevention in Ontario has already been mentioned. The work of our Industrial Accident Prevention Associations needs the complete co-operation of engineers, for our Field Force and for our services in those industries included in our membership. Engineers have a responsibility and an opportunity that is not given to the average man in industry. On behalf, therefore, of those who will benefit by the engineer's knowledge, experience and ability, your co-operation is asked in accident prevention work inside your own organization, remembering that accidents are not prevented by meetings and discussions unless someone does something about it subsequently. Huxley said "The great end of life is not knowledge but action." It does no good to hear about accident prevention work and organization—unless each of us does something about it afterwards.

A Brief Study and Comparison of Crushed Rock and River Gravel Aggregates at Edmonton, Alberta

H. R. Webb, M.E.I.C., E. H. Davis, S.E.I.C.,† and G. Ross, S.E.I.C.†.*

The district immediately surrounding Edmonton is poorly supplied with natural deposits of sand and gravel of suitable characteristics for concrete. Most of the deposits which are found have certain local properties which render them questionable. As a result there have been developed certain sources of supply and certain methods of technique in preparing suitable final aggregates.

Practically all of the concrete for important jobs is now supplied by a central mixing plant. Up until recently general contractors on jobs of any size set up their own plant, and made their own concrete, but they now find the aggregate situation so uncertain that they have to turn to the above-mentioned organization for coarse aggregate or concrete, with the natural result that they usually buy concrete.

The local central mixing plant is making the best of a rather difficult situation in regard to coarse aggregate. The one large gravel pit of reasonably suitable material is located some forty to fifty miles west of Edmonton and has not been in active operation since the early years of the depression, so the two sources of rock most easily available have been developed as construction has picked up. These two sources are:

(*a*) field stones from the surrounding area, and
(*b*) river gravel from the North Saskatchewan river.

The field stones are brought in by truck from all directions, and the haulage distance is now about twenty miles. This distance is, of course, increasing steadily with time. A stock pile of several thousand cubic yards of these stones is kept on hand. The material in the stones is largely quartzite and dolomite. They average about nine inches in diameter. (See Fig. 1.)

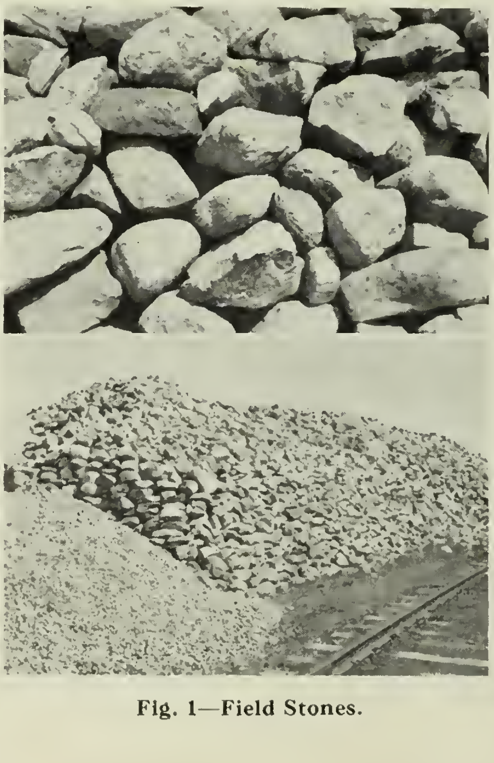

Fig. 1—Field Stones.

The gravel from the river is a well-graded material with very smooth rounded particles. It is removed from the river by bucket and cable, and is then washed and separated into two sizes by a one inch screen. Both of the fractions contain undesirable elements. In the larger size there are lumps of shoft shale, brown pieces of hard clay and some coal. These are picked out by hand by boys placed along the belt conveying the material to the loading hopper. The fraction passing the one inch screen contains considerable coal, most of which lies between the quarter inch and half inch screens. The company's engineer has devised an effective washing system whereby separation of the coal takes place due to its lower specific gravity, and the remaining gravel is then transported to the same hopper. All material from the river below the quarter inch screen is wasted.

For the final concrete aggregate both of the above materials are put through a gyratory crusher. The field stones yield crushed rock with almost no smooth surface or rounded shape. The river gravel contains few stones larger than 1½ in. in dia. so it passes through the crusher almost unchanged. Stones and river gravel are put through the crusher simultaneously, then it passes to screens which separate the product into three sizes, below ¼ in., ¼ in. to 1 in. and 1 in. to 1½ in. The final aggregate then

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contains both crushed material and round gravel. Plain river gravel is also stored separately in a bin feeding to the batching equipment. Concrete is mixed in 1½ cu. yd. batches and in weighing the materials several hundred pounds of river gravel is put into each batch with the crushed mixture in order to smooth up the mix and save on mixing water. Crushed aggregates with some round gravel present are shown in Fig. 2, ¼ in. to 1 in. in Fig. 2a and 1 in. to 1½ in. in Fig. 2b.

Outline of Investigation

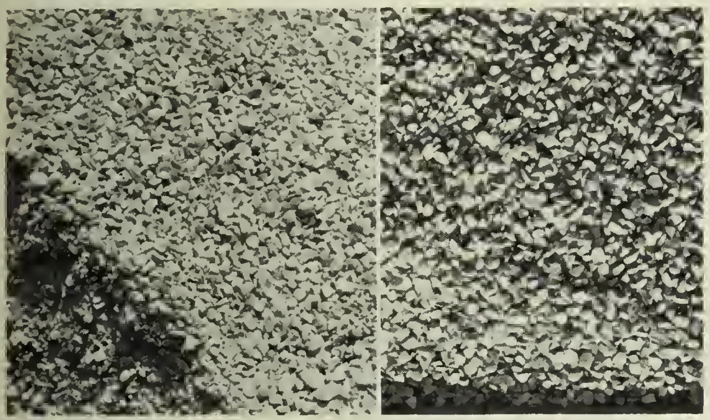
In order to obtain information on the effects of variations in the proportion of river gravel and crushed field stones in the aggregate, a small investigation was planned as a laboratory problem for the two last named writers.

Table 1 shows the combinations of aggregates and water-cement ratios selected.

One consistency, that to give a medium slump of 3 to 4 inches and a flow of about 170 to 180 per cent on a flow table using a 6¾ in. by 10 in. truncated cone mould 5 in. high with twenty drops of ½ in. in 30 seconds, was also adopted.

One cylinder was mixed at a time, placed in a 6 in. by 12 in. waxed paper form and rodded according to standard procedure. After 48 hours the form was removed and the cylinder stored in water at 65 deg. F. until tested. All cylinders were tested at 28 days.

For testing, each cylinder was capped on both ends with plaster of paris and machined steel plates, and after one hour was tested under standard conditions.



a b

Fig. 2—Crushed Aggregate with Some Round Gravel Present.

Table I

Test Cylinder Outline

R.G. = River gravel. C.R. = Crushed rock.

Coarse Aggregate	Water-cement ratio by volume				Total
	0.70	0.85	1.00	1.15	
100% River Gravel	4 cyl.	4 cyl.	4 cyl.	4 cyl.	16 cyl
80% R.G. 20% C.R.	4 cyl.	4 cyl	4 cyl.	4 cyl.	16 cyl.
60% R.G. 40% C.R.	4 cyl.	4 cyl.	4 cyl.	4 cyl.	16 cyl.
40% R.G. 60% C.R.	4 cyl.	4 cyl.	4 cyl.	4 cyl.	16 cyl.
20% R.G. 80% C.R.	4 cyl.	4 cyl.	4 cyl.	4 cyl.	16 cyl.
100% Crushed Rock	4 cyl.	4 cyl.	4 cyl.	4 cyl.	16 cyl.
Total	24 cyl.	24 cyl.	24 cyl.	24 cyl.	96 cyl.

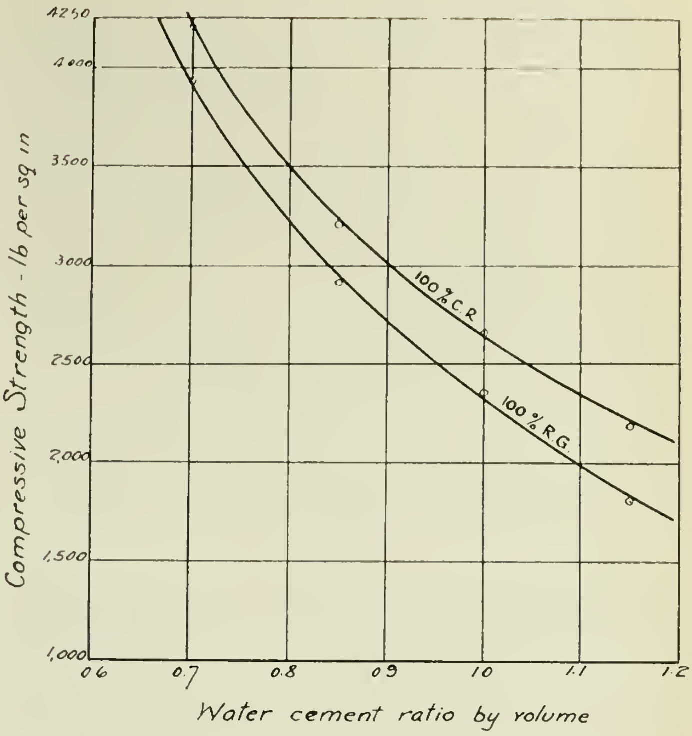


Fig. 3.

The mixes in the top half of Table I were carried out by operator "A," those in the lower half by operator "B." Every attempt was made to keep identical technique throughout.

The properties of the materials used are tabulated in Table II.

Table II

Aggregate Characteristics

		Sand	River Gravel	Crushed Rock
Apparent specific gravity		2.63	2.60	2.63
Unit weight, lb. cu. ft		110.	102.	99.
Per cent voids		33.1	37.0	39.6
Surface moisture		0	0	0
Absorption (lab.)			0.57%	1.33%
Absorption (field)			0.43%	0.89%
Colorimetric test		Dark brown		
	Sieve	Per cent Retained, Cumulative		
		Sand	R. G.	C. R.
Sieve analysis	1½″	0.	0.	0.
	¾″	0.	42.3	42.3
	⅜″	0.6	90.4	90.4
	No. 4	3.2	100.	100.
	" 8	11.4	100.	100.
	" 16	21.2	100.	100.
	" 30	51.3	100.	100.
	" 50	92.5	100.	100.
	" 100	98.0	100.	100.

The sand used in these tests is known locally as "Northern Sand," and occurs in a large deposit about sixty miles north of Edmonton. The sand has a decided rusty colour and contains fine soft coal which greatly affects the colour test. The colorimetric test for this sand runs all the way from a deep straw colour through cherry red to very dark brown.*

Cement conformed to standard specifications and sufficient was obtained to complete the tests.

*Effect of Finely Divided Lignite Coal on the Strength of Concrete, I. F. Morrison and H. R. Webb, M.E.I.C., A.S.T.M. Proc., Vol. 24, p. 841.

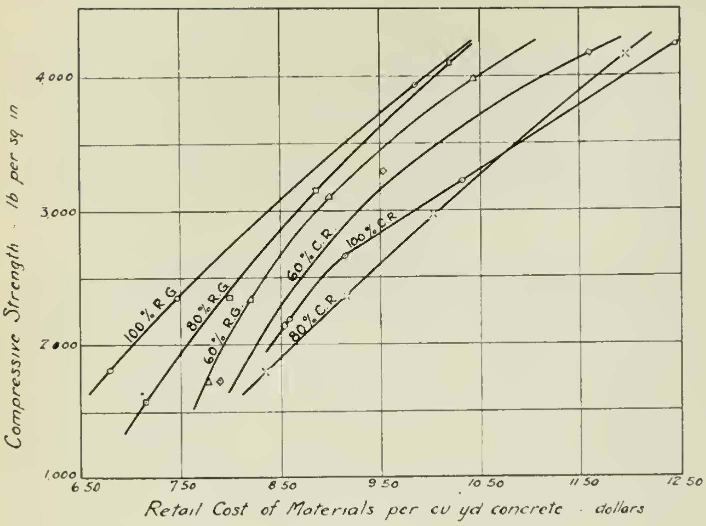


Fig. 4.

The river gravel and crushed rock samples were almost identical in grading, and in order to eliminate grading as a variable the selected grading was taken between the two, and all materials were screened and recombined to the grading shown. In these mixes the crushed rock was hand picked, all round particles being excluded.

Results

(a) Water-cement Ratio and Compressive Strength Relation.

The water-cement ratio-compressive strength curves for the mixes containing 100 per cent C.R. and 100 per cent R.G. as coarse aggregates are shown in Fig. 3. The curves for the other aggregate combinations lie in the space between the two shown. It is thus seen that for any given water-cement ratio, within the limits of this investigation, and approximately equal consistency, local crushed rock results in from 200 to 400 lb./sq. in. higher strength than local river gravel.

(b) Cost-Compressive Strength Relation.

For the computation of cost the yield of each mix was computed and then the cost of materials per cu. yd. of concrete. The prices used were the regular retail prices for these materials on the Edmonton market, and were as follows:

Cement, \$0.95 per 87½ lb. bag,
Sand, \$3.00 per cu. yd.,
River Gravel, \$2.25 per cu. yd.,
Crushed Rock, \$3.50 per cu. yd.

The cost-compressive strength data are plotted in Fig. 4.

The curve for 100 per cent crushed rock appears to be decidedly out of place, and that for 80 per cent C.R. gives approximately a straight line. Examination of the data shows that the average consistency of the 100 per cent C.R. mixes was definitely lower than the others, and so a displacement of the whole curve to the left would be natural.

The same information is shown again in Fig. 5 in slightly different form.

The shape and slope of these curves give definite evidence that economy, as far as compressive strength is concerned, increases with increase in the proportion of river gravel in the aggregate, or decreases with increase in the crushed rock.

These results will prove useful in dealing with these local materials. Probable small differences in technique, as well as the personal equations of operators A and B, have probably introduced uncertainties in some of the plotted values. The mixtures high in crushed rock were harsh, and equal consistencies were not only not completely realized but even if realized might not represent equal placeability. The crusher dust clinging to the crushed rock was dis-

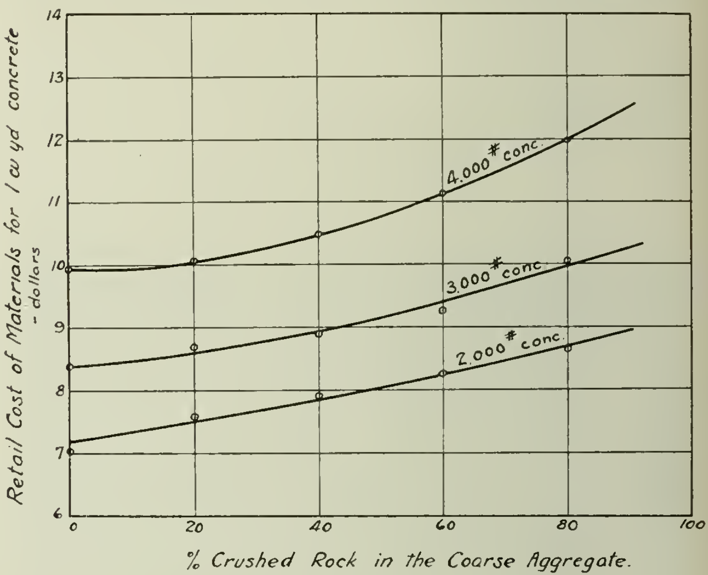


Fig. 5.

regarded in this investigation, although the writers are aware that considerable variation occurs according to whether the field stones and river gravel are wet or dry when passed through the crusher. All of the crushed rock used was taken from the bin at one time.

It is hoped to continue to study these materials, to fill in the gaps in the above and to extend the tests to include other characteristics.

The New 50 kw. Transmitters of the Canadian Broadcasting Corporation

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Executive Assistant, Canadian Broadcasting Corporation, Montreal.

Paper presented (in French) before the Quebec Branch of The Engineering Institute of Canada, March 17th, 1938.

SUMMARY.—A brief description of the two new stations (CBL and CBF) of the Canadian Broadcasting Corporation, which have been established as part of the Corporation's policy to secure adequate radio coverage in all parts of the Dominion.

The radio picture as visualized in Europe is quite different from that presented in the new world, and day by day the difference becomes more and more apparent.

A comparison between the attitude toward radio in Europe and that which is found in North America, would lead us to believe that broadcasting, if not a very powerful weapon, is at least a factor in greatly influencing the mentality of the people.

Fortunately for us who live in the new world, so free from any overbearing influences from unfriendly neighbouring nations, we are able to consider radio simply as a source of education, merriment and cheer.

Without attempting to describe fully the policy of the Canadian Broadcasting Corporation as regards broadcasting, it is possible to sketch the general plan of the technical achievements which have resulted from the development of radio in Canada since the foundation of the Corporation.

From the beginning, the inadequacy of the number of broadcasting stations in Canada was realized, for neither the outlets of the Corporation nor the private stations were in a position to properly serve the population of Canada.

In the month of December 1936, the total power of the broadcasting stations in Canada amounted to 78.2 kw. and the investment in the Corporation stations and in the private stations, taking depreciation into account, was estimated at $1,900,000.

Thus it was the duty of the Corporation, before proceeding in any other line of endeavour, to extend the coverage of its stations in Canada, so as to assure as wide as possible a distribution of programmes. With this in mind, and as an initial measure, it was decided to proceed with the construction of two 50 kw. transmitters to cover the densely inhabited portions of the Provinces of Ontario and Quebec.

At the time of its inception, the Corporation's listening audience comprised about fifty per cent of the population of Canada. Upon the inauguration of the two regional transmitters now in Toronto and Montreal, the total power of the broadcasting stations in Canada was more than doubled; the value of plant and equipment both of private stations and of the Corporation's stations, was increased by forty per cent, and the coverage of the Corporation's network was extended to eighty per cent of the population of Canada.

These statistics justify the capital expenditure which has been incurred by the Corporation in Toronto and Montreal. The new transmitters are located, with respect to the major centres of population, in such a way as to assure good reception to as great a number of listeners as possible, within the zone known as that of primary service.

At this point one must differentiate between the primary and the secondary zones; the latter, which may extend to about 2,000 miles from the transmitting point, is that in which night time reception alone is possible, whilst the primary zones are those areas in which continuous daytime and night time reception is possible.

Engineering studies are being carried out with the object of securing primary zones as large as possible, whilst at the same time retaining a secondary zone of satisfactory proportions.

Progress in radio engineering, as in all other branches of engineering, has led to the standardization of equipment and specifications and accordingly a standard series of power-ratings of transmitters has been generally adopted. Normally, transmitters are rated in powers of 100, 500, 1,000, 5,000 and 50,000 watts; from this point the next step is to 500,000 watts. This represents the practice followed in America, although in European countries, between the 50,000 and the 500,000 figures, intermediate steps of

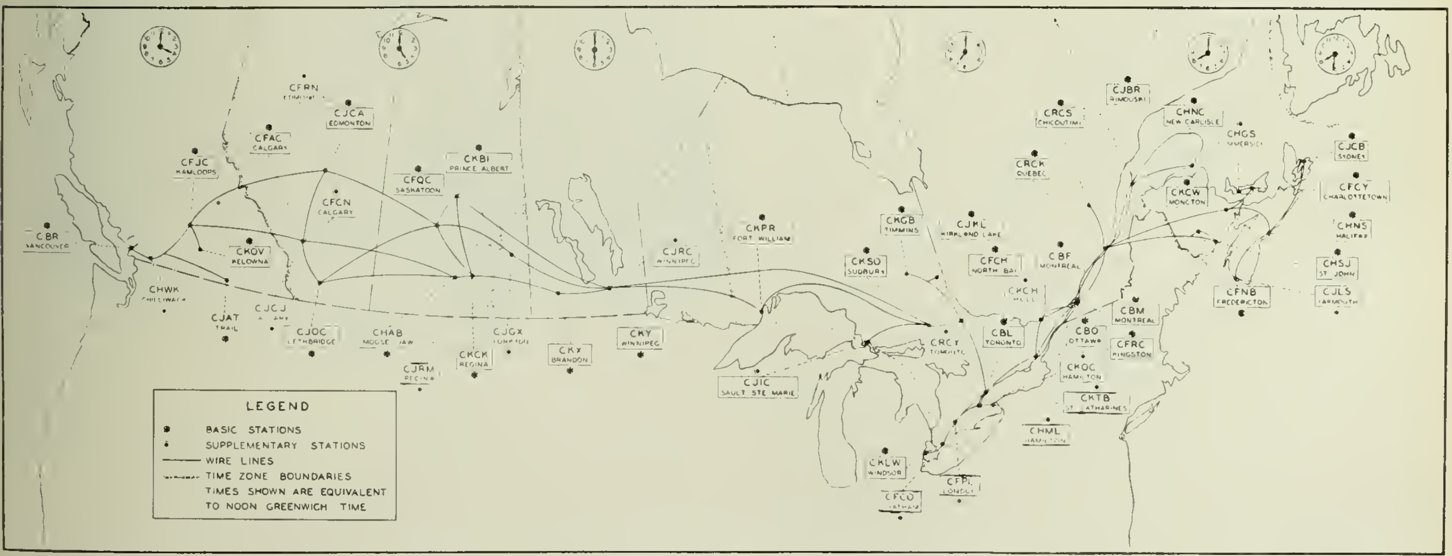

Fig. 1—Canadian Broadcasting Corporation Network (Corrected to April 1st, 1938).

100,000 or 150,000 watts are set. The following stations are examples of the above ratings of powers:

CRCS	Chicoutimi	100 watts
CKCK	Regina	500 "
CFQC	Saskatoon	1,000 "
CKAC	Montreal	5,000 "
CBF	Montreal	50,000 "
WLW	Cincinnati	500,000 "

Fig. 2—View of Transmitter Main Panel and Central Room.

The choice of the factor of 10, whilst arbitrary in appearance, in reality is not so; it results quite logically from technical studies. It should be noted that in the zone of effective reception, multiplication of the transmitting power by 10 will result in giving $\sqrt{10}$ times the former signal voltage.

The intermediate steps of 100,000 and 150,000 watts which are utilized in certain countries have been adopted as a compromise produced by the lack of or prohibitive cost of larger equipment in those localities.

The new transmitting stations of the Corporation (CBL and CBF) are located a few miles from Toronto and Montreal respectively, and are of similar design. As the buildings which house the broadcasting equipment are intended for special purposes they depart somewhat from the practices ordinarily followed in construction and design.

The construction of the Verchères station was commenced in the month of June 1937 and by the end of November the work was almost terminated. The Verchères transmitter was actually inaugurated on the 11th of December 1937 and that at Hornby on Christmas Day 1937.

In each case the main building houses the 50,000 watt transmitter as well as the auxiliary equipment, and provides at the same time for the future installation of a short wave transmitter.

The auxiliary equipment comprises substation transformers, a workshop, stores for spare parts and spare tubes, cleaning and ventilating equipment; limited accommodation for the personnel and a garage is also provided.

The building is of reinforced concrete of the monolithic type of construction. The reinforcing bars used are all tied to the grounding system of the transmitter.

The walls and ceilings are covered with insulating material: the walls by 2 in. of rockwool and ½ in. of fibre board, and the ceilings with a special sound-absorbing plaster called zonolite, 4 in. thick. The lighting of the control room of the transmitter is provided for by a glass-brick wall, comprising one complete side of the room. To give necessary security, the metallic bars of the window frames are close enough together to prevent the passage of a person in case the glass is broken, and the window locking devices are so arranged as to render them inaccessible from the outside if the glass is broken.

The heating of the various rooms of the building is effected by radiators as well as by air ducts. The air carried by the air ducts is heated during winter and cooled during summer. The necessary heat for this air is partly obtained from the cooling water which cools the plates of the tubes in the final stages; this results in a saving of approximately 1,000 gal. of oil per year.

The electrical installation of Verchères and Hornby involve practically all phases of electricity as well as of communications engineering.

As regards power, the transmission lines and station mains have to provide for several hundred kilowatts and the service must be continuous and uninterrupted. So as to prevent any interruptions in the operation of the station, the transmission lines have been set up in duplicate. At Verchères, for example, the internal mains carry 3 phase current at 460 volts. The total load is approximately 200 kw. and the power factor is better than 90 per cent. A further block of power of 50 kva. has been provided for to supply the short wave transmitter which would be fed from the 460 volt bus. The lighting and domestic loads such as heating, air conditioning, etc. amount to about 50 kva. The Shawinigan Water and Power Co. and the Southern Canada Power Co. deliver power at the exterior substation at 13,200 volts, which is stepped down to 460 volts for the station mains. Within the building itself, circuit breakers and cutouts, as well as the auxiliary equipment, are provided.

For satisfactory service the voltage of the 460 volt bus must not vary more than 4 per cent and the load varies syllabically from 120 to 180 kw. These are conditions which are quite exacting and which require the installation of load impedance transformers in the substation.

The transmitters were built by the Northern Electric Company. The high efficiency circuit used in the final stage of the transmitters was developed by Mr. W. H. Doherty of the Bell Telephone Laboratories, and is an example of the most recent advance in radio engineering.

The transmitting equipment consists of a quartz-crystal-controlled oscillator feeding a three-stage radio-frequency amplifier; a three-stage audio-frequency amplifier, the water cooled modulator stage and the final high power stage; the necessary equipment for providing D.C. voltages as well as A.C. voltages of different values, the rectifying unit, the antenna coupling unit and the water cooling system for the tubes.

These various elements are combined and connected so as to produce a carrier wave having a stability of the order of one part in 100,000, which will be modulated, that is varied in amplitude, by the programme signal, and so as to amplify this modulated carrier wave and feed the vertical antenna, from which electro-magnetic radiation takes place. The power of the unmodulated carrier wave is 50 kw.

To prevent accidental contact with various high voltages, special protective devices are installed on the various parts of the transmitter. The transmitter itself is totally enclosed and the enclosure is provided with doors electrically interlocked with the high voltage system; this prevents the application of any dangerous voltages when the doors are opened.

Other relay-operated protective devices permit the grounding of certain parts of the high voltage system to complete the scheme of protection.

The starting of the transmitter is controlled by a relay-operated sequence from a main control panel. Circuit conditions and relevant information pertaining to the various parts of the transmitter are indicated by meters and by various signal lights.

The radio-frequency portion of the transmitter is installed in four panel units located on the main floor of the building; these metallic panels form a continuous front panel. The high voltage transformers, regulators, choke coils and protective devices, etc., as well as the water cooling system are all located in the basement.

The high voltage rectifiers as well as the grid bias rectifiers and filter condensers are located in the main enclosure.

The first panel unit comprises two quartz-crystal-controlled oscillators, one of which can be used in case of failure of the other unit, a three-stage radio-frequency amplifier, a three-stage audio-frequency amplifier, the various rectifying units for the high voltage required for these circuits as well as the control equipment of the various circuits.

The second panel unit contains a high power modulating unit composed of two water cooled tubes; the third and fourth panel units form the output radio frequency stage where the two 100 kw. water cooled tubes, shielded input and output circuits as well as the tuning controls and accessory equipment of this amplifier are located.

The concentric transmission line which connects the final stage to the antenna, and the one-quarter wave length harmonic shunt connects directly with the output terminals of this amplifier.

The equipment for the circulation and cooling of the water used in the water cooled stages consists of two pumps, of which one can be used as a spare, two air blast radiators with blower motor and the associated disconnects, storage tank and necessary dials and fittings; this equipment is located in the basement.

The dissipation of the heat produced in the water cooled tubes requires a circulation of 40 gal. of water per min. At the outlet of the water cooling jackets, the temperature is approximately 88 deg. F.; after having gone through the

Fig. 3—Tuning House. Co-axial Feed Line, Rear of Transmitter Building and Substation.

heat recovery radiators, the temperature at the outlet of the storage tank is approximately 80 deg. The normal temperature in the water cooling jackets is between 80 and 85 deg., depending on outside temperature.

The regulation of the voltage on the 460 volt bus is effected by a regulator with a normal rating of 27 kva. and provides for a variation of 45 per cent in the voltage, that is 22½ per cent buck or 22½ per cent boost. A secondary

Fig. 4—Blower and Pump Room. Heat Recovery Radiators on Left.

regulator is provided to control the transformers which provide filament voltages because the life of the tubes is more or less a direct function of the voltage stability.

Insofar as actual radio frequency energy is concerned, the latest practice has been followed, that is, the use of a radiating mast. At Verchères a structural steel mast 585 ft. high, properly guyed and resting on an insulator, forms the antenna system. This mast is connected to the transmitter by a co-axial line, and the coupling of the mast to the transmission line is done in a tuning house located near the mast.

The grounding system is composed of approximately 19 miles of wire buried underground to form the spokes of a wheel, the centre of which is the base of the antenna; 120 spokes are 600 ft. long and other shorter ones are placed in between.

All metallic parts of the building, as well as water pipes, window frames, etc., are tied to this ground system. This grounding of all metallic parts insures against the loss of expensive radio-frequency energy within the building itself. Experience has shown that a good ground system has the same effect as increasing the power of the station.

Since a tower of this height constitutes a danger to aviation service, lights have been placed at every 100 ft. on the mast in such a way as to be visible from all directions. A beacon is installed on the top of the mast itself.

A broadcast transmitter is composed of networks and circuits of a complex nature, which require electrical energy at various voltages, and of different natures. These voltages are supplied through conduits which must meet the requirements of the Quebec Electrical Inspection authorities. The various control circuits can be operated from the operator's desk from which proper supervision of all the various parts of the transmitter can be had.

The programmes carried by wire circuits from the Corporation's studios in Montreal, Toronto or from elsewhere, must be amplified to compensate for the loss that occurs in all line transmissions. So as to check and maintain the signal level fed to the transmitter, the necessary indicating apparatus is installed on the operating table and assures a continuous check of the signal level and the quality of the programmes.

The duties and responsibilities of the engineering staff of the Corporation did not end when the transmitting stations were built. The daily schedule of operation and the maintenance of a broadcast plant such as that which is found at Verchères, requires the continuous attention of several engineers and technicians. CBF operates at present 13 hours a day; during the period of operation, no inspection can be performed, which means that to assure a continuous service for a period of 16 hours, a daily work schedule of approximately 24 hours is required.

During broadcast time, two operators, under the Chief Engineer or his assistant, are always on duty.

The personnel of the Corporation working at the Verchères station comprises eight men. This allows two shifts of two men in the 16 hours of operation and also provides for the maintenance and routine inspection work which has to be carried out during the remaining eight hours. Regular control of the quality of the signal is effected; normally the quality, or the fidelity of the transmitter is checked by a series of observations at predetermined frequencies, and the depth of modulation is checked by a cathode-ray oscilloscope.

Insofar as coverage of CBF is concerned, when the plans were prepared by the engineers of the Corporation, it had been anticipated that in Quebec City the signal strength would be about one half millivolt. Measurements carried out during the week of March 6th, 1938, indicate that nowhere in Quebec City was the signal below 0.63 millivolt. This gives tangible evidence that the hopes of the Engineering Department have been more than realized. As an indication of what this signal level means, it will be sufficient to mention that no outside station provides in Quebec a signal better than 0.2 millivolt. Consequently, CBF is in a position to provide perfect reception to all listeners in that city.

This is but a brief sketch of the outline of the Corporation's Verchères station, or for that matter, at Hornby, which is exactly the same; the technical details and refinements which the Corporation has been able to include in each of these stations, would in themselves be the subject of several papers.

Without any doubt whatever, the Corporation possesses at Verchères and Hornby two broadcasting stations that can be compared with any other station in North America. The installation of these two stations is an indication of the intention of the Corporation to build, maintain and operate, throughout Canada, a sufficient number of high powered stations that will bring Canadian programmes to all Canadian listeners.

The Importance of Research and Development in Maintaining Technical Progress

M. W. Smith,

Manager of Engineering, Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa., U.S.A.

Paper presented before the Seventh International Management Congress, Washington, D.C., September 19th-23rd, 1938.

SUMMARY.—Research and development work are usually regarded as very technical subjects and are generally so treated, but it is recognized that Management has a very definite interest in their influence on technical progress, particularly in the industrial fields. This discussion is presented with this point in mind, and various suggestions and illustrations as to how this kind of activity may be stimulated and more effectively controlled are offered.

Research and allied developments are among the greatest factors contributing to the advancement of our standard of living. Through inventions resulting from its application we have travelled farther along the road of technical progress to a safer and more enjoyable life in the past hundred years than in all the preceding time. The last twenty-five years have surpassed all others and we can expect technical development to progress at an even faster rate in the future.

The scope of research is almost unlimited. It is effectively applied in almost every branch of the basic sciences. It influences the progress and trends of our industries, commerce, agriculture, public health and safety, employment, and even our national defence. While these various branches of research are broadly related and would be very interesting to discuss, it is considered desirable to limit this discussion to the field of industrial research with which the author is best acquainted, so as to indicate better in more specific terms some of the problems and responsibilities of Management in the planning and administration of these functions.

Industrial Research and Development

There was a time, not so many years ago, when industry looked to the laboratories of the universities and endowed foundations for its research work, particularly in the fields of basic sciences. While it still recognizes the value of research done by these institutions and attempts to follow it closely through co-operation with them, industry is gradually assuming this responsibility even on fundamental work because results can usually be obtained more promptly by a more concentrated and continuous effort and by limiting the choice of fields of endeavour to those of greatest interest to the particular industry concerned. Although industry may concentrate its research in fields of its immediate interests, progressive companies also follow the work done in allied fields and in basic sciences even to the extent of maintaining fellowships in universities and other independent research organizations. They also maintain close contacts with foreign developments, and history reveals many instances where discoveries were made in one country and subsequently developed and commercialized in another.

Research is one of the most effective and certain means of protecting capital invested in industry from the decay of obsolescence. Reference was recently made in one of the financial papers to an investigation made by the investment divisions of several large insurance companies, to determine from an actuarial standpoint the mortality rate of certain kinds of businesses. One point on which they all agreed and placed considerable emphasis was that the companies which died invariably did little or no research. These companies just gradually "went to seed" with old products which were made obsolete by competitors who developed new methods, processes and machinery to build products with more desirable performance and characteristics. A progressive company must not only protect itself against the creation of obsolescence from a competitive standpoint but industry in general must strive toward the creation of obsolescence as one of the most effective means of stimulating new business and prosperity. If new business had to depend entirely on the replacement of equipment and commodities which had been worn out or consumed, our progress would indeed be slow and our standard of living and employment would be stagnant. Only through the creation of obsolescence by the introduction of new and improved products can business expect to grow.

Unless we stop and reflect, we are likely to get the impression that our present industries and products have always been in existence, when as a matter of fact, probably one-fourth of our present production is of products entirely unknown fifty years ago, and even those that were known at that time have been modified and improved to such an extent that they can hardly be recognized as the same.

There was a time when business enterprises were quite firmly established and maintained for generations, but the last few decades have seen whole industries wiped out by the forward march of progress. Business men have not fully recognized this danger and adjusted themselves to it. There is still an instinct in the old to fight the new, but nothing except ruin can result from a strict adherence to such a viewpoint or policy where the new is something inevitable because of its economic advantage. A business man is not justified in abandoning an old, established business at the first sight of a substitute product, but neither is he justified in assuming that because it is a substitute for his product it is necessarily an enemy of his. By absorbing it or modifying his product through development work, he may find the opportunity to make his business more profitable than ever.

Aviation may seriously alter the railroad passenger business, but the railroads which have invested in aviation lines will win no matter which way the tide turns. Buses and trucking might put some railroad lines out of business but the railroads which own large bus lines and big trucking routes will carry the traffic in any event. That's the difference between just being in the railroad business and being in the transportation business.

Shortly before the advent of radio broadcasting, there were probably at least fifty companies in the United States manufacturing phonographs. For a quarter of a century, many of them had done little or no research or development work. Almost over night, a new form of audio entertainment appeared in the home. It immediately became apparent that the radio music and speech quality was vastly superior to that of the phonograph. Greatly decreased sales resulted in serious financial difficulty in spite of frantic advertising. However, a few of the most progressive companies promptly got in contact with radio experts, and after intensive research, incorporated in their apparatus electronic amplifiers, scientifically designed loud speakers and electric recording with an astonishing improvement in quality. These companies soon began to prosper once more, while the others who ignored research and development promptly disappeared.

These illustrations emphasize the important part research and development play in the growth of industrial organization, but at the same time it must be recognized that even this activity can be carried to an extreme. Companies can also fail because of too much engineering and development expense if it is not effectively and efficiently controlled.

Types of Research

Depending upon its purpose, research and development in industry can be considered from various viewpoints, but for the purpose of analysis and study of functions and operations, it may logically be considered from the following three viewpoints:

1. Basic, or fundamental, research which involves studies and investigations at the frontiers of the basic sciences of physics, chemistry, etc., to determine the properties, characteristics and behaviour of matter quite without regard to any immediate or specific commercial uses or application.
2. Specific, or applied, research which is conducted to obtain definite information, solve a particular problem, improve an old product, or develop a new product or line of equipment.
3. Commercial development, which has for its purpose extensions to existing lines of products and improvements in their characteristics and performance. This type of development is not directed toward the discovery or perfection of new kinds of products, but toward improvements and cost reductions in existing ones so as to enhance their competitive standing or value.

Fundamental Research

The nature of fundamental research requires that it be undertaken on a comparatively long-range basis and it should be recognized that important results or achievements may not be realized for several years. Here the problem of Management is largely one of the proper selection of personnel and general fields of investigations. The success of this kind of work is largely dependent upon individual effort and Management can provide only limited detail supervision. The personnel must be selected with this point in mind. In addition to good technical ability and qualifications, men for this work should have an abundance of initiative, enthusiasm, courage and imagination. The recognition of the importance of the selection and development of men for research work has been demonstrated by the establishment of special training courses and opportunities to do advanced work in industry.

For instance, the Company with which the author is associated recently adopted a plan for the establishment of ten positions in its Research Laboratories, to be known as "Research Fellowships." These Fellowships will be open to young scientific workers in physics, chemical physics, physical metallurgy, etc., enabling them to carry on studies of pure scientific value in these fields. Appointments will be made for a one-year period, with the possibility of renewal for a second year. Applicants are required to have training equivalent to a doctor's degree and have already demonstrated ability of a high order in scientific research. In this way it is hoped that a steady stream of the best young scientists will pass through the Laboratories in years to come. While there are no definite commitments, it is expected that some of these men will want to remain on the regular staff of the Laboratories. Others will return to academic work in leading universities and other institutions after having acquired an insight into the scientific problems of the electrical industry. While the Research Fellows will be given considerable freedom as to the particular research problem on which they will work, it is expected that in all cases, the broad field of work will correspond to one of the existing activities of the Laboratories. It is planned to keep the working programme as flexible as possible in order to adapt it to current progress in physics and chemistry. Experience indicates that important advances in industry may be expected from fundamental knowledge gained through such a programme and the operation of this projected Fellowship Plan should also serve to keep the Laboratories in closer contact with other scientific institutions with which these men may later become associated.

Specific or Applied Research

Although specific, or applied, research cannot in all cases be sharply distinguished from fundamental, or pioneering, research, its purpose is different in that it is usually conducted with a definite objective in mind and with the idea of early application. It represents the major activity of most industrial research laboratories because it is usually directed toward improvements in established lines of equipment. For instance, because of troubles experienced on a new product or because of the desire to extend the application of an existing product into new fields of application beyond previous limits of knowledge and experience, certain information and data may be necessary. This may require some fundamental research but it is largely a question of finding the answer to a problem which already exists and is not of a pioneering nature.

Because of its nature, applied research is often subject to the pressure of production from other divisions of the Company, which have a commercial interest in the project. This condition, together with the fact that the Management has an appreciation of the nature and scope of the problem, presents the opportunity, and even necessity, for much more supervision and direction of the work than can be expected on fundamental subjects. This kind of work must be followed closely and actively by the Management to see that it progresses with reasonable speed and that specific projects are not drawn out beyond profitable limits. It is just as important to know when to stop an unpromising project as it is to start an attractive one. Moreover, the pressure for immediate results on specific subjects should not be allowed to crowd out fundamental work which is likely to be neglected because of budget limitations or because immediate requirements or prospects do not appear urgent.

Effective and efficient operation requires careful consideration of the organization and personnel and the classification of the types and scope of the work. In a large laboratory it is usually advisable to group the organization into several divisions with personnel and equipment best suited for work in a particular field or branch of science. This is particularly desirable if there are a large variety of subjects to be treated which can be grouped into general classifications. On the other hand, care must be used to avoid building barriers between divisions which will unduly limit the exchange of knowledge and experience between them. Quite often the knowledge obtained or the method of analysis or approach used in the solution of one problem may be quite helpful in attacking another. It is therefore desirable to set up effective systems and regulations for exchanging and disseminating information and results of investigations throughout the organization by means of adequate records, reports, seminars, conferences, etc. Adequate library facilities are also essential in this plan. All current literature should be carefully scanned and items of interest on various subjects should be summarized and referred to those particularly interested in or engaged in work on the subject. The practice of becoming thoroughly acquainted with the status of the art through surveys of existing literature before work on any new project is actively started should be encouraged.

Incubation of New Products

Out of basic fundamental research or even as a by-product of some specific research on another subject may come a new idea or product which has the possibility of commercial development and exploitation. Here Management has a very definite problem and responsibility which is often neglected. A review of products which have come out of research indicates that few of them seemed to be important at the time they were first conceived. It is beyond the power of human conception and vision to recognize the future value and possibilities of many such developments and it is only after they have had an opportunity to spread their effect over a period of time that they are fully appreciated. Nevertheless, Management must continually be alive to its obligations and take steps to encourage the practical development of new ideas and eliminate barriers which too often exist in their path.

An illustration of the obscure nature of discoveries is found in the phenomena connected with the discharge of electricity through gases. The faint glow discharges which it is possible to get in tubes with gas at low pressures first attracted only the scientists and physicists in the laboratory nearly fifty years ago. This toy of the scientist, however, led to two outstanding discoveries. The first was the discovery of the electron by Thompson, which historians will probably regard as the most important technical event to date. The second was the discovery of the x-ray by Roentgen, which has done much to alleviate human suffering and to prolong life, primarily because of its use for diagnostic purposes but also through direct treatment of disease.

The first attempts to use these glow discharges commercially were in the field of lighting, through the work of Moore and Hewitt in developing the mercury vapour lamp. Today it is not the high efficiency which makes this type of light attractive, but the brilliant and unusual colours which are obtained in neon signs. Another development coming from these gas discharges is the form of rectifiers and inverters for the electrical power field. One of the most recent applications of the gas discharge principle, unforeseen in the early days, is the development of a special tube by Rentschler and James, which has very high lethal, or germicidal, powers.

Sometimes a specific development is not complete within itself, and other developments requiring research in allied fields must be completed and combined with it before a commercial success can be made of the idea. A better realization of this condition and responsibility by those in charge of the over-all activity should work toward the elimination of unnecessary delays in the progress of commercial development.

In 1880, a man by the name of Fritts, a pioneer inventor, filed a patent application on talking motion pictures. A review of this case will show that it contained practically all of the fundamental features which exist in the art at the present time. Yet the commercial application of talking pictures was delayed a generation because the elements called for were not promptly developed. For example, his photo-sensitive device would not respond to the frequencies of speech and music.

It is recognized that the progress of such basically new ideas must necessarily be slow because of human limitations and lack of appreciation of future commercial possibilities. However, a better realization of this lack of appreciation and the acceptance of the responsibility on the part of Management to see that steps are taken to develop component parts and principles instead of allowing new ideas and products to flounder around in the laboratories for lack of attention, should go a long way toward accelerating the progress of new developments.

Pilot Plants

Sometimes the difficulties encountered in promoting a new product of the laboratories are much more real and specific than the lack of vision to perceive their potential possibilities. Large industrial companies are usually organized into divisions which are responsible for the design, manufacture and sale of established lines of products. They are likely to be reluctant to take over a new product until its market and profit possibilities have been determined. This condition often results in a long delay between the research development stage and the commercial application of the product.

To eliminate this unsatisfactory condition usually requires some intermediate stage of development. It is not practical to do commercial development work involving the study of manufacturing processes and cost reduction methods in a research laboratory. On the other hand, established operating divisions of a company, which are charged with the responsibility of making a satisfactory profit, cannot be expected to take over a new product until its commercial possibilities have been investigated. An intermediate organization is therefore desirable to carry the new product through the necessary incubation stage to determine its commercial value. Many of the chemical industries have solved this problem satisfactorily by the establishment of "pilot plants," where new processes are developed on a commercial scale. This general idea is now being successfully applied in other types of industries and can be expected to accelerate technical progress and developments in the future.

Very careful consideration and good business judgment must be exercised in the selection of new projects to be reasonably certain that they have sufficient merit and commercial possibilities even to justify carrying through an incubation stage. Here Management has a difficult and somewhat paradoxical problem of not being over-persuaded by the enthusiasm of the inventor and at the same time maintaining the enthusiasm of the research personnel when their projects, in which they are personally interested, are turned down for lack of economic or commercial value. While the maintenance of an optimistic point of view is desirable, business cannot ignore economic considerations. The morale of the research group can usually be maintained in such cases by a frank discussion of the reasons for the decision. It should be realized that in spite of careful selection and accelerated progress, unprofitable operation on new products for prolonged periods is the rule which in turn increases the risk industry must continually assume and is a fact which is not generally appreciated by the public.

Commercial Development

In the final analysis, the climax to all industrial research and development work is the purchase and use of a new product by the ultimate consumer. It is therefore essential to study the consumer's needs and desires as a guide in the development of new products and to follow his reactions to newly developed products to determine their acceptance. The increasing importance of this viewpoint has been recognized and market analyses and studies of the trends of consumers' needs and desires are being reflected back down the line in such a way that they have a large influence on commercial development.

In large industrial organizations, commercial development work is usually conducted outside the research group and by the Operating Divisions who are responsible for the design, manufacture and sale of various lines of established products. This work is largely directed toward the elimination of minor troubles and the application of improvements in performance reliability, appearance, etc., so as to increase the public appeal and acceptance of a product. It involves the study of material processes and standardization, manufacturing methods and procedures, tool equipment and production methods, and cost reductions of all kinds. Although this kind of work has a very definite and specific objective, it often brings out limitations and lack of knowledge and information which lead to research work of the types described above.

Influence of Patents

A discussion of the subject of technical progress would hardly be complete without emphasizing the important influence of the patent system, particularly at this time when there seems to be so much agitation in some circles to place limitations on private research and patent rights. It has been stated that "no fewer than fifteen bills to prohibit the patenting of labour-saving machinery or improvements thereof have been introduced during the present Congress." A great deal of our technical progress in America can be credited to our patent system, and any action to limit its protection would indeed be regrettable. It costs money to develop and exploit inventions. The protection afforded by patent claims provides incentive to develop new things and under such conditions they may be exploited for a long enough time to become established. Without such protection, capital could not afford to venture into new fields, and industrial research would become very secretive, and because of the resulting lack of co-operation, our great advances in living standards and human comfort would be seriously handicapped. Let us be determined to support and encourage individual and private initiative rather than curb it, so long as it is based on sound economic foundations. Scientific advances based on economic improvements are inevitable. Economic laws and human nature cannot be effectively legislated against.

Attitude of Management Important

In this discussion, development activities and functions have been broken down to some extent in an effort to clarify and illustrate methods of control and supervision, but it is recognized that close co-operation and co-ordination of all phases of the work are essential to successful operation. Francis Bacon recognized the importance of organized research as far back as 1620, when he said:

> "If many useful discoveries have been made by accident or upon occasion when men were not seeking for them but were busy about other things, no one can doubt but that when they apply themselves to seek and make this their business, and that, too, by method and in order and not by desultory impulses, they will discover far more."

It is almost axiomatic that technical progress is dependent entirely on progress or accomplishments in research and development work in the various branches of science, and unlimited illustrations could be supplied to substantiate this claim. It therefore appears that the greatest responsibility—or probably we should say opportunity—of Management in maintaining technical progress is to accelerate research and development work through better administration and control of organizations engaged in this kind of work. In addition to a more rigid application of the usual principles of efficiency and economy of operation, a sympathetic and encouraging attitude on the part of the top Management of a company is considered essential. This promotes co-operation and teamwork among the personnel of research groups and is conducive to good performance, which, after all, is a large factor in the determination of the rate of our future progress.

No invention or development is an unmixed good even though it may be based on sound economic principles. As inventions enlarge our activities and broaden our lives in one direction, they cause shrinkage and distress in another. It is the gradual but positive net progress over a long period of time which counts and we must not become disturbed and thrown from our long-range course by temporary upsets in our social and economic progress. Any basically new idea is really beyond our comprehension and vision. If we could visualize it, it would be immediately developed. However, we may be sure that engineers and scientists will continue to make new discoveries—new ways to heal and save, new ways to kill and destroy; and out of it all we will have new joys and new sorrows along the road of progress to better standards of living.

An Estimate of the Uplift on Piers Between Sluice Gates

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In designing gravity dams, it is customary to assume that hydrostatic uplift may act on any horizontal joint, varying linearly from full head at the upstream end to zero or to tailwater head at the downstream end of the joint. To this may be applied a coefficient of reduction, equivalent to the assumption that this uplift acts only over some fraction of the width of the joint. These assumptions should logically be brought into the design of the other hydraulic structures associated with the dam. The purpose of this paper is to show how this may be done for piers between open sluice gates, using a method which is valid for other structures as well; and not to discuss the general concept of uplift or the extent to which it is reduced by drainage and grouting.

On our sluice pier, the uplift on any horizontal joint may be considered to be equal to full head from the nose back to the plane of the gate seats, diminishing thence to zero at the sides and end of the joint downstream linearly with the length of path. The magnitude and position of the total uplift force upstream from the gate seats is determined by mere inspection, and our problem is to find similar values for the part of the joint downstream.

The linear variation of uplift pressure involves the tacit assumption of the law of capillary flow, wherein pressure is inversely proportional to length of path, and velocity is directly proportional to difference of pressure. This law incidentally causes one to doubt the validity of the assumption of a parabolic variation of uplift, which is occasionally found in technical literature. It also suggests that the coefficient of reduction should be applied to the width of the joint rather than to the upstream head, for precision of language only, because uplift over half a joint causes the same moments and forces as half uplift over the whole joint.

In the flow of heat, temperature is likewise inversely proportional to length of path, and velocity directly proportional to difference in temperature. Hence some of the equations already obtained by the mathematical physicist for the flow of heat can be used for uplift by taking pressure as the analogue of temperature.

In the present case of a horizontal joint in a sluice pier, the heat analogy is the steady state problem of the distribution of temperature in a long, thin conducting strip, with both faces insulated, the sides kept at temperature zero, and one end, representing the trace of the plane of the gate seats, kept at some non-uniform temperature $u = f(x)$, later made constant at $u = h$, all as shown in Fig. 1 (a). In theory a closer approximation would be obtained by giving $f(x)$ the discontinuous values shown in Fig. 1 (b), to provide for the fact that the gate seats are inside the pier sides, but neglect of this point is on the side of safety, and it saves much analytical complexity. The solution is given by R. A. Houston*, with a result in a form which requires only an easy integration of a series to make it suitable for numerical calculation in the present case; and it was afterwards found to have been well treated by Sokolnikoff and Sokolnikoff.†

An account of the development will be given from these and other sources, in response to the editorial suggestion that the use of a little more space for the purpose would be justified by convenience to some readers to whom the references are not readily available.

*An Introduction to Mathematical Physics, p. 84.

†Higher Mathematics for Engineers and Physicists, p. 313.

The analysis begins with an equation expressing the simple fact that inflow to an element equals outflow, when conditions have become steady and there is no generation or absorption within the element. This equation, the equation of continuity, is of very general application in many cases of flow, such as the flow of fluids and of electricity as well as of heat, and its derivation in a form which can be reduced, using δ as a symbol for partial differentiation, to

$$\frac{\delta^2 u}{\delta x^2} + \frac{\delta^2 u}{\delta z^2} = 0 \qquad (1)$$

can be found in many text-books on these branches of physics. We require a solution in the form $u = F(x, z)$ so that the temperature at any point can be found by mere substitution of numerical values of the coordinates of the point, including of course the points of known temperature at the boundaries. Otherwise expressed, the solution is a function of x and z which satisfies the equation and also the boundary conditions. There is no general way of building up a solution by taking the boundary conditions as a starting point: it is necessary to select, from a certain infinite class of functions which satisfy the equation, the particular one which satisfies the boundary conditions. It can fortunately be shown that a solution thus obtained is unique. This process has long been an important part of mathematical physics, and many solutions have been published, some of them, particularly in the field of capillary

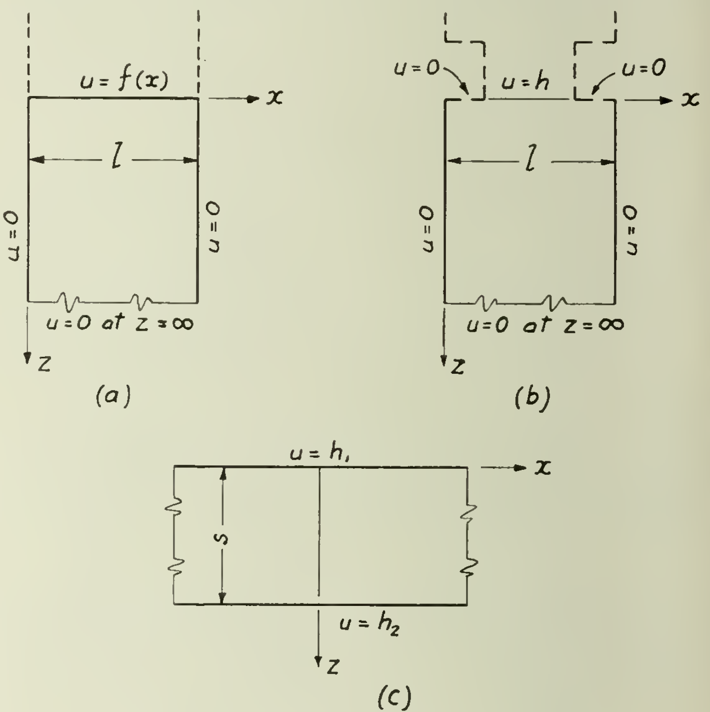


Fig. 1.

flow around cut-off walls in dams on permeable soil, of such complexity that one is amazed to find them confirmed by experiment.

A simple example, from the sources mentioned, may be useful. In Fig. 1(c) is shown a long strip, of width s insulated on both faces and subjected to the edge temperatures shown. The origin 0 is supposed to be far enough from the ends to be unaffected by temperatures there.

Hence $\delta u/\delta x = 0$ and the equation of continuity becomes simply $\delta^2 u/\delta z^2 = 0$ which on integration becomes $u = Az + B$. Introducing the boundary conditions and solving for the constants we get $u = h_1 - (h_1 - h_2)\, z/s$, a simple linear distribution of temperature. The analogy with the linear uplift in dams is obvious.

Returning to the particular case of Fig. 1(a) we require a function which satisfies equation (1) and also satisfies the boundary conditions

(a) $u = f(x)$ for $z = 0$
(b) $u = 0$ for $z = \infty$
(c) $u = 0$ for $x = 0$
(d) $u = 0$ for $x = l$

By trial it is seen that $u = be^{-\beta z} \sin \beta x$ is a particular solution of equation (1) which also satisfies conditions (b) and (c), where b and β are constants, and it is worth further investigation for possible adjustment to the other two conditions. Condition (d) can be met by putting $\beta = m\pi/l$. Equation (1) is linear, so a constant times a solution is a solution, and the sum of any number of such solutions is a solution. Hence giving m all possible values, and putting $e^z = \exp(z)$ for ease in printing we get a solution

$$u = \sum_{m=1}^{m=\infty} b_m \exp(-m\pi z/l) \sin(m\pi x/l)$$

When $z = 0$ this becomes

$$u = \sum_{m=1}^{m=\infty} b_m \sin(m\pi x/l)$$

and it must reduce to $f(x)$ to fulfil condition (a). This can be done by adjusting the values of the constants b in this series so that the sum will be $f(x)$ and by a theorem in Fourier series this will be so if the constants are given the values

$$b_m = \frac{2}{l}\int_0^l f(x) \sin(m\pi x/l)\, dx$$

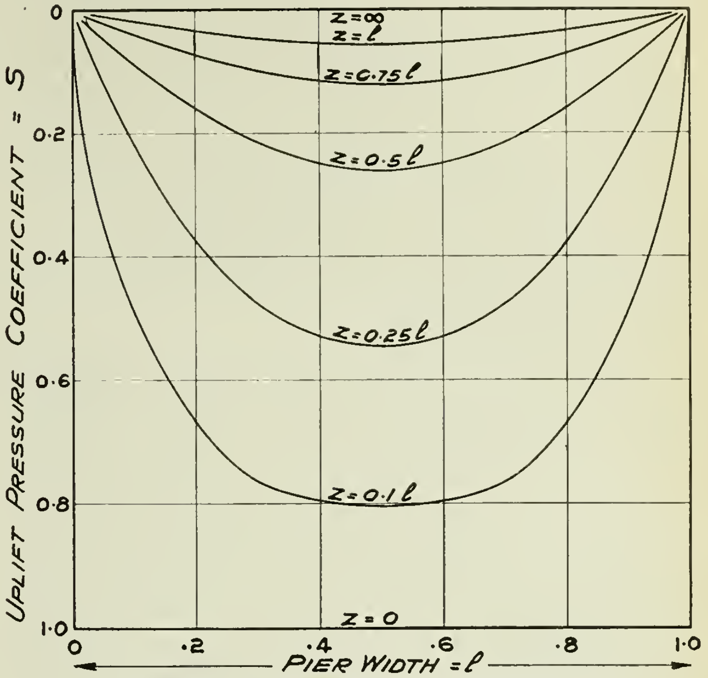
Putting $f(x) = h$ the successive values of b are found by integrations, and are then substituted in the solution to give

$$u = (4\ h/\pi)\Big(\exp\ (-\pi z/l)\ \sin\ (\pi x/l) + \frac{1}{3}\exp\ (-3\ \pi z/l)$$
$$\sin\ (3\ \pi x/l) + \frac{1}{5}\exp(-5\ \pi z/l) \sin\ (5\ \pi x/l) + \ldots\ldots\Big)$$
$$= h\,S$$

an infinite series in two variables from which the temperature at any point can be calculated by substituting the appropriate values of the coordinates. The convergence is rapid, so numerical work is not difficult with proper tables of functions. Care should be taken with the signs of the sine terms as they change with the size of the arguments.

For our purposes, u is taken as the pressure at any point, and h as equal to the external hydrostatic pressure on the joint upstream, both measured in feet of water. Actually h might be taken a little smaller, because it is not measured to a free surface, but the error is small, and again on the side of safety.

A calculation of the pressures at different points on the base downstream from the gates is shown in Fig. 2. The pressure along the axis of the joint is seen to decrease rapidly with the distance, so that it is less than 5 per cent of the head at one pier-width downstream from the gates. This is of an order comparable with the uncertainty in the unit weight of the pier material, so uplift further downstream can be neglected. To escape this approximation the solution can be made to apply to a pier of any finite length by adding a set of hyperbolic function multipliers, but the



CURVE OF UPLIFT COEFFICIENT AT VARIOUS POSITIONS ON HORIZONTAL JOINT

Fig. 2.

process of taking a joint of infinite length and neglecting the unimportant pressures gives a slightly larger uplift, an error again on the side of safety.

By graphical integration, the uplift on the square area mentioned, taking w as the weight of a cubic foot of water, is found to be 0.26 whl^2 lb. acting at a distance 0.263 l feet from the gate seats. For practical purposes one would probably take both these numerical coefficients as 1/4.

The problem has then been solved by a method which appears rational. If the objection be raised that it is a lot of trouble to take over a small point, the answer is that it represents the cost of only a few yards of concrete, a very small proportion of the waste caused by an arbitrary assumption which would probably err on the side of excessive safety through apprehension of the associated uncertainty.

The same principle of course applies to other forms of joints which might occur at intakes or unusual corners. If the solution can be taken or easily built up directly from a good text book as in the present case, little time need be spent: if not, recourse to the electrical analogy of potentials between suitable conductors in a tray of salt solution will give satisfactory results much more quickly than would a purely analytical treatment.

Abstracts of Current Literature

Economics of High Pressure Steam for Paper Mill Power Plants

By Alf Kolflat, Paper Trade Journal, September 15th, 1938.

Abstracted by H. O. Keay, M.E.I.C.

Economics of high pressure steam for paper mill power plants is the subject of an article of especial interest to engineers and operators who are confronted with the problem of a new or revamped steam plant in the paper industry.

While steam pressure of 1,200 lb. per sq. in. and temperatures of 925 deg. F. are becoming quite common in the central stations of the utility companies, in the mills of the paper industry pressures of 450 lb. and 650 lb. and steam temperature of 725 deg. F. may be considered high in comparison with the 100 lb. and 150 lb., with no superheat, in most of the older plants.

In discussing the heat economy of high pressure steam in general, the author differentiates between "Condensing Power," characteristic of the central stations, and "By-Product Power" generally employed by industrial plants where a considerable demand for lower pressure steam for heating and drying processes obtains. When steam is used for the generation of power alone, approximately one-third of the heat in the steam can be converted into power and the remaining two-thirds of the heat is lost to the circulating water in the condensers. On the other hand, when steam is generated not only for producing power but also to supply process and heating requirements, then most of the heat which otherwise would be discharged to the condensers can be used in the process. If all of the steam from the engines or turbines is used in the process, then the fuel requirement for the generation of "by-product power" is roughly one-third of the fuel requirement for condensing power.

On account of the considerable demand for power in the production of mechanical pulp in most paper mills, there are few cases where the ratios between power and process steam are such that all of the power required can be made as "by-product power," so a part of the total requirement has to be made in the condensing steam plant or obtained through purchase of hydro-electric power.

In his calculations the author has selected 150 lb. gauge pressure and 450 deg. F. steam temperature as a basis, partly because this is the practical safe limit for the cast-iron fittings and valves with which most paper mills have been equipped, and partly because this pressure-temperature relationship is well suited to the different processes involved. On the assumption of constant turbine efficiency, three interesting sets of curves are plotted, showing the relationship: (1) between steam pressure, steam temperature and heat content in relation to pressure, (2) between steam pressure and relative turbine water rates for various throttle pressures and exhaust pressures, and (3) between steam pressures and relative heat rates for condensing cycle at 2 in. Hg. exhaust pressure.

Variation in turbine efficiency with size and steam pressure is noted, and curves are drawn showing the relationship between steam pressure at the throttle and turbo-generator basic efficiency for units of 1,000 kw., 3,000 kw. and 7,500 kw. capacity.

The adoption of high pressure steam for industrial turbines has led to the use of automatic extraction pressure machines wherein a variable amount of steam can be extracted for process uses at any desired intermediate pressure which can be maintained at all loads. In this connection the author points out that the machine should be as well adapted as possible to the prevailing steam flow conditions of the particular plant, and that where a number of extraction pressures are desired a better over-all turbine room efficiency will usually be obtained if these openings are divided between different machines instead of designing each machine for more than one automatic extraction opening. Curves are drawn showing the relationship between steam pressure and relative over-all plant heat rate, and the cost of different size steam generating units as well as construction costs of complete turbine and boiler plants.

While emphasizing the fact that each installation is a problem in itself and can only be analyzed as such, the author arrives at the following general conclusions:

1. For a new paper mill power plant with approximately 2,500 kw. turbine capacity and approximately 75,000 lb. per hr. steam capacity, the most economical steam pressure is between 400 and 450 lb. gauge pressure.
2. With a turbine room capacity of 5,000 kw. and a boiler room steaming capacity of approximately 150,000 lb. per hr., the most economical steam pressure is between 600 and 650 lb. gauge, but the net annual saving, after allowing for fixed charges, over that which would be obtained with the 450 lb. installation is small.
3. With a turbine room capacity of approximately 12,500 kw. and a boiler room capacity of 375,000 lb. per hr., the maximum economy is obtained with a steam pressure approximating 850 lb. gauge, but the net savings over 650 lb. gauge pressure are small.

Transmission Line in Mountainous Country

By Earl Baughn, Electrical World, July 2nd, 1938

Abstracted by H. S. Grove, A.M.E.I.C.

A 53-mile, 110-kv., wood-pole transmission line, built in mountainous country and along the almost inaccessible rocky shores of a lake, is described by the author. The conductor, 0.444 in. dia., is composite stranded of 5 strands, galvanized S.M. steel, 2 strands tinned H.D. copper, with a breaking strength of 9,000 lb. and a conductivity equivalent of No. 3 copper. Joints are made with twisted copper sleeves, tinned to prevent contact between the copper of the sleeve and the galvanizing of the steel.

Structures are, in general, two-pole H type, class 3, pentrex treated, Western red cedar. Horizontal spacing is 10 ft. 6 in. on all spans up to 1,800 ft., increased to 15 ft. on longer spans, the maximum span being 2,683 ft. Loading is N.E.S.C. medium and an average span of 938 ft. is obtained. Small angles are made on modifications of the two-pole tangent structure, and large angles on three-pole structures. Dead-end structures are used only where necessary. At 1½ mile intervals a "storm structure" is employed, consisting of a modified tangent H structure with suspension insulators on double crossarms good for full conductor tension and guyed four ways. Where double crossarms are bolted together with wooden blocking between, split timber-rings are used. These serve the double purpose of giving shear strength and of separating the timber by ¼ in. to arrest decay.

Side hill structures are framed with crossarms parallel with the ground where the slope is less than 2 to 1, thereby saving the cost of longer poles for the downhill side. On steeper side hills crossarms are framed at two levels 5 ft. apart. At two places it was necessary to string the line along the face of a cliff. Here the conductors were suspended from 8 in. pipe booms extending horizontally and guyed to rock anchors.

There is one lake crossing of 4,651 ft. span, with the incoming and outgoing line making approximate right angles with the line. Crossing structures consist of three 50 ft. steel masts at each shore, guyed three ways. The crossing conductors are 30 per cent all copperweld, 9/16 in. dia., with a breaking strength of 25,000 lb. The conductor separation is 50 ft.

Engineering and Health

By Harvey N. Davis, Mechanical Engineering, September 1938

Abstracted by L. M. Arkley, M.E.I.C.

In an article on Engineering and Health Mr. Davis, who is President of the American Society of Mechanical Engineers, compares, in an interesting way, the relative merits of the doctor and the engineer as promoters of health. At first thought it would appear that the medical man would have the better of the argument, but the author makes out a very good case for the engineer. In the first place he calls attention to the great personal appeal of the doctor, who comes to the patient at a time when weakened resistance and uncertainty of the future renders the ministrations of the doctor a wonderful help; not so the case of the engineer, who is not dealing with the individual but with the health of masses of people, the majority of whom never know to whom they are indebted for their freedom from disease or improvement in health.

In making this comparison there are two factors which must be considered and the product of these factors gives the final result; there is an intensity factor and a quantity factor. The intensity factor of the doctor with his personal contact may be very high, while the quantity factor of the engineer dealing with masses of people may be much higher than that of the doctor.

Sanitation

The greatest contribution of the engineer to the promotion of health lies in the field of sanitation and under this head may be included water supply, sewerage and sewage disposal plants. By bringing abundant supplies of pure water into towns and cities, a boon that only those who have lived in arid regions can appreciate, by building sewers and sewage-disposal plants, by modern methods of refuse collection and disposal, by the invention and fabrication of modern plumbing fixtures which make cleanliness easy and by a patient persevering fight against atmospheric and stream pollution, engineers have undoubtedly saved many lives and relieved the world of much suffering.

Diet

In the important field of diet the engineer has played an outstanding part. By the development of tin plate and of intricate machines for fashioning it, he has made possible the canning of food on a tremendous scale and thus increased the distribution of health giving materials. Along this same line may be mentioned the invention and manufacture of refrigeration machines and their application to cold-storage warehouses, to trains, ships, motor trucks and all means of transportation of perishable food products. By these means engineers have profoundly affected the dietary habits of whole nations and have made possible the elimination of deficiency, diseases, and of the lowered resistance to infection that malnutrition causes.

Housing

In the matter of housing engineers have improved both the materials and methods of construction; they have flooded houses, offices and workships with eye-saving light, they have provided the central heating plant and air conditioning is just around the corner.

National Standard of Living

The author states that "the standard of living of a community is nothing else than its production of goods and services per capita per year." And the above depends on the production per man hour of expended labour and this can be increased by giving the producer help in the form of inanimate slaves such as horse-power and kilowatts (1 hp. per day = work of 30 men) and also by giving him better tools with which to work. Only by such means as these can the standard of living of any community be permanently raised and this in turn will raise the health of the whole population and only the engineers can do this.

Mental Health and Physical Health

All that has been said so far concerns our physical health, but what is of even more importance is our mental health. Always important in itself it often influences if it does not completely dominate physical conditions. There are at least two contributing factors to mental ill-health in which engineers should be interested. The first depends on the fact that a large proportion of men and women spend more than one third of their waking hours in an industrial job of some sort.

Enjoying one's work is greatly enhanced by, if it is not actually dependent on, having a job that one can do well. This is where the engineers come in. They are beginning to feel their way into new fields of management which involve both adjusting jobs to their holders and assigning men to the right jobs, and the effect of this is to greatly improve the mental health of the workers. The second and more serious cause of mental ill-health is what might be termed social insecurity. There is no worry so insistent as that which besets a self-respecting industrial worker and his family if there is danger of him losing his job, so engineers should concentrate on this question and try to improve working conditions so as to give greater security to the workers.

Speed in Relation to Signalling

Abstract of an article appearing in The Railway Gazette, October 7th, 1938, which in turn is an abridgement of a paper by A. W. Woodbridge, M.S.C., read before the Institution of Railway Signal Engineers.

Abstracted by J. L. Busfield, M.E.I.C.

The fundamental axiom of train working, that one train only shall occupy a section of track at one time, implies that a following train can be brought to a stand before colliding with it. The article discusses the factors involved in bringing a train to a stand, which in turn have a considerable bearing on the capacity of a railway line.

There are three distances to be considered when stopping a train, the first is what is known as overlap, being the nearest point to which a following train can be allowed to approach under block signal work, and may vary from practically zero to a quarter mile. The second is braking and sighting distance, the former being the actual distance which a train can be brought to a stand, the latter corresponding to the time in which a driver can see the visual signal and take action. Visual signal reaction times are discussed, together with the corresponding effect in train movement.

While the stopping of a train is of very great importance, the effect of the signalling system in through running must not be overlooked, and formulae are developed in connection with this phase of the problem, especially for determining the minimum distance a first train must travel before a second enters its section.

Britain's First Oil Well

The Petroleum Times, August 13th, 1938.

Abstracted by A. A. Swinnerton, A.M.E.I.C.

Following a two-year search for oil in Great Britain, the first well has been struck at Dalkeith near Edinburgh, Scotland, according to an article in the August 13th issue of The Petroleum Times. This well, known officially as the Anglo-American Company's Midlothian No. 1, first struck oil on June 27th at a depth of 1,733 ft. In the 5-day period, July 4th to 9th, 42 barrels were produced by "swabbing." In order to increase production, it was decided to "shoot" the well. The hole was cleaned out, and on July 14th the well was shot with a 450-lb. charge of blasting gelatine and dynamite. The well was then cleaned out to the 1,760 ft. depth by a rotary drill, and pumping was started. Pumping 16 hours a day, the well yielded 59 barrels of clean oil in 9 days.

A sample of the oil was sent to the Anglo-American Company's laboratory for analysis, the published result being:

Specific gravity at 1.5 deg. C......	0.823	
Petrol...........................	11	per cent
Kerosene.........................	13	" "
Gas oil, estimated................	10-15	" "

and the remainder, fuel oil.

The Anglo-American Company are now going to further test the zone between 2,050 and 2,150 ft., where promising shows were indicated by test boring.

Automatic Operator for Water-gas Plants

The Engineer, September 9th, 1938

Abstracted by A. A. Swinnerton, A.M.E.I.C.

An illustrated article in "The Engineer" of September 9th, 1938, describes the arrangement and details of a machine for the automatic operation of small and medium sized water-gas plants. The device incorporates a rotary cam mechanism, which is rotated intermittently by a motor gear unit, the circuit of which is periodically closed and interrupted to start and stop the motor. A solenoid switch is provided for switching on the motor current, the closing of the solenoid switch being effected by a time clock at predetermined times in accordance with the requirements of the operation of the plant; the motor is switched off by means of a commutator.

With water-gas plants, which are not automatically charged with fuel, there is a setting of the various operating valves, called the "no run" position, at which it is usual to shut down the plant or charge it with fuel. The automatic control mechanism herein described is adapted to effect the stoppage of the mechanism automatically at the "no run" position when desired. The closing of the solenoid switch is effected at predetermined intervals by a contact clock. This clock contains a time wheel, which is rotated at a uniform speed by an eddy current motor; on the periphery of this time-wheel there are several adjustable strikers. These strikers close the contact for one or two seconds; this starts the motor which rotates the valve-operating cams, when the shaft has made a partial revolution the contact is broken and the motor stops. The next partial rotation and operation of the valves is effected as soon as the succeeding striker on the time-wheel closes the time switch contacts.

To effect the stoppage of the motor when the "no run" position is reached, an additional contact disc is provided, which is in circuit with a lamp or other visual indicator. When the lamp goes out, the attendant opens a switch, stopping both the time clock and the automatic operator. This enables the plant to stand in a condition in which it can be safely clinkered, charged with fuel, or left idling. When the plant is to be re-started, the attendant rotates the cam shaft by hand from the "no run" to the "blow" position, and then closes the switches. The plant is then put on automatic operation and commences to carry through the cyclic operation according to the setting of the time clock strikers. Suitable provision is also made for operating the valve mechanism, by hand, if necessary.

Active Carbon from Bituminous Coal

The Engineer, September 9th, 1938

Abstracted by A. A. Swinnerton, A.M.E.I.C.

A new process for the production of active carbon from graded lump coal has been developed as a result of joint investigations by the Fuel Research Organization of the Department of Scientific and Industrial Research and the Chemical Defence Research Department. An account of the inquiry is given in a Fuel Research Technical Paper issued by the Department. Active carbon has been produced in England for some time by a process which involved the very fine grinding of the coal, briquetting at high pressure without a binder, carbonizing at a relatively low temperature, and activating the resulting coke with steam. The investigation was undertaken with the object of using carefully graded lump coal so that the necessity for grinding and briquetting would be eliminated. It was found that coals were available in that country which had, as a natural property, the correct degree of caking power to give a strong hard coke, without a large cell structure, which is necessary for producing the active carbon. In the early stages of the investigation, when the quantities of coal for trial were usually small, coal was carbonized at about 480 deg. C. in small-scale retorts at the Fuel Research Station at Greenwich and the resultant coke activated in laboratory apparatus at the Chemical Defence Research Department's laboratories. In the later stages of the investigation, when sufficiently large supplies of coal were available, the activation was carried out in semi-technical plant at the Fuel Research Station. For full-scale experiments two retorts, erected for experiments on the production of smokeless domestic fuel, were used. Here it was found that a coke prepared at 650 deg C. gave just as active a carbon as that prepared at 480 deg., while the strength of the product was greater. In tests made to ascertain the suitability of the carbons for industrial use, it was found that in connection with solvent recovery the activity of the best carbon made was about 75 per cent of that of good commercial carbons now available. Other tests showed the new product to be almost equal and in some cases superior to the carbon commonly employed.

FIFTY-THIRD

ANNUAL GENERAL MEETING

and

GENERAL PROFESSIONAL MEETING

Under the Distinguished Patronage of

HIS EXCELLENCY THE GOVERNOR-GENERAL

OTTAWA— TUESDAY AND WEDNESDAY FEBRUARY 21 and 22, 1939

Every member of The Institute should try to make plans to attend this meeting. The hospitality of the Ottawa Branch has been proved at former meetings, and members are assured that this meeting will be no exception. Attendance at an Annual Meeting is one of those occasions at which members are given the opportunity not only of enhancing their engineering knowledge, but also of renewing old friendships, establishing new acquaintances. The meeting offers a change from the daily routine of dealing with the forces of nature to the more human side of engineering affairs which should be of no little benefit to all members of the profession.

There will be many special guests of The Institute and prominent visitors representing American and other engineering societies.

FEATURES

Report of Council for 1938

Retiring President's Address

Scrutineers' Report

Induction of New President

The Institute Banquet

A comprehensive series of Papers on The Western Drought Situation and other important subjects

Prize, Medal and Honorary Membership Awards

Smoking Concert

Luncheons

Watch for further announcements in The Journal

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."

VOLUME XXI NOVEMBER, 1938 No. 11

The Institute and the Young Engineer

The welfare of the recent graduate in engineering has always been a matter of concern to the senior engineer. The amount of this concern has not been a fixed quantity, but has varied between rather high and low limits, but to-day the interest is again approaching the upper levels, and within The Institute has become a matter of considerable importance. Much consideration has been given to it and attempts are being made now to formulate plans that will enable The Institute to do a real work for the young man within the organization.

The subject is not an easy one with which to deal. There are many factors that enter into it, which are not apparent at first glance, and the further the investigation is carried the more complicated become the considerations. It is not easy to determine how far this interest in the recent graduate should go; which of his several needs should be catered to first; how this assistance should be made available; who shall carry on the work, and how it can be made to apply with equal facility to all parts of Canada. These are some of the points which have to be settled before any real progress can be made, and which are being wrestled with at the moment.

Similar problems exist in other parts of the world, and one of the first approaches to the Canadian situation is a study of what has been done or is being done in other places. Much of the history of other movements has already been digested, and much more lies ahead for further study, but an unusual opportunity to see from the inside what is being done along these lines in the United States was afforded The Institute recently in New York as an outcome of a secretarial meeting in Washington during the Seventh International Management Congress.

The Institute was invited to send observers to the annual meeting of the Engineers' Council for Professional Development, well known as the E.C.P.D., in order that the deliberations and findings of that body which is dealing with the same problems in the States that we have in Canada, might be made available to The Engineering Institute of Canada. This was a splendid privilege. To sit in with a group of engineers as prominent as this in educational matters and in practice, backed up by the support of the leading professional societies of the country, was an opportunity that does not come to many people. The Institute is greatly indebted to the E.C.P.D. for their helpful attitude, and once more makes grateful acknowledgment of an international relationship that is priceless in its value.

A meeting that was attended by such educationalists as the presidents of the Massachusetts Institute of Technology, the Carnegie Institute of Technology, the Polytechnic Institute of Brooklyn, the Case School of Applied Science, and deans of such schools of engineering as Columbia, Cornell, Yale, Missouri, Kansas, by such engineers as the president of the Bell Telephone Laboratories and vice-president of the American Telephone and Telegraph and winner of the 1938 award of the John Fritz Gold Medal, the highest American engineering honour, was certain to contribute great things to the cause of engineering education and welfare.

The representative of The Institute gained a great insight into the operations of this important body that is trying so hard and doing so much to improve conditions for the student and the engineer. The policy of The Institute will be greatly affected by what was learned at this all-day meeting of the E.C.P.D. The Journal hopes at a later date to publish much material on this important phase of Institute activities.

Engineers and the Peace of the World

EDITOR'S NOTE:—At this time of stress, no apology is needed for presenting to our members the following timely and thought-compelling extracts from a recent leading article in the editorial columns of *The Engineer.*

"The war that never began is over. The gas barricades in city offices are down again, the blankets are stowed away, and the sand bins are emptied. We all are sleeping once more peacefully in our beds; the conversation in omnibus and train has no longer a sable refrain, and the country is returning to its normal vocations. Only here and there may you hear a long-faced pessimist dolefully proclaiming that we have only put off the evil day, as if, for all the world, that were not a good thing in itself. Ills that are postponed long enough may never come at all, unless engendered by our own folly or supineness. Let us then rejoice that one evil which was waiting at the window sill, nay, tapping at the window, has been exorcised. Let us seek peace and ensue it, not by living in continual suspicion and dread of our neighbours, but by winning their esteem and their confidence and extending to them an equal measure of sympathy. That is the gold Mr. Chamberlain aimed at in his Anglo-German agreement. His arrow will never reach it if it is winged with distrust and tipped with the hatred of a political system which differs from our own . . . There is more hope in the present solution than in any that might have been wrought . . . through the destruction of great cities, invaluable treasures of art, the retardation of the world's progress towards contentment, and the sacrifice of millions of those young lives in whose laps the future lies. Tell us not that this Peace will break down as others have broken down, that aggressors will arise, and that the force of arms will once again embroil the world in a greater Armageddon . . .

"Mr. Chamberlain has shown us that a better way is possible, but his never to be too greatly praised effort would not have achieved success had not all the peoples of Europe been opposed to war. It would be fruitless now to discuss the remarkable and by many unanticipated resources for the protection and organization of this kingdom against invasion which the crisis revealed; just as it would be valueless to discuss the resolution with which the people were determined to pursue the war had it come upon them. The bald fact, which there is no blinking, is that every nation of Europe is terrified at the thought of a war carried on with all the horrid means which scientists and engineers have evolved. Above all, the aeroplane, with its cargo of deadly gas and incendiary bombs, has brought such terror to the peoples of Germany and Great Britain, with their dense populations, that neither nation would readily enter into conflict with the other.

"In a sense, therefore, it may be said that we have come one step nearer that consummation so often foretold when war would have such terrors that it would never be incurred. For that we have, paradoxically, to thank the scientists and engineers. If they have not made war impossible they have made it well nigh unthinkable. And, having got that far, cannot they carry their beneficent work to a further and better stage? It is the merest truism to say that there is no single industry that does not rely and depend upon the services of engineers. The rise, progress, and development of all nations is in their hands. Within the ambit of their proper functions they, from all nations, meet in friendly concourse for the discussion of technical questions. Science binds them into a single whole. Cannot that great unity be turned to an international purpose of incalculable importance and grandeur? Cannot it be used for the perpetuation of peace? It would be inopportune to discuss at this stage the manner in which the combined influence of the scientists and engineers, industrial and professional, of all nations might be exerted to prevent the outbreak of hostilities, but it is not inopportune to suggest that the potential power which resides in the internationality of technical science is so great that its ability to enforce peace, even upon military dictatorships, is incalculable. Yet we look not so much to its power to restrain force, as upon a better and greater power, the power to engender such friendliness and unanimity between all nations that the thought of war would be intolerable to all alike. After all is said and done, and whether a nation be democratic, autocratic, or republican, it is in these days the people themselves who must suffer and prosecute the war, and it is therefore to their friendliness and to their mutual toleration that we must in the end look for the reign of perpetual peace. It is our confirmed belief that in the encouragement of better international understanding the engineer, with his mind trained to reason, can play, and will play, a splendid part."

—*The Engineer*, October 7th, 1938.

The St. Lawrence Waterways

Proposals as Affecting the Dominion of Canada

At a recent dinner meeting of the Hamilton Branch, held in honour of Dr. Challies, the speaker called attention to certain provisions in the St. Lawrence Waterways Treaty in the form now being suggested in the United States, which, in his opinion, are open to serious objection when looked at from the Canadian point of view.

The following notes give in brief the features in regard to which he considers the new proposals detrimental to Canadian interests. None of these are concerned with the engineering phases of the St. Lawrence development, as regards which there is practical unanimity. Certain of the new proposals, however, bring up legal and economic questions which vitally affect the status of the Dominion and the purse of every Canadian taxpayer.

Many years in the service of the Dominion government in charge of federal water power branches, and consulting engineer to the Department of External Affairs regarding international waterway matters, Dr. Challies is recognized as an authority upon administration, investigatory, and international features of water power resources. He remarked that in the new proposals the basic conclusion, payment in proportion to benefit, which was reached by the International Joint Commission of 1921, has been thrown overboard, and in its place parity of capital expenditure and less than parity in maintenance and operating charges has been suggested. Thus the first point raised by Dr. Challies was that the fundamental principle of sharing cost in proportion to benefits has been abandoned. In his opinion a fifty-fifty division of the capital cost (as now proposed) would be unfair to Canada because no credit is given the Dominion for $34,000,000 spent upon a ship canal below Montreal. Only partial credit is given for the $70,000,000 spent by this country on the St. Lawrence and early Welland canals, all of which have been free and open to and extensively used by American shipping.

Next the speaker pointed out that Canada would be burdened unduly by the proposal that each country will for ever maintain and operate the canalization works in its own territory. An official estimate of these charges indicated that Canada would have to pay about $2,000,000 per annum and the United States $750,000. It had been estimated that the American traffic which may be expected to use the new waterway will be from three to eight times as great as the Canadian. Thus the relative annual expenditures contemplated seem entirely out of line with the benefits obtained.

The speaker further considered that there were two serious legal objections to the proposed treaty. At the present time the United States had no legal right, by treaty or convention, to the use of the St. Lawrence canals. The Roosevelt treaty, however, would in the most definite and complete manner give the United States perpetual equal rights with Canada in the use of all the projected St. Lawrence canals, and this enlargement of American rights in the Canadian reaches of the St. Lawrence would be strongly resented in the province of Quebec. Another legal objection to the treaty was that Canada's persistent protests against the withdrawal of water from the Great Lakes through the Chicago diversion canals would be compromised in a way greatly favouring the United States.

Dr. Challies highly commended the action of the Hamilton Chamber of Commerce in establishing a committee headed by F. I. Ker, M.E.I.C., for the purpose of making a special study of the proposals for the Great Lakes to Ocean Waterway.

Joint International Meeting

Invitations have been received, and accepted, from the American Society of Civil Engineers and American Society of Mechanical Engineers to participate with them in meetings with the English Institutions of Civil and Mechanical Engineers, to take place in New York in September of next year, during the World's Fair. So far not many details have been completed, but the portions of the general plans which have been disclosed, indicate that it will be a most unusual occasion.

Preliminary discussions have already taken place with the mechanicals in Washington and with the civils in Rochester, and on October 21st, a real committee meeting was held at the Engineers' Club in New York. The Institute was represented by President Challies, Past President J. M. R. Fairbairn, Chairman of Committee on International Relations, the Presidential nominee H. W. McKiel and the General Secretary. The committee in charge for the American Society of Civil Engineers is headed by Malcolm Pirnie, Vice-President of the Society.

It is expected that another meeting will take place in late November or December, at which all plans will be finalized. At that time a detailed announcement will be made in The Journal. In the meantime members are advised to keep the week of September 4th, 1939, clear of other engagements. The World's Fair is said to be the greatest ever yet attempted and this joint meeting of engineers seems to deserve the same enthusiastic description.

Headquarters Staff

Organization

Council having decided to fill, early in 1939, the vacant position of assistant to the general secretary of The Institute, has requested the Executive Committees of the branches to advise the General Secretary by the 15th of December of any branch member who may desire to be considered for the vacancy. Any interested member of The Institute should communicate at once with the General Secretary of The Institute or with the Secretary of his branch who will be glad to furnish application forms. As it is the desire of Council that all applications be passed upon in the first instance by the Executive Committee of the applicant's branch, it is necessary that all applications reach Headquarters through a branch secretary. Should any applications reach Headquarters direct, they will be promptly remitted to the secretary of the applicant's branch for the preliminary consideration of that Executive Committee.

Application forms and other relative information have been placed in the hands of the branch secretaries. For the guidance of prospective candidates the following list of desirable qualifications is given:

The applicant should be—

1. A member of The Institute.
2. A member of a Provincial Professional Association.
3. A graduate in engineering of a recognized Canadian University.
4. Actively interested in Institute affairs.
5. Experienced in journalism.
6. Experienced in public speaking.
7. Of good appearance, pleasant personality, and good health.
8. Proficient in French or prepared to become so.
9. Between the ages of thirty and thirty-five.

Presidential Activities in October

At the joint meeting of the Montreal Branch of The Institute with the Montreal Chapter of the American Society of Heating and Ventilating Engineers on the evening of October 6th, the President had an opportunity to welcome to The Institute's Headquarters one of the newest professional engineering bodies with international membership. An interesting feature of this occasion was the fact that the new president of the American Society of Heating and Ventilating Engineers, Mr. Holt Gurney of Toronto, was a classmate of the President.

On Saturday, October 8th, accompanied by Councillor Newell and the General Secretary, the President attended a supper meeting of the St. Maurice Valley Branch at the Cascade Inn, Shawinigan Falls. Following supper, the Chairman of the Branch, Mr. Ward, skilfully conducted a round-table discussion regarding the "Status of the Engineer," participated in by the President, Councillor Newell, Vice-President Keay, Councillor-elect Wardle, Branch Vice-Chairman Bradshaw, John Fregeau and the General Secretary.

At Rochester, on Thursday, October 13th, the President and the General Secretary conferred with officers of the American Society of Civil Engineers regarding arrangements for a congress of engineers in connection with the World's Fair in New York next September, under the auspices of the Institution of Civil Engineers of Great Britain, the American Society and the Canadian Institute.

Friday, the 14th of October, will never be forgotten by J. B. Challies. That afternoon his Alma Mater conferred upon him the honorary degree, Doctor of Engineering. His "Graduating Class," as His Excellency the Governor-General so aptly termed it, consisted of the Lady Tweedsmuir, the High Commissioner to Great Britain from India, Malik Sir Firozkhan Noon, the Rt. Hon. Ernest Lapointe, and President Fox of the University of Western Ontario, all of whom were awarded LL.D.'s.

President Cody in presenting Mr. Challies read the following citation:

"The engineer has played a notable part in developing and conserving the material resources of Canada. In a country like Canada which has in its rivers and lakes about half the fresh water on the surface of the globe, the hydraulic engineer is indispensable to the generation and application of power derived from descending water. Today the University honours an outstanding member of this profession in the person of John Bow Challies, one of our graduates of the ancient vintage of 1903. Soon after his graduation he entered the Dominion Civil Service in the Department of the Interior, water-power branch, of which he ultimately rose to be chief shortly before the War. He built up a highly efficient organization, which included a hydrographic survey of the rivers and water supplies of our vast Dominion. Later this developed into the Water Resources branch of which he became director. He was recognized as an authority on the conservation of water power resources, especially in their international significance, and has contributed to scientific magazines many articles on this subject.

University of Toronto Convocation for the Conferring of Honorary Degrees.

Left to right: Right Honourable Ernest Lapointe, K.C., B.A., LL.D., Minister of Justice and Attorney-General of Canada; John Bow Challies, C.E., M.E.I.C., President of The Engineering Institute of Canada; Malik Sir Firozkhan Noon, K.C.I.E., M.A., High Commissioner for India in Great Britain and Northern Ireland; Henri Jordan, Conductor of the Schubert Choir of Brantford, and William Sherwood Fox, M.A., Ph.D., D.Litt., LL.D., F.R.S.C., President of the University of Western Ontario.

"He retired from Government service to become a departmental manager of the Shawinigan Water and Power Company in charge of water resources, and later assistant general manager.

"This year he has by his fellow engineers been elected to be president of the Engineering Institute of Canada—the highest position—in the gift of his profession.

"I present to you John Bow Challies, a great civil servant, an eminent hydraulic engineer, and the official head of the engineering profession in Canada, that he may receive at your hands the degree of Doctor of Engineering, *honoris causa.*"

After Convocation, accompanied by Past-President Gen. Mitchell, Vice-Presidents McCrory and Buchanan, several Councillors and Chairman Sisson of the Toronto Branch, and the General Secretary, he motored to Hamilton where some 150 engineers from south-western Ontario were gathered to celebrate his so recently acquired honour. The following evening, the President was host at a dinner at the University Club, Toronto, tendered the members of the Faculty of Engineering and the executive officers of the various engineering organizations centering in Toronto. Some 66 engineers participated in a round-table discussion regarding the contribution which the various engineering bodies could make in advancing the prestige of the profession and in increasing its usefulness to the public.

On Thursday evening, October 20th, at a house-warming to celebrate the renovations at Headquarters, the President introduced the presidential nominee, Dean H. W. McKiel, to a large gathering of the Montreal Branch.

On Friday, October 21st, a delegation from The Institute, consisting of the President, Past-President J. M. R. Fairbairn, the presidential nominee, Dean McKiel, and the General Secretary conferred in New York with a committee of the American Society of Civil Engineers regarding a Congress of British, American and Canadian engineers to be held in New York in September, 1939. By invitation this delegation was afforded an opportunity to sit in upon an important conference of representatives of the Founder Societies and other important engineering organizations in the United States, regarding the Engineering Council for Professional Development.

The President and the presidential nominee, Dean McKiel, accompanied by a large delegation of Montreal engineers, attended a complimentary banquet of the Kingston Branch to Prof. Malcolm on Saturday evening, October 22nd, in celebration of his appointment as Director of the Department of Civil Engineering of Cornell University.

On October 24th, President Challies left to visit the Western Branches.

Meeting of Council

A meeting of Council was held at Headquarters on October 7th, 1938, with President J. B. Challies in the chair, and ten other members of Council present.

Resolutions were passed recording the regret of Council on hearing of the deaths of H. L. Swan, M.E.I.C., of Victoria, an active member of Council during the years 1934 to 1937, and C. C. Ross, M.E.I.C., of Calgary, lately an administrative officer of the government of the province of Alberta. The Secretary was directed to convey these messages of sympathy to the families of the deceased members.

The President reported that following the award of the Sir John Kennedy Medal to Past-President Dennis, and as Colonel Dennis would not be able to attend the forthcoming Annual Meeting, arrangements were being made to present the medal to him during the President's forthcoming visit to the Victoria Branch.

Arrangements were completed for a joint committee of Council and the Ottawa Branch to look after the preliminary arrangements for the various functions of the forthcoming Annual General Meeting at Ottawa.

Vice-President Buchanan reported that a most enthusiastic and successful joint meeting of the Border Cities and London branches had been held in Sarnia on September 24th, with a full attendance from those branches and representatives of the Sault Ste Marie branch. This report was received with appreciation.

The results of the ballots of corporate members of The Institute in Saskatchewan and of members of the Association of Professional Engineers of Saskatchewan were reported, showing in each case an almost unanimous vote in favour of the proposed agreement. Following this report, it was unanimously resolved that the President and the General Secretary be duly authorized to sign the agreement between The Engineering Institute of Canada and the Association of Professional Engineers of Saskatchewan, the ceremony to take place at Regina during the President's forthcoming western visit.

The President expressed the hope that as many members of Council as possible would make an effort to attend the special dinner meeting of the Kingston Branch to be held on October 22nd to celebrate Dr. W. L. Malcolm's appointment as Director of the School of Civil Engineering at Cornell University.

F. S. B. Heward, M.E.I.C., The Institute's representative on the National Board of the Canadian Chamber of Commerce, presented an interesting report of the recent Convention of the Chamber at the Seigniory Club, which he had attended with the President. He drew attention to the excellence of the papers which had been presented, and the discussions thereon. The President remarked on the valuable brochure which had been prepared by the Chamber of Commerce containing a summary of all the briefs which had been presented to the Rowell Commission on Dominion-Provincial Relations. It was decided that this brochure should be circulated among members of Council and branch chairmen.

A report was presented from Mr. Busfield, chairman of the Publication Committee, announcing that the winner of the competition for the design of a cover for the Engineering Journal was John G. Hall, M.E.I.C., and that abstracts had already been received from some of the recently appointed advisory technical editors.

The Secretary reported that replies had now been received from twenty branches regarding the proposed reorganization of Council as suggested by Professor Spencer's Committee on Membership and Management. Twelve of the branches who had replied had indicated their approval of the proposal. It was decided that all replies received should be referred to Professor Spencer's committee for consideration.

A resolution was presented from the Montreal Branch commenting with approval on the larger number of Council meetings which were now being held away from Headquarters, and the wider circulation which was being given to minutes of Council.

Two resignations were accepted; three reinstatements were approved; the names of five Students in arrears were removed from the list of members; four special cases were considered and decisions reached in accordance with their merits.

Approval was given to the recommendation of the Finance Committee that a list of members be published in the December Journal.

Discussion took place regarding the appointment of an assistant to the General Secretary, after which it was resolved, with one member of Council dissenting, that steps should be taken to secure the names of suitable candidates for this appointment, the appointment not to be actually made until authorized by a letter ballot of all members of Council.

The General Secretary reported regarding his attendance at the Seventh International Management Congress held in Washington, D.C., on September 19th to 23rd, 1938, during which he had been able to meet officers of other societies interested in industrial management with a view to formulating a workable policy for The Institute with reference to this important subject. He had also been able to discuss the possibilities of The Institute's co-operation with the Engineers' Council for Professional Development. In regard to all these matters, most gratifying offers of assistance had been received from the distinguished American engineers present at the Congress. Council expressed appreciation of the kind reception which had been accorded to Mr. Wright on this occasion.

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

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

The Council rose at eleven o'clock p.m.

OBITUARIES

James Henry Barber, M.E.I.C.

We regret to learn of the death of one of the Life Members of The Institute, Mr. James Henry Barber, in Toronto on August 24th. Mr. Barber was born at Coburg, Ont., in 1857. He attended Upper Canada College, Toronto, and later studied at the University of Toronto and the College of Technology. His first engineering experience was obtained as rodman on the reconstruction of the Cobourg and Peterborough Railway in 1873. He spent the following year in Montreal in the office of W. L. Kinmond and Company, engineers. In 1875 he entered the service of James Ross, chief engineer of the Victoria Railway, and was appointed a year later to the position of assistant engineer on the construction of the railway. In 1879 he became assistant engineer on the Credit Valley Railway and had charge of construction between Milton and Galt and remained here a year. In 1881 he was made assistant engineer and afterwards engineer in charge of the St. Thomas extension of the Credit Valley Railway. In the same year he began a three year connection with the Ontario and Quebec Railway first as engineer in charge of a location party and afterwards as division engineer. From 1884 to 1886 he was resident engineer on the Burks Falls Division of the Northern and Pacific Junction Railway, becoming in the following year division engineer on the West Ontario Pacific Railway between London and Woodstock.

Mr. Barber's connection with the Canadian Pacific Railway lasted more than 35 years. During this time he was in charge of many important construction projects on the system, taking part in the laying of steel through the Selkirk Mountains in British Columbia. He later transferred to bridge construction and supervised foundation work on many of the line's important bridges, including the Lachine bridge. Mr. Barber has been residing in Toronto since his retirement from the Canadian Pacific Railway in 1922.

He joined the Canadian Society of Civil Engineers in 1887 and became a Life Member of The Institute in 1922.

Henry Wardlaw McAll, M.E.I.C.

The death of Henry Wardlaw McAll, M.E.I.C., occurred September 29th at his home in Toronto. He was born at Leeds, England, April 26th, 1869. He received his technical education at the City and Guilds Technical College from which he received a diploma in 1869. In 1891 he gave up his work in England and came to Canada where he joined the engineers staff of the Canadian Pacific Railway at Crow's Nest Pass. In 1903 he came to Montreal as assistant resident engineer with the Grand Trunk Railway. He was soon transferred to the Middle Division, Toronto, where he remained until 1906 when he was again transferred, this time to the Northern Division. In 1912 he became associated with the Toronto Works Department. During the construction of the waterfront viaduct he acted as resident engineer. He has also held the position of assistant engineer of the Department of Railways and Bridges of the City of Toronto.

Mr. McAll joined the Canadian Society of Civil Engineers as an Associate Member in 1912, becoming a Member in 1913.

Hamilton Lindsay Swan, M.E.I.C.

Great regret will be felt at the death of Hamilton Lindsay Swan, M.E.I.C., which occurred on August 25th in Vancouver, B.C. He was born at Gilford, County Down, Ireland, on August 29th, 1890. He received his technical training at the Crystal Palace School of Engineering, Norwood, England, following their short course from 1905-07. He then served a three-year apprenticeship to Beyer Peacock and Company, engineers, Manchester, England, and obtained a certificate in advanced applied mechanics from the Manchester School of Technology.

In 1910 Mr. Swan came to Canada and settled at Penticton, B.C. Until 1916 he worked on the construction of the Kettle Valley Railway, leaving then to join the Canadian Engineers with whom he served overseas until 1919. On his return to Canada he worked for a year as

H. L. Swan, M.E.I.C.

chief draughtsman for the Kettle Valley Railway Company at Penticton, B.C., before going into private practice there as a partner in the firm of Swan and Augustine, civil engineers and land surveyors. In 1924 he was made chairman of the Board of Works and acting Municipal Engineer. The following year he became resident engineer, Department of Public Works, B.C., working on the Cariboo highway and Alexandra bridge, Spuzzum, B.C. He served in the capacity of assistant district engineer for the Department of Public Works in the Yale, New Westminster, Merrit and Cranbrook districts, becoming district engineer of Engineering District No. 1, Victoria, B.C. in 1930.

J. H. Thompson, A.M.E.I.C.

In the spring of 1938 Mr. Swan relinquished his post as district engineer and accepted the appointment of administrator of the highway traffic branch of the Department. It is regrettable that he was unable to be longer in this position. He had filled all others so well.

Mr. Swan joined The Institute as an Associate Member in 1915, transferring to Member in 1928. In 1932 he served as chairman of the Victoria Branch. He will be indeed missed by members of the Western Branches as well as mourned by all members of The Institute.

John Henry Thompson, A.M.E.I.C.

The death of John Henry Thompson, A.M.E.I.C., chief engineer of the Canadian Marconi Co., occurred at his home in Montreal West on October 29th. Born in Durham, England, on September 15th, 1883, Mr. Thompson graduated from Durham University in 1910 with the degree of B.Sc. and the following year joined the Canadian General Electric Company, Limited, in Toronto. He enlisted in 1914 in the R.C.N.V.R. and served in the submarine service before being transferred to the radio signal service with the rank of lieutenant.

After the war, Mr. Thompson was appointed chief radio engineer in Ottawa with the Department of Marine and served in this capacity until 1922 when he joined Canadian Marconi, as chief engineer, a position which he filled admirably for 17 years. He attended world radio conferences in Madrid, Cairo and other European countries forming part of the Canadian delegations as one of their radio engineering advisers.

Mr. Thompson joined The Institute in 1917 as an Associate Member.

PERSONALS

P. S. Gregory, M.E.I.C., assistant general manager, the Shawinigan Water and Power Company, was elected to the board of directors of the Fairchild Aircraft Limited.

James H. Wheatley, A.M.E.I.C., has been appointed to the position of superintendent, general shops, replacing the late E. J. Turley. He graduated from McGill University in 1912 with degree of B.Sc. in mechanical engineering, he entered the Northern Electric Company as assistant cable engineer and remained here until 1915 when he was appointed superintendent of time fuse production with the British Munitions Company of Verdun. Enlisting with the Canadian Engineering Corps, he was on his way overseas when the Armistice was signed. After the war he rejoined the Northern Electric Company in the power apparatus sales division. Following a short time spent in the United States, he was associated with the Steel Company of Canada as superintendent of the bolt and nut works division. In 1926 he was appointed superintendent of Domestic Gas Appliances, Limited.

Edward C. Hay, Jr.E.I.C., has been transferred by the Canadian Westinghouse Company Limited, Hamilton, to assume charge of the company's office in Regina as sales engineer of the Province of Saskatchewan.

Dr. T. Kennard Thomson, M.E.I.C., and Mrs. Thomson celebrated their golden wedding anniversary in New York on September 26th. Dr. Thomson is a well-known consulting civil engineer of New York and a Life Member of The Institute, to which he was admitted in 1888 as a Member.

F. C. Mechin, A.M.E.I.C., manager of the Montreal Refineries of the Imperial Oil Company, was present at the launching of the all-welded steel oil tanker *Petrolite* at Sorel on October 22nd. This vessel, costing $465,000, is Canadian designed and built and will be used off the coast of Peru. At the ceremony, Mr. Mechin made a short speech of thanks for the honour which they conferred on his daughter, Miss Marilyn Grant Mechin, in asking her to sponsor the *Petrolite*, and congratulated the shipping company on the completion of such a fine vessel.

Promotion in the R.C.A.F.

The Institute takes this opportunity to congratulate the following members who have been promoted in the Royal Canadian Air Force.

Air Vice-Marshal G. M. Croil, A.M.E.I.C., has been advanced from Air Commodore and **Air Commodore E. W. Stedman,** M.E.I.C., from Group Captain. **Air Vice-Marshal J. Lindsay Gordon,** A.M.E.I.C., was formerly District Officer Commanding Military District No. 10. **Group Captain W. R. Kenny,** A.M.E.I.C., has been promoted from Wing Commander, **Wing Commander D. C. M. Hume,** A.M.E.I.C., from Squadron Leader, **Squadron Leader H. B. Godwin,** A.M.E.I.C., from Flight Lieutenant, and **Flight Lieutenant M. M. Hendrick,** Jr.E.I.C., from Flying Officer.

Visitors to Headquarters

C. C. Kirby, M.E.I.C., President of the Dominion Council of Professional Engineers, came to Headquarters on October 4th.

Alex. T. Cairncross, A.M.E.I.C., is now at his home in Long Branch, Ont., on a furlough from China, where he has been technical adviser, Department of Engineering of the Generalissimo's Staff, National Government of China, Chengtu, Szechewan, and later with the Municipal Council, Department of Finance at Shanghai. He called at Headquarters on October 17th.

Spencer G. Scoular, city engineer designate, Dunedin, N.Z., was present at the meeting of the Montreal Branch on October 20th. He has been sent on a seven months' trip to investigate municipal works in other parts of the world. P. E. Jarman, M.E.I.C., general manager of the City of Westmount, acted as guide for Mr. Scoular during his stay in Montreal.

D. S. Waters, S.E.I.C., spent some time in Montreal during his vacation and visited Headquarters on October 4th. He is with the Canadian Bridge Company at Walkerville, Ont.

W. C. Tatham, S.E.I.C., has now returned to Canada, and visited Headquarters on October 3rd. For the past three years he has been in South Africa, for a time with the East Geduld Mines Limited, Springs, Transvaal, and later as ventilation officer, Grootvlei Proprietary Mines Limited, in the same place. Before returning he spent some time at Entebbe, Uganda, B.E.A.

Ceremonies Marking First Co-operative Agreement Heard Over National Broadcast from Regina

On Saturday evening, October 29th, a number of members of the Montreal Branch and their wives gathered at Headquarters to hear a Dominion-wide radio broadcast of the addresses given by Mr. J. W. D. Farrell, President of the Association of Professional Engineers of Saskatchewan, and Dr. J. B. Challies, President of The Engineering Institute of Canada, at a banquet held in Regina, forming part of the ceremonies marking the consummation of the first Co-operative Agreement between The Engineering Institute of Canada and a Provincial Professional Association. This national hook-up was made possible through the kindness of Dr. A Frigon, M.E.I.C., of the Canadian Broadcasting Commission, and by an instrument installed at Headquarters through the courtesy of the Northern Electric Company.

ELECTIONS AND TRANSFERS

At the meeting of Council held on September 9th, 1938, the following elections and transfers were effected:

Member

JONES, Reginald Elsdon, (Univ. of Toronto), asst. engr., Hydro-Electric Power Commn. of Ontario, Toronto, Ont.

Associate Members

BLOXHAM, Horace William, (Coventry Tech. Inst.), res. engr., subway constrn., Bruce Divn., C.P.R., Hamilton, Ont.

BURGESS, Frederick Victor, (Mount Allison Univ.), chief dftsman., mech. dept., Dominion Coal Co. Ltd., Bridgeport, N.S.

SIMPSON, Frederick Creswell, (Robert Gordon Tech. Coll.), field engr., Herbert Morris Crane & Hoist Co. Ltd., Niagara Falls, Ont.

YOUNG, John Paterson, B.Sc., (Queen's Univ.), asst. supt. of constrn., Dept. of Public Works, Kingston, Ont.

Junior

WANLESS, Graham George, B.Sc., (McGill Univ.), mech. dept., Dominion Rubber Co. Ltd., Montreal, Que.

Transferred from the class of Associate Member to that of Member

GEIGER, Douglas George, B.Sc. (E.E. & M.E.), (Queen's Univ.), transmission engr., gen. engrg. dept., Bell Telephone Co. of Canada, Toronto, Ont.

McCOLOUGH, Reginald Walker, S.B., (N.S. Tech. Coll.), chief engr., Nova Scotia Dept. of Highways, Halifax, N.S.

WALLACE, Gordon Leslie, B.A.Sc., (Univ. of Toronto), consltg. engr., 36 Evelyn Crescent, Toronto, Ont.

WILLIAMS, Edward Clifford, (City & Guilds of London), mgr., air conditioning divn., Can. Gen. Elec. Co. Ltd., Toronto, Ont.

Transferred from the class of Junior to that of Associate Member

CULLWICK, Ernest Geoffrey, B.A., M.A. (Engrg.), (Cambridge Univ.), professor and head of dept. of electrical engrg., University of Alberta, Edmonton, Alta.

GRANT, Alex. J., Jr., B.Sc. (Civil), (McGill Univ.), engr., Angus Robertson Ltd., Montreal, Que.

Transferred from the class of Student to that of Associate Member

AYER, Thomas H., B.Sc. (E.E.), (N.S. Tech. Coll.), shift operator, Shawinigan Water & Power Company, Rapide Blanc, Que.

Transferred from the class of Student to that of Junior

DOBBIN, Davin Crawford, B.Eng., (McGill Univ.), time study man, Dominion Rubber Co. Ltd., St. Jerome, Que.

GERSOVITZ, Frank, B.Eng., (McGill Univ.), private practice, 3980 Cote des Neiges Road, Montreal, Que.

LANGSTON, John Francis, B.Sc. (Civil), (Univ. of Alta.), Lane Wells Co., Okotoks, Alta.

McCOLL, William Ross, B.A.Sc., (Univ. of Toronto), asst. to the supt., Ontario works, Steel Company of Canada, Hamilton, Ont.

McKNIGHT, Charles Ernest Voyle, B.Sc., (Queen's Univ.), safety director, Lake Shore Mines Ltd., Kirkland Lake, Ont.

Student Admitted

MACKINNON, Donald Lauchlan, (Univ. of N.B.), 550 Charlotte St., Fredericton, N.B.

At the meeting of Council held on October 7th, 1938, the following elections and transfers were effected:

Member

BURNETT, Francis C. E., (Heriot Watt College), 145 Percival Ave., Montreal West, Que.

Associate Members

EMERY, Roy William, B.A.Sc. (Civil), (Univ. of Toronto), designer and dftsman., Toronto Iron Works, Toronto, Ont.

TASCHEREAU, Joseph Roger Charles, B.A.Sc., C.E., (Ecole Polytechnique, Montreal), mgr., contract divn., commercial and distribution dept., Shawinigan Water & Power Company, Montreal, Que.

WING, Ernest, plant engr., Canada and Dominion Sugar Co. Ltd., Montreal, Que.

YOUNG, Ross A., B.Sc. (C.E.), (Univ. of Man.), dftsman., Canadian Car and Foundry Co. Ltd., Montreal, Que.

Juniors

BRADLEY, Joseph Gerald, (McGill Univ.), asst. supt., Sherwin Williams Co. of Canada, Red Mill, Que.

CLARKSON, Arthur Grant, B.A.Sc. (Mech.), (Univ. of Toronto), junior dftsman., Algoma Steel Corporation, Sault Ste Marie, Ont.

LAYTON, Michael Shakespear, B.Sc., (McGill Univ.), asst. chemist, Steel Company of Canada, Montreal, Que.

MARCOTTE, Roland, B.Sc. (Elec.), (Milwaukee Sch. of Engrg.), asst. to power engr., Saguenay Power Co. Ltd., Arvida, Que.

MELDRUM, Alan Hayward, B.Sc. (Chem.), (Univ. of Alta.), observer, Algoma Steel Corporation, Sault Ste Marie, Ont.

McMULKIN, Francis John, B.S. (Metal.), (Mich. Coll. of Mining), asst. metallographer, Algoma Steel Corporation, Sault Ste Marie, Ont.

SIBBALD, Stanley W., B.A.Sc. (Chem.), (Univ. of Toronto), chemist, coke oven dept., Algoma Steel Corporation, Sault Ste Marie, Ont.

Transferred from the class of Associate Member to that of Member

WHITMAN, Karl Ewart, B.Sc. (Civil), (N.S. Tech. Coll.), chief designing engr., Nova Scotia Power Commission, Halifax, N.S.

Transferred from the class of Junior to that of Associate Member

JEPSEN, Viggo, (Horsens Tech. School), chief dftsman., Consolidated Paper Corpn. Ltd., Grand Mere, Que.

WARNOCK, Robert Nicholson, B.Sc. (Civil), (McGill Univ.), vice-president, Chas. Warnock & Co. Ltd., Montreal, Que.

Transferred from the class of Student to that of Junior

TINKLER, Howard H., B.Eng., (McGill Univ.), asst. engr., Montreal branch, Iron Fireman Mfg. Co. of Canada, Montreal, Que.

Students Admitted

CALDER, John, (McGill Univ.), 772 Sherbrooke St. W., Montreal, Que.

JESS, Robert Edmond, (McGill Univ.), 3592 University St., Montreal, Que.

PHRIPP, Clarence Frank, (Univ. of Toronto), 286 Dupont St., Toronto, Ont.

WRIGHT, Austin Meade, (McGill Univ.), 2349 Grand Blvd., Montreal, Que.

BOOK REVIEW

The Canada Year Book 1938

Canada Dominion Bureau of Statistics, Ottawa, Ont., 1938. 1,141 pp., 9 x 6½. $1.50, cloth.

The Canada Year Book is the official statistical annual of the country and contains a thoroughly up-to-date account of the natural resources of the Dominion and their development, the history of the country, its institutions, its demography, the different branches of production, trade, transportation, finance, education, etc.—in brief, a comprehensive study within the limits of a single volume of the social and economic condition of the Dominion. This new edition has been thoroughly revised throughout and includes in all its chapters the latest information available up to the date of going to press.

The 1938 Canada Year Book extends to almost 1,200 pages, dealing with all phases of the national life and more especially with those susceptible of statistical measurement. A statistical summary of the progress of Canada is included in the introductory matter. This gives a picture in figures of the remarkable progress which the country has made since the first census of the Dominion was taken in 1871, sixty-seven years ago.

Attention may be called to some of the more important features of the present volume.

In Chapter I, which treats of Physiography, a revised article on the Geology of Canada appears at pp. 16-27; Part III—Seismology—last published in the 1931 Year Book is brought up to date this year; and a special article, "The Flora of Canada," prepared by John Adams, M.A. (Cantab.), Division of Botany, Experimental Farm, Ottawa, appears at pp. 30-59 as Part IV. In Part VII, which deals with Climate and Meteorology, a new section and tables on Times of Sunrise and Sunset in Canada are given.

At pp. 78-90, an additional Part on Historic Sites and Monuments in Canada is added to Chapter II. A section on the Government of Canada's Arctic Territory has been added to Chapter III at pp. 92-93, and at pp. 110-119 the provincial legislatures from 1924 to the present are tabulated, tying-in with the series from Confederation to 1923 published in the 1924 Year Book.

A special feature of Chapter VIII—Agriculture—this year is the article appearing at pp. 223-230 dealing with the Prairie Farm Rehabilitation Program inaugurated by the Dominion Government to alleviate the conditions brought about by the incidence of the recent agricultural crisis in the West, and to provide for permanent improvements in areas suffering from drought and soil-drifting.

All the space that could be spared in Chapter XIX—Labour and Wages—has been given to a summary review of Labour Legislation in Canada, which appears at pp. 787-796, and to an extended treatment of Mothers' Allowances by individual provinces.

In addition to the special features mentioned, some progress has been made in filling in the new framework of Chapter XVIII—Transportation and Communications—as it was recast last year, but unfortunately certain of the statistical series are not yet complete. The section of Chapter XXI—Public Finance—which deals with Capital Investments in Canada and Canadian Investments Abroad, has been completely revised and a new series of historical statistics on a comparable basis, which entirely replaces all earlier figures, is now presented for the years 1926 to 1935 at pp. 896-899. In Chapter XXIII—Currency and Banking—the tables concerning Loan and Trust Companies have been recast, statistics regarding Small Loans Companies separated therefrom, and a separate section on Small Loans Companies added: the business of these companies has now reached considerable proportions and, in view of the special legislation governing their incorporation and operation, the separation is desirable. The review of life insurance given in Chapter XXIII has been rounded out by the inclusion of text and tables covering the business of Canadian companies abroad and Chapter XXV—Education—has been recast, both in regard to textual treatment and tabular presentations.

A list of special articles appearing in past editions from the year 1922-23 to 1937 will be found at page vi immediately preceding the map of Canada.

There are over thirty maps and charts contained in the volume, and two photo-gelatine inserts illustrating the sections on "The Flora of Canada" and "Historic Sites and Monuments," respectively. Three lithographed maps are included.

Persons requiring the Year Book may obtain it from the King's Printer, Ottawa, as long as the supply lasts, at the price of $1.50, which covers merely the cost of paper, printing and binding. By a special concession, a limited number of paper-bound copies have been set aside for ministers of religion, *bona fide* students and school teachers, who may obtain copies at the nominal price of 50 cents each.

ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

Canadian Electrical Association: Proceedings, 48th Annual Convention, 1938.

New Zealand Institution of Engineers: Rules, 1938; Year Book and List of Members, 1937.

Reports, etc.

American Library Association: The Annex of the Library of Congress, 1938.

Canada Department of Labour: Investigation into an alleged Combine in the Distribution of Tobacco Products, 1938.

Canada Geological Survey: Lake Etchemin Map-Area, Quebec; Cranbrook Map-Area, British Columbia; Thetford, Disraeli, and Eastern Half of Warwick Map-Areas, Quebec; Fossil Flora of Sydney Coalfield, Nova Scotia; Mining Industry of Yukon, 1937. (Memoirs 199, 207, 211, 215, 218.)

Canada Bureau of Mines Explosives Division: Annual Report, 1937.

Canada Lands, Parks and Forests Branch: Brown-Stain in Sugar Maple, W. E. Wakefield. (Dominion Forest Service Circular 53.)

Electrochemical Society: Use of the Glass Electrode to Evaluate Quinhydrone Electrode Errors in the Examination of Canned Foods; Brighteners in Silver Plating Solutions; Silver Plating from Acid Complex Iodide Baths; Dielectric Tests on Films of Shellac Varnish; Polymerization of Acetylene by Slow Electrons; Silver Membranes; Properties and Applications of Some of the Vinyl Resins; The Nkana Copper Refinery of Rhokana Corporation Limited; Corrosion of Silver Anodes in Potassium Silver Cyanide Plating Solution; Thermosetting Resins; Anodic and Ordinary Corrosion of Ferrous Metals in Various Acids; Studies of Electrochemical Polarization; Dielectric Constant and Loss of Plastics as Related to their Composition; Alloys of Silver and Iron; The Electro-deposition of Chromium from Trivalent Salt Solutions. (Preprints 74-12 to 74-26.)

Canada National Research Council: Annual Report, 1936-37.

Ontario Department of Mines: Annual Report, 1937.

Quebec Ministère de la Voirie: Convention des Ingénieurs, 1937.

U.S. Geological Survey: Gold Placers of the Fortymile, Eagle, and Circle Districts, Alaska (Bulletin 897-C); Geology of the Marathon Region, Texas; Oligocene Foraminifera from Choctaw Bluff, Alabama; the Force Required to Move Particles on a Stream Bed (Professional Papers 187, 189-D, 189-E); Surface Water Supply of the United States, 1936, Pt. 2 South Atlantic Slope and Eastern Gulf of Mexico Basins, Pt. 5 Hudson Bay and Upper Mississippi River Basins; Surface Water Supply of Hawaii, July 1, 1935 to June 30, 1936 (Water-Supply Papers 802, 805, 815).

University of Illinois: Two Investigations on Transit Instruments; Papers Presented at the 25th Annual Conference on Highway Engineering, March 2-4, 1938; The Chemical Engineering Unit Process-Oxidation; Factors Involved in Plate Efficiencies for Fractionating Columns. (Bulletins.)

World Power Conference: (Sectional Meetings, Vienna, 1938): General Report: Section A Supply of Energy for Agriculture, Section B Supply of Energy for Small-Scale Industries, Section C Supply of Energy for Household Purposes, Section D Supply of Energy for Public Lighting, Section E Supply of Energy for Electric Railways.

Technical Books, etc.

The Consulting Engineer, prepared by George C. Diehl and Robert Ridgway. N.Y. American Institute of Consulting Engineers, 1938. 18 pp., 9 x 6 in., paper.

This brochure contains contributions from six eminent engineers on the training, experience, accomplishments and industries of the consulting engineer.

Design of Steel Buildings. By H. D. Hauf. 2nd ed. N.Y., John Wiley and Sons, 1938. 232 pp., diagrs., charts, tables, 9 x 6 in., cloth, $2.75.

General principles of structural steel design as applied to the commoner types of buildings, with consideration of the various structural units, elements and stresses which enter into such work. Since it is intended to be used in conjunction with the structural steel handbooks, the book contains but few tables of structural shapes and analogous materials.

Elements of Water Supply Engineering. By E. L. Waterman. 2nd ed. N.Y., John Wiley and Sons, 1938. 329 pp., illus., diagrs., charts, maps, tables, 9 x 6 in., cloth, $3.50.

The aim of this text is to provide a work upon the fundamentals of the subject which can be covered thoroughly in the time usually allotted to courses in civil engineering. The topics are arranged in the order in which they appear in the development of a system, the public water supply being followed from source to customer.

Manuel de Savonnier. By A. Matagrin. Paris, Gauthier-Villars, 1938. 268 pp., illus., 7 x 5¼ in., paper.

American Society of Mechanical Engineers **Mechanical Catalog and Directory,** 1939. N.Y., The Society, 1938. 478 pp., illus., 11½ x 9 in., cloth.

Mechanics of Materials. By P. G. Laurson and W. J. Cox. N.Y., John Wiley and Sons, 1938. 408 pp., illus., diagrs., 9¼ x 6 in., cloth, $3.75.

Structural Design. By C. T. Bishop. New York, John Wiley & Sons, 1938. 254 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $3.50.

This book is intended for basic courses in the design of steel structures. The fundamental principles of design are first applied to detached individual members without regard to their relation to other members in a structure, a plan that enables the student to concentrate his attention upon the few new principles involved in each case. The application of these principles is then illustrated by the design of interconnected members of typical structures.

Thermodynamics Fluid Flow and Heat Transmission. Huber O. Croft. N.Y., McGraw-Hill, 1938. 312 pp., illus., 9¼ x 6 in., cloth, $3.50.

U.S. Works Progress Administration **Bibliography of Aeronautics,** Pt. 18—Laws and Regulations, Pt. 24—Air Mail. N.Y., W.P.A., 1938.

MEETINGS

American Society of Heating and Ventilating Engineers—Annual Meeting, January 23rd to 26th, 1939, William Penn Hotel, Pittsburgh, Pa.

Canadian Construction Association—January 10th-12th, at Winnipeg, Man.

The Canadian Institute of Mining and Metallurgy—Annual Western Meeting, November 9th, 10th, 11th, at Vancouver. H. Mortimer Lamb, Vancouver Secretary, British Columbia Division.

Canadian Institute on Sewage and Sanitation—October 20th-21st, at the Royal York Hotel, Toronto. Secretary, Dr. A. E. Berry, M.E.I.C., Ontario Department of Health, Parliament Buildings, Toronto, Ont.

The Engineering Institute of Canada—Annual General and Professional Meeting, February 20th-22nd, 1939, at Ottawa.

E.I.C. Peterborough Branch—Annual Banquet in the evening and Special Meeting of Council in the afternoon, November 26th.

Thirteenth Exposition of Power and Mechanical Engineering—December 5th to 10th, 1938, Grand Central Palace, New York.

Twelfth National Asphalt Conference—February 20th to 24th, 1939, Biltmore Hotel, Los Angeles, Calif.

Additional information about any of these functions may be secured from the General Secretary.

BOOK NOTES

The following notes on new books appear here through the courtesy of the Engineering Societies Library of New York. As yet, the books are not in The Institute Library, but inquiries will be welcomed at Headquarters, or may be sent direct to the publishers.

About Petroleum. By J. G. Crowther. London, New York, Toronto, Oxford University Press, 1938. 181 pp., illus., diagrs., 9 x 6 in., cloth, $2.25.

A very simple description of the petroleum industry, intended for those who are curious about what petroleum is, where it comes from, how it is produced, and how it is transformed into the familiar commercial products. Such special phases as geophysical prospecting and knock phenomena in engines are briefly treated.

Advanced Mathematics for Engineers. By H. W. Reddick and F. H. Miller. New York, John Wiley & Sons, 1938. 473 pp., diagrs., cnarts, tables, 9 x 6 in., cloth, $4.00.

Differential equations, vector analysis, probability, operational calculus, and the more complex mathematical functions and series are discussed, emphasis being placed on physical applications by illustrating each principal topic by problems relating to civil, electrical, mechanical and chemical engineering. Definitions, physical laws, theorems and physical units are presented with particular care.

Air Conditioning. By C. A. Fuller with collaboration of D. Snow. New York, Norman W. Henley Publishing Co., 1938. 577 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $4.00.

In addition to the customary information concerning thermodynamic fundamentals, design of distributing equipment, principles of condensers, evaporators, etc., and descriptions of installations, the subject of codes and ordinaces covering air conditioning is discussed. The non-technically trained reader has been primarily considered.

Airplane Design. By K. D. Wood. 3 ed. June 1938, published by the author at Purdue University, Lafayette, Ind., distributed by the Cornell Co-Op. Society, Ithaca, N.Y. Illus., diagrs., charts, tables, 11 x 9 in., paper, $4.00.

A textbook of airplane layout and stress analysis calculations with particular emphasis on economics of design. Load factors, materials, costs, and drafting procedure are discussed, as well as the actual work of technical design for the various component parts. Appendices contain design data for practical work.

Applied Mechanics. By H. F. Girvin. Scranton, Pa., International Textbook Co., 1938. 336 pp., diagrs., tables, 9 x 6 in., cloth, $3.00.

A comprehensive treatment of the subject, containing a very large number of descriptive problems. The material has been so arranged that the chapters covering graphical solutions may be used as a text for a course in Graphic Statics, being segregated from the purely mathematical treatment.

Atomic Structure. By L. B. Loeb. New York, John Wiley & Sons, 1938. 446 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $4.50.

This textbook is intended to supplement a basic course in physics and to provide students who have a working knowledge of the calculus with a thorough grounding in atomic structure. The subject is developed on an essentially experimental and historical basis. Starting with an account of early discoveries and the prenuclear atom, the author discusses the nuclear atom, the electrical properties of atoms, the kinetic nature of a gas, the electron theory of metals and the wave mechanical concept of the metallic state. There is a bibliography.

Bibliography on Industrial Radiography. (Document 1139). By H. R. Isenburger. Washington, D.C., American Documentation Institute, 1938. 52 pp., typewritten, 12 x 9 in., paper, $0.72 in microfilm, or $3.32 in black and white prints.

This supplement to St. John and Isenburger's book, "Industrial Radiography," contains 776 references, arranged chronologically and covering material from early 18th century general theory to the most recent 1938 applications.

British Chemical Industry, its Rise and Development. By Sir G. T. Morgan and D. D. Pratt. London, Edward Arnold & Co.; New York, Longmans, Green & Co., 1938. 387 pp., illus., diagrs., charts, tables, 10 x 7 in., cloth, $6.25.

This work presents the substance of a series of public lectures at the University College of Wales. The factors underlying the origin and development of the principal chemical industries of Great Britain are presented in clear, simple language, and an excellent picture of present conditions is given.

The **Brunels,** Father and Son. By C. B. Noble. London, Cobden-Sanderson, 1938. 279 pp., illus., diagrs., 9 x 6 in., cloth, 15s.

An account of the lives of two men who contributed some of the most notable engineering feats during the early and middle nineteenth century, including the original Thames tunnel and the Great Eastern steamship. Contains much original material from diaries, letters, etc.

La Corrosion en Métallurgie. By C. Grard. Paris, Éditions Berger-Levrault, 1936. 345 pp., illus., diagrs., charts, tables, 10 x 7 in., paper, 50 frs.

A comprehensive textbook of the corrosion of metals when exposed to moisture, the atmosphere or salt water. The book is based upon the results obtained by the various research institutions studying this problem, especially those of Commission Française de Corrosion, of which the author is President.

Davison's Textile Blue Book, United States, Canada and Mexico. Handy edition, Seventy-third Year, July 1938 to July 1939. Ridgewood, N.J., Davison Publishing Co., 1938. 1,234 pp., maps, 8 x 5 in., cloth. $5.00.

An annual publication containing lists of manufacturers of cotton, rayon, silk and knit goods, and of dyers and finishers, geographically arranged. Commission merchants, dealers and importers are listed, also domestic and foreign raw cotton firms, cotton compresses and warehouses. Two special lists cover pertinent associations and railroads serving the various mills.

Decibels and Phons, a Musical Analogy. By L. S. Lloyd. London, New York and Toronto, Oxford University Press, 1938. 18 pp., tables, 9 x 6 in., paper, $0.50.

An explanation of the meaning of the terms "phon" and "decibel" by considering the phon as a loudness-interval, comparable to the musical interval of a major third, and the decibel as representing the energy-interval which produces the phon.

Diesel Engines. By B. J. von Bongart. New York, D. Van Nostrand Co., 1938. 335 pp., illus., diagrs., charts, tables, 10 x 6 in., cloth, $5.50.

Primarily designed as a text for the study of internal combustion engines of the compression-ignition type, this book covers general principles, the customary equipment, and the various types of engines within this field. There are also embodied the results of certain researches by the author and others on particular problems in Diesel engineering.

Direct-Current Machinery. By T. C. McFarland. Scranton, Pa., International Textbook Co., 1938. 439 pp., diagrs., charts, tables, 9 x 5 in., lea., $4.00.

As a matter of review, the first chapter of this text is devoted to the fundamental concepts of electricity and magnetism. In treating of direct-current machinery a physical picture of the assembly is first presented, then operating characteristics and control, proceeding from no-load characteristics to load characteristics are discussed. Material on the no-load saturation curve and armature reaction is included.

Edison's Open Door. By A. O. Tate. New York, E. P. Dutton & Co., 1938. 320 pp., 9 x 6 in., cloth, $3.00.

The author was intimately associated with Edison between the years 1883 and 1894, being for the greater part of that time his private secretary and an officer in his various personal corporate enterprises. His narrative is an informal account of Edison during one of the most dramatic periods of his life, based upon personal knowledge. Incidentally, many other interesting characters and events are discussed. The book is a readable, welcome addition to Edisonia.

Electric Power Circuits, Theory and Applications. Vol. 2 **Power System Stability.** By O. G. C. Dahl. New York and London, McGraw-Hill Book Co., 1938. 698 pp., diagrs., charts, tables, 10 x 6 in., cloth, $7.00.

The subject of power system stability is very fully treated, with a wealth of diagrams, tables and mathematical analyses. There are several chapters on each of the following topics: steady-state power limits, steady-state stability and transient stability, considering carrying conditions and different methods of analysis. Other chapters cover load characteristics, circuit equations for faulted networks, exciter analysis, damper windings, inertia and grounding.

Electromagnetics. By A. O'Rahilly, with a foreword by A. W. Conway. London, New York and Toronto, Longmans, Green & Co., 1938. 884 pp., diagrs., tables, 9 x 6 in., cloth, $12.50.

A critical review of the classical theory of electricity, discussing fundamentals, and the work of the men who have had an important influence on the thought and action in this field of physics. At the end of this comprehensive survey appear two chapters in which a radical exposition of the meaning of the symbols of physics is worked out and the question of basic units and dimensions is treated. There is a large bibliography.

Electro-Plating, a Survey of Modern Practice including Nickel, Zinc, Cadmium, Chromium, and the Analysis of Solutions. By S. Field and A. D. Weill. 3 ed. rev. London, Sir Isaac Pitman & Sons, Ltd.; New York, Pitman Publishing Corp., 1938. 381 pp., illus., diagrs., charts, tables, 8 x 5 in., cloth, $4.00.

This volume is intended to provide the electroplater with a simply worded, practical account of recent advances in the art. The scientific principles involved are revised, advice is given on equipment and solutions, and methods for depositing the usual metals are described in detail. A chapter on metal colouring is included. The new edition has been enlarged, chiefly by more scientific data and by material on the chemistry of plating solutions.

The Elements of Ferrous Metallurgy. By J. L. Rosenholtz and J. F. Oesterle. 2 ed. New York, John Wiley & Sons, 1938. 258 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $3.00.

A general elementary treatment for students not specializing in metallurgy. Blast furnace practice, steel-making processes, heat treatment, the structure and working of various steels, and iron foundry work are treated concisely and clearly.

Elements of Ordnance, prepared under the direction of Lt.-Col. T. J. Hayes. New York, John Wiley & Sons, 1938. 715 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $6.50.

This textbook, intended for use at West Point, is essentially a revision of McFarland's "Textbook of Ordnance and Gunnery." It aims to give the student a broad foundation, upon which further technical studies can be based.

Engineering Mechanics. By S. Fairman and C. S. Cutshall. New York, John Wiley & Sons, 1938. 267 pp., diagrs., tables, 9 x 6 in., cloth, $2.75.

The object of this elementary text is to present only as much material as can be conveniently covered in the time available for a basic course. Topics covered in prerequisite courses and material which may be deferred to more advanced courses are consequently omitted. Otherwise the book contains the customary treatment of statics and kinetics, numerous problems being included.

Engineering Terminology, Definitions of Technical Words and Phrases. By V. J. Brown and D. G. Runner. Chicago, Gillette Publishing Co., 1938. 310 pp., illus., diagrs., 9 x 6 in., cloth, $3.50.

A list of terms often used in technical writing and specifications, with definitions obtained from the usage of various trade and engineering organizations. The terms apply especially to civil engineering and architecture. In addition the book contains a concise Spanish-English and English-Spanish dictionary of highway terms, a brief German-English dictionary of terms for mineral aggregates and several tables of technical symbols, abbreviations, conversion factors, etc.

Farm Gas Engines and Tractors. By F. R. Jones. 2 ed. New York and London, McGraw-Hill Book Co., 1938. 486 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $3.75.

The first part of this text deals with the fundamentals involved in the construction and operation of the simple internal-combustion engine, with particular application to the small stationary engine for farm use. Part two deals with the construction and operation of the various types of farm tractors. The text is clear and practical and the various topics are treated in detail.

Fluid Mechanics for Hydraulic Engineers (Engineering Societies Monographs). By H. Rouse. New York and London, McGraw-Hill Book Co., 1938. 422 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $5.00.

Intended specifically for graduate students and practising engineers, this volume presents in systematic detail the fundamental principles of fluid motion and their application to various phases of hydraulic engineering. Emphasis is placed upon sound physical analysis of actual flow phenomena, in the effort to provide more dependable methods of approach than empirical hydraulics can afford.

Foremanship and Supervision. By F. Cushman. 2 ed. New York, John Wiley & Sons, 1938. 286 pp., illus., diagrs., charts, tables, 8 x 5 in., cloth, $2.50.

A practical handbook for foreman conference leaders and supervisors of vocational education. It deals with the conference type of educational procedure, which is distinguished by the stimulation of a group to active thought through the efforts of a leader who encourages and guides discussion, as opposed to other types in which the leader acts as instructor.

Great Britain. Dept. of Scientific and Industrial Research. **Lubrication Research** Technical Paper No. 3. The **Friction** of an **Oscillating Bearing**, by A. Fogg and C. Jakeman. London, His Majesty's Stationery Office; [obtainable from British Library of Information, 270 Madison Ave., New York], 1938. 28 pp., illus., diagrs., charts, tables, 10 x 6 in., paper, $0.30.

The purpose of this investigation was to determine the characteristics of the friction of a journal bearing subjected to oscillating motion under different conditions of load, temperature and frequency of oscillation, and to examine the effect of different lubricants on the friction.

Great Britain. Dept. of Scientific and Industrial Research. **Road Research** Technical Paper No. 5. **The Grading of Aggregates** and **Workability of Concrete.** London, His Majesty's Stationery Office; [obtainable from British Library of Information, 270 Madison Ave., New York], 1938. 42 pp., illus., diagrs., charts, tables, paper, $0.45.

Gives the results of an investigation of the effect of the grading of the aggregate upon the strength and workability of concrete. A new conception of workability is given, a method for measuring it is described, and a wide range of cement contents, aggregate gradings and types is examined.

Handbook of Aeronautics, Vol. 3. **Design Data and Formulae—Aircraft and Airscrews.** Ed. by The Royal Aeronautical Society and the Institution of Aeronautical Engineers. London, Sir Isaac Pitman & Sons; New York, Pitman Publishing Corp., 1938. 250 pp., diagrs., charts, tables, 9 x 6 in., cloth, $6.00.

BRANCH NEWS

Border Cities Branch

J. F. Bridge, A.M.E.I.C., Secretary-Treasurer.

London Branch

D. S. Scrymgeour, A.M.E.I.C., Secretary-Treasurer.
Jno. R. Rostron, A.M.E.I.C., Branch News Editor.

The opening meeting of the fall season was featured by a joint Professional Meeting of Border Cities Branch and the London Branch at Sarnia on September 24th, 1938. A full account of which appeared in the October number of The Journal.

Invitations had been sent out to other branches of The Institute and to the Association of Registered Professional Engineers of Ontario. The following list shows the localities represented and the number attending from each: London 31, Windsor 29, Sarnia 15, Toronto 7, Montreal 5, Port Huron 4, Walkerville 4, Woodstock 3, St. Thomas 3, Sault Ste. Marie 2, Chatham 2, Detroit 2, Stratford 2, Hamilton 1, Marysville 1, Wayne 1. Total registration 112.

Hamilton Branch

A. R. Hannaford, A.M.E.I.C., Secretary-Treasurer.
W. E. Brown, Jr.E.I.C., Branch News Editor.

The regular monthly meeting took the form of a joint meeting of the Hamilton group of the American Institute of Electrical Engineers and the Hamilton Branch, E.I.C., and was held in Convocation Hall, McMaster University, on October 6th, 1938.

Mr. T. A. Boyd, of the Research Department, General Motors, Detroit, addressed the meeting on the subject "The Place of Research in the Evolution of the Automobile." The speaker asked the question, "What is the use of Research?", pointing out that the average man thinks of the automobile today as being perfect and yet automotive engineers in 1909 thought they had achieved perfection.

In answer to his own question, Mr. Boyd first traced the history of the development of the automobile, pointing out that in itself the automobile is not an invention but rather the product of a long genealogy. The essential features of the motor car had been invented long before the motor car became a reality.

Probably the forerunner of our automobile was the Nuremberg carriage of 1649 with its human engine, and about the same time a sailing carriage was developed, propelled by a sail. Early steam carriages gave us the cylinder and piston, crank and connecting rod, change gear and differential gear, and even front drive steering wheel.

Lenoir's gas engine in 1860 and Otto's gas engine in 1876 with its compressed charge were important developments, to be followed by the Panhard and Levassor car, the pioneer of the modern car. Tribute was paid to Charles Goodyear's contribution, namely, the means of vulcanizing rubber. The last important development cited was Kettering's electric self-starter. The speaker illustrated all these developments with slides.

Mr. Boyd then took his audience on a rapid tour of a research laboratory, showing the facilities for testing the performance of a car and its component parts, such as the dynamometer, the spectroscope, the cold room, means of testing brakes, gears, lubrication, springs, finish and plating. Finally the speaker showed views of the "proving grounds," where the cars undergo actual road tests. Here there are grades of various degrees, speed bed, mile long straightaways, skid pad and bath tub, all designed to subject the car to extreme operating conditions in order to test its performance.

The foregoing is a cross-section of the part research and engineering have played in producing our automobile. Their improvements have reduced the price per pound from 50c to 20c for cars in the lower price bracket and have saved car buyers in Canada and the United States a billion dollars per year.

Mr. Boyd pointed out that the future for research in the automotive industry is just as glorious as the past, despite the fact that there are already 100,000 U.S. patents related to the automobile. There is a need for a lighter and more efficient engine, lighter metals, steel which will withstand rust and a lubricant which will carry higher bearing pressures.

The meeting was opened by D. W. Callander, Chairman of Hamilton group A.I.E.E., who then turned the chair over to W. Hollingworth, M.E.I.C. Mr. Boyd was introduced by Emil L. DuBois, president of the Hamilton Motor Products, Limited. The attendance was 218.

October the 14th was arranged as a special day of activities to honour our President, J. B. Challies, M.E.I.C., and also an occasion of welcome to our General Secretary, L. Austin Wright, A.M.E.I.C.

Special representations came from the following Branches: London, Niagara Peninsula, Toronto; and also the Grand Valley Group of Registered Professional Engineers and numerous friendly Engineering Societies.

During the afternoon about 85 engineers and visitors made tours of inspection through the plants of the Steel Company of Canada, The Dominion Foundries and Steel Company and the Burlington Steel Company.

At 6 o'clock members assembled in the Laura Secord room of the Royal Connaught hotel for the reception of the President who was coming from Toronto where, during the afternoon, he had been honoured by the University of Toronto with the honorary degree of Doctor of Engineering. Dr. Challies arrived at a few minutes to seven and his entrance was made to the lusty strains of "For he's a jolly good fellow."

At 7 o'clock, 122 sat down to dinner in the dining room and to enjoy a evening that will long be remembered by the Hamilton Branch.

The speaker of the evening, Dr. Challies, was introduced by Major Hugh Lumsden, M.E.I.C., in his most sincere and affectionate manner.

Dr. Challies gave us a stirring address on matters concerning the engineering profession and cited some of the policies that The Institute is trying to effect. He challenged engineers throughout the Dominion to assist the movement to bring the profession to its rightful status. He pointed out that 71 years ago there was no engineering or engineering faculty at any school in Canada; that 53 years ago there was no engineering society in Canada and that only within very recent years has the engineer been accorded any professional status.

He urged members of The Institute to co-operate with all other groups of authorized engineers and to follow these four ideals: support the Provincial Associations; sustain the National Association; encourage the young engineers; take part and give leadership where possible in public service as our contribution to good government.

Dr. Challies continued with an interesting talk on the St. Lawrence Waterways proposals, and an abstract of this portion of his talk will be found elsewhere in this issue.

E. P. Muntz, M.E.I.C., moved a vote of thanks to Dr. Challies.

Mr. Wright, in a few well chosen words, expressed his pleasure in being with us and hoped for an invitation to say more at some future time, which opportunity he will surely get.

W. J. W. Reid, M.E.I.C., our Chairman, introduced Mr. McCulloch, of the Hamilton *Spectator*, who gave the gathering a very skilful picture of the affairs of the world as seen by those who are perhaps able to see some distance through the maze of swiftly moving events of the present weeks and months.

Kingston Branch

R. A. Low, A.M.E.I.C., Secretary-Treasurer.

The Members of the Kingston Branch and their guests met at the Kingston Badminton Club on the evening of October 22nd to honour Dr. W. L. Malcolm, M.E.I.C., past Professor of Municipal Engineering at Queen's University, recently appointed Director of the School of Civil Engineering, Cornell University; and Dr. J. B. Challies, the President, on his annual visit to the Branch.

Among the many guests, prominent in Canadian educational and engineering circles, were: Principal R. C. Wallace, Vice-Principal W. E. McNeill and Dean A. L. Clark, of Queen's University; Brigadier H. D. G. Crerar, Commandant, and Prof. L. N. Richardson of the Royal Military College; Dean H. W. McKiel, M.E.I.C., of Mount Allison University; J. A. McCrory, M.E.I.C., Vice-President for Quebec; Fraser Keith, M.E.I.C., Ross Dobbin, M.E.I.C., former Vice-President for Ontario, and others from the Montreal, Peterborough and Ottawa branches.

Numerous letters were received, expressing regret at being unable to attend, and extending heartiest good wishes to Dr. Malcolm in his new sphere.

Major H. H. Lawson, M.E.I.C., Chairman of the Kingston Branch, presided.

After the Toast to the King, Lt.-Col. L. F. Grant, M.E.I.C., in proposing the toast to Dr. Malcolm, outlined his career and his outstanding services as a scholar, teacher, engineer, soldier and gentleman. "At a time of life when most men would be content to rest on their laurels, Dr. Malcolm had forged steadily on in his chosen field, and through his efforts Queen's today had one of the outstanding Sanitary Engineering laboratories on this continent." The speaker concluded by expressing the deep regret that Dr. Malcolm's colleagues, fellow engineers and friends had felt at his departure, but said that in attaining this high position at Cornell, he had brought honour not only to himself, but to Queen's and Canadian engineers. A hearty "For He's a Jolly Good Fellow" followed.

Dr. Malcolm expressed his deep appreciation for the many tributes that had been paid him and voiced his regret at having to leave his colleagues and friends at Queen's, the Royal Military College and Kingston. He spoke of happy days spent at Queen's and the cordial relations existing there, and then briefly outlined his work at Cornell, as Director of the Civil School, contrasting the Canadian and American universities. He paid tribute to Principal Wallace, Dr. McNeill, Dean Clark and T. A. McGinnis, for their counsel and assistance in making possible the construction of the Sanitary Engineering laboratory. He expressed the hope that greater co-operation would result between Queen's and Cornell, in view of the fact that Prof. Baty, his successor at Queen's, was a Cornell Graduate and several of the Queen's staff were also graduates of the same school, and, he added, he hoped as an individual to assist in the promotion of good relations between Canadian and American universities. Dr. Malcolm asked all his colleagues and friends to remember that Cornell is not far distant and that they would always be very welcome guests. He voiced his intention of forever maintaining his relations and friendships in Canada and concluded with an "Au Revoir, Not Goodbye."

The Toast to the Profession was proposed by Lt.-Col. W. P. Wilgar, M.E.I.C., who paid tribute to Dr. Malcolm and his work at Queen's. In his own inimitable style, he then introduced the President, Dr. J. B. Challies, as one of the famous class of '03 engineers from Varsity, Queen's and McGill, and as one who had devoted much of his time to the service of The Institute.

Dr. Challies in responding to the toast to the profession outlined the great advance of the engineering profession that has been made in the last sixty years, and alluded to the fact that at the time of Confederation there was not one Engineering School in Canada. For decades, no engineers had entered public life, but now many engineers held high public positions and, he added, that we as engineers had gained equal status with other professions. He discussed at length the progress made in bettering relationships between the provincial bodies and The Institute, and stated that in Saskatchewan reciprocal membership had now been provided for. He looked forward to a much closer co-operation with all the provincial associations. A policy of assisting the young engineer in becoming established after graduation was, the speaker remarked, an essential one for The Institute, and one that should be adopted at an early date. In concluding, Dr. Challies paid high tribute to Dr. Malcolm, and said that we had in him a worthy ambassador of good will to further strengthen the bond of friendship between the United States and Canada.

Others who spoke briefly were Dean McKiel, Mr. Ross Dobbin, Mr. McCrory and Mr. Austin Wright, General Secretary.

After the dinner, guests and members met in the lounge and enjoyed a pleasant get-together which gave all an opportunity of extending their best wishes to Dr. Malcolm and also of greeting Dr. Challies and Mr. Wright.

Montreal Branch

E. R. Smallhorn, A.M.E.I.C., Secretary-Treasurer.

Visit to Shawinigan Falls

On Saturday, September 17th, 1938, about 65 members left Windsor Station at 9.15 a.m. for Shawinigan Falls. Some years had elapsed since the last visit to this district, and it was felt that while the trip would be new to many, even those who had been there before would be interested in again making a visit. This proved to be so, as most of those who went were senior members.

The Montreal Branch was pleased to accept the kind invitation of the Shawinigan Water and Power Company, who were the hosts from the time the train arrived until it departed. They met the train with a fleet of automobiles, entertained the party at luncheon and tea at the Cascade Inn, and transported everybody between the various plants, the Inn, and back to the train.

Arriving at Shawinigan Falls shortly after noon, the first event was the luncheon at the Inn. J. A. McCrory, M.E.I.C., vice-president of the Shawinigan Water and Power Company, welcomed the party on behalf of his Company. B. R. Perry, M.E.I.C., Chairman of the Montreal Branch, and H. J. Ward, A.M.E.I.C., Chairman of the St. Maurice Valley Branch, spoke briefly. Both expressed thanks to the Shawinigan Company for their hospitality, and both expressed pleasure in the opportunity afforded by the occasion to the members of both branches to become better acquainted. Mr. Perry also thanked the management of the Consolidated Paper Corporation for the arrangement they had made to operate the Belgo Mill on Saturday afternoon—contrary to their usual practice—for the benefit of the party.

After luncheon the party visited the paper mill, Shawinigan Power House No. 1 and the Carbide Company. At each plant guides were ready to receive the party, and as there was one guide to every six or seven visitors, the plant inspections were in the nature of a personally conducted tour. At each plant every department was operating, and the visit to the Carbide Plant was timed so that everybody saw a carbide furnace being tapped.

The party was then driven back to the Inn, where cocktails, etc., and tea were served until train time, 7.30 p.m.

It was only by careful scheduling that such an ambitious programme was covered in such a short time, and appreciation was expressed to those members of the Shawinigan staff who were responsible for the arrangements.

The party travelled to and from Shawinigan Falls in special chair cars. These cars went direct from Montreal, and waited at Shawinigan for the party for the return trip.

On the way back the committee of the Branch in charge had provided refreshments aboard the train, playing cards, etc. As a result, the return journey passed quickly and pleasantly.

The whole trip was very enjoyable, and the Branch have already conveyed their thanks to the Shawinigan Water and Power Company for their hospitality, and careful preparation of the programme, and to Dick Heartz and his committee for their work in co-operation with the Shawinigan Company with the Railway Company.

Joint Meeting with the Montreal Chapter of the A.S.H.V.E.

On October 6th a joint meeting of the Montreal Branch with the Montreal Chapter of the American Society of Heating and Ventilating Engineers was planned to take advantage of the fact that the officers and members of Council of the A.S.H.V.E. were in Montreal, holding their quarterly meeting under the presidency of E. Holt Gurney, of Toronto, the first Canadian to head the Society.

Two papers were presented before the meeting, "Air Conditioning in Glass Brick Building," by J. Herbert Walker, Member of Council, A.S.H.V.E., and engineering assistant to the general manager of the Detroit Edison Company, and "The Architect and the Engineer," by James F. McIntire, Member of Council and 1st Vice-President A.S.H.V.E., and Vice-President of the United States Radiator Corporation.

B. R. Perry, M.E.I.C., Chairman of the Montreal Branch, E.I.C., and G. Lorne Wiggs, M.E.I.C., Member of Council, A.S.H.V.E., were the joint chairmen of the meeting. President Challies extended a welcome to the visitors on behalf of The Institute.

Some Psychological Aspects of Scientific Management

The meeting on October 13th was addressed by L. P. Alvin, an engineer from Paris who holds the position of Paris Director of the Cie Generale de Traction sur les Voies Navigables. Mr. Alvin is widely known on the continent in transportation and engineering circles and in 1935 was awarded the Inland Water Transport Medal of the French Institute of Transport. He had been attending the International Management Congress in Washington, September 19th-23rd. In his paper Mr. Alvin stressed the importance of considering the workers' psychology in planning any scheme of factory organization. Social consequences of reorganization should be considered both from the aspect of improved efficiency and from the standpoint of the workers' wellbeing. Science and psychology in industry are inseparable, especially in the case of smaller firms, and technical superiority alone is not sufficient to ensure the success of a scientific management scheme.

Prior to the meeting, a courtesy dinner was held at the Windsor hotel, 6.30 p.m. J. S. Cameron, M.E.I.C., acted as chairman of the meeting.

Junior Section

On Monday, October 17th, the first meeting of the fall session of the Junior Section of the Montreal Branch was addressed by A. N. Farrell, A.M.E.I.C., on the subject of "Scientific Property Management." Mr. Farrell graduated from McGill University in civil engineering in 1924 and for the past ten years has been with the Royal Trust Company, Montreal, supervising property, maintenance and repairs. Following this interesting address a Bethlehem sound film on "Structural Shapes" was shown. Refreshments were served after the meeting.

Technical Film

"Steel, Man's Servant" was the title of the film shown to the Montreal Branch meeting on October 20th through the courtesy of the United States Steel Corporation. This was the first meeting held since the completion of the renovations at Headquarters and following the showing of the film an informal evening was spent and refreshments served. President Challies introduced the president elect, Dean H. W. McKiel, to the 350 members present, and altogether it was a most enjoyable gathering.

R. E. Heartz, M.E.I.C., acted as chairman.

Ottawa Branch

R. K. Odell, A.M.E.I.C., Secretary-Treasurer.

Electrification of Canals in France

On the evening of October 12th, at the auditorium of the National Research Laboratories, L. P. Alvin, noted French engineer from Paris, France, gave an address on transportation in France with particular reference to the system of canals in that country used largely for the transport of bulk freight. Mr. Alvin stated that there were various problems common to rail, road, and water systems of transportation in connection with the attainment of a high commercial speed.

The main problems he enumerated as:

1. Speed in free circulation.
2. The operation of the carrying units whether singly or coupled together in "trains."
3. The spacing of the units in travel so as to obtain the greatest freedom in motion and efficiency.

In an endeavour to obtain the best solution for these problems, so far as the canal system is concerned, there has been effected an electrification, that is, barges are drawn through canals by the use of electrical engines, travelling on railroad tracks placed alongside of the canal shores. In this particular regard France is the most advanced country in the world, another notable example of electrification being at the Panama Canal where, however, it is operated in certain sections only. For the greater part of the canal system it has been found more expedient to operate the barges singly.

The address, which was illustrated with lantern slides, dealt largely with the methods used and types of equipment employed in carrying on this electrification work.

The chairman of the Branch, W. F. M. Bryce, A.M.E.I.C., presided, and the vote of thanks to the speaker at the conclusion was moved by G. J. Desbarats, Hon.M.E.I.C., and seconded by J. J. Murphy, M.E.I.C. Following the address proper, a very interesting period of discussion ensued when many questions bearing upon the subject of the address—in some cases rather remotely—were discussed.

Peterborough Branch

A. L. Maltby, Jr. E.I.C., Secretary-Treasurer.
J. L. McKeever, Jr. E.I.C., Branch News Editor.

The opening meeting of the 1938-39 season took the form of a supper and social gathering at the Kawartha Golf and Country Club on Thursday, September 29th. For the past few years the opening meeting has taken this form and a number of the members have been asked to invite as their guest a junior engineer, usually a student on the C.G.E. Test Course, who is not yet a member of the Branch. This gives the young engineer a chance to meet the members and to gain an idea of the objects and activities of The Institute with the hope that he may feel the urge to join the Branch. Past meetings of this type have been highly successful and the present one was no exception.

After the supper the Branch chairman, W. T. Fanjoy, A.M.E.I.C., gave a short outline of the activities of the Branch, following which our Councillor, A. B. Gates, A.M.E.I.C., outlined the work of Council and gave his ideas as to probable future relations between The Institute and the Professional Associations. The guests were then introduced to the meeting by I. F. McRae, A.M.E.I.C., who at the same time gave a short summary of the more lurid details in their respective pasts.

The remainder of the evening was spent in viewing films and playing table-tennis. The attendance was 53.

The first technical meeting of the 1938-39 season was held on Thursday, October 13th, at which the speaker was Mr. J. M. Somerville of the engineering staff, Canadian Porcelain Company, and his subject:

The Manufacture of High Voltage Wet Process Insulators

Mr. Somerville was able to show samples of the various ingredients of porcelain and his talk was well illustrated by slides picturing all the stages of the manufacture. He described the grinding of the materials in the ball mills, the mixing, and pumping of the mix through the filter presses. The cake taken from the filter presses is treated according to the product to be made, for instance some types of insulators are moulded while others are moulded and turned in a lathe.

The firing of the insulator is an extremely important part of the manufacture and must be carefully controlled while sampling and testing is carried out in all the various stages. The finished insulator is tested both mechanically and electrically and a very small percentage of defects in a batch may mean the scrapping of the whole batch. Standard electrical tests consist of high frequency and both wet and dry normal frequency flashover.

By means of his slides the speaker described the various designs of suspension and pin type insulators in use with comments on the special designs suited to locations where fog or conducting-fumes are present.

The numerous questions asked of the speaker after the presentation of his paper indicated the interest with which it was received by the Branch. The attendance was 36.

Saguenay Branch

F. T. Boutilier, A.M.E.I.C., Secretary-Treasurer.
J. W. Ward, A.M.E.I.C., Branch News Editor.

Operating Experience with Rotary Converters

The regular monthly meeting of the Saguenay Branch was held in the main office of the Aluminum Company of Canada at Arvida, Que., on Friday evening, August 5th, 1938. The guest speaker for the evening was Mr. William Fraser, electrical engineer with the Aluminum Company of Canada Ltd., who spoke on "Operating Experiences with Rotary Converters."

Since aluminum is manufactured by the electrolytic process and requires a large amount of direct current, rotary converters are an important unit in the process. Mr. Fraser has had considerable experience in this field and his remarks were extremely interesting and instructive. Some of the most important points brought out are as follows:

The absence of commutating difficulties, due to field distortion. This objectionable characteristic of D.C. motors and generators is practically eliminated in rotary converters because the windings carry the difference between the alternating and direct currents. A.C. brush wear has been reduced by helical grooves cut on the face of the slip rings. These grooves pass over the face of the brush and allow the local hot spots to cool off and distribute the contact points over the entire brush face. The method used to cut the grooves with the armature in place was clearly illustrated with lantern slides.

Flash-over is produced by short circuit currents flowing through the brush face and striking an arc between the bars of the commutator. These arcs fill the space between the brush arms with ionized gases and flash-over occurs either between the brush arms or between a brush arm and ground. The short circuit currents through the brush face are produced by distortion of the magnetic field when synchronizing currents flow in the armature conductors. These synchronizing currents may be due to outside A.C. line disturbances or rapid fluctuations in load on the D.C. side of the converter. Flash-over due to field distortion can be minimized by setting the brushes slightly off the neutral position.

At full load a rotary converter should be run at unit power factor. If the power factor were changed from unity to say 95 per cent in an alternator or synchronous motor, the heating of the coils would be increased approximately 11 per cent while in a rotary converter the heating of certain of the coils would be increased 85 per cent.

A meeting of the Saguenay Branch was held in the main office of the Aluminum Company of Canada, Ltd. at Arvida, Que., on Wednesday evening, September 7th, 1938.

Two sound pictures supplied by Imperial Oil Company, namely "The Inside Story" and "Design for Power," were presented to the gathering, and were extremely interesting both from the technical point of view and from the point of view of the layman.

"The Inside Story" dealt with the lubrication of all types of equipment, showing clearly why lubrication was necessary and the results of poor and good lubrication.

"Design for Power" dwelt primarily on the lubrication and combustion features of the automobile engine, and showed how lubrication and gasoline quality had such a major part in bringing the automobile engine to the high point of efficiency it has reached today.

When the pictures had been run, Mr. Tanner of the Imperial Oil Company Staff answered a large number of questions brought up by some of the members.

Saint John Branch

F. A. Patriquen, Jr.E.I.C., Secretary-Treasurer.
F. L. Black, Jr.E.I.C., Branch News Editor.

Thirty members of the Saint John Branch attended the opening meeting of the winter season in the Admiral Beatty hotel on Thursday, October 13th, 1938. The meeting was preceded by a dinner which started at 6.00 p.m. This is the first time that a dinner has been held in connection with a regular monthly meeting of the Branch, the idea of the change being, that it leaves the evening free after 8.00 or 8.15 p.m. for other engagements of the members.

The Branch chairman, W. H. Blake, A.M.E.I.C., was in the chair, and Mr. L. W. Simms, President of the T. S. Simms and Company, manufacturers of brushes and brooms, addressed the Branch on "Research in Industry." His talk outlined the part that engineers, their reports and their time studies played in the very diversified processes of manufacture carried on by his company. Mr. Simms also outlined the history of the company, its different products or "lines" and the difficulties in keeping costs on the various products.

After a very hearty vote of thanks, the meeting adjourned at 8.00 p.m.

St. Maurice Valley Branch

L. B. Stewart, Jr.E.I.C., Secretary-Treasurer

On October 8th, 1938, the St. Maurice Valley Branch, E.I.C., had the pleasure of entertaining the Presidential party at a Branch dinner at the Cascade Inn, Shawinigan Falls. The party consisted of the President, J. B. Challies, M.E.I.C., the General Secretary, L. Austin Wright, A.M.E.I.C., and the Chairman of the Committee on Professional Interests, Fred Newell, M.E.I.C.

The Chairman of the Branch, H. J. Ward, A.M.E.I.C., and 28 members were present to honour these distinguished guests.

In introducing the President, Mr. Ward expressed the pleasure of the Branch at being privileged to hear of the work of The Institute from these important Headquarters officials. He referred to the high standing of Mr. Challies in the profession, and offered congratulations for the honour which was about to be bestowed upon him by the University of Toronto, an honorary Doctor of Engineering.

Mr. Challies thanked the Branch for their invitation to visit here, and remarked that, because of his business connection, he felt quite at home in this district.

He spoke of the many reasons engineers have for being thankful at this thanksgiving season, and reported on the success of the E.I.C. in its various branches of endeavour. He mentioned his recent visit to the Maritime Branches and of his proposed trip to Ontario and the West.

He paid a fine tribute to Professor McKiel, of Sackville, N.B., the unanimous nominee of the Nominating Committee for President next year. He said that Professor McKiel's ideal was to look after the young engineer, and that this should be the primary purpose and opportunity of The Institute as a whole.

He spoke of the prestige of the E.I.C. both in this and in other countries, and of the many Canadian engineers who are holding key positions in industry and in finance and in various provincial and federal governments.

In closing he paid tribute to the work on Council of Vice-President Keay and of Councillor Wardle, both members of this Branch.

On request of the Chairman, Mr. Challies introduced Mr. Newell, stating that he is Chief Engineer of the Dominion Bridge Co., and Chairman of the E.I.C.'s Committee on Professional Interests.

Mr. Newell spoke on the negotiations that have been carried on in regard to "Co-operation" between The Institute and the professional associations of the various provinces. He described the success of these negotiations in some provinces and the difficulties that have been met with in others.

Mr. Ward then introduced Mr. Wright, giving a brief résumé of his career and attainments.

Mr. Wright spoke on the value of membership in the E.I.C., naming and illustrating many advantages that accrue from such membership.

He mentioned the services supplied by The Institute to its members, such as Employment, the Library, the guidance of students, introductions to outside organizations and to foreign countries, etc., etc., and explained how these services are being increased and improved.

After a few closing remarks the Chairman adjourned the meeting at 10.30 p.m.

Toronto Branch

J. J. Spence, A.M.E.I.C., Secretary-Treasurer.
D. D. Whitson, A.M.E.I.C., Branch News Editor.

On Tuesday, September 13th, 1938, the branch held its first meeting of the 1938-39 season in the form of a golf tournament and dinner at the Islington Golf Club. Dull skies held the number of players to thirty, but the competition was keen, and good fellowship reigned to such an extent that the tournament promises to be an annual event. Percy Dobson, M.E.I.C., showed the members how to play, touring Islington's long fairways in 88, taking the low gross prize, with Hew Scott, M.E.I.C., in second place, and S. R. Frost, A.M.E.I.C., lately of the Niagara Branch, getting low net among the handicap players. At dinner the numbers had increased to 45. There were many short speeches, one of the most enjoyable being by Eric Muntz, M.E.I.C., of the Hamilton Branch. Harry Brandon, A.M.E.I.C., was chairman of the committee in charge, and was ably assisted by Nichol MacNicol, M.E.I.C., and Barry Watson, A.M.E.I.C.

New and Revised Specifications

British Standard Specifications are kept on file and may be consulted at the following offices: H.M. Senior Trade Commissioner, 1111 Beaver Hall Hill, Montreal; H.M. Trade Commissioner, 67 Yonge Street, Toronto; H.M. Trade Commissioner, 703 Royal Bank Building, Winnipeg; H.M. Trade Commissioner, 850 Hastings Street West, Vancouver.

Canadian Engineering Standards Association: S47T-1938 Standard Specifications for Welded Steel Buildings, Welding by the Metallic Arc Process, Tentative Welding Qualification Code for Fabricators, Contractors, Supervisors and Welders; S48T-1938 Tentative Specification for Metallic Arc (Iron and Steel) Electrodes for Welded Steel Buildings. The scope of these specifications applies specifically to steel structures for buildings and does not include welding of bridges, pressure vessels or mechanical equipment.) C22.2 No. 7-1938 Portable Electric Displays and Incandescent-Lamp Signs. These specifications are $0.50 each.

Canadian Government Purchasing Standards Committee: Specification for Gasoline; Fuel Oil; Illuminating Oils; Petroleum Lubricating Oils; Aviation Fuel; Diesel Fuel Oil. Procedure for the Determination of Gum Content of Gasoline in the Presence of Top Cylinder Lubricant (tentative); Procedure for the Determination of Gum Stability of Gasoline (tentative).

U.S. Department of Commerce National Bureau of Standards: Building Materials and Structures, Report BMS2 Methods of Determining the Structural Properties of Low-Cost House Constructions; Report BMS3 Suitability of Fiber Insulating Lath as a Plaster Base.

Preliminary Report Issued on Fallentimber Area, Alberta

Oil and gas possibilities of structures in the Fallentimber area, fifty-five miles northwest of Calgary in Alberta, are discussed by B. R. MacKay in his preliminary report (Paper 38-23) on the geology of the area issued recently by the Geological Survey Division, Department of Mines and Resources, Ottawa.

Geological interest in the 370 sq. mi. area is centred chiefly on four anticlinal structures, cross sections of which appear on a map accompanying the report, which also shows the geology of the area. Two of these structures have been partly tested by drilling, but the depth of the Palaeozoic limestone is as yet a matter of inference, as no holes sufficiently deep to tap this formation have been drilled. However, from the geological studies the minimum distance to the limestone is estimated to be at least 7,500 ft.

A well put down on the Monarch anticline in 1914 tested this structure only to a depth of 3,500 ft. A small seepage of crude oil was reported to have been struck at a depth of 808 ft., and in some of the lower sandstone horizons a number of other small seepages of oil and sufficient flows of gas to supply light, heat and power for the drilling plant were encountered.

Fallentimber area lies fifteen miles west of the Calgary, Red Deer and Edmonton Branch of the Canadian Pacific Railway, and twenty-five miles north of the Calgary-Banff highway. Good motor roads run west into the area from Olds, Didsbury and Carstairs, the road from Olds being the one most widely travelled. Supplies are obtained chiefly from Sundre and Cremona.

Copies of the report and accompanying map may be obtained from the Director, Mines and Geology Branch, Department of Mines and Resources, Ottawa.

Preliminary Notice

of Applications for Admission and for Transfer

October 26th, 1938.

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 December 1938.

L. Austin Wright, General 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

DRAKE—EDWARD MICHAEL, of 3484 Westmore Ave., Montreal, Que. Born at Blaine Lake, Sask., Dec. 1st, 1911; Educ.: B.Eng., McGill Univ., 1934; 1934-35, student engr., 1935-37, sales engr., A. Reyrolle & Co., Hebburn-on-Tyne, England; 1937 to date, sales engr., Northern Electric Co. Ltd., Montreal, Que.

References: W. R. Bunting, C. V. Christie, A. V. Armstrong.

FAIR—JOHN LOWTHER, of 576 Sherbrooke St., Peterborough, Ont. Born at Guelph, Ont., Nov. 9th, 1912; Educ.: B.A.Sc. (Elec.), Univ. of Toronto, 1935; 1934 (summer), and May, 1935, to Sept., 1936, W. C. Wood Co. Ltd., Toronto, on assembly, test, installn. and service of commercial refrigeration and elect'l. farm equipment; 1936-37, mtce. work, Toronto, and 1937 to date, student's course, Can. Gen. Elec. Co. Ltd., Peterborough, Ont.

References: W. T. Fanjoy, B. I. Burgess, B. Ottewell, J. Cameron, H. R. Sills.

GREGOR—MICHAEL, of 6 Riley Road, Port Arthur, Ont. Born at Derbent, Russia, Feb. 6th, 1888; Educ.: C.E.,Inst. Engrs. of Ways and Communications, St. Petersburg, Russia, 1912; R.P.E. of New York State. Member A.S.C.E.; 1914-15, chief engr., First Russian Aircraft Corpn.; 1915-18, cons. engr., Th. Meltzer; 1918-20, constrn. engr., Gov. of Georgia, Russia; 1928-32, design and cons. engr., Bird Aircraft Corpn., Brooklyn, N.Y.; 1931-34, consltg. engr., Seversky Aircraft Corpn.; 1934-37, consltg. engr., New York City; Nov. 1937 to date, chief aeronautical engr., Canadian Car and Foundry Company, Fort William, Ont.

References: G. R. Duncan, P. E. Doncaster, D. Boyd, W. S. Atwood.

MITCHELL—KEITH WESTON, of 803-17th Ave. North West, Calgary, Alta. Born at Edmonton, Alta., Oct. 26th, 1908; Educ.: B.Sc. (Civil), Queen's Univ., 1934; 1934, rodman, Ontario Dept. of Highways; With the Canadian Western Natural Gas. Light, Heat & Power Co. Ltd., Calgary, as follows: 1935, establishing grades, etc., 1936 (summer), designing and supting. constrn. of concrete piers, laying of bitumastic pavement; 1936 to date, work covered design and superintending of various works, including concrete floor, roof structure, gas transmission lines, air ventilating and conditioning layout for office bldg. and auditorium, inspection and reports on boiler plant efficiencies, design of footings to support steel to rehang boilers, supting rebuilding of same and installing Smoot automatic controls.

References: E. W. Bowness, W. B. Trotter, F. J. Heuperman, W. P. Wilgar, W. L. Malcolm, J. S. Neil.

McHENRY—MORRIS JAMES, of 64 Grenview Blvd., Toronto, Ont. Born at Catasauqua, Penna., Aug. 7th, 1888; Educ.: B.A.Sc. (Elec.), McGill Univ. 1910; 1910-12, elect'l. design dftsman., Smith Kerry & Chace, Toronto; 1912-16, sales engr., Can. Gen. Elec. Co. Ltd., Toronto; 1916-18, asst. mgr., Toronto office, apparatus sales dept., Can. Gen. Elec. Co.; 1918-24, mgr. and sec'y-treas., Walkerville Hydro Electric, Walkerville, Ont.; 1924-26, sales mgr., Ferranti Electric, Toronto; 1926-30, mgr., U.S. sales dept., Can. Gen. Elec. Co. Ltd., Toronto, and 1930-38, mgr., Toronto district for same company; at present, director, sales promotion, Hydro-Electric Power Commn. of Ontario, Toronto, Ont.

References: W. E. P. Duncan, C. E. Sisson, T. H. Hogg, W. E. Ross, E. V. Buchanan.

ROSS—DONALD KENNETH, of 2055 Mansfield St., Montreal, Que. Born at Regina, Sask., Aug. 20th, 1907; Educ.: B.Sc., 1930, M.Sc., 1933, Univ. of Man. 3 years post-grad. work at McGill (1933-36). All work for Ph.D. degree, except thesis, finished; 1927-29 (summers), rodman and road inspr., Manitoba Good Roads; 1929-32, materials and testing engr. i/c asphaltic paving and testing of materials, Manitoba Good Roads Assn.; 1936 to date, mgr., Montreal and Maritimes district, Donald-Hunt Limited, inspection engrs., Montreal, Que.

References: J. R. Donald, H. W. B. Swabey, A. G. Murphy, K. E. Whitman.

SMITH—DONALD SINCLAIR, of 3484 Westmore Ave., Montreal, Que. Born at Newark, N.J., June 3rd, 1910; Educ.: B.A.Sc., M.A.Sc., 1933, Univ. of B.C.; 1933-35. student engr., 1935-36, engr., tech. and research dept., A. Reyrolle & Co., Hebburn-on-Tyne, England: 1936 to date, sales engr., Northern Electric Co. Ltd., Montreal, Que.

References: E. G. Cullwick, H. P. Archibald, A. V. Armstrong, W. R. Bunting, C. R. Crysdale, H. Fellows.

WEIR—CHARLES VICTOR FRASER, of Edmonton, Alta. Born at New Glasgow, N.S., Jan. 14th, 1902; Educ.: B.A.Sc., Univ. of Toronto, 1929; 1927 (summer), dftsman and inspr., Horne Copper Corpn., Noranda, Que.; 1928 (summer), meter dept. work, H.E.P.C. of Ont.; 1929-30, installn. engr., 1930-31, service engr., 1931-32, emergency engr., Northern Electric Co. Ltd., Montreal; 1937, dftsman, Dec. 1937 to date, field engr., power plant dept., City of Edmonton, Alta.

References: R. G. Watson, W. I. McFarland, C. A. Robb, H. R. Webb, E. L. Smith, R. S. L. Wilson.

FOR TRANSFER FROM THE CLASS OF ASSOCIATE MEMBER TO THAT OF MEMBER

DAWSON—WILLIAM ASH, of Orillia, Ont. Born at Barrie, Ont., Aug. 16th, 1892; Educ.: B.Sc. (Mech.), Queen's Univ., 1923; 1923-35, with the Ford Motor Co. of Canada as follows: 1923-28, mech. dftsman, 1928-30, contact man between Canadian and American plants; 1930-35, supervisor of machine and tool design and stock specifications; 1935-37, asst. supt. of shops and foundries, Algoma Steel Corpn., Sault Ste. Marie, Ont.; 1937-38, plant engr., Chrysler Corporation of Canada, supervised installn of machy. and equipment of new motor plant at Windsor, Ont.; at present, plant mgr., E. Long Limited Engineering Works, Orillia, Ont., bldg. special mining equipment and gen. engrg. work. (*St. 1921, A.M. 1925.*)

References: L. T. Rutledge, F. Smallwood, B. Candlish, E. M. Krebser, H. J. A. Chambers, R. C. Leslie, C. F. Davison.

MECHIN—FREDERICK CHARLES, of 11844 Notre Dame St. E., Pointe Aux Trembles, Que. Born at Claremont, Ont., March 15th, 1887; Educ.: B.A.Sc., Univ. of Toronto, 1914; 1909-14 (summers), land survey and constrn. work; 1914, field engr. and asst. supt. of constrn., Raymond Constrn. Co.; 1917-18, C.E.F. Forestry Unit, on staff of Civil Engineer in Chief of the Admiralty; in charge of oil pipe line constrn. in Scotland; With the Imperial Oil Limited as follows: 1916, field engr., Montreal; 1917, supt of constrn., Halifax; 1919-20, mech. supt. and refinery engr., Halifax; 1921-22, asst. supt. of refinery, Halifax; 1923-34, supt. of refinery, and 1935 to date, manager, Montreal Refinery. (*A.M. 1917.*)

References: J. B. Challies, O. O. Lefebvre, J. M. R. Fairbairn, W. F. Drysdale, deG. Beaubien, B. R. Perry.

McCAMMON—JOHN WHYTE, of 11 Belfrage Road, Westmount, Que. Born at Inverness, Que., July 13th, 1888; Educ.: B.Sc. (E.E.), McGill Univ., 1912; 1908-11, engrg. ap'tice, Canadian Westinghouse Co.; 1912-13, asst. mech. and elect'l engr., on constrn. of Mount Royal Tunnel, Mackenzie Mann Co.; 1913-23, mgr., hydraulic and elect'l dep'ts., Canadian Fairbanks Morse Co.; 1923-29, contracting engr., sales mgr. and director, Charles Walmsley & Co. of Canada Ltd.; 1929-34, asst. gen. mgr., Beauharnois Light, Heat & Power Co.; 1934-35, private consltg. work; 1935-37, commissioner, Quebec Electricity Commission; 1937 to date, controller, Provincial Electricity Board, Montreal, Que. (*Jr. 1913, A.M. 1924.*)

References: O. O. Lefebvre, J. B. Challies, E. A. Ryan, R. A. C. Henry, C. V. Christie, A. Frigon.

FOR TRANSFER FROM THE CLASS OF JUNIOR

CROSSLAND—CHARLES WILFRED, of Ottawa, Ont. Born at Barrie, Ont., Jan. 4th, 1906; Educ.: B.Sc. McGill Univ., 1931, M.Sc. Mass. Inst. Tech., 1932; 1933-35, aircraft stress calculator, Hawker Aircraft; 1935-36, aircraft stress calculator, Saunders-Roe Ltd.; 1936-38, asst. engr., and Jan. 1938 to date, senior asst. engr., aeronautical br., Dept. of National Defence, Ottawa, Ont. (*St. 1928, Jr. 1934.*)

References: E. W. Stedman, A. Ferrier, C. M. McKergow, A. R. Roberts, R. DeL. French.

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DESMARAIS—JEAN RENE, of 351 Charlotte St., Peterborough, Ont. Born at Montreal, Que., Sept. 21st, 1911; Educ.: B.A.Sc., C.E., Ecole Polytechnique, Montreal, 1937; 1937-38, testing dept., July 1938 to date, industrial control engrg. dept., Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*St. 1936.*)

References: W. T. Fanjoy, H. R. Sills, B. I. Burgess, G. R. Langley, W. M. Cruthers, J. Cameron, A. B. Gates.

SWARTZ—JOSEPH NORMAN, of Cornwall, Ont. Born at Montreal, Aug. 5th, 1911; Educ.: B.Eng., 1934, Ph.D., 1937, McGill Univ.; 1934-37, research, dept. of industrial chemistry, McGill Univ.; 1937 to date, technical control dept., Howard Smith Paper Mills, Cornwall, Ont. (*St. 1934.*)

References: J. B. Phillips, J. J. Crawford.

STEPHENSON—STEPHEN, of Toronto, Ont. Born at London, England, June 11th, 1907; Educ.: 1921-25, Oundle School, England; (Was to have taken B.Sc. at Manchester Univ., but could not do so, due to death of father. Took Oxford and Cambridge Exam. of close to same standard); Bell Telephone Course. Northern Electric Wire and Cable Course; 1925-26, student course, British Westinghouse; 1927-28, engrg. sales work in England; 1929-30, outside plant engr., Bell Telephone Company of Canada; 1931-35, manager, automobile parts and equipment business for self; 8 mos., 1936, sales engr., Metallic Roofing Co., roads supplies divn., design of small steel bridges, sales of culverts and professional advice to counties and townships; 1936-37, power apparatus and wire and cable engr., Northern Electric Co., including 3 mos. course and writing thesis covering manufactures at Montreal plant; 1937 to date, engr., Whiting Corporation of Canada Ltd., Toronto, Ont., changing American design to Canadian standards, purchase of components, supervision of manufacture and control of production on overhead electric cranes, cupolas, ladles, misc. foundry equipment, rly. turntables and electric jacks, and chemical equipment (evaporators, etc.). (*St. 1930.*)

References: H. A. Lumsden, L. F. Grant, J. A. Loy, W. G. Tyler, A. V. Armstrong, A. T. Perrin, J. E. Goodman, A. Ritchie, R. A. Low.

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VOLUME XXI, No. 12 DECEMBER, 1938

THE arrangement and contents of this number of the Journal are somewhat unusual inasmuch as a full list of members is published in the place usually occupied by technical papers. Such a list is necessary in the conduct of the business of The Institute, and is useful and informative to the membership at large.

Members are reminded that they should make an effort to keep this number close at hand, as it will probably be necessary or desirable to make frequent reference to it in the future. It is also suggested that each member check his own record in both the alphabetical and geographical list, and notify Headquarters if any error appears. In this way such errors may be removed from any subsequent lists that may be published.

The December number has been selected for the purpose, principally because it marks the end of the year, and is the last number to appear with all the physical characteristics which have identified the Journal for the last several years. Therefore it seems quite appropriate that this cycle should conclude with the tabulation of the full strength of The Institute, and a list of officers, both past and present, who have had responsible charge of its affairs.

This list is issued for the personal use of members only, and each member is requested not to permit his copy to be used as a basis of circulation or for other purposes not in the interest of the membership or The Institute.

THE ENGINEERING INSTITUTE OF CANADA

List of Officers and Members of Council since the establishment of The Institute, showing the years during which office has been held.

PRESIDENTS

Anderson, W. P.	1904.
Blackwell, K. W.	1903.
Bovey, H. T.	1900.
Butler, M. J.	1914.
Camsell, C.	1932.
Challies, J. B.	1938.
Cleveland, E. A.	1936.
Decary, A. R.	1927.
Dennis, J. S.	1917.
Desbarats, G. J.	1937.
Duggan, G. H.	1916.
Fairbairn, J. M. R.	1921.
Francis, Walter J.	1923, 1924.
Gaby, F. A.	1935.
Galbraith, John	1908.
Gamble, F. C.	1915.
Gzowski, C. S.	1889, 1890, 1891.
Grant, A. J.	1930.
Hannaford, E. P.	1893.
Jennings, W. T.	1899.
Johnson, Phelps	1913.
Keating, E. H.	1901.
Keefer, S.	1888.
Keefer, T. C.	1887, 1897.
Kennedy, John	1892.
Lefebvre, O. O.	1933.
Leonard, R. W.	1919.
Lumsden, H. D.	1906.
Marceau, Ernest	1905.
Mitchell, C. H.	1929.
Monro, Thos.	1895.
Mountain, Geo. A.	1909.
Murphy, Martin	1902.
Peterson, P. A.	1894.
Porter, S. G.	1931.
Ross, R. A.	1920.
Rust, C. H.	1911.
Ruttan, H. N.	1910.
Shearwood, F. P.	1934.
Smith, Julian C.	1928.
St. Laurent, A.	1923.
Sullivan, John G.	1922.
Surveyer, A.	1924, 1925.
Thompson, W. G. McN.	1898.
Tye, W. F.	1912.
Vaughan, H. H.	1918.
Walbank, W. McL.	1907.
Walkem, G. A.	1926.
Wallis, H.	1896.

VICE-PRESIDENTS

Acres, H. G.	1921, 1922.
Anderson, W. P.	1902.
Blackwell, K. W.	1898, 1899.
Bovey, H. T.	1896, 1897.
Bowman, F. A.	1924, 1925.
Brown, E.	1933, 1934.
Brydone-Jack, E. E.	1915.
Buchanan, E. V.	1938.
Butler, M. J.	1906, 1907.
Cameron, E. G.	1934, 1935.
Carpenter, H. S.	1937, 1938.
Caton, E. V.	1935, 1936.
Chace, W. G.	1920, 1921.
Challies, J. B.	1924, 1925.
Condon, F. O.	1928, 1929.
Dawson, A. S.	1925, 1926.
Decary, A. R.	1924.
Dennis, J. S.	1907.
Desbarats, J. G.	1909.
Dobbin, R. L.	1936, 1937.
Dodwell, C. E. W.	1904, 1911.
Duggan, G. H.	1900, 1901, 1902, 1903, 1908.
Dunsmore, R. L.	1938.
Fairbairn, J. M. R.	1917, 1918.
Faulkner, F. R.	1930, 1931.
Francis, Walter J.	1919, 1920, 1921, 1922, 1923.
Gamble, F. C.	1913, 1914.
Gillespie, P.	1926, 1927.
Grant, A. J.	1928, 1929.
Gray, A.	1934, 1935.
Gzowski, C. S.	1887, 1888.
Hannaford, E. P.	1888, 1889, 1890, 1891.
Harkness, A. H.	1932, 1933.
Haultain, H. E. T.	1918, 1919.
Hayward, R. F.	1918, 1919.
Holgate, H.	1911, 1912.
Hunter, J. H.	1927, 1928.
Jennings, W. T.	1892, 1893, 1895, 1897.
Johnson, Phelps	1907.
Keating, E. H.	1899, 1900.
Keay, H. O.	1938.
Keefer, C. H.	1904, 1905.
Kennedy, John	1887, 1890, 1891.
Lefebvre, O. O.	1931, 1932.
Leonard, R. W.	1910.
Lewis, D. O.	1919, 1920.
Loudon, T. R.	1930, 1931.
Lumsden, H. D.	1898.
Lynch, F. J.	1891.
McCrory, J. A.	1937, 1938.
Macdonald, Chas.	1896.
MacDougall, A.	1894.
MacDougall, G. D.	1926, 1927.
Mackenzie, C. J.	1929, 1930.
McKiel, H. W.	1936, 1937.
MacLeod, G. R.	1929, 1930.
MacLeod, M. H.	1908.
Macpherson, D.	1905.
Marceau, E.	1901, 1902, 1903, 1904.
Mifflen, S. C.	1932, 1933.
Mitchell, C. H.	1920, 1921, 1922, 1923.
Mitchell, W. G.	1926, 1927, 1928, 1929, 1930, 1931.
Monro, Thos.	1892, 1893.
Monsarrat, C. N.	1917.
Mountain, G. A.	1903, 1905.
Muckleston, H. B.	1931, 1932.
Murphy, M.	1895.
Normandin, A. B.	1932, 1933, 1934, 1935, 1936, 1937.
Perley, H. F.	1888, 1889, 1890.
Peterson, P. A.	1889, 1892, 1893.
Porter, S. G.	1927, 1928.
Pratley, P. L.	1935, 1936.
Ross, R. A.	1914, 1915, 1916.
Rust, C. H.	1901, 1910.
Ruttan, H. N.	1909.
Shanly, W.	1887.
Shearwood, F. P.	1923, 1924, 1925.
Smith, C. B.	1906.
St. George, P. W.	1894, 1898, 1899, 1900.
St. Laurent, A.	1910, 1916, 1917.
Sullivan, J. G.	1911, 1912, 1913.
Surveyer, A.	1922, 1923.
Thompson, W. G. McN.	1896, 1897.
Thornton, K. B.	1925, 1926.
Tye, W. F.	1908, 1909, 1910.
Vaughan, H. H.	1912, 1913, 1914.
Walbank, W. McL.	1906.
Walkem, Geo. A.	1923, 1924.
Wallis, H.	1894, 1895.
White, T. H.	1916, 1917, 1918.
Wilson, R. S. L.	1933, 1934.

COUNCILLORS

Abbott, H.	1888, 1894.
Adams, W. C.	1927, 1928, 1929.
Allan, L. M.	1930.
Ambrose, J. R. W.	1916, 1917, 1918.
Anderson, J. N.	1927.
Anderson, W. P.	1890, 1891, 1901.
Antonisen, J.	1927.
Armstrong, C. G. R.	1935, 1936.
Archibald, P. S.	1894, 1895, 1901, 1911, 1912, 1913.
Arkley, L. M.	1926.
Askin, R. J.	1937, 1938.
Atkinson, M. B.	1928.
Attwood, C. H.	1930.
Baillairgé, C. P.	1902.
Baillairgé, G. F.	1889.
Baillarge, W. D.	1913, 1914, 1915.
Baltzell, W. H.	1924, 1925.
Barclay, W. D.	1896.
Barltrop, I. C.	1938.
Barnett, J. D.	1889, 1890, 1891, 1892, 1893, 1894, 1895, 1896, 1898.
Barrington, Y.C.	1936, 1937.
Bayfield, H. A.	1909.
Bayne, B. E.	1938.
Bell, J. A.	1910.
Bennett, H. F.	1930.
Bertram, Sir Alex.	1919, 1920, 1921.
Bigwood, H. M.	1924.
Blackburn, R. N.	1923, 1924, 1925.
Blackett, V. C.	1930.
Blackwell, K. W.	1889, 1890, 1891, 1892, 1902.
Blanchard, A. C. D.	1920, 1921, 1922, 1923.
Bonn, W. E.	1937, 1938.
Boswell, St. Geo. J.	1889, 1893, 1896, 1897, 1898, 1899, 1900, 1903, 1904.
Bovey, H. T.	1892, 1893, 1894, 1895.
Bowman, A. J. M.	1928.
Bowman, F. A.	1913, 1914, 1915, 1920, 1921, 1922.
Boyle, R. W.	1927, 1937, 1938.
Brakenridge, C.	1923, 1924, 1925.
Brazier, H. A.	1925.
Breithaupt, W. H.	1907, 1908.
Brereton, W. P.	1919, 1920, 1921.
Brooks, N. E.	1918, 1919, 1920.
Brophy, G. P.	1929.
Brown, C. B.	1915, 1916, 1917, 1934, 1935, 1936.
Brown, Ernest	1918, 1919, 1920.
Brown, Fred'k. B.	1920, 1921, 1922, 1923, 1924, 1925.
Brown, F. R. F.	1888, 1889, 1890, 1891, 1893.
Brown, G. S.	1929, 1936, 1937.
Brown, S. P.	1915, 1916, 1917.
Brydone-Jack, E. E.	1911, 1912, 1913.
Buchan, P. H.	1931, 1932, 1937, 1938.
Bucke, W. A.	1914, 1915, 1916.
Burbidge, G. H.	1926, 1931, 1932, 1933, 1934, 1935, 1936.
Burchell, H. C.	1905.
Burwell, H. M.	1920, 1921, 1922.
Busfield, J. L.	1926, 1927, 1928, 1930, 1931, 1932, 1933, 1934, 1935, 1938.
Buss, P. E.	1937.
Busteed, F. F.	1908, 1911.
Butler, M. J.	1896, 1897, 1904, 1905.
Butler, W. R.	1896, 1901, 1902, 1903, 1904, 1908.
Calvert, D. G.	1930.
Cambie, H. J.	1892, 1896, 1901, 1904, 1910.
Cameron, E. G.	1931, 1932, 1933.
Cameron, K. M.	1924, 1925.
Campbell, A. W.	1910.
Camsell, C.	1929, 1930.
Carpenter, H. S.	1921, 1922, 1923.
Cartwright, C. E.	1912, 1913, 1914.
Caton, E. V.	1925, 1926.
Cauchon, J. E. N.	1930, 1931.
Chace, W. G.	1915, 1916, 1917.
Chadwick, K. M.	1931.
Challies, J. B.	1920, 1921, 1922.
Chambers, A. R.	1925.
Chambers, H. J. A.	1937, 1938.
Chandler, R. B.	1928.
Chanute, O.	1894.
Chapleau, S. J.	1913, 1914, 1915.
Chipman, W.	1899, 1901, 1902.
Christie, C. V.	1931, 1932, 1933.
Cimon, J. M. H.	1930, 1931, 1932, 1933, 1934, 1935, 1936, 1937.
Clark, F. W.	1924.
Clark, G. T.	1923, 1924, 1925.
Clarke, W. E.	1928.
Clendening, C. S.	1934, 1935.
Cleveland, E. A.	1927.
Cockburn, J. R.	1934, 1935, 1936.
Combe, F. A.	1929, 1930, 1931.
Condon, F. O.	1926.
Conway, G. R. G.	1914, 1915, 1916.
Copp, W. P.	1931, 1932.
Coste, J. L. N.	1898.
Cousineau, A.	1934, 1935, 1936.
Coutlee, C. R.	1909, 1910, 1911, 1912, 1913.
Craig, G. W.	1920, 1921, 1922.
Craig, H. B. R.	1920, 1921, 1924.
Craig, J. D.	1928, 1929.
Crealock, A. B.	1935, 1936, 1937.
Crookshank, A. R.	1931, 1932.
Crudge, H. J.	1933, 1934, 1935.
Cunningham, G. C.	1889, 1893, 1894, 1895, 1896, 1897.
D'Aeth, J. B.	1937, 1938.
Darling, E. H.	1930, 1931.
David, E.	1928.
Davy, R. F.	1929.
Dawson, K. L.	1927.
Dawson, W. R.	1896.
Decary, A. R.	1914, 1915, 1916, 1917, 1918, 1919, 1920, 1921, 1922, 1923, 1925.
deHart, J. B.	1932, 1933.
Dennis, J. S.	1906, 1911.
Desbarats, G. J.	1900, 1907, 1933, 1934.
Dickson, T. H.	1936, 1937.
Dingwall, R. M.	1937, 1938.
Dion, A. A.	1907, 1908, 1915, 1916, 1917.
Dixon, H. A.	1928, 1929.
Doane, F. W. W.	1909, 1911.
Doane, H. W. L.	1928.
Dobbin, R. L.	1921, 1922, 1924, 1925, 1926, 1927, 1928, 1929, 1930, 1931, 1932, 1933, 1934, 1935.
Dodge, G. B.	1921, 1922, 1923.
Dodwell, C. E. W.	1890, 1891, 1892, 1895, 1897, 1898, 1899, 1900, 1903, 1907, 1910.
Domville, C. K.	1893.
Donkin, H.	1891, 1894, 1916, 1917, 1918.
Doucet, A. E.	1905, 1908, 1909, 1910, 1911, 1912, 1913, 1914, 1916, 1917, 1918.
Dow, J.	1926.
Dubuc, A. E.	1923.
Duchastel, J. A.	1922, 1923, 1924.
Duff, W. Arch.	1913, 1914, 1915.
Duggan, G. H.	1894, 1896, 1898, 1899, 1904, 1907, 1912, 1913, 1914.
Dunn, Guy C.	1920, 1921, 1922.
Duperron, A.	1937, 1938.
Durley, R. J.	1905, 1906, 1907, 1908, 1910, 1913, 1914, 1915.
Dyer, A. F.	1933, 1934.
Edwards, C. P.	1923, 1924, 1925.
Elliot, L. B.	1918, 1919, 1920, 1921.
Ellis, D. S.	1929.
Fairbairn, J. M. R.	1910, 1913, 1914, 1915, 1916.
Farmer, J. T.	1925, 1926, 1927.
Faulkner, F. R.	1924.
Fellowes, C. L.	1911, 1912, 1913, 1914.
Fergie, C.	1906, 1909.
Fetherstonhaugh, E. P.	1923, 1924, 1925.
Findlay, R. H.	1938.
Finnie, O. S.	1926.
Ford, A. L.	1927.
Forrester, T. A. J.	1915, 1916, 1917.
Francis, Walter J.	1910, 1913, 1914, 1915, 1916, 1917, 1918.
Frigon, A.	1935, 1936, 1937.
Galbraith, J.	1894, 1895, 1898, 1899, 1900, 1901, 1903, 1906.
Gale, G. Gordon	1919, 1920, 1921.
Gamble, F. C.	1892, 1898.
Garden, G. H.	1894.
Gates, A. B.	1936, 1937, 1938.
Gibault, J. E.	1919, 1920, 1921, 1922, 1923, 1924.
Gibb, R. J.	1928.
Gillespie, Peter	1918, 1919, 1920.
Gilpin, E.	1889.
Gisborne, F. N.	1887, 1888, 1889, 1891, 1892.

NOTE.—Names of deceased officers shown in italics.

Goodman, J. E. 1937, 1938.
Goodspeed, F. G. 1934, 1935, 1936.
Goodwin, L. F. 1933, 1934, 1935, 1936.
Grandmont, B. 1927, 1928, 1929, 1930, 1931, 1932, 1933, 1934, 1935, 1936, 1937.
Grant, L. F. 1927, 1938.
Gray, Alex. 1919, 1920, 1921.
Gray, E. R. 1920, 1921, 1922.
Green, F. C. 1926, 1932, 1933.
Greig, A. R. 1919, 1922, 1923, 1924.
Gunn, A. S. 1929.
Gutelius, F. P. 1907, 1908, 1908.
Haddin, J. 1938.
Haddow, A. W. 1926.
Hall, N. M. 1931.
Hannaford, E. P. 1887.
Hardman, J. E. 1906, 1907, 1910
Harkness, A. H. 1920.
Harris, R. C. 1933, 1934.
Haskins, Wm. 1894.
Haultain, H. E. T. 1910, 1911, 1912, 1913, 1914, 1915.
Hay, A. K. 1936, 1937.
Hay, A. L. 1931.
Herdt, L. A. 1906, 1909, 1910, 1911, 1912.
Hering, E. 1900, 1901.
Hertzberg, C. S. L. 1933, 1934, 1935.
Hesketh, J. A. 1911, 1912, 1913, 1914.
Heward, F. S. B. 1936, 1937, 1938.
Hewson, E. G. 1924, 1925, 1926.
Hoare, E. A. 1891, 1892, 1902, 1906.
Hobson, J. 1888, 1891, 1892.
Holden, O. 1938.
Holgate, H. 1906, 1908.
Houston, G. N. 1924, 1930, 1931.
Howard, S. 1899, 1902, 1903.
Hunter, J. H. 1925, 1926.
Irwin, H. 1896, 1897.
Jackson, W. 1934, 1935.
Jamieson, J. A. 1907.
Jaquays, H. M. 1911, 1912.
Jemmett, D. M. 1931, 1932.
Jennings, P. J. 1928.
Jennings, W. T. 1887, 1888, 1889, 1890, 1891.
Johnson, Phelps 1904, 1905, 1906, 1910, 1911, 1912.
Johnson, E. P. 1927.
Johnson, E. V. 1902, 1907.
Johnston, A. C. 1937, 1938.
Johnston, H. L. 1921, 1922, 1923.
Johnston, H. S. 1935, 1936, 1937, 1938.
Johnston, W. J. 1930, 1933, 1934.
Keating, E. H. 1896, 1897, 1898.
Keefer, C. H. 1892, 1893, 1903.
Keefer, G. A. 1889, 1890, 1897, 1905, 1907.
Keefer, S. 1887.
Keeley, D. H. 1897.
Keith, Fraser S. 1928, 1929, 1930.
Keith, J. C. 1927.
Kelley, H. G. 1910, 1911, 1913.
Kelsch, R. S. 1908, 1910.
Kennedy, John 1888, 1889, 1899, 1900, 1901, 1902, 1903, 1904, 1905, 1906, 1907.
Kennedy, J. C. 1911, 1912, 1913.
Kennedy, J. H. 1917, 1918, 1919.
Kennedy, W., Jr. 1908, 1909.
Ker, N. J. 1902, 1908, 1909, 1915, 1916, 1917.
Kerry, J. G. G. 1906, 1908.
Ketchum, H. G. C. 1890, 1892.
Kirby, C. C. 1921, 1922, 1923.
Kirby, G. H. 1935, 1936.
Lafleur, E. D. 1916, 1917, 1918.
LaMothe, G. E. 1925, 1931, 1932.
Lang, J. L. 1938.
Lariviere, A. 1938.
Laurie, W. H. 1907.
Lavoie, E. 1926.
Layne, G. F. 1927, 1933, 1934.
Lazier, F. S. 1925.
Lea, R. S. 1907, 1909.
LeBaron, K. S. 1938.
Lee, F. 1914, 1915, 1916.
Lees, T. 1930.
Lefebvre, O. O. 1925, 1926, 1928, 1929, 1930.
LeGrand, J. G. 1909, 1911, 1912.
Leonard, R. W. 1905, 1908, 1909.
Lesage, L. 1887, 1888.
Lewis, D. O. 1916, 1917, 1918.
Lewis, H. M. 1925.
Livingstone, R. 1928.
Longley, H. 1917, 1918, 1919.
Loucks, R. W. E. 1931.
Loudon, T. R. 1927, 1928, 1929.
Lumsden, H. A. 1938.
Lumsden, H. D. 1887, 1892, 1893, 1895.
Lumsden, J. F. 1929.
Macallum, A. F. 1927, 1928.
MacDougall, A. 1887, 1888, 1892, 1893, 1896, 1897.
Macdougall, G. D. 1923, 1924, 1925.
Macintyre, R. W. 1919, 1920.
MacKay, H. M. 1914, 1915, 1916.
Mackenzie, C. J. 1931, 1932.
Mackenzie, H. R. 1926, 1927, 1928.
MacKenzie, W. B. 1899, 1902, 1903, 1904, 1905, 1912, 1913, 1914.
Mackie, G. D. 1918, 1919, 1920, 1921.
MacLeod, G. R. 1922, 1923, 1924, 1925, 1926, 1927.
MacLeod, H. A. F. 1888, 1894.
MacLeod, H. J. 1933, 1934.
MacLeod, M. H. 1906, 1918, 1919.
Macphail, Alex. 1922, 1923, 1924.
MacPherson, D. 1895, 1897, 1898, 1899, 1900, 1901, 1903, 1904, 1906, 1907, 1909, 1910, 1911, 1912, 1913, 1914.
Macredie, J. R. C. 1920, 1921, 1922.
Main, T. C. 1936, 1937.
Malcolm, W. L. 1930.
Manock, W. R. 1938.
Marceau, E. 1897, 1898, 1899, 1900.
Massey, G. H. 1890.
Matheson, E. G. 1918, 1919, 1920.
Matheson, W. G. 1896, 1902.
McCaghey, N. F. 1928.
McCannel, D. A. R. 1929, 1930, 1933, 1934.
McCarthy, G. A. 1917, 1918, 1919.
McCarthy, J. M. 1900, 1902.
McColl, R. 1906, 1908, 1911, 1912, 1914, 1915, 1916.
McConnell, B. D. 1889, 1901.
McCrory, J. A. 1930, 1931, 1932, 1933, 1934, 1935.
McDougall, D. H. 1918, 1919, 1920.
McGillivray, A. 1927, 1928.
McHenry, E. H. 1904.
McKenzie, B. Stuart 1920.
McKergow, C. M. 1923, 1924, 1925, 1926, 1927, 1928.
McKiel, H. W. 1927.
McKnight, W. F. 1929.
McLaren, W. F. 1925, 1926, 1927, 1928.
McLean, D. L. 1926, 1927.
McLean, H. J. 1936, 1937.
McLean, W. A. 1919, 1920, 1921.
McLeish, J. 1932, 1933.
McNab, W. 1900, 1907.
Meech, H. W. 1925.
Mifflen, S. C. 1929, 1930.
Miller, W. C. 1927.
Mitchell, C. H. 1908, 1909.
Mitchell, G. B. 1925.
Mohun, E. 1893, 1903, 1906.
Monro, Thos. 1890, 1891, 1899, 1900.
Monsarrat, C. N. 1910, 1912, 1913, 1914.
Moodie, W. T. 1924.
Morkill, J. T. 1911, 1912.
Morrison, J. R. 1932, 1933.
Motley, P. B. 1929, 1930, 1931.
Mountain, Geo. A. 1893, 1899, 1900, 1901.
Muirhead, J. 1926.
Muntz, E. P. 1936, 1937.
Murdoch, G. G. 1925.
Murphy, E. P. 1936, 1937.
Murphy, John 1918, 1919, 1920.
Murphy, M. 1888, 1889, 1897.
Near, W. P. 1928, 1929, 1930, 1931, 1932.
Newell, F. 1932, 1933, 1934, 1936, 1937, 1938.
Normandin, A. B. 1924, 1926, 1927, 1928, 1929.
Odell, C. M. 1908.
Oliver, S. S. 1921, 1922, 1923.
Owens, E. J. 1937, 1938.
Owens, R. B. 1904, 1905.
Oxley, J. M. 1926, 1927, 1928.
Paine, N. D. 1929.
Palmer, R. K. 1924, 1929.
Papineau, L. G. 1907.
Parent, P. E. 1911, 1912, 1913.
Paulin, F. W. 1932, 1933, 1934, 1935.
Pearce, Wm. 1917, 1918, 1919, 1920.
Perley, H. F. 1887.
Peters, F. H. 1918, 1919, 1931, 1932.
Peters, H. 1887, 1894, 1897, 1898.
Peterson, P. A. 1887, 1888, 1890, 1891.
Pickering, A. E. 1930, 1931, 1932, 1933, 1934, 1935.
Pitts, C. M. 1934, 1935.
Poole, H. S. 1887, 1888, 1893, 1901.
Porter, G. F. 1923.
Porter, J. B. 1904, 1905, 1906.
Porter, J. E. 1926.
Porter, J. W. 1932, 1933.
Porter, Sam G. 1921 ,1922, 1923.
Powell, W. H. 1928.
Pratley, P. L. 1927, 1928, 1929, 1932, 1933, 1934.
Preston, F. M. 1930.
Rannie, J. L. 1926, 1927.
Redpath, F. R. 1893.
Ridout, Thos. 1893.
Risley, W. C. 1926, 1927.
Robb, D. W. 1908.
Robertson, A. K. 1930.
Robertson, J. M. 1918, 1919, 1920.
Robinson, L. H. 1932, 1933.
Rogers, C. S. G. 1925.
Rogers, R. B. 1901, 1902, 1903, 1904.
Rolfson, O. 1933, 1934.
Ross, D. A. 1916, 1917, 1918, 1922 1923, 1924.
Ross, James 1900, 1901.
Ross, J. H. 1929.
Ross, R. A. 1903, 1906, 1907, 1909, 1916, 1917, 1918, 1919.
Ross, R. W. 1925, 1931, 1932.
Rounthwaite, C. H. E. 1922, 1923, 1924, 1925, 1926, 1927.
Russell, B. 1932, 1933.
Rust, C. H. 1899, 1900, 1905, 1907.
Rutledge, L. T. 1928.
Ruttan, H. N. 1887, 1888, 1890, 1891, 1892, 1894, 1895, 1897, 1898, 1899, 1902, 1906.
Ryan, E. A. 1935, 1936, 1937.
Safford, H. R. 1916, 1917, 1918.
Sauder, P.M. 1927.
Schema. n, C. H. 1929, 1930.
Schreiber, C. 1887, 1888.
Schwitzer, J. E. 1908, 1909.
Scott, T. S. 1926.
Scott, W. M. 1921, 1922, 1923.
Shanly, C. N. 1924, 1933, 1934.
Shanly, J. M. 1895, 1898, 1910, 1911, 1912.
Shearwood, F. P. 1909, 1921, 1922, 1923.
Silliman, J. M. 1928.
Smallwood, F. 1936, 1937.
Smith, C. B. 1898, 1901, 1902, 1903, 1904.
Smith, H. B. 1895, 1921.
Smith, Julian C. 1917, 1918, 1919, 1920, 1921, 1922.
Smyth, C. M. 1934, 1935.
Smythe, R. E. 1936.
Speer, C. H. 1929.
Spencer, R. A. 1937, 1938.
Sproule, W. J. 1895, 1896.
Stansfield, E. 1930.
Stead, G. 1927.
Stedman, E. W. 1935, 1936.
Steel, F. M. 1934, 1935.
Stephens, J. 1928.
Stewart, A. F. 1911, 1912, 1913, 1922, 1923, 1924.
Stewart, D. A. 1896.
Stewart, W. J. 1911, 1912.
St. George, P. W. 1887, 1888, 1890, 1891, 1892, 1893, 1904, 1905.
St. Laurent, A. 1909.
Sullivan, J. G. 1910, 1918.
Surtees, R. 1895.
Surveyer, A. 1915, 1916, 1917, 1918, 1919, 1920, 1921.
Swan, H. L. 1934, 1935, 1936, 1937.
Tapley, A. G. 1926.
Taunton, A. J. 1938.
Taylor, T. 1931, 1932, 1933.
Tennant, D. C. 1931, 1932, 1933.
Theuerkauf, A. P. 1938.
Thompson, W. G. 1895.
Thorne, B. L. 1923, 1924, 1925.
Thorne, H. 1929.
Thornton, K. B. 1921, 1922, 1923.
Thornton, L. A. 1918, 1919, 1920.
Torrens, G. C. 1931.
Tracy, T. H. 1900.
Traill, J. J. 1932, 1933, 1934.
Trowsdale, R. S. 1926, 1931.
Trutch, Sir J. W. 1890, 1891.
Tye, W. F. 1905, 1906, 1907.
Uniacke, R. F. 1914, 1915, 1916.
Vallée, L. A. 1894, 1895, 1903, 1909.
Vance, J. A. 1933, 1934, 1935, 1936, 1937, 1938.
Vandervoort, G. A. 1935, 1936.
Vanier, J. E. 1889.
Vaughan, F. P. 1924.
Vaughan, H. H. 1910, 1911.
Viens, E. 1938.
Wainwright, J. G. R. 1928, 1929, 1930.
Wake, H. R. 1930.
Walbank, W. McL. 1898, 1903, 1904.
Walkem, G. A. 1921, 1922.
Wallis, H. 1887, 1900.
Wanklyn, F. L. 1909.
Watson, J. T. 1938.
Webb, H. R. 1935, 1936.
Webster, G. H. 1906.
Weller, J. L. 1915, 1916, 1917.
West, A. E. 1931, 1932.
West, F. L. 1928.
Weston, S. R. 1929.
White, Jas. 1917, 1918, 1919.
White, T. H. 1913, 1914, 1915.
Wicksteed, H. K. 1908, 1925, 1926, 1927.
Wilgar, W. P. 1925.
Wilmot, E. A. 1899.
Wilson, R. S. L. 1922, 1923, 1924, 1929.
Wootton, A. S. 1933, 1934, 1935, 1936.
Wragge, E. 1889, 1890.
Wright, C. H. 1926.
Wynne-Roberts, L. W. 1930, 1931, 1932.
Wynne-Roberts, R. O. 1922, 1923, 1924.
Young, R. B. 1929, 1930, 1931.
Young, S. 1935, 1936.
Young, W. B. 1929.
Young, C. R. 1921, 1922, 1923.

TREASURERS

Adams, W. C. 1931-32.
Beaubien, deGaspe 1938.
Bertram, Sir Alex. 1919-1926.
Blackwell, K. M. 1894-1897.
Bovey, H. T. 1887.
Busfield, J. L. 1937.
Challies, J. B. 1933-1936.
Duchastel de Montrouge, J. A. 1938.
Irwin, H. 1898-1908.
Marceau, Ernest 1909-1919.
Pratley, P. L. 1933.
Shearwood, F. P. 1926-1930.
Wallis, H. 1888-1893.

SECRETARIES

Bovey, H. T. 1887-1891.
Durley, R. J. 1925-1938.
Keith, Fraser S. 1917-1925.
McLeod, C. H. 1891-1916.
Wright, L. Austin 1938.

LIST OF MEMBERS

OF

THE ENGINEERING INSTITUTE OF CANADA

CORRECTED TO NOVEMBER 15th, 1938

In the following list (†) prefixed to a name indicates the contributor of a paper published in the Transactions of The Institute; (*D*) prefixed to a name indicates the award of the Duggan Medal; (*G*) prefixed to a name indicates the award of the Gzowski medal; (𝔎) prefixed to a name indicates the award of the Sir John Kennedy medal; (*L*) prefixed to a name indicates the award of the Leonard medal; (*P*) prefixed to a name indicates the award of the Plummer medal; (𝔓) prefixed to a name indicates the award of the Past-Presidents' prize; (*q*) prefixed to a name indicates admission under the special provisions of the Quebec Act; (♂) prefixed to a name indicates Service with Allied Armies.

HONORARY MEMBERS

H.R.H. ARTHUR, Duke of Connaught and Strathearn, K.G., P.C., G.B.E. (*Hon.M. 1912*)

BESSBOROUGH, The Right Hon. the Earl of, P.C., G.C.M.G., Stansted Park, Rowlands Castle, Sussex, England. (*Hon.M. 1931*)

TWEEDSMUIR, His Excellency The Right Hon. Lord, P.C., G.C.M.G., C.H., Governor-General of Canada, Ottawa, Ont. (*Hon.M. 1936*)

WILLINGDON, The Most Hon. the Marquess, P.C., G.C.S.I., G.C.M.G., G.C.I.E., G.B.E., London, S.W.1, England. (*Hon.M. 1927*)

H.R.H. EDWARD, Duke of Windsor, K.G. (*Hon.M. 1919*)

ADAMS, Frank D., Ph.D., D.Sc., F.G.S.A., F.R.S., 1173 Mountain St., Montreal, Que. (*Hon.M. 1917*)

ANGUS, Robert William, B.A.Sc., (Tor. '97), M.E., Prof., Head of Dept. of Mech. Engrg., University of Toronto, Toronto, Ont. (*M. 1921*) (*Hon.M. 1937*)

CLARK, Arthur L., B.Sc., Ph.D., F.R.S.C., Dean of the Faculty of Applied Science, Queen's University, Kingston, Ont. (*Affil. 1920*) (*Hon.M. 1922*)

DESBARATS, George J., C.M.G., B.Sc., P.L.S., 330 Wilbrod St., Ottawa, Ont. (*M. 1897*) (*Hon.M. 1936*) (*Past-President*)

𝔎.*G.*†DUGGAN, Geo. Herrick, D.Sc., (Tor. '83), LL.D., (Queen's), LL.D., (McGill), Chairman, Dom. Bridge Co., Ltd., Montreal, Que. (*H*) 3636 McTavish St. (*A.M. 1888*) (*M. 1890*) (*Past President*) (*Hon.M. 1937*)

♂GIBB, Sir Alexander, C.B., G.B.E., D.S.M., LL.D., (Edin.), Senior Partner, Sir Alexander Gibb & Partners, Queen Anne's Lodge, Westminster, London, S.W.1, England. (*H*) Tangier Park, nr. Basingstoke, Hants. (*M. 1932*) (*Hon.M. 1937*)

HOWE, Clarence Decatur, The Hon., B.Sc., (M.I.T. '07), Minister of Transport, Parliament Bldgs., Ottawa, Ont. (*M. 1922*) (*Hon.M. 1937*)

HUNGERFORD, Samuel Jas., Chairman, C.N.R., 355 McGill St., Montreal, Que. (*M. 1919*) (*Hon.M. 1937*)

MAGRATH, Chas. Alexander, LL.D., (Tor. '26), F.R.S.C., 841 St. Charles St., Victoria, B.C. (*M. 1917*) (*Life Member*) (*Hon.M. 1938*)

♂RABUT, Jacques, (Ecole Nat. des Ponts et Chaussées '11), Charles Rabut & Cie, 27 Rue Cambacérés, Paris, France. (*Hon.M. 1937*)

STIRLING, Grote, The Hon., M.P. for Yale, Kelowna, B.C. (*M 1927*) (*Hon.M. 1937*)

MEMBERS

ABBOTT, A. C., B.Sc., (McGill '26), Shawinigan Water & Power Co., Three Rivers, Que. (*H*) 677 St. Ursule St. (*S. 1925*) (*A.M. 1931*)

ABBOTT, Chas. A., Little Priory, Shorne, nr. Gravesend, England. (*A.M. 1903*)

ABBOTT, Harold F., B.Sc., (McGill '28), Beauharnois L. H. and P. Co., Box 100, Beauharnois, Que. (*S. 1926*) (*A.M. 1936*)

ABBOTT-SMITH, H. B., B.Sc., (McGill '23), Asst. Meter Engr., Shawinigan Water & Power Co., Power Bldg., Montreal, Que. (*H*) 4765 Roslyn Ave. (*S. 1923*) (*Jr. 1931*)

♂ABBOTT, Wm. Hamilton, Capt., M.C., Merrickville, Ont. (*A.M. 1920*)

ABELL, Harry C., B.Sc. in E.E., P.O. Box 98, Mandedville, New Orleans, La., U.S.A. (*M. 1904*)

ABRAMSON, Isaac Albert, B.Sc., (Alta. '29), Calgary Power Co., Calgary, Alta. (*H*) 1806–8th St. S.W. (*Jr. 1931*)

ACHESON, H. R. M., B.Sc., (Alta. '29), Supply Engr., Spruce Falls Power & Paper Co. Ltd., Kapuskasing, Ont. (*S. 1926*) (*Jr. 1934*)

G.†ACKERMAN, Paul, Cons. Elec. Engr., Shawinigan Water & Power Co., Power Bldg., Montreal, Que. (*H*) 4078 Hingston Ave. (*A.M. 1921*)

ACKHURST, Wm. Hall, 113 Henry St., Halifax, N.S. (*S. 1938*)

ACRES, Henry G., M.E. and E.E., (Tor. '03), D.Sc., Cons. Engr., H. G. Acres & Co., Niagara Falls, Ont. Box 310, Niagara-on-the-Lake, Ont. (*M. 1915*)

♂ADAM, James, Capt., Civil Engr. and Architect, 14 Metcalfe St., Ottawa, Ont. (*H*) 263 MacLaren St. (*A.M. 1911*)

ADAM, Jos. A., Asst. Engr., D.P.W., Canada, 1254 Bishop St., Montreal, Que. (*H*) 4048 Old Orchard Ave. (*Jr. 1915*) (*A.M. 1926*)

𝔓.ADAMS, Eric G., B.Sc., (McGill '29), M.B.A., (Harvard), Coverdale & Colpitts, Cons. Engrs., 120 Wall St., New York, N.Y. (*H*) 10 Grove St. (*S. 1928*) (*Jr. 1934*)

♂ADAMS, Francis P., Major, City Engineer, City Hall, Brantford, Ont. (*H*) 264 Erie Ave. (*A.M. 1910*)

ADAMS, G. R., B.Sc., (Queen's '27), 1831 Dorchester St. W., Montreal, Que. (*S. 1925*) (*A.M. 1934*)

ADAMS, John DeWitt, B.Sc., (Alta. '33), Dept. of Highways, 119 King St., London, Ont. (*Jr. 1937*)

ADAMS, Philip Ernest, B.Sc., (Vermont '09), Designing Engr., Canadian Bridge Co., Ltd., Walkerville, Ont. (*H*) 1182 Chilver Rd. (*M. 1927*)

♂ADAMS, Wm. Douglas, Major, M.C., (R.M.C., Kingston '08), Toronto Mgr., H. E. McKeen & Co., Ltd., 68 King St. E., Toronto, Ont. (*H*) 63 Blythewood Rd. (*S. 1908*) (*Jr. 1912*) (*A.M. 1922*) (*M. 1936*)

ADAMSON, W. B., B.Sc., (Alta. '38), 9137–84th Ave., Edmonton, Alta. (*S. 1937*)

ADDIE, Donald Kyle, B.Sc., (McGill '25), Supervising Engr., Ball Bros. Co., Muncie, Indiana, U.S.A. (*Jr. 1926*) (*A.M. 1936*)

ADDIE, Geo. Kyle, Lt.-Col., B.A.Sc., (McGill '89), Q.L.S., 148 St. Cyrille St., Quebec, Que. (*S. 1887*) (*A.M. 1898*) (*M. 1935*)

ADDISON, John H., B.A.Sc., (Tor. '33), Supt., Martin-Bird Gold Mines Ltd., Larder Lake, Ont. (*H*) 431 Broadview Ave., Toronto, Ont. (*S. 1932*) (*Jr. 1935*)

♂ADLARD, L. S., Major, B.A.Sc., (Tor. '15), Principal, Govt. College of Engrg., Rasul, Punjab, India. (*H*) 60 Howard St., Toronto, Canada. (*S. 1914*) (*A.M. 1924*)

ADLINGTON, Wilfred Ernest, B.Sc., (M.I.T. '27), Gen. Mgr., Bennett (Hyde) Ltd., Boston Mills, Hyde, Cheshire, England. (*H*) Windy Ridge, Wetneth Low, Gee Cross, Cheshire. (*Jr. 1928*)

AEBERLI, J. Adolf, M.E., Mech. Engr., Hydro-Electric Power Comm. of Ontario, Toronto, Ont. (*H*) 257 Kingswood Rd. (*M. 1921*)

AFFLECK, Garnet, Dist. Engr., D.P.W., Man., Rm. 316, Parliament Bldgs., Winnipeg, Man. (*H*) 674 Fisher St. (*S. 1909*) (*Jr. 1912*) (*A.M. 1920*)

AFFLECK, John K., B.A.Sc., (Tor. '21), Supt., Dry Colour Dept., Imperial Varnish and Colour Co. Ltd., 6 Morse St., Toronto, Ont. (*H*) 26 Cavendish St. (*S. 1920*) (*A.M. 1922*)

AGAR, George, Chief Designer and Estimator, Indust. Dept., Canadian Vickers, Ltd., P.O. Box 550, Montreal, Que. (*H*) 64 Nelson St., Montreal West, Que. (*A.M. 1924*)

AGGIMAN, Jacques Nissim, B.Sc., (McGill '17), Man'g. Dir., J. Aggiman Construction Co., Pk. 249, Ankara, Turkey. (*S. 1916*) (*Jr. 1917*) (*A.M. 1919*) (*M. 1929*)

AGNEW, T. Chas., B.Sc., (Queen's '29), Minneapolis-Honeywell Regulator Co. Ltd., Toronto, Ont. (*H*) 350 Concord Ave. (*S. 1928*) (*A.M. 1936*)

AHEARN, Wm. J., B.Sc., (Queen's '37), Bell Telephone Co. of Canada, Quebec, Que. (*H*) 114 Rue St. Jean. (*S. 1935*)

AHERN, Arthur Weston, B.Sc., (McGill '22), The James Ruddick Engineering Construction Co., Quebec, Que. (*H*) 255 Fraser St. (*S. 1920*) (*A.M. 1926*)

AIRD, Andre, B.A.Sc., (Ecole Polytech., Montreal '38), 824 Stanley Park, Montreal, Que. (*S. 1936*)

AITKENS, John C., B.Sc., (Man. '29), Mine Engr., Madsen Red Lake Gold Mines Ltd., Madsen, Ont. (*H*) Boissevain, Man. (*S. 1928*) (*Jr. 1934*) (*A.M. 1937*)

AKERLEY, Wm. Burpee, B.Sc., (N.B. '32), Asst. Engr., Dept. of Highways, N.B. (*H*) 8 Barker St., Saint John, N.B. (*S. 1932*) (*Jr. 1936*)

AKIN, T. Bernard, B.Sc., (N.S.T.C. '32), Clifton Ave., Windsor, N.S. (*S. 1932*)

♂ALBERGA, Albert Miller, B.Sc., (McGill '16), Supt. P.W., Dept. P.W., Savanna-la-Mar, Jamaica, B.W.I. (*H*) Montego Bay, Jamaica, B.W.I. (*S. 1915*) (*Jr. 1920*) (*A.M. 1925*)

ALDER, J. Dacre, Asst. Chief Engr., Darling Bros., Ltd., P.O. Box 187, 140 Prince St., Montreal, Que. (*M. 1921*)

ALEXANDER, Alwin Paul, B.Sc., (Alta. '33), Monarch, Alta. (*S. 1933*)

ALEXANDER, David Tasker, Chief Dftsman, The Canadian Bridge Co. Ltd., Walkerville, Ont. (*H*) 420 Indian Rd., Sandwich, Ont. (*M. 1931*)

ALEXANDER, Fred. Wm., Engr., Mtce. of Way, C.P.R., Winnipeg, Man. (*A.M. 1907*) (*M. 1917*)

♂ALEXANDER, Geo. Burpee, B.Sc., (N.B. '14), Divn. Engr., C.P.R., P.O. Box 613, Revelstoke, B.C. (*A.M. 1936*)

ALEXANDER, John Andrew, B.Eng., (McGill '38), Chemist, McColl Frontenac Oil Co., Montreal, Que. (*H*) 209 Strathearn Ave., Montreal West, Que. (*S. 1937*)

ALEXANDER, Richard C. F., (R.M.C., Kingston '96), Sr. Office Engr., Engrg. Br., Dept. of Transport, Ottawa, Ont. (*H*) 370 Lewis St. (*S. 1897*) (*A.M. 1904*)

♂ALEXANDER, Stanley Geo., Chief Engr. Steam Plants, Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*H*) 460 Sherbrooke St. (*Affil. 1935*)

ALEXANDER, Wm. Ronald, B.A.Sc., (Tor. '35), 285 Heath St. E., Toronto, Ont. (*S. 1936*)

ALGOT, C. A., B.Sc., (Alta. '37), Derwent, Alta. (*S. 1937*)

†ALLAIRE, Alexander, M.E., Regional Engr., Region 5, P.W. Administration, 803 Electric Bldg., Fort Worth, Texas, U.S.A. (*H*) Forest Park Apts. (*A.M. 1910*) (*M. 1913*)

ALLAIRE, Lucien, B.A.Sc., (Ecole Polytech., Montreal '35), Surveyor, Dept. of Agriculture, Que., Quebec, Que. (*H*) 2182 Sherbrooke St. E., Montreal, Que. (*S. 1936*) (*Jr. 1938*)

♂ALLAN, E. Blake, Capt., M.C., B.A.Sc., (Tor. '16), C.E., Res Engr., Dept. of Highways, Oromocto, N.B. (*S. 1915*) (*A.M. 1920*)

♂ALLAN, J. Lorn, Capt., B.A.Sc., (Tor.), Town Engr., Dartmouth, N.S. (*H*) 32 Newcastle St. (*S. 1899*) (*A.M. 1904*) (*M. 1913*) (*Life Member*)

ALLAN, Robt. G., B.Sc., (Queen's '38), 51 Harbord St., Toronto, Ont. (*S. 1937*)

ALLCHURCH, Harry, Checker, Mech. and Str'l. Equipment, Dom. Bridge Co. Ltd., Lachine, Que. (*H*) 134–24th Ave. (*A.M. 1928*)

†ALLCUT, Edgar Alfred, B.Sc., M.Sc., (Birmingham '09), M.E., (Tor. '30), Prof. Mech. Engrg., University of Toronto, Toronto, Ont. (*H*) 48 Foxbar Rd. (*M. 1926*)

ALLEN, Archie Menzo, Constrn. Engr., Alberta Govt. Telephones, Edmonton, Alta. (*H*) 10758–83rd Ave. (*A.M. 1937*)

ALLEN, Charles Albert, Str'l. Designer, Archt.'s Office, Bell Telephone Co. of Canada, Montreal, Que. (*H*) 44 Lake Ave., Strathmore. Que. (*A.M. 1921*)

ALLEN, Norman, B.A.Sc., (Tor. '27), Box 37, Ingersoll, Ont. (*Jr. 1929*)

ALLEN, Richard T. W., B.Sc., (Alta. '35), Dftsman., Dom. Govt. B.C. (*H*) Okanagan Landing, B.C. (*S. 1935*)

ALLEN, Robt. William, Asst. City Engr., City Hall, Regina, Sask. (*H*) 2360 Smith St. (*Jr. 1918*) (*A.M. 1922*) (*M. 1936*)

ALLINGHAM, Ralph, Supt. of Constrn., Semet Solvay Engineering Corpn., 40 Rector St., New York, N.Y. (*H*) 37 Prescott Rd., White Plains, N.Y. (*S. 1914*) (*Jr. 1919*) (*A.M. 1923*)

ALLISON, Jesse Graham, B.Sc., (S. Calif. '27), P.O. Box 1078, Los Angeles, Calif., U.S.A. (*S. 1924*) (*Jr. 1931*)

ALLISON, John Logie, Box 313, Place d'Armes P.O., Montreal, Que. (*A.M. 1887*) (*M. 1895*) (*Life Member*)

ALLWRIGHT, Ernest Gilbert, Reclamation Engr., Aluminum Co. of Canada, Box 116, Arvida, Que. (*Affil. 1938*)

AMAN, T. F. S., B Sc., (Queen's '35), Canada Cement Co., Plant No. 5, Point Anne, Ont. (*H*) 77 Highland Ave., Belleville, Ont. (*S. 1934*)

AMBROSE, John R. W., E.M., Supt., Toronto Terminals Railway Co., 402 New Union Station, Toronto, Ont. (*H*) 230 Dunvegan Rd. (*A.M. 1911*) (*M. 1913*)

AMES, Arthur John, Mang'g. Director, Instruments, Ltd., 240 Sparks St., Ottawa, Ont. (*H*) 184 Holmwood Ave. (*Affil. 1922*)

AMOS, Arthur (*q*), (Ecole Polytech., Montreal), 31 Mt. Carmel St., Quebec, Que. (*A.M. 1899*)

AMOS, Louis Auguste, (R.M.C., Kingston), Arch. and C.E., L. A. & P. C. Amos, 1414 Crescent St., Montreal, Que. (*S. 1893*) (*A.M. 1896*) (*M. 1915*)

ANDERSEN, Viggo, B.Sc., (R.T.C., Copenhagen), 4987 Earnscliffe Ave., Montreal, Que. (*Jr. 1928*)

ANDERSON, Clarence Aubrey, 54 Oakland Rd., Halifax, N.S. (*A.M. 1932*)

ANDERSON, Clifford Thos., B.A.Sc., (Tor. '29), Control Asst., Thunder Bay Paper Co. Ltd., Port Arthur, Ont. (*H*) 461 St. Patrick's Sq. (*A.M. 1936*)

ANDERSON, Dan., B.Sc., (McGill '23), Elec. Engr., Quebec North Shore Paper Co., Baie Comeau, Que. (*S. 1919*) (*Jr. 1925*) (*A.M. 1930*)

ANDERSON, Frederick, Capt., (R.M.C., Kingston), 150 Metcalfe St., Ottawa, Ont. (*M. 1909*)

♂ANDERSON, Geo. Benson, Capt., Acting Dist. Engr., D.P.W. Canada, Sault Ste. Marie, Ont. (*A.M. 1919*)

ANDERSON, Hope Vere, Asst. Chief, Aids to Navigation, Dept. of Transport, Hunter Bldg., Ottawa, Ont. (*H*) 102 Fentiman Ave. (*M. 1935*)

ANDERSON, John Marshall, Dist. Engr., Alberta Prov. Govt., Box 280, Hanna, Alta. (*A.M. 1919*)

♂ANDERSON, John N., Lieut., (R.T.C., Glasgow), Man'g. Director, Wm. N. O'Neil Co. (Victoria), Ltd., 551 Yates St., Victoria, B.C. (*H*) 2000 Beach Drive. (*A.M. 1919*)

ANDERSON, Oscar Victor, E.E., (Minn. '10), Field Engr., Stations Dept., Toronto Hydro-Electric System, Toronto, Ont. (*H*) 68 Indian Rd. Crescent. (*M. 1936*)

ANDERSON, Roderick Victor, B.A.Sc., (B.C. '31), Asst. Engr., Tropical Oil Co., Barranca Bermeja, Colombia, S.A. (*S. 1928*) (*Jr. 1937*)

♂ANDERSON, T. V., Major-Gen., D.S.O., B.Sc., (McGill), Chief of Gen. Staff, Dept. National Defence, Ottawa, Ont. (*H*) 459 Lauirer Ave. E. (S. *1900*) (*A.M. 1911*)

ANDERSON, William, 2640 Alder St., Vancouver, B.C. (*M. 1913*) (*Life Member*)

ANDERSON, Wm., Mgr., Calgary Water Power Co. Ltd., Calgary, Alta. (*H*) 313–8th Ave. W. (*A.M. 1924*)

ANDERSON, Y. R., B.Sc., (Sask. '24), Ceramic Engr., The Cooksville Co. Ltd., 46 Bloor St. W., Toronto, Ont. (*H*) 34 Hillside Ave., Mimico, Ont. (*A.M. 1930*)

ANDRÉ, K. B., B.Sc., (Queen's '37), 324 Johnson St., Kingston, Ont. (*S. 1937*)

ANDREWES, Wm. E., (R.M.C., Kingston '24), B.Sc., (McGill '27), Major, R.C.E., D.E.O., M.D. No. 1, National Defence Bldg., London, Ont. (*H*) 43 Rattle St. (*Jr. 1930*) (*A.M. 1937*)

ANDREWS, Russell Herbert, B.Sc., (Man. '24), Elec. Engr., City of Winnipeg Hydro-Electric System, Winnipeg, Man. (*H*) 398 Maryland St. (*A.M. 1929*)

ANGEL, John B., B.Eng., (McGill '35), Dir. and Gen. Supt., United Nail & Foundry Co. Ltd., St. John's, Nfld. (*H*) 146 Hamilton St. (*S. 1935*)

ANGELL, Henry Gerald, Santos, Springdale Rd., Broadstone, Dorset, England. (*Jr. 1914*) (*A.M. 1922*)

ANGLIN, Arthur Baker, B.Sc., (Queen's '33), Asst. Chief Chemist, The British American Oil Refineries Ltd., Royal Bank Bldg., Toronto, Ont. (*H*) 434 Walmer Rd. (*S. 1933*)

♂ANGLIN, Douglas Gould, Major, B.Sc., C.E., (Queen's '12), Asst. Mgr. and Vice-Pres., Anglin-Norcross, Quebec, Ltd., 892 Sherbrooke St. W., Montreal, Que. (*H*) 11 Severn Ave., Westmount, Que. (*S. 1912*) (*A.M. 1920*)

ANGUS, F. William, B.Sc., (McGill '29), Transm. Engr., Bell Telephone Co. of Canada, Montreal, Que. (*H*) 3065 Cedar Ave. (*S. 1929*) (*A.M. 1931*)

ANGUS, William Forrest, Pres., Dominion Bridge Co. Ltd., P.O. Box 280, Montreal, Que. (*H*) 3564 Peel St. (*S. 1895*) (*A.M. 1903*) (*M. 1913*)

ANNETT, Fred A., Assoc. Editor, "Power," McGraw-Hill Publishing Co. Inc., 330-W. 42nd St., New York, N.Y. (*H*) 143-72 Cherry Ave., Flushing, N.Y. (*Affil. 1927*)

ANSLEY, Fred. C., B.Sc., (Queen's '37), Ford Motor Co. of Canada. (*H*) 826 Argyle Rd., Walkerville, Ont. (*S. 1937*)

ANSON, Clement Matthew, B.Sc., (McGill '25), Asst. Gen. Mgr., Dom. Steel and Coal Corp., Ltd., Sydney, N.S. (*H*) 46 Rigby Rd. (*A.M. 1931*)

ANTENBRING, Clarence V., B.Sc., (Man. '26), Designer, Cowin & Co., Pacific and Yeoman Sts., Winnipeg, Man. (*H*) 417 Machray Ave. (*S. 1924*) (*A.M. 1937*)

ANTLIFF, Jas. C., B.Sc., (McGill '23), Gen. Asst., Montreal Light, Heat and Power Cons., P.O. Box 1710, Montreal, Que. (*H*) 3791 Marlowe Ave., N.D.G. (*S. 1923*) (*A.M. 1928*)

ANTONISEN, Joachim, Civil Engr., 431 St. Patricks Sq., Port Arthur, Ont. (*A.M. 1907*) (*M. 1921*) (*Life Member*)

ANVIK, Herlaug, (Oslo '15), Efficiency Engr., Can. International Paper Co. Ltd., Hawkesbury, Ont. (*M. 1937*)

ARCAND, Louis J., B.Sc., (McGill '31), (M.Eng., '32), 1221 Beaudry St., Montreal, Que. (*S. 1929*)

ARCHAMBAULT, Geo., 288 McDougall Ave., Outremont, Que. (*S. 1937*)

ARCHAMBAULT, Jos. U., B.Sc., (Ecole Polytech., Montreal, '27), Engr., Quebec Public Service Comm., Court House, Quebec, Que. (*H*) 54 St. Ursule St. (*S. 1925*) (*A.M. 1931*)

ARCHER, Maurice Geo., (R.M.C., Kingston), B.Eng., (McGill '33), Archer & Dufresne, Cons. Engrs., 105 Mountain Hill, Quebec, Que. (*H*) 195 St. Cyrille St. (*S. 1933*) (*Jr. 1938*)

ARCHIBALD, Charles Blair, Mgr., Wabana Opers., Dominion Steel and Coal Co., Ltd., Wabana, Nfld. (*S. 1910*) (*A.M. 1917*)

†ARCHIBALD, Ernest M., B.Sc., (McGill '99), Vice-Pres., Powers and Archibald, Inc., 217 Harvey Bldg., West Palm Beach, Fla., U.S.A. (*A.M. 1906*)

ARCHIBALD, Frank R., B.Eng., (McGill '36), 28 Moreland St., Roxbury, Mass., U.S.A. (*S. 1936*)

ARCHIBALD, Geo. DeWolfe, City Engr., Saskatoon, Sask. (*1938*)

ARCHIBALD, Harry P., B.A.Sc., Sole Partner, Bayfield & Archibald, 448 Seymour St., Vancouver, B.C. (*H*) 1304 Walnut St. (*A.M. 1910*)

ARCHIBALD, Manning C., B.Sc., (N.S.T.C. '33), Engr., Woodstock Public Utilities Comm., Woodstock, Ont. (*H*) 372 Drew St. (*S. 1931*)

♂ARCHIBALD, Samuel Wallace, Major, B.A.Sc., (Tor. '22), O.L.S. '25, Cons. Engr. and O.L.S., 489 Richmond St., London, Ont. (*H*) 292 Queens Ave. (*A.M. 1928*) (*M. 1935*)

ARKLEY, Lorne McK., C.E., M.Sc., (McGill '00), Prof., Head of Dept. Mech. Engrg., Queen's University, Kingston, Ont. (*H*) 22 Kensington Ave. (*S. 1899*) (*A.M. 1906*) (*M. 1914*)

ARMSTRONG, Arnold V., B.Sc., (McGill '23), Sales Mgr., Cutler-Hammer Ltd., 384 Pope Ave., Toronto 6, Ont. (*S. 1920*) (*Jr. 1929*) (*A.M. 1936*) (*M. 1938*)

ARMSTRONG, C. G. Russell, B.A.Sc., (Tor. '20), O.L.S., Partner, Newman & Armstrong, Cons. Engrs. and Surveyors, 605-6 Bartlett Bldg., Windsor, Ont. (*H*) 392 Josephine Ave. (*Jr. 1921*) (*A.M. 1925*)

ARMSTRONG, Douglas Bond, Designing Engr., Dominion Bridge Co., Ltd., Montreal, Que. (*H*) 4196 Hingston Ave. (*A.M. 1923*)

ARMSTRONG, H. V., (Tor. '09), Asst. Station Engr., H.E.P.C. of Ont., 620 University Ave., Toronto, Ont. (*H*) 42 Lorindale Ave. (*A.M. 1915*)

ARMSTRONG, John Edwin, C.E., (Cornell '08), Asst. Chief Engr., C.P.R., Rm. 401, Windsor Station, Montreal, Que. (*H*) 4060 Marlowe Ave. (*A.M. 1917*)

ARMSTRONG, J. Lloyd, B.Eng., (McGill '36), Northern Electric Co. Ltd., Montreal, Que. (*H*) 74 Courcelette Ave., Outremont, Que. (*S. 1936*)

ARMSTRONG, L. H., B.Sc., (McGill '22), Asst. Engr. in Trans. and Equipment Dept., Companhia Telephonica Brasileira, Caixa Postal 2835, Rio de Janeiro, Brazil. (*S. 1919*) (*A.M. 1930*)

ARMSTRONG, Owen F. C., B.Sc., (N.S.T.C. '28), Traffic Asst., Bell Telephone Co. of Canada, 87 Ontario St. W., Montreal, Que. (*H*) 9 Water Edge Ave., Lakeside, Que. (*S. 1926*) (*A.M. 1935*)

ARMSTRONG, Thomas S., 258 Algoma St. N., Port Arthur, Ont. (*M. 1907*) (*Life Member*)

ARMSTRONG, Walter J., B.Sc., (Cornell '09), Cons. Engr., Rm. 703, Dominion Square Bldg., Montreal, Que. (*H*) 15 Willow Ave., Westmount, Que. (*A.M. 1916*) (*M. 1921*)

ARNASON, Einar, B.Sc., (Man. '37), 9 Cornish Ave., Winnipeg, Man. (*S. 1937*)

♂ARNOLD, Guy Walker, B.Sc., (N.B. '12), Elec. Engr., Can. Westinghouse Co. Ltd., Hamilton, Ont. (*H*) 272 Stinson Crescent. (*A.M. 1928*)

ARTHEY, Geo. Clayton, B.Sc., (Queen's '34), 357 Kensington Ave., Westmount, Que. (*S. 1934*)

†ASHBRIDGE, Wellington Thomas, C.E., (Tor. '88), 1444 Queen St. E., Toronto, Ont. (*S. 1887*) (*A.M. 1892*) (*Life Member*)

†ASHCROFT, Glenn B., B.S., and C.E., (Case '00 and '05), Sr. Strl. Engr., California State D.P.W., Divn. Architecture, P.W. Bldg., Sacramento, Calif. Address: 1823 Alameda Ave., Alameda, Calif. (*A.M. 1904*)

♂ASHFORD, Arthur Geo., Major, address unknown. (*A.M. 1930*)

♂ASHWORTH, John Kershaw, Mgr., R. & M. Bearings Canada, Ltd., 1006 Mountain St., Montreal, Que. (*H*) 1485 Bernard Ave., Outremont, Que. (*A.M. 1926*)

ASKIN, R. J., B.Sc., (Queen's '23), Mgr., Thunder Bay Paper Co. Ltd., Port Arthur, Ont. (*H*) 524 Red River Rd. (*S. 1922*) (*A.M. 1926*) (*M. 1937*)

ASKWITH, Francis Lloyd Geo., 222 Powell Ave., Ottawa, Ont. (*S. 1938*)

ASKWITH, Frank Chatham, Commr. of Works, Corp. of Ottawa, City Hall, Ottawa, Ont. (*H*) 222 Powell Ave. (*S. 1910*) (*Jr. 1913*) (*A.M. 1919*)

ASKWITH, Winston M., B.Eng., (McGill '36), Asst. Engr., Federal District Comm., 298 Carling Ave., Ottawa, Ont. (*H*) 222 Powell Ave. (*Jr. 1937*)

ASPLIN, Albert Grant, B.Eng., (McGill '38), Box 262, Fort Erie North, Ont. (*S. 1937*)

ASQUITH, A. Reginald, Auburn, Ont. (*S. 1938*)

ASSELIN, Hector, 118 Maplewood Ave., Outremont, Que. (*S. 1937*)

ASSELIN, Jean, B.A.Sc., C.E., (Ecole Polytech., Montreal '29), Town Engr. and Mgr., La Tuque, Que. (*H*) 175 St. Joseph St. (*A.M. 1934*)

ASTELS, Fletcher, B.Sc., (Tri-State '24), Apt. 4, 474 Cooper St., Ottawa, Ont. (*A.M. 1937*)

ATHEY, Frank A. P., B.Sc., (Man. '38), Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*H*) 508 Bolivar St. (*S. 1937*)

ATKINSON, Fred, Pres. and Gen. Mgr., Atwood Ltd., 520 University Tower, Montreal, Que. (*H*) 3425 Montclair Ave. (*Affil. 1925*)

ATKINSON, M. Brodie, B.Sc., (McGill '04), Asst. Supt., Welland Canals, Dept. of Transport, St. Catharines, Ont. (*H*) 150 Ontario St. (*S. 1904*) (*A.M. 1909*) (*M. 1918*)

ATTENBOROUGH, Ernest A., Can. Illinois Tools Ltd., Toronto, Ont. (*H*) 72 East Lynn Ave. (*Jr. 1935*)

ATTWOOD, Chas. Hartley, Deputy Minister of Mines and Natural Resources, Man., Parliament Bldgs., Winnipeg, Man. (*H*) 6 Rochester Apts., Edmonton St. (*A.M. 1915*)

ATWOOD, A. G. M. Lysons, B.Sc., (N.S.T.C. '27), Mech. Engr., Aluminum Co. of Canada, Ltd., Shawinigan Falls, Que. (*S. 1927*) (*A.M. 1934*)

ATWOOD, Wm. S., Vice-Pres., Can. Car & Foundry Co. Ltd., 621 Craig St. W., Montreal, Que. (*H*) 659 Murray Hill, Westmount, Que. (*M. 1914*)

AULD, Jas. Robertson, B.A.Sc., (Tor. '27), Can. Industries Ltd., Beaver Hall, Bldg., Montreal, Que. (*Jr. 1929*)

AULD, Jas. Robertson, B.A.Sc., (Tor. '27), Can. Industries Ltd., Beaver Hall Bldg., Montreal, Que. (*Jr. 1929*)

AULD, Wm. Fraser, B.A.Sc., (Tor. '27), Elec. Engr', Lincoln Electric Co. of Canada Ltd., 65-67 Bellwoods Ave., Toronto 3, Ont. (*H*) 1574 Bathurst St. (*Jr. 1929*) (*A.M. 1936*)

♂AUSTIN, Frank Douglas, B.A.Sc., (Tor. '15), Res. Engr., Dept. of Highways, Ont., Div'n. 4, Grimsby, Ont. (*H*) 16 Murray St. (*A.M. 1934*)

AUSTIN, Reginald N., Hydraulic Engr., Dom. Wheel and Foundries Ltd., 171 Eastern Ave., Toronto, Ont. (*H*) 7 Rosedale Rd. (*A.M. 1922*)

AVERY, Eric, Engr., Dom. Bridge Co. Ltd., Calgary, Alta. (*H*) 733 Alexander Crescent. (*A.M. 1935*)

AYER, Thos. Haliburton, B.Sc., (N.S.T.C. '30), Shawinigan Water & Power Co., Rapide Blanc, Que. (*S. 1930*) (*A.M. 1938*)

♂BABBITT, Archie Randolph, B.Sc., (N.B. '10), Dept. of Highways, N.B. (*H*) 301 University Ave., Fredericton, N.B. (*A.M. 1924*)

♂BABBITT, Sam. Wellington, Mining Engr., Minto Coal Co. Ltd., Minto, N.B. (*A.M. 1929*)

BABCOCK, Harold Austin, B.A.Sc., (Tor. '17), Partner, Margison & Babcock, 210 Dundas St. W., Toronto, Ont. (*H*) 103 Sheldrake Blvd. (*A.M. 1922*)

BABIN, Arsene, B.A., Res. Engr. on Constrn., Quebec North Shore Paper Co., Baie Comeau, Que. (*S. 1905*) (*A.M. 1910*)

BACKLER, I. S., B.Eng., (McGill '32), Cons. Engr., 360 Recollet St., Montreal, Que. (*H*) Apt. 16, 1577 Van Horne Ave. W. (*S. 1930*) (*Jr. 1937*)

BACON, Chas. I., B.Sc., (N.S.T.C. '34), Asst. Mgr., Stormont Electric Light and Power Co. Ltd., and The Cornwall Street Rly., Cornwall, Ont. (*S. 1930*)

♂BACON, Thos. H., Lieut., B.Sc., (McGill '11), Inspr., Can. Underwriters' Assoc., 524 Coristine Bldg., 20 St. Nicholas St., Montreal, Que. (*H*) Apt. 4, 17 Chesterfield Ave., Westmount, Que. (*S. 1910*) (*Jr. 1913*) (*A.M. 1921*)

♂BADGLEY, Leonard Amey, Lieut., B.A.Sc., (Tor. '11), Strl. Engr., City of Toronto, Dept. of Bldgs., City Hall, Toronto, Ont. (*H*) 106 Lawrence Ave. E. (*Jr. 1914*) (*A.M. 1924*)

BAGGS, Wm. Clyde, B.Eng., (McGill '36), Bathurst Power & Paper Co. Ltd., Bathurst, N.B. (*H*) Curling, Nfld. (*S. 1935*)

BAILEY, Chas. David, Engr., Dom. Bridge Co. Ltd., Lachine, Que. (*H*) 110 Pointe Claire Ave., Pointe Claire, Que. (*A.M. 1935*)

♂BAILEY, Harold Milton, Capt., City Engr., City Hall, Yorkton, Sask. (*H*) 160–4th Ave. (*A.M. 1922*)

BAILEY, Loring W., B.Sc., (McGill '25), Sta. Supt., Gatineau Power Co., Grand Falls, N.B. (*S. 1922*) (*A.M. 1937*)

BAILLIE, Edward Leonard, B.Sc., (N.S.T.C. '26), Asphalt Sales Engr., Imperial Oil Ltd., Halifax, N.S. (*H*) 348 Quinpool Rd. (*Jr. 1926*) (*A.M. 1931*)

BAIN, Archie Marcus, B.Sc., (Man. '28), M.Sc., (McGill '29), Str'l. Designer, Dom. Bridge Co. Ltd., Montreal, Que. (*S. 1925*) (*Jr. 1930*) (*A.M. 1938*)

BAIN, Wm. Alex., B.A.Sc., (B.C. '26), Res. Engr., B.C. Pulp and Paper Co. Ltd., Woodfibre, B.C. (*A.M. 1934*)

BAINBRIDGE, Robert Arthur, 19 Marlborough Ave., Victoria, B.C. (*M. 1903*) (*Life Member*)

BAIRD, Albert Foster, B.Sc., (E.E.), (N.B. '14), M.Sc., (N.B. '17), Prof. of Elec. Engrg., University of N.B., Fredericton, N.B. (*H*) 800 Regent St. (*A.M. 1922*) (*M. 1927*)

BAIRD, Earle Meharg, B.A.Sc., (Tor. '23), Engr., Township of Scarboro, 1683 Kingston Rd., Toronto 13, Ont. (*H*) 11 Avalon Blvd. (*Jr. 1925*)

BAIRD, John A., B.A.Sc., (Tor. '11), O.L.S., Cons. Engr. and Surveyor, Royal Bank Bldg., Sarnia, Ont. (*H*) Corunna, Ont. (*M. 1926*)

BAIRD, J. Boyd, M.Sc., (McGill '09), Secy., Newfoundland Board of Fire Underwriters, Bank of N.S. Bldg., Water St., St. John's, Nfld. (*H*) 11 Monkstown Rd. (*S. 1908*) (*A.M. 1913*)

BAIRD, Malcolm F., B.Sc., (N.B. '37), Can. Westinghouse Co., Hamilton, Ont. (*H*) 732 Cannon St. (*S. 1937*)

♂BAKER, Hugh Cossart, Major, M.C., McLeod, Young & Scott, Metropolitan Bldg., Toronto, Ont. (*H*) 35 Haddon St., Toronto 12, Ont. (*A.M. 1908*)

♂BAKER, Jas. Davidson, Lieut., Deputy Minister of Telephones and Gen. Mgr., Alberta Govt. Telephones, 400 C.P.R. Bldg., Edmonton, Alta. (*H*) 11045–85th Ave. (*M. 1935*)

BAKER, John Arthur, B.A.Sc., (B.C. '30), Sales Engr., Bepco Canada, Ltd., 45 Niagara St., Toronto, Ont. (*H*) 63 Boustead Ave. (*S. 1930*) (*Jr. 1938*)

BAKER, Rogerson Albert, B.A.Sc., (Tor. '37), Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*S. 1937*)

BAKER, Stephen Malor, B.Sc., (McGill '29), Asst. Plant Engr., Proctor & Gamble, Ltd., Hamilton, Ont. (*H*) 27 Waverly Ave., Hamilton Beach, Ont. (*S. 1927*)

BAKER, W. Gordon, B.Eng., (McGill '37), Hotel Iroquois, Asbestos, Que. (*S. 1937*)

BAKHMETEFF, His Excellency, Prof. Boris A., Cons. Engr., Rm. 1425, 250 West 75th St., New York, N.Y., Prof., Columbia University. (*H*) 55 East 72nd St. (*M. 1917*)

BALDRY, G. E., Chief Engr., Baldry Engineering and Construction Co. Ltd., 314 Broadway Ave., Winnipeg, Man. (*Affil. 1936*)

BALDRY, Geo. S., B.Sc., (No. Dakota '35), Supt., Baldry Engineering and Construction Co. Ltd., 314 Broadway Ave., Winnipeg, Man. (*S. 1931*)

BALDWIN, R. A., Engr. of Constrn., C.N.R., Rm. 439, Union Station, Toronto, Ont. (*H*) 26 Oriole Gardens. (*M. 1919*)

BALDWIN, Wm. A., B.Sc., (McGill '29), Supt., High Falls Generating Station, Maclaren Quebec Power Co., Buckingham, Que. (*S. 1929*)

BALFOUR, Reginald H., B.Sc., (McGill '97), Dist. Mgr., Can. Telephones & Supplies Ltd., 5795 De Gaspe Ave., Montreal, Que. (*H*) 644 Belmont Ave., Westmount, Que. (*S. 1899*) (*A.M. 1903*)

BALL, Alf. N., B.Sc., (Queen's '14), D.L.S., S.L.S., Chief Engr., E. B. Eddy Co., Hull, Que. (*H*) 119 Powell Ave., Ottawa, Ont. (*A.M. 1919*) (*M. 1936*)

BALL, Francis Caldwell, B.A.Sc., (Tor. '23), Asst. Sewer Engr., Corp. of City of London, City Engr.'s Dept., City Hall, London, Ont. (*H*) 374 Tecumseh Ave. (*S. 1920*) (*A.M. 1926*)

♂BALL, Spencer, Lt.-Col., B.Sc., (Sask. '16), Prof. Civil Engrg., Nova Scotia Technical College, Halifax, N.S. (*H*) 196 Atlantic St. (*S. 1915*) (*Jr. 1920*) (*M. 1932*)

BALL, Walter Lance, Cheticamp, N.S. (*A.M. 1921*)

BALLANTYNE, Norman F., M.E., (Cornell '93), 110 Hawthorne Ave., Ottawa, Ont. (*A.M. 1906*)

♂BALLANTYNE, Thomas B., B.Sc., (McGill '08), Asst. Dist. Engr., C.P.R., Union Station, Toronto, Ont. (*H*) 215 High Park Ave. (*S. 1908*) (*A.M. 1913*)

BALLARD, B. G., B.Sc., (Queen's '24), Assoc. Research Engr., National Research Council, Ottawa, Ont. (*H*) 297 James St. (*A.M. 1931*)

BALLOU, Frederick H., M.E., (Stevens I.T. '08), Chief Engr., B.C. Sugar Refining Co. Ltd., and Can. Sugar Factories Ltd., Vancouver, B.C. (*H*) 1391 W. 46th Ave. (*M. 1937*)

BALLS, Matthew, Asst. Engr., Shawinigan Water and Power Co., Power Bldg., Montreal, Que. (*H*) 26 Stratford Rd., Hampstead, Que. (*A.M. 1919*)

BALMFORTH, Harold, B.E., (Sask. '24), 3234 Dominion St., New Westminster, B.C. (*A.M. 1936*)

BALTZELL, Willie Harry, 361 N. Craig St., Pittsburgh, Pa., U.S.A. (*M. 1920*)

BALTZER, Clarence Edwin, B.Sc., (Queen's '20), Engr., Testing and Research Labs., Bureau of Mines, Dept. of Mines and Resources, 560 Booth St., Ottawa, Ont. (*H*) 13 St. Francis St. (*S. 1919*) (*A.M. 1925*)

BANCROFT, Gilbert H., Mech. Dftsman., Cons. Mining & Smelting Co. of Canada, Trail, B.C. (*H*) 7 Forrest Dr., Warfield, B.C. (*A.M. 1936*)

BANG, Claus M., B.Sc., Mgr., Hydro-Elec. Power Dev., International Power and Paper Co. of Newfoundland, Ltd., Deer Lake, Nfld. (*A.M. 1922*)

♂BANGS, Raymond Gardner, Lieut., B.Sc., (McGill '16), Transp. and Public Utilities Br., Bureau of Statistics, Dept. of Trade and Commerce, Ottawa, Ont. (*H*) 191 Somerset St. W. (*S. 1916*) (*A.M. 1919*)

BANKS, S. R., M.Eng., (Liverpool '24), Asst. Engr., Monsarrat & Pratley, 909 Drummond Bldg., Montreal, Que. (*H*) 67–53rd Ave., Lachine, Que. (*Jr. 1930*) (*A.M. 1934*)

BARBER, Wm., B.A.Sc., (Tor. '06), Mgr., Barber Construction Co., Fleet and Spadina Ave., Toronto, Ont. (*A.M. 1911*)

BARBOUR, C. A., B.Sc., (N.B. '31), The Boiler Inspection and Insurance Co., Montreal, Que. (*H*) 55 Lazard Ave., Town of Mount Royal, Que. (*S. 1930*) (*Jr. 1935*)

BARBOUR, Frank A., B.A., Cons. Engr., 1119 Tremont Bldg., Boston, Mass. (*H*) Salem Rd., Framingham, Mass. (*M. 1904*)

BARBOUR, Ronald Granville, B.Sc., (N.B. '24), (M.Sc. '27), Industrial Engr., T. Pringle & Son Ltd., Room 706, 485 McGill St., Montreal, Que. (*H*) Apt. 15, 4100 Cote des Neiges Rd. (*S. 1923*) (*A.M. 1937*)

BARCLAY, Jas. Bow, Northern Construction Co. and J. W. Stewart Ltd., Vancouver, B.C. (*H*) 2879 W. 28th Ave. (*A.M. 1936*)

♂BARCLAY, Noel M., Lieut., M.C., B.Sc., (Glasgow), Asst. Engr., Montreal Sewers Comm., Room 403, City Hall, Montreal, Que. (*H*) 3496 Cote des Neiges Rd. (*A.M. 1914*)

♂BARLTROP, Ivan Chas., Capt., B.A., (Cantab.), Asst. Engr., D.P.W. of B.C., Parliament Bldgs., Victoria, B.C. (*H*) 1954 Monteith St. (*A.M. 1923*)

BARNECUT, Reginald, B.Sc., (Alta. '23), Chief Dftsman., Dom. Bridge Co. Ltd., Calgary, Alta. (*H*) 1230–16th Ave. N.W. (*A.M. 1931*)

BARNES, Chas. T., Str'l. Engr., City of Winnipeg Hydro-Electric System, 55 Princess St., Winnipeg, Man. (*H*) 343 Dubuc St., Norwood. (*Jr. 1920*) (*A.M. 1923*)

BARNES, Chiles M., Str'l. Designer, Chemical Construction Corp., 30 Rockefeller Plaza, New York, N.Y. (*H*) 3601 31st Ave., Astoria, N.Y. (*Jr. 1917*) (*A.M. 1922*)

BARNES, Frank Harvey, B.Sc., (McGill '12), Port Hope, Ont. (*A.M. 1928*)

♂BARNES, Harry Fairweather, B.Sc., (N.B. '12), Secy. and Municipal Engr., British Municipal Council, Tientsin, China. (*H*) 170 Bruce Rd. (*A.M. 1916*) (*M. 1924*)

BARNES, John, Mech. Designer, Can. Gen. Elec. Co., Ltd., Peterborough, Ont. (*H*) 5 Gottesmore St., Sub. P.O. No. 1. (*A.M. 1921*)

♂BARNETT, Harold Evans, B.Sc., (N.B. '18), Dom. Construction Corp. Ltd., Liverpool, N.S. (*Jr. 1921*) (*A.M. 1931*)

BARNETT, Thos. Arthur, Gen. Supt., H.E.P.C. of Ont., Bala, Ont. (*H*) 2408 Stanley St., Niagara Falls, Ont. (*A.M. 1922*)

BARNHILL, B. E., B.Eng., (King's, Halifax '99), 306 Architects Bldg., Los Angeles, Calif., U.S.A. (*A.M. 1907*) (*M. 1921*)

BARNHOUSE, Frank Wm., B.Sc., (Alta. '34), Wire and Cable Sales Engr., Can. Gen. Elec. Co. Ltd., 212 King St. W., Toronto, Ont. (*H*) 77 Burnaby Blvd. (*S. 1933*) (*Jr. 1938*)

BARNSLEY, Frank R., B.A.Sc., (B.C. '27), Mgr., Air Conditioning Divn., Can. Gen. Elec. Co. Ltd., 1000 Beaver Hall Hill, Montreal, Que. (*H*) 5245 Byron Ave. (*S. 1924*) (*A.M. 1938*)

♂BARNUM, John Baylor, Field Engr., Montreal Light, Heat and Power Co., Cedars, Que. (*A.M. 1922*)

BARR, F. G. F., B.A.Sc., (Tor. '27), Gen. Traffic Dept., Bell Telephone Co. of Canada, Ltd., 76 Adelaide St., Toronto, Ont. (*H*) 43 Admiral Rd. (*S. 1926*) (*A.M. 1937*)

BARR, Shirley, 5564 Queen Mary Rd., Hampstead, Montreal, Que. (*M. 1921*)

♂BARRETT, Andrew Grant, B.Sc., (Queen's '21), Str'l. and Mech. Engr., Yukon Cons. Gold Corp. Ltd., Dawson, Y.T. (*H*) Williamstown, Ont. (*S. 1921*) (*Jr. 1925*) (*A.M. 1931*)

BARRETT, Michael Jos., B.E. (N.S.T.C. '35), Ventilating Engr., Sun Life Assurance Co. of Canada, Montreal, Que. (*H*) 9626 LaSalle Rd., Ville LaSalle, Que. (*Jr. 1938*)

BARRINGTON, Yorke C., Town Engr., Town Hall, Box 629, Sydney Mines, N.S. (*A.M. 1923*)

♂BARRY, David, Major, Engrg. Branch, Dept. of National Defence, Birks Bldg., Ottawa, Ont. (*A.M. 1911*)

BARRY, Oswald, B.Eng., (McGill '36), C.P.R., Room 401, Windsor Station, Montreal, Que. (*H*) 1545 Mackay St. (*S. 1936*)

BARRY, William Henry, Chief Engr., Worth Bros. Inc., 4400 Worth St., Los Angeles, Calif. (*H*) 8178 N. Chestnut Ave., South Gate. (*A.M. 1924*)

♂BARTON, Harold Miall, Lieut., D.L.S., Geodetic Survey of Canada, Dept. Mines and Resources, Ottawa, Ont. (*H*) 31 Broadway Ave. (*A.M. 1921*)

♂BARTON, Robert A., Lieut., B.Sc., Private Practice, Box 1198, Penticton, B.C. (*A.M. 1910*)

BARWICK, Oliver A., B.Arch., (McGill '14), Sr. Asst. Archt., Dept. National Defence, 507 Canadian Bldg., Ottawa, Ont. Address: P.O. Box 767, Station B. (*A.M. 1923*)

BASTABLE, Ross W., B.Sc., (McGill '22), Superv. of Bldgs., E.A., Bell Telephone Co. of Canada, 1050 Beaver Hall Hill, Montreal, Que. (*H*) 96–44th Ave., Lachine, Que. (*S. 1920*) (*A.M. 1930*)

♂BATE, Chas. Ben., Capt., M.C., D.C.M., B.Sc., (Queen's '15), James Ruddick, Cons. Engr., Quebec, Que. (*H*) Loretteville, Que. (*A.M. 1919*)

BATES, Charles Lynn, B.S. in C.E., (M.I.T. '03), Chief Engr., P.G.E. Rly., Squamish, B.C. (*H*) 2243–1st Ave. W., Vancouver, B.C. (*A.M. 1907*) (*M. 1936*)

BATES, Harold C., B.Sc., (Queen's '17), 40 Baby Point Rd., Toronto, Ont. (*S. 1916*) (*Jr. 1920*)

BATES, John Seaman, B.S., (Acadia '09), Ph.D., (Columbia '14), Price & Pierce Ltd., 27 Clements Lane, London E.C.4, England. (*H*) Manor Fields, London, S.W.15. (*A.M. 1915*)

BATES, Ralph E., 76 Mill St. S., Brampton, Ont. (*S. 1936*)

♂BATY, Edward, 2nd Lieut., Dist. Plant Engr., Bell Telephone Co. of Canada, Plateau Bldg., Montreal, Que. (*H*) 180 Gohier St., St. Laurent, Que. (*A.M. 1931*)

BAULNE, Stanislas Albert, D.A.Sc., Baulne & Leonard, C.E., 354 St. Catherine St. E., Montreal, Que. (*S. 1899*) (*A.M. 1913*)

BAUMAN, Bert, B.Sc., (McGill '27), Constrn. Engr., Aluminum Co. of Canada, Ltd., Box 42, Arvida, Que. (*S. 1927*) (*A.M. 1936*)

BAXTER, Gordon B., B.Sc., (McGill '26), Asst. Elec. Supt., Can. International Paper Co., Box 482, Three Rivers, Que. (*H*) 1491 Blvd. des Forges. (*S. 1924*) (*Jr. 1929*)

BAXTER, John G. M., B.I., (Prague '25), address unknown. (*Jr. 1927*) (*A.M. 1929*)

♂BAYNE, Blair Edmundston, Lieut., B.Sc., (N.S.T.C. '22), Maintainer, Unit Cars, C.N.R., Moncton, N.B. (*H*) 51 Cameron St. (*Jr. 1920*) (*A.M. 1927*)

BAYNE, Geo. Manning, Engr., Heating Engr'g. Divn., Can. Westinghouse Co. Ltd., Hamilton, Ont. (*H*) 186 Rosslyn Ave. S. (*A.M. 1922*)

♂BEACH, Floyd K., Major, D.L.S., i/c Petroleum and Nat. Gas Records, Dept. of Lands and Mines, Alta., Telephone Bldg., Calgary, Alta. (*H*) 1914–5A St. W. (*S. 1910*) (*A.M. 1913*) (*M. 1935*)

BEACH, John E., B.Sc., (Alta. '35), 72 Admiral Rd., Toronto, Ont. (*S. 1935*)

BEALE, Alfred M., B.Sc., (London), D.L.S., Water Power Engr., Dom. Water and Power Bureau, Dept. Mines and Resources, Ottawa, Ont. (*H*) 12 Lisgar Rd., Rockcliffe, Ont. (*S. 1907*) (*A.M. 1912*)

BEAM, Donald C., B.A.Sc., (Tor. '28), Technical Secretary, Bldg. Dept., Corp. of City of Toronto, City Hall, Toronto, Ont. (*H*) 360 Elm Rd. (*S. 1926*) (*Jr. 1927*) (*A.M. 1935*)

BEAMENT, Geo. Edwin, (R.M.C., Kingston), B.A.Sc., (Tor. '31), Beament & Beament, Ottawa Electric Bldg., 56 Sparks St., Ottawa, Ont. (*H*) 9 Marlborough Ave. (*Jr. 1932*)

BEANEY, Sydney Wm., Sales Engr., Jos. Taylor & Son, 612 Sherbourne St., Toronto, Ont. (*H*) 125 Erskine Ave. (*Affil. 1936*)

BEATH, Laurence Raymond, B.Eng., (McGill '35), Price Bros. & Co., Kenogami, Que. (*H*) 1545 Albert St., Regina, Sask. (*S. 1935*)

BEATON, Neville, Res. Engr., Powell River Co. Ltd., Powell River, B.C. (*A.M. 1935*)

BEATTY, James Edward, (R.M.C., Kingston), D.L.S., 318 St. George Apts., 321 Bloor St., Toronto, Ont. (*A.M. 1905*) (*M. 1915*) (*Life Member*)

BEAUBIEN, deGaspe, B.Sc., (McGill '06), Cons. Engr., de Gaspe Beaubien & Co., Rm. 1104, University Tower, 660 St. Catherine St. W., Montreal, Que. (*H*) 462 St. Catherine Rd., Outremont, Que. (*S. 1903*) (*A.M. 1908*) (*M. 1921*) (*Treasurer, E.I.C.*)

BEAUCHEMIN, Jules Armand, B.A.Sc., (Ecole Polytech., Montreal '11), Chief Engr., Provincial Electricity Board, 132 St. James St., Montreal, Que. (*H*) 5444 Grovehill Place. (*A.M. 1919*)

BEAUDET, Guy, B.A.Sc., (Ecole Polytech., Montreal '38), City Engr., Thetford Mines, Que. (*S. 1936*)

BEAUDRY, Louis, B.A.Sc., (Ecole Polytech., Montreal '21), Engr.-in-Chief, Port of Quebec, Dept. of Transport, Quebec, Que. (*H*) 4 Laporte St. (*S. 1919*) (*A.M. 1926*)

BEAULIEU, Gerard, B.A.Sc., (Ecole Polytech., Montreal '36), Dom. Bridge Co. Ltd., Montreal, Que. (*H*) Apt. 1, 3679 Laval Ave. (*S. 1935*)

BEAVER, Hugh Eyre Campbell, Partner, Sir Alexander Gibb and Partners, Cons. Engrs., Queen Anne's Lodge, Westminster, London, England, S.W.1. (*H*) "Luxford," Crowborough, Sussex, England. (*M. 1937*)

BECK, Alfred Edward, B.Sc., (McGill '03), 275 Russell Hill Rd., Toronto, Ont. (*S. 1899*) (*A.M. 1907*)

BECK, Edward Alfred, Dom. Bridge Co. Ltd., Montreal, Que. (*H*) 106 Irvine Ave., Westmount, Que. (*A.M. 1920*)

BECK, Humphrey C., Mgr., Substations Dept., English Electric Co., Stafford, England. (*H*) 12 Baswich Lane. (*A.M. 1934*)

BECKER, Donald Fay, Sec.-Treas., Richfield Distributors Ltd., 1005–9th Ave. E., Calgary, Alta. (*H*) 3213 Elbow Drive. (*Jr. 1935*)

BECKER, Fred A., B.A.Sc., (Tor. '24), Sales Engr., Can. Gen. Elec. Co., Ltd., 212 King St. W., Toronto, Ont. (*H*) 31 Rathnally Ave. (*Jr. 1928*) (*A.M. 1931*)

BECKER, Howard Warren, B.A., B.Sc., (Alta. '33), Chem. Engr., Richfield Distributors Ltd., 1005–9th Ave. E., Calgary, Alta. (*Jr. 1935*)

BECKER, S. J., B.Eng., (McGill '38), 282 Villeneuve St. W., Montreal, Que. (*S. 1937*)

BEDFORD-JONES, Chas. E., B.A.Sc., (Tor. '33), 2320 Lincoln Ave., Montreal, Que. (*S. 1932*)

BEDOUKIAN, P. Z., B.Eng., (McGill '36), W. J. Bush & Co., 432 St. Helen St., Montreal, Que. (*S. 1936*)

BEER, Alfred Netlam, 3821 Draper Ave., Montreal, Que. (*A.M. 1915*)

♂BEGG, Jas. M., B.Sc., (Glasgow), 3439 Walkley Ave., N.D.G., Montreal, Que. (*A.M. 1913*) (*M. 1928*)

BEGLEY, Wm., Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*H*) 211 Rubidge St. (*S. 1938*)

BÉIQUE, Freddy Paul, 550 Davaar Ave., Outremont, Que. (*S. 1937*)

BÉIQUE, Henri F., B.Eng., (McGill '36), Engr., Quebec Power Co., Quebec Power Bldg., Quebec, Que. (*H*) 33 Laporte St. (*S. 1936*)

BÉIQUE, Paul A., B.A.Sc., (Ecole Polytech., Montreal), Q.L.S., Cons. Engr., 477 St. Francois Xavier St., Montreal, Que.; Vice-Pres., Montreal Tramways Comm. (*H*) 615 Dunlop Ave., Outremont, Que. (*S. 1904*) (*A.M. 1913*)

BELANGER, Alex. Albert, Asst. Engr., Bd. Transport Commrs., Union Station, Ottawa, Ont. (*H*) 544 King Edward Ave. (*S. 1899*) (*A.M. 1907*)

BELANGER, Guy, B.Sc., (Ecole Polytech., Montreal '37), 249 St. Catherine Rd., Outremont, Que. (*S. 1936*)

BELANGER, Maurice, 53 Ste. Catherine Rd., Montreal, Que. (*S. 1938*)

BELANGER, Raphael, B.Sc., (Ecole Polytech., Montreal '23), City Engr., Valleyfield, Que. (*H*) 47 Jacques Cartier St. (*S. 1921*) (*A.M. 1927*)

BELANGER, René, B.A.Sc., Supt., Quebec Pulp and Paper Corp., Chicoutimi, Que. (*H*) 53 Price St. (*A.M. 1935*)

BELL, Fred'k. A., B.Sc., (Queen's '10), O.L.S., County Engr., and Gen. Practice, Court House, St. Thomas, Ont. (*H*) 2 Prince Albert St. (*S. 1906*) (*A.M. 1913*)

BELL, F. Jno., Can. Representative for British Engrg. Cos., Royal Bank Bldg., Toronto, Ont. (*H*) 80 Highlands Ave. (*M. 1918*)

♂BELL, George Edward, Capt., B.Sc., (McGill '07), London Mgr., Deloro Smelting and Refining Co. Ltd., 8 Waterloo Place, London, S.W.1., England. (*H*) Overdale, Copthorne Rd., Croxley Green, Herts. (*S. 1901*) (*A.M. 1908*) (*M. 1914*)

BELL, Harry H., B.Sc., (N.S.T.C. '29), S.M., (M.I.T. '33), Montreal Engineering Co., 244 St. James St., Montreal, Que. (*H*) 407 Walpole Ave., Town of Mount Royal, Que. (*S. 1928*) (*Jr. 1931*) (*A.M. 1934*)

♂BELL, Richard Thos., Chief Engr., Jaeger Truck Mixers (England) Ltd., 54 Victoria St., London, S.W.1, England. (*H*) Highbury, Ringley Ave., Horley, Surrey. (*M. 1928*)

BELLAMY, Franklin J., Private Practice, 9 Lyndhurst Rd., Exeter, Devon, England. (*M. 1910*)

BELLAMY, Keith Lacy, B.Sc., (Queen's '35), 2548 Taylor St., Niagara Falls, Ont. (*S. 1934*)

♂BELL-IRVING, Robt., Capt., B.Sc., (McGill '14), B.C.L.S., Vice-Pres., Powell River Co., Ltd., Standard Bank Bldg., Vancouver, B.C. (*H*) 1646 Laurier Ave. (*A.M. 1920*) (*M. 1936*)

BELLE-ISLE, Jacques G., B.A.Sc., (Ecole Polytech., Montreal '38), Asst. Divn. Engr., Roads Dept., Quebec, Beauceville, Que. (*S. 1938*)

BELLIVEAU, John Edmund, Asst. Chief Engr., Dept. of Highways, N.S., Halifax, N.S. (*A.M. 1918*)

BEMAN, Edwin Arthur, B.E., (Sask. '28), Sutcliffe Co. Ltd., New Liskeard, Ont. (*A.M. 1931*)

BENETT, Chas. Morgan, B.Sc., (McGill '23), Steel Co. of Canada, Montreal, Que. (*H*) 49 Chesterfield Ave., Westmount, Que. (*A.M. 1934*)

BENJAFIELD, P. G., B.Sc., (Queen's '32), International Nickel Co. of Canada, Levack, Ont. (*S. 1928*) (*Jr. 1938*)

BENJAFIELD, J. F., B.Sc., (Queen's '33), Field Engr., Foundation Co. of Canada, Ltd., 1538 Sherbrooke St. W., Montreal, Que. (*S. 1933*) (*Jr. 1938*)

BENJAMIN, Abraham, B.Sc., (McGill '24), Designer, Montreal L., H. and P. Cons., Power Bldg., Montreal, Que. (*H*) 4839 Melrose Ave., N.D.G. (*S. 1921*) (*Jr. 1928*) (*A.M. 1935*)

BENJAMIN, Archie, B.Sc., (McGill '28), Montreal L., H. and P. Cons., Rm. 307, Power Bldg., Montreal, Que. (*S. 1926*) (*Jr. 1933*)

♂BENNET, W. Herbert, Lieut., B.Sc., (Queen's '19), Engr., Montreal Sewers Comm., City Hall, Montreal, Que. (*H*) 3453 Rosedale Ave. (*S. 1919*) (*Jr. 1922*) (*A.M. 1924*)

BENNETT, Arthur J., B.Sc., (McGill '27), Sales Engr., English Electric Co. of Canada, Ltd., 50 King St. E., Toronto, Ont. Address: Kirkland Lake Hotel, Kirkland Lake, Ont. (*S. 1925*) (*A.M. 1935*)

♂BENNETT, Chas. S., Lieut., B.Sc., (N.B. '12), Chief Engr., National Harbours Bd., Halifax, N.S. (*H*) 32 Rosebank Ave. (*Jr. 1914*) (*A.M. 1927*)

BENNETT, Geo. Francis C., B.Sc., (McGill '31), Sales Engr., Can. Westinghouse Co., Ltd., 158 Granville St., Halifax, N.S. (*H*) 3 Cartaret St. (*S. 1929*) (*Jr. 1936*)

♂BENNETT, Harry Frederick, Capt., B.Sc., (N.B.' 08), Dist. Engr., D.P.W., Canada, P.O. Box 668, London, Ont. (*S. 1907*) (*Jr. 1914*) (*A.M. 1920*) (*M. 1935*)

BENNETT, Jas. Earl, B.E., (Sask. '26), Bridge Inspr., Gov't. Sask. (*H*) 2 Lorscott Mansions, Regina, Sask. (*1938*)

BENNETT, Robt. Douglas, B.Eng., (McGill '32), M.Sc., '33; Ph.D., Can. Industries Ltd., Shawinigan Falls, Que. (*S. 1930*) (*A.M. 1938*)

♂BENNETT, Stewart Gordon, Capt., M.C., B.A.Sc., (Tor. '14), Partner and Vice-Pres., Beardmore & Co., 37 Front St. E., Toronto, Ont. (*H*) 4 Dale Ave. (*A.M. 1926*)

BENNY, Walter R., B.Eng., (McGill '32), Asst. Engr., C.P.R., Rm. 354, Union Sta., Toronto, Ont. (*H*) 59 Breadalbane St. (*S. 1928*) (*Jr. 1936*)

BENNY, Walter W., B.A.Sc., (McGill '98), 85 Bellwood Ave., Ottawa, Ont. (*S. 1899*) (*A.M. 1904*)

BENOIT, Andre Persillier, B.Eng., (McGill '34), Dom. Rubber Co. Ltd., Montreal, Que. (*H*) Apt. 14, 410 Sherbrooke St. W. (*S. 1933*)

BENOIT, Jacques, B.A.Sc., (Ecole Polytech., Montreal '33), Dist. Sales Mgr., Wallace & Tiernan Ltd., Room 309, 1502 St. Catherine St. W., Montreal, Que. (*H*) 1485 Bernard Ave., Outremont, Que. (*S. 1933*) (*Jr. 1938*)

BENSON, Willard McLean, B.Sc., (N.B. '35), Hoyle Gold Mines Ltd., Pamour, Ont. (*H*) 845 Charlotte St., Fredericton, N.B. (*S. 1935*)

BENTLEY, Kenneth Earl, B.Sc., (N.S.T.C. '34), Imperial Oil Ltd., P.O. Box 490, Dartmouth, N.S. (*H*) Avenue A, Imperoyal, N.S. (*S. 1934*)

BENTLEY, Wm. Heathcote, Dept. of Telephones, Gov't. Sask. (*H*) 198 Angus Cres., Regina, Sask. (*1938*)

BERENSTEIN, Leslie, B.Sc., (McGill '30), Str'l. Engr., Louis Pickard & Co. Inc., 2070 Papineau Ave., Montreal, Que. (*H*) 3785 Girouard Ave. (*S. 1929*)

BERESKIN, A. I., B.Sc., (Man. '30), D.L.S., Dept. of National Defence, Winnipeg, Man. (*H*) 1307 Portage Ave. (*S. 1925*) (*Jr. 1931*)

BERGER, B. A., B.Sc., (McGill '30), Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*S. 1928*) (*Jr. 1936*)

BERGMAN, Wesley H., B.Sc., (Alta. '36), 313 Maitland Ave., Peterborough, Ont. (*S. 1936*)

BERLINGUET, F. X. T., D.L.S., P.L.S., Q.L.S., Cons. Engr., D.P.W., Three Rivers, Que. (*H*) 747 Laviolette Ave. (*A.M. 1887*) (*M. 1890*) (*Life Member*)

BERNIER, Hubert, 1011 Sherbrooke St. E., Montreal, Que. (*S. 1937*)

BERRINGER, O. B., B.Sc., M.E., (N.S.T.C. '32 and '35), Lunenburg, N.S. (*S. 1933*) (*Jr. 1938*)

♂BERRY, Albert Edward, Lieut., C.E., M.A.Sc., (Tor.), Ph.D., Director, Sanitary Engrg. Divn., Dept. of Health, Ont., Parliament Bldgs., Toronto, Ont. (*H*) 235 Gainsborough Rd. (*A.M. 1921*) (*M. 1934*)

BERRY, Effingham Deans, (R.T.C., Glasgow), Chief Dftsman., E. B. Eddy Co. Ltd., Hull, Que. (*H*) 150 Aylmer Ave., Ottawa, Ont. (*A.M. 1933*)

BERRY, Melville Douglas, B.Sc. (Man. '31), Elec. Engr., Leland Electric Canada Ltd., Toronto, Ont. (*H*) 31 Stanhope Ave. (*S. 1928*) (*Jr. 1936*)

BERRY, Theodore Victor, B.A.Sc., (B.C. '23), Sec.-Treas., Vancouver and Dists., Joint Sewerage and Drainage Bd., 1303 Sun Bldg., Vancouver, B.C. (*H*) 3007-W. 36th Ave. (*A.M. 1934*)

BERTRAM, H. Graham, B.Sc., (Queen's '10), Vice-Pres. and Gen. Mgr., The John Bertram & Sons Co., Ltd., Dundas, Ont. (*M. 1920*)

BERTRAND, G., 178 Ave. Daumesnil, Paris 12, France. (*S. 1928*)

BERTRAND, J. N. Tetu, B.A., (Laval '83), Isle Verte, Que. (*S. 1897*) (*A.M. 1906*) (*Life Member*)

BEUGLER, Edwin James, Cons. Engr., Private Practice, South Main St., Cheshire, Conn., U.S.A. (*M. 1907*)

♂BEVAN, William Henry Basil, A/Major, D.C.M., Asst. Dist. Engr., C.N.R., Montreal, Que. (*H*) 4019 Melrose Ave., N.D.G. (*A.M. 1921*)

♂BEWS, Douglas Waldron, B.Sc., (Queen's '14), Dfting. Instructor, Belleville Technical School. (*H*) 184 Albert St., Belleville, Ont. (*Jr. 1916*) (*A.M. 1921*)

♂BICKERDIKE, Robt., Lieut.-Col., D.S.O., Ma.E., (McGill '91), 4426 Harvard Ave., Montreal, Que. (*S. 1888*) (*A.M. 1895*) (*M. 1900*) (*Life Member*)

♂BIDDELL, Cecil Henry, Lieut., D.L.S., 2207 Angus St., Regina, Sask. (*A.M. 1920*)

BIEDERMANN, Othmar, Mgr., Oerlikon-Canada, Ltd., 1514 University Tower Bldg., Montreal, Que. (*H*) Apt. 16, 3546 Durocher St. (*A.M. 1936*)

BIELER, Jacques Louis, B.Sc., (McGill '23), Engr., Dom. Oilcloth and Linoleum Co., Montreal, Que. (*H*) 643 Milton St. (*S. 1920*) (*Jr. 1928*) (*A.M. 1936*)

BIESENTHAL, Clarence G., B.Sc., (Queen's '36), Spruce Falls Power and Paper Co., Kapuskasing, Ont. (*S. 1935*) (*Jr. 1938*)

BILLETTE, Roger, B.Eng., (McGill '31), Shawinigan Water and Power Co., Montreal, Que. (*H*) Valleyfield, Que. (*S. 1931*) (*Jr. 1937*)

BILLIE, Frank R. V., B.A., (Loyola), B.Sc., (McGill '27), Engr. and Contractor, P.O. Box 1185, Smith's Falls, Ont. (*S. 1927*) (*A.M. 1936*)

BILLINGS, A. W. K., A.M., (Harvard '96), Vice-Pres., Brazilian Traction, Light and Power Co., Ltd. and Subsidiaries, 25 King St. W., Toronto, Ont. (*H*) 1277 Avenida Brasil, Sao Paulo, S.P. Brazil. (*M. 1930*)

BILLINGS, Geo. Michael, (R.M.C., Kingston), B.Sc., (Queen's '36), Lieut., R.C.C.S., Camp Borden, Ont. (*S. 1936*)

BINGHAM, Albert R., R.R. 1, Massena, N.Y. (*A.M. 1921*)

BINNS, Geo. F., B.Sc., (McGill '23), 5550 Cote St. Luc Rd., Montreal, Que. (*S. 1921*) (*Jr. 1930*) (*A.M. 1930*)

BINNS, Frank, B.S., (Tuft's '09), M.S., (Purdue '35), Instructor Engrg. Drawing, Mount Allison University, Sackville, N.B. (*A.M. 1938*)

♂BIRD, Frederick George, Major, M.C., B.Sc., (Queen's '14), i/c Land Dept., Imperial Oil Ltd., 606–2nd St. W., Calgary, Alta. (*H*) 3809–8th St. W. (*A.M. 1920*)

♂BIRD, Hubert John Allen, Capt., Pres. and Gen. Mgr., Bird Construction Co. Ltd., P.O. Box 2865, Winnipeg, Man. (*H*) 919 Somerset Ave., Fort Garry. (*A.M. 1929*)

♂BIRKETT, Leonard Harris, Sales Mgr., Combustion Engineering Corp. Ltd., Dominion Square Bldg., Montreal, Que. (*H*) 4690 Roslyn Ave. (*A.M. 1927*)

♂BIRRELL, Allan Lloyd, Cons. Elec. and Mech. Engr., Allan L. Birrell, 372 Bay St., Toronto 2, Ont. (*H*) 93 Kingsway. (*A.M. 1921*)

♂BISHOP, Arthur Leonard, Col., (R.M.C., Kingston '14), Pres., The Coniagas Mines, Ltd., 1514 Canada Permanent Bldg., Toronto, Ont. (*H*) 69 Forest Hill Rd. (*Jr. 1919*) (*A.M. 1924*) (*M. 1936*)

BISHOP, William Israel (*q*), Pres., William I. Bishop, Ltd., New Birks Bldg., Montreal, Que. (*S. 1896*) (*A.M. 1899*) (*M. 1907*)

BISHOP, Wm. J., Prin. Asst. Engr., Dept. of Highways, Ont., White River, Ont. (*H*) 352 McLaren St., Ottawa, Ont. (*S. 1909*) (*A.M. 1911*)

BISSETT, James Randolph, B.Sc., (Tor. '12), Sr. Asst. Engr., Dom. Water and Power Bureau, Dept. Mines and Resources, Ottawa, Ont. (*H*) 24 Driveway. (*A.M. 1916*)

BIZIER, Jos. Lionel, B.A.Sc., (Ecole Polytech., Montreal '27), National Harbours Board, Port of Quebec, Quebec, Que. (*H*) 59 Murray Ave. (*A.M. 1931*)

BLACHFORD, H. E., B.Sc., (McGill '31), Technical Asst., Can. Electrical Assoc., Montreal, Que. (*H*) 133 Hillcrest Ave., Montreal West, Que. (*S. 1930*) (*Jr. 1938*)

BLACK, Frank Leslie, B.Sc., (N.S.T.C. '31), N.B. Electric Power Comm., Box 820, Saint John, N.B. (*H*) 144 Carmarthen St. (*S. 1930*) (*Jr. 1934*)

BLACK, Hugh Murray, B.Sc., (McGill '23), Dist. Mgr., English Electric Co. Ltd., 50 King St. E., Toronto, Ont. (*H*) 50 Chudleigh Ave. (*S. 1921*) (*A.M. 1930*)

BLACK, John Alfred, B.Sc., (N.S.T.C. '30), Couron Mining Co., Perron, Que. (*S. 1929*) (*A.M. 1934*)

BLACK, Maurice W., Canada Construction Co., Ltd., Royal Bank Bldg., Fredericton, N.B. (*S. 1907*) (*Jr. 1912*) (*A.M. 1916*) (*M. 1922*)

BLACK, S. W. Bruce, B.A.Sc., (Tor. '13), Asst. Engr., H.E.P.C. of Ont., 620 University Ave., Toronto, Ont. (*H*) 88 St. Germain Ave. (*A.M. 1920*)

BLACK, Wm. D., B.A.Sc., (Tor. '09), Pres., Otis-Fensom Elevator Co., Ltd., Hamilton, Ont. (*H*) 454 Queen St. S. (*S. 1908*) (*A.M. 1912*) (*M. 1928*)

BLACKETT, Victor St. Clair, B.Sc., (McGill '10), Asst. Engr., Engrg. Dept., C.N.R., Moncton, N.B. (*H*) 229 Highfield St. (*A.M. 1921*)

BLACKMORE, C. L., B.Sc., (McGill '27), Pres., C. L. Blackmore & Co. Ltd., 5112 Decarie Blvd., Montreal, Que. (*S. 1925*) (*Jr. 1930*) (*A.M. 1937*)

BLADON, James Buckley, Chief Engr., Darling Bros., Ltd., Montreal, Que. (*H*) 85 Holton Ave., Westmount, Que. (*M. 1922*)

BLAINE, D. S., (R.M.C., Kingston '32), B.Sc., (Queen's '34), 275 James St. S., Hamilton, Ont. (*H*) 9720–106th St., Edmonton, Alta. (*S. 1934*)

BLAIR, David E., B.Sc., (McGill '97), Gen. Mgr., Montreal Tramways Co., Montreal, Que. (*H*) 752 Upper Lansdowne Ave., Westmount, Que. (*A.M. 1904*) (*M. 1927*)

BLAIR, Donald, Strl. Engr., Dept. of National Defence, Rm. 507, Canadian Bldg., Ottawa, Ont. (*H*) 173 Daly Ave. (*A.M. 1934*)

♂BLAIR, Fager Jas., Lieut., (Tor. '10), Wks. Engr., Toronto Harbour Commrs., Toronto, Ont. (*H*) 91 Alexandra Blvd. (*A.M. 1921*)

BLAIR, Jas., Plant Engr., Imperial Oil Ltd., E. Calgary, Alta. (*H*) 107–10th Ave., N.E., Calgary, Alta. (*S. 1931*)

♂BLAIR, Robert Thomson, Lieut., (R.T.C., Glasgow), Asst. Bldg. Inspr., City Hall, City of Vancouver, Vancouver, B.C. (*H*) 6062 McDonald St. (*A.M. 1921*)

BLAKE, Jas. Hewat, Mech. Supt., Dept. of Lands, B.C., Parliament Bldg., Victoria, B.C. (*H*) 1603 Jubilee Ave. (*A.M. 1923*)

♂BLAKE, Wm. Henry, Major, M.C., R.C.E., D.E.O., M.D. No. 7, Dept. National Defence, The Armoury, Saint John, N.B. (*H*) 196 King St. E. (*A.M. 1931*)

†BLANCHARD, A. C. D., B.Sc., (McGill '01), Engr., Montreal Engineering Co. Ltd., 244 St. James St., Montreal, Que. (*H*) 8027 Western Ave. (*S. 1901*) (*A.M. 1904*) (*M. 1911*)

BLANCHARD, Arthur Horace, C.E., M.A., address unknown. (*M. 1912*)

♂BLANCHARD, Aubrey B., Capt., B.A., (Dalhousie), Divn. Engr., Constrn., Dept. of Highways, N.S., Sydney, N.S. (*H*) 69 College Road, Truro, N.S. (*S. 1904*) (*A.M. 1910*) (*M. 1915*)

BLANCHARD, C. Haliburton, Dist. Engr., Reclam. Branch, Man. D.P.W., Parliament Bldg., Winnipeg, Man. Dist. Office: Garson, Man. (*A.M. 1919*)

BLANCHARD, Joseph Elie, Director of P.W., City of Montreal, City Hall, Montreal, Que. (*H*) 11930 Valmont St. (*M. 1920*)

BLOCK, J. Ben., B.Eng., (McGill '37), 3511 Jeanne Mance St., Montreal, Que. (*S. 1937*)

BLOOMFIELD, Jas. M., Supt. of Utilities, Town of Kamsack, Kamsack, Sask. (*A.M. 1929*)

BLOXHAM, Horace Wm., Field Engr., Dept. of Highways, Ont., Grimsby, Ont. (*H*) 171 King St., St. Catharines, Ont. (*A.M. 1938*)

BLUE, Albert C., B.A.Sc., (Tor. '21), Foster Wheeler Limited, St. Catharines, Ont. (*H*) 7 Thairs Ave. (*S. 1920*) (*Jr. 1927*) (*A.M. 1932*)

♂BLUE, Walter Edgar, Major, D.S.O., (R.M.C., Kingston '10), Mgr., Dev. Dept., Gatineau Power Co., Box 88, Ottawa, Ont. (*H*) 638 Rideau St., Ottawa, Ont. (*S. 1910*) (*Jr. 1913*) (*A.M. 1919*)

†BLUMENTHAL, Samuel, B.Sc., (McGill '04), Asst. Engr., Bridge Dept., C.P.R., Rm. 401, Windsor Sta., Montreal, Que. (*H*) 63 Strathearn Ave., Montreal West. (*S. 1903*) (*A.M. 1909*)

BOAST, C. W., B.Sc., (McGill '17), Plant Engr., Spruce Falls Power and Paper Co., Ltd., Kapuskasing, Ont. (*S. 1917*) (*A.M. 1922*)

BOAST, Richard G., B.Sc., (McGill '11), Divn. Engr., T. & N.O. Rly., Englehart, Ont. (*H*) 96 Ferguson St., North Bay, Ont. (*S. 1908*) (*Jr. 1912*) (*A.M. 1922*)

BODWELL, G. L., (R.M.C., Kingston '36), B.A.Sc., (Tor. '37), University of Toronto, Toronto, Ont. (*S. 1935*)

BODWELL, Harold A., Str'l. Engr., Toronto Hydro-Electric System, Toronto, Ont. (*H*) 37 Columbine Ave. (*M. 1921*)

BOESE, G. Philip F., Asst. Engr., Dept. of Nat. Res., C.P.R., Calgary, Alta. (*S. 1909*) (*A.M. 1919*)

BOESE, P. Raymond, N.Y.C. R.R., Rm. 914, 466 Lexington Ave., New York, N.Y. (*S. 1909*) (*Jr. 1914*) (*A.M. 1922*)

BOGART, Evan Winston, B.Sc., (Alta. '37), Canada Packers Ltd., Edmonton, Alta. (*H*) 12341–128th Ave. (*S. 1937*)

♂BOGART, J. L. H., Brig., D.S.O., (R.M.C., Kingston), B.Sc., (Queen's '03), 353 MacKay St., Pembroke, Ont. (*A.M. 1902*)

BOISCLAIR, Robt., Apt. 6, 1320 Demontigny St. E., Montreal, Que. (*S. 1938*)

BOISMENU, Romeo, Engr., Town Supt., Town Hall, Hawkesbury, Ont. (*H*) 2 Smerdon "Annex." (*A.M. 1937*)

BOISVERT, Chas. H., C.E., (Ecole Polytech., Montreal '25), Quebec Public Service Comm., Court House, Quebec, Que. (*H*) 49 Laurentides Ave. (*Jr. 1927*) (*A.M. 1932*)

BOIVIN, Thos. J., Asst. Engr., Eastern Canada Steel and Iron Works, Ltd., Quebec, Que. (*H*) 189 Holland Ave. (*A.M. 1929*)

BOLDUC, Armand, B.A.Sc., (Ecole Polytech., Montreal '37), 207 Park G. E. Cartier, Montreal, Que. (*S. 1936*)

♂BOLGER, Edmund Jos., Major, Engr., Futterer & Reid, Mining Engrs., 822 Federal Bldg., 85 Richmond St. N., Toronto, Ont. (*S. 1904*) (*Jr. 1911*) (*A.M. 1915*)

BOLTON, Launcelot Lawrence, M.A., B.Sc., (Queen's '06), General Executive Asst., Mines and Geology Br., Dept. of Mines and Resources, Ottawa, Ont. (*H*) 76 Fentiman Ave. (*M. 1926*)

♂BOND, Frank Lorn Campbell, Major, D.S.O., B.Sc., (McGill '98), Gen. Mgr., Central Region, C.N.R., Union Sta., Toronto, Ont. (*S. 1898*) (*A.M. 1902*) (*M. 1919*)

BONE, Allan Turner, B.Sc., (McGill '16), Vice-Pres., J. L. E. Price & Co., Ltd., Beaver Hall Bldg., Montreal, Que. (*H*) 46 Summit Circle, Westmount, Que. (*A.M. 1922*)

BONE, P. Turner, 340–4th Ave. West, Calgary, Alta. (*M. 1914*)

♂BONHAM, Robert Lincoln, Lieut., B.Sc., (Queen's '21), Supt. of Operation, Western Region, Canada Creosoting Co., Ltd., Toronto General Trust Bldg., Calgary, Alta. (*H*) 2401 Carlton St. (*Jr. 1921*) (*A.M. 1930*)

BONN, Wm. Ernest, Div'l. Engr., Can. Dredge and Dock Co., Ltd., 302 Harbour Commrs. Bldg., Toronto, Ont. (*H*) 215 Richview Ave. (*Jr. 1914*) (*A.M. 1918*) (*M. 1935*)

BONNELL, A. Robertson, B.Sc., (N.B. '35), Instr'man., D.P.W., N.B. (*H*) 161 Argyle St., Fredericton, N.B. (*S. 1935*) (*Jr. 1938*)

BONNELL, M. B., B.Sc., (Tor. '05), Patent Examiner, Dom. Govt. Patent Office, Ottawa, Ont. (*H*) 378 Elgin St. (*A.M. 1922*)

BONNEY, Albert J., B.Sc., (Queen's '35), The Quaker Oats Co., Peterborough, Ont. (*H*) 162-B Park Hill Rd. (*S. 1935*)

BONNYCASTLE, Wm. Robinson, 2535 Marine Drive W., Vancouver, B.C. (*M. 1917*)

BOOKER, G. Ernest, P.O. Box 104, Uxbridge, Ont. (*A.M. 1918*)

BOONE, Harold P., B.Sc., (N.B. '37), Can. Westinghouse Co., Hamilton, Ont. (*H*) 732 Cannon St. E. (*S. 1937*)

BOOTH, Keith A., B.Sc., (Man. '34), B.Eng., (McGill '36), i/c Records Dept., Price Bros. & Co., Kenogami, Que. (*S. 1936*) (*Jr. 1938*)

BOOTH, Mark Westaway, Steam Engr., Dom. Steel and Coal Corp. Ltd., Sydney, N.S. (*H*) 160 Whitney Ave. (*A.M. 1912*) (*M. 1926*)

BORBEY, John P., B.A.Sc., (Tor. '34), Designer, Dom. Bridge Co. Ltd., Lachine, Que. (*H*) Apt. 21, 6876 Sherbrooke St. W., Montreal, Que. (*Jr. 1937*)

BOSTOCK, Wm. Norman, (R.M.C., Kingston), B.Sc., (McGill '25), D.L.S., Capt. R.C.E., Staff College Quetta, India. (*S. 1925*) (*A.M. 1935*)

BOSWELL, Elias John, (Tor. '95), O.L.S., D.L.S., L.S., H.E.P.C. of Ont., 620 University. Ave., Toronto, Ont. (*H*) 249 Sheldrake Blvd. (*S. 1897*) (*A.M. 1900*)

BOUCHARD, Jean, B.A.Sc., (Ecole Polytech., Montreal '31), City Engr., St. Hyacinthe, Que. (*H*) 213 Cascades St. (*A.M. 1937*)

BOUCHER, Raymond, B.A.Sc., (Ecole Polytech., Montreal '33), M.Sc., (M.I.T. '34), Prof. of Hydraulics, Ecole Polytechnique, 1430 St. Denis St., Montreal, Que. (*H*) 2539 Sherbrooke St. E., Apt. 18. (*S. 1932*) (*Jr. 1934*)

BOULIAN, J. J., Constrn. Supt., Power Corp. of Canada Ltd., 355 St. James St., Montreal, Que. (*A.M. 1927*)

BOULTON, Beverley Knight, B.Sc., (McGill '25), Supt. of Oper., Beauharnois L.H. and P. Cons., P.O. Box 100, Beauharnois, Que. (*S. 1923*) (*Jr. 1930*) (*A.M. 1931*)

BOULVA, Charles, Apt. 10, 824 Cherrier St., Montreal, Que. (*S. 1938*)

BOURBONNAIS, Geo. Valois, Royal Military College, Kingston, Ont. (*S. 1938*)

BOURBONNAIS, Paul Emile, B.A., B.A.Sc., (Ecole Polytech., Montreal '14), Chief Engr., Quebec Streams Comm., Rm. 222, New Court House, Montreal, Que. (*H*) 1570 St. Joseph Blvd. E. (*A.M. 1928*)

BOURGET, Maurice, B.A.Sc., (Ecole Polytech., Montreal '32), Engrg. Staff, Zachee Langlais, Cons. Engr., 105 Mountain Hill, Quebec, Que. (*H*) 390 St Joseph St., Lauzon, Que. (*A.M. 1936*)

BOURNE, Herbert Frederick, Res. Engr., D.P.W., B.C., Parliament Bldgs., Victoria, B.C. (*H*) 1154 Esquimalt Rd., Esquimalt, B.C. (*A.M. 1925*)

BOURNE, J. D., B.Eng., (McGill '37), Radio Engr., Northern Electric Co. Ltd., Montreal, Que. (*H*) 32 Holton Ave., Westmount, Que. (*S. 1937*)

♂BOURNE, O. B., Lieut., (Tor. '07), 142 Broughton Ave., Montreal West, Que. (*S. 1909*) (*A.M. 1912*)

BOUSQUET, Paul, Ecole Polytechnique de Montreal, Montreal, Que. (*S. 1938*)

BOUTILIER, Fred. Thomas, B.Sc., (N.S.T.C. '28), Asst. to Aluminum Plant Supt., Aluminum Co. of Canada, Ltd., Box 101, Arvida, Que. (*S. 1928*) (*A.M. 1937*)

BOUTILIER, T. T., B.Sc., (Acadia '34), B.E., (N.S.T.C. '36), Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*H*) Apt. 10, 1845 St. Luke St. (*S. 1937*)

♂BOWDEN, Harold Arthur, Lieut., Instr'man., C.N.R., Edmonton, Alta. (*A.M. 1920*)

BOWEN, Henry Blane, Chief of Motive Power and Rolling Stock, C.P.R. Co., Rm. 1000, Windsor Station, Montreal, Que. (*H*) 3018 Bresley Rd. (*M. 1935*)

BOWEN, J. A. C., B.A.Sc., (Tor. '35), Field Engr., Toronto Harbour Commrs., Airport Divn., Toronto, Ont. (*H*) 70–36th St., Long Branch, Ont. (*S. 1932*) (*Jr. 1934*) (*A.M. 1936*)

BOWEN, Sydney, (A.C.G.I.), Designing Engr., Exolon Co. Ltd., Thorold, Ont. (*H*) 97 Pine St. N. (*A.M. 1919*)

BOWER, J. H. W., B.A.Sc., (Tor. '14), Supt., The Hospital for Sick Children, 67 College St., Toronto, Ont. (*H*) 41 Glengowan Rd. (*A.M. 1923*)

BOWERING, Reginald, B.Sc., (Man. '38), 300 St. George St., Toronto, Ont. (*S. 1936*)

BOWLES, Wm. Shedden, B.Sc., (McGill '30), Asst. to Mgr., Can. Stebbins Engrg. and Mfg. Co. Ltd., 323 Drummond Bldg., Montreal, Que. (*H*) 12 Park Place, Apt. 5, Westmount, Que. (*S. 1929*) (*Jr. 1935*)

BOWMAN, Alex. John Maclean, Vice-Pres. and Gen. Mgr., Cross Supplies and Paving Ltd., 1272 Windsor Ave., Windsor, Ont. (*H*) 298 Kildare Rd., Walkerville, Ont. (*A.M. 1920*)

BOWMAN, Chas. A., Editor, *The Citizen*, Southam Publishing Co., Ltd., Ottawa, Ont. (*H*) 446 Cloverdale Rd., Rockcliffe. (*A.M. 1923*)

♂BOWMAN, Edgar Peterson, Lieut., B.A.Sc., (Tor. '11), O.L.S., D.L.S., Private Practice, 341 Waterloo Ave., Guelph, Ont. (*A.M. 1912*)

♂BOWMAN, Frederick, Lieut., (Tor. '11), c/o Evans, Deacon, Hornibrook Construction Pty. Ltd., Ryan House, Charlotte St., Brisbane, Queensland, Australia. (*S. 1911*) (*Jr. 1916*) (*A.M. 1923*)

†BOWMAN, Fred. A., M.A., B.E., (King's, Halifax), Staff Engr., Maritime Telegraph and Telephone Co., Ltd., Box 110, Halifax, N.S. (*H*) 10 Connaught Ave. (*S. 1887*) (*A.M. 1891*) (*M. 1905*) (*Life Member*)

BOWMAN, R. F. Patrick, B.Sc., (Alta. '28), Roadmaster, C.P.R., Lethbridge, Alta. (*H*) 6 Connaught Mansions. (*S. 1926*) (*Jr. 1930*) (*A.M. 1935*)

BOWN, C. Roy, B.Sc., (McGill '23), Asst. Chief Engr., Canada and Dom. Sugar Co., 1410 Montmorency St., Montreal, Que. (*H*) 5404 Clanranald Ave. (*S. 1921*) (*Jr. 1925*) (*A.M. 1935*)

BOWN, W. E., B.Sc., (McGill '23), Asst. Gen. Supt., British Empire Steel Corp., Sydney, N.S. (*H*) 11 Tain St. (*S. 1921*) (*A.M. 1930*)

BOWNESS, Ernest W., B.Sc., (McGill '05), Vice-Pres. i/c Operations, Canadian Utilities Ltd.; Can. Western Nat. Gas L.H. and P. Co.; North Western Utilities Ltd.; Dom. Gas and Electric Co. Address: 215–6th Ave. W., Calgary, Alta. (*H*) 1238–14th Ave. W. (*S. 1908*) (*A.M. 1910*) (*M. 1926*)

BOWNESS, Frank, Chief Dftsman., Can. Gen. Elec. Co., Ltd., Peterborough, Ont. (*H*) 273 Rubidge St. (*A.M. 1922*)

BOYD, Charles Stanley, B.Sc., (Queen's '17), Chief Dftsman., Horton Steel Works, Box 209, Fort Erie North, Ont. (*S. 1917*) (*A.M. 1921*)

*G.*BOYD, David, B.Sc., (McGill '28), Mgr., Can. Car and Foundry Co., Fort William, Ont. (*A.M. 1935*)

BOYD, Harold Cecil Traynor, B.A., M.A., (Cantab.), 4190 St. Catherine St. W., Westmount, Que. (*A.M. 1932*)

♂BOYD, J. W. Gamble, Flt. Lieut., Dftsman., Aluminum Co. of Canada, Sterling Rd., Toronto, Ont. (*H*) 37 Hilton Ave. (*Jr. 1922*)

BOYLE, Robt. Wm., M.A., M.Sc., Ph.D., (McGill), LL.D., Director, Divn. of Physics and Engrg., National Research Council, Canada, Ottawa, Ont. (*H*) 25 Buena Vista Rd., Rockcliffe. (*M. 1924*)

♂BRACE, James H., Major, B.Sc., C.E., (Wis.), Vice-Pres., Fraser Brace Engineering Co. Ltd., 107 Craig St. W., Montreal, Que. (*H*) 637 Carleton Ave., Westmount, Que. (*M. 1916*)

BRACKEN, W. D., B.Sc., (Queen's '23), Supt., Can. Niagara Power Co. Ltd., Niagara Falls, Ont. (*H*) 1975 Drummond Rd. (*S. 1922*) (*A.M. 1933*)

BRADDELL, E. S. P., B.Sc., (Man. '32), Northern Electric Co. Ltd., 65 Rorie St., Winnipeg, Man. (*H*) 104 Chestnut St. (*S. 1931*) (*Jr. 1937*)

BRADFIELD, John Ross, B.Sc., (McGill '22), Plant Engr., Noranda Mines, Ltd., Noranda, Que. (*S. 1921*) (*Jr. 1927*) (*A.M. 1933*)

BRADFORD, G. A. M., B.E., (Sask. '32), Imperial Oil Ltd., Box 158, Sarnia, Ont. (*Jr. 1937*)

BRADLEY, Alan Edward, B.Sc., (Man. '35), B.Eng., (McGill '36), Engr., Man. Bridge and Iron Wks., Winnipeg, Man. (*H*) 176 Lyle St. (*S. 1936*)

♂BRADLEY, Jas. Harrison, Lieut., Engr., Holcroft & Co., 6545 Epworth Blvd., Detroit, Mich. (*H*) 14014 Grandmont Rd. (*A.M. 1917*)

BRADLEY, Jos. Gerald, Demerara Bauxite Co., McKenzie, via Georgetown, British Guiana, S.A. (*Jr. 1938*)

BRADLEY, Nicholas Hillburn, D.L.S., A.L.S., Dist. Engr., D.P.W., Lethbridge, Alta. (*H*) 631–14th St. S. (*A.M. 1922*)

BRADLEY, Robt. Auldon, Welland Ship Canal, Dept. of Transport, St. Catharines, Ont. (*H*) 23 Catharine St. (*Jr. 1927*) (*A.M. 1930*)

BRADSHAW, Frederick W., B.Sc., (McGill '25), Asst. to Chief Engr., Cons. Paper Corp. Ltd., Grand'Mere, Que. (*S. 1920*) (*Jr. 1925*) (*A.M. 1929*)

BRAIN, Cecil, B.Sc., (McGill '28), Asst. to Plant Engr., Inter. Power and Paper Co., Corner Brook, Nfld. (*H*) 3 Armstrong Ave. (*S. 1927*) (*Jr. 1929*) (*A.M. 1936*)

BRAKENRIDGE, Charles, (R.T.C., Glasgow), City Engr., City Hall, Vancouver, B.C. (*H*) 3450–3rd Ave. W. (*A.M. 1915*) (*M. 1919*)

♂BRANCH, Alec J., Water Master, Lethbridge Northern Irrigation Dist., Lethbridge, Alta. Address: Box 395, Picture Butte, Alta. (*A.M. 1925*)

BRANCHAUD, Henri, B.A.Sc., (Ecole Polytech., Montreal '36), E.S.S.A., (Paris '37), Welding Engr., Can. Liquid Air Co., 1111 Beaver Hall Hill, Montreal, Que. (*H*) 636 Dunlop Ave., Outremont, Que. (*S. 1935*)

BRANDON, Edgar T. J., B.A.Sc., (Tor. '02), 301 Indian Rd., Toronto, Ont. (*S. 1904*) (*A.M. 1911*)

BRANDON, Harry Elmer, B.A.Sc., (Tor. '07), Asst. Engr., H.E.P.C. of Ont., 620 University Ave., Toronto, Ont. (*H*) 447 Blythwood Rd. (*A.M. 1926*)

BRANNEN, A. D., B.E., (N.S.T.C. '38), Barrington Passage, N.S. (*S. 1938*)

BRANNEN, Edwin Ralph, B.Sc., (N.B. '35), Can. Johns-Manville Co., Asbestos, Que. (*H*) North Devon, N.B. (*S. 1935*)

BRAULT, Paul G. A., B.Sc., (McGill '21), Designer, Dom. Bridge Co. Ltd., Lachine, Que. (*H*) 4913 Patricia Ave., Montreal, Que. (*S. 1920*) (*A.M. 1927*)

BRAZIER, Henry Arthur, Prop., H. A. Brazier Construction Co. Ltd. Address: 1691 Bathurst St., Toronto, Ont. (*A.M. 1915*) (*M. 1922*)

BREAKEY, Jas., Editor, "Modern Power and Engineering," Toronto, Ont. (*H*) 44 Brentwood Rd., Substa. 82, Toronto 3, Ont. (*Jr. 1931*) (*A.M. 1935*)

BREED, Chas. B., B.S., (M.I.T. '97), Head of Dept. of Civil and Sanitary Engrg., Mass. Inst. of Tech., Cambridge, Mass. (*H*) 32 Harvard St., Newtonville, Mass. (*M. 1930*)

♂BREEN, Jos. Melville, B.A.Sc., (Tor. '21), Chief of Tech. Staff, Canada Cement Co. Ltd., Canada Cement Bldg., Montreal, Que. (*H*) 65 Kennedy Park Rd., Toronto, Ont. (*A.M. 1924*)

BREHAUT, H. B., B.Sc., (Sask. '27), Manitoba Bridge and Iron Wks. Ltd., Winnipeg, Man. (*H*) Ste. 7, Bellcrest Apts. (*S. 1927*) (*A.M. 1928*)

♂BREITHAUPT, Carl Louis, B.A.Sc., (Tor. '22), Asst. Production Mgr., The Acme Rayon Co., 1294 W. 70th St., Cleveland, Ohio, U.S.A. (*H*) 2238 Tudor Drive, Cleveland Heights, Ohio. (*S. 1921*) (*A.M. 1925*)

†BREITHAUPT, Wm. Henry, C.E., (Renss.), Cons. Engr., 15 Queen St. N., Kitchener, Ont. (*H*) 66 Margaret Ave. (*M 1903*) (*Life Member*)

BREMNER, Douglas, B.Sc., (McGill '15), Pres. and Man. Dir., Bremner, Norris & Co. Ltd., 2049 McGill College Ave., Montreal, Que. (*H*) 3769 The Boulevard, Westmount, Que. (*S. 1914*) (*A.M. 1917*) (*M. 1928*)

BRERETON, Wilfred Proctor, B.A.Sc., (Tor. '03), City Engr., Corp. of City of Winnipeg, 223 James Ave., Winnipeg, Man. (*H*) 1015 Grosvenor Ave. (*A.M. 1908*) (*M. 1918*)

♂†BRETT, John Francis, Lieut., Divn. Engr., Montreal Water Board, 3161 Joseph St., Verdun, Que. (*H*) 4180 Melrose Ave., Montreal, Que. (*S. 1914*) (*Jr. 1919*) (*A.M. 1920*)

BREWER, Douglas Jared, B.Sc., (N.B. '35), 235 Carleton St., Fredericton, N.B. (*S. 1935*)

BREWER, H. B., B.Sc., (N.B. '28), Res. Engr., Can. Industries Ltd., James Island, B.C. (*Jr. 1930*)

BREWS, R. W., B.Sc., (Alta. '36), Partner, R. L. Brews & Co., 304–11th Ave. E., Calgary, Alta. (*H*) 418–3rd Ave. W. (*S. 1936*)

BRICAULT, F., B.A.Sc., (Ecole Polytech., Montreal '36), 165 Pine St., Sudbury, Ont. (*S. 1935*)

BRICELAND, E. V., B.Sc., (Queen's '37), Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*H*) 494 Charlotte St. (*S. 1937*)

♂BRICKENDEN, Frederick M., Capt., (Tor.), 66 Ethelbert St., Winnipeg, Man. (*S. 1910*) (*Jr. 1913*) (*A.M. 1918*)

BRIDGE, David E., B.Sc., (Tor. '30), Instructor, Hamilton Technical Institute, Hamilton, Ont. (*H*) 50 Fairholt Rd. S. (*S. 1930*) (*Jr. 1937*)

BRIDGE, J. Franklin, B.A.Sc., (Tor. '25), Asst. Mgr., Windsor Salt Plant, Can. Industries Ltd., Windsor, Ont. (*H*) 641 Partington Ave. (*A.M. 1934*)

BRIDGES, Ernest T., Operating Mgr., Ont. Divn., Dom. Bridge Co. Ltd., 1139 Shaw St., Toronto, Ont. (*H*) 290 High Park Ave. (*A.M. 1921*)

BRIDGES, Frederick, Port Warden, 70 Ramsay St., Sorel, Que. (*M. 1930*)

BRIDGES, Robt. Jas., B.Sc., (Man. '38), Box 303, Souris, Man. (*S. 1938*)

♂BRIERCLIFFE, Henry C. D., B.Sc., (McGill '11), Private Practice, 201 Ash St., Winnipeg, Man. (*A.M. 1919*)

BRIGGS, Herbert Lee, B.Sc., (Man. '28), Oper. Engr., City of Winnipeg Hydro Electric System, Winnipeg, Man. (*H*) 609 Ingersoll St. (*S. 1926*) (*A.M. 1931*)

♂BRIGHT, David Mussen, Major, Pres., D. M. Bright & Co., Cons. Engrs., New Bank of Toronto Bldg., London, Ont. (*H*) 254 Briscoe St. (*A.M. 1921*)

BRITTAIN, Norman W., B.Sc., (N.B. '32), Private Practice, Minto, N.B. (*S. 1932*) (*A.M. 1938*)

BRODERICK, C. A., Surveyor and C.E., P.O. Drawer 2186, Trail, B.C. (*H*) Riverside Ave. (*Jr. 1913*)

BRONSON, Frederic E., B.Sc., (McGill '09), Man'g. Dir., The Bronson Co., 150 Middle St., Ottawa, Ont. (*H*) Rockcliffe Park. (*S. 1908*) (*A.M. 1913*) (*M. 1925*)

BROOKE, John (*q*), Hervey Junction, Que. (*A.M. 1899*) (*Life Member*)

♂BROOKS, Chas. L., Lieut., B.Sc., (McGill '22), Gen. Traffic Engr., E.A., The Bell Telephone Co. of Canada, Ltd., Montreal, Que. (*H*) 4025 Dorchester St. W., Westmount, Que. (*S. 1921*) (*A.M. 1930*)

BROOKS, John Kenneth, 77 Priory Rd., London, N.W.6, England. (*A.M. 1932*)

BROSSARD, Leo, B.A., C.E., (Ecole Polytech., Montreal '36), Asst. Prof. of Mineralogy, Ecole Polytechnique, 1430 St. Denis St., Montreal, Que. (*S. 1936*)

BROSSEAU, R. B., Saguenay Electric Co. Ltd. (*H*) 122 Jacques Cartier St., Chicoutimi, Que. (*S. 1936*)

BROUGHTON, Wm. Hamilton, Chief Engr., Power Plant, Absorption Plant 2, Royalite Oil Co. Ltd., Turner Valley, Alta. (*H*) 825–5th Ave. N.W., Calgary, Alta. (*A.M. 1926*)

BROWN, Collingwood B., Jr., C.E., (Cornell), Chief Engr., Oper. Dept., C.N.R., Rm. 408, 360 McGill St., Montreal, Que. (*H*) 152 Easton Ave., Montreal West, Que. (*S. 1902*) (*A.M. 1909*) (*M. 1914*)

BROWN, Donald Whidden, B.Sc., (Queen's '38), Box 167, Fort Erie North, Ont. (*S. 1937*)

G.†BROWN, Ernest, M.Sc., M.Eng., Dean of the Faculty of Engrg., McGill University, Montreal, Que. (*H*) 4035 Harvard Ave. (*A.M. 1906*) (*M. 1917*)

BROWN, Ernest F., B.Eng., (McGill '35), Dom. Bridge Co. Ltd., Lachine, Que. (*H*) 7219 Alexandra Ave., Montreal, Que. (*S. 1935*)

BROWN, George Laing, (Tor. '93), Town Engr., Morrisburg, Ont. (*A.M. 1907*) (*Life Member*)

♂BROWN, George Sandles, Canal Supt., D.N.R., C.P.R., 207–7th St. S., Lethbridge, Alta., Private Box 123. (*Jr. 1921*) (*A.M. 1921*)

BROWN, Gordon Jas., Dom. Bridge Co. Ltd., Box 280, Montreal, Que. (*H*) 2307 Melrose Ave., N.D.G. (*S. 1936*)

BROWN, Harry Cleophas, B.Sc., (McGill '17), Elec. Engr., New York World's Fair 1939 Inc., 350–5th Ave., New York, N.Y. (*H*) 2445–15th St. N.W., Washington, D.C. (*A.M. 1925*)

♂BROWN, Hilton Orland, Lieut., B.A.Sc., (Tor. '12), Res. Engr., Ste. Anne Paper Co., Beaupre, Que. (*A.M. 1929*)

BROWN, John A. W., B.A.Sc., O.L.S., 70 Spadina Ave., Hamilton, Ont. (*S. 1908*) (*A.M. 1913*)

BROWN, John Edwin, B.Sc., (Sask. '24), Sec.-Treas., McTavish, McKay & Co. Ltd., 1013–8th Ave. W., Calgary, Alta. (*H*) 1427–7th St. N.W. (*Jr. 1925*) (*A.M. 1929*)

BROWN, John Elliott, Gen. Mgr., Ottawa Hydro-Elec. Comm., Ottawa, Ont. (*H*) 143 Carling Ave. (*M. 1918*)

BROWN, LeRoy, B.A.Sc., (Tor. '15), Pres. and Mgr., L. R. Brown & Co. Ltd., Engrs. and Contrs., Sault Ste. Marie, Ont. (*H*) 52 The Drive. (*S. 1914*) (*A.M. 1917*)

BROWN, Lindsay H., Britannia Heights, Ont. (*S. 1938*)

BROWN, M. Sutherland, (R.M.C. '38), Bowker Place, Oak Bay, Victoria, B.C. (*S. 1937*)

BROWN, Philip Piggott, Cons. Engr., 33 Commerce Bldg., 640 W. Hastings St., Vancouver, B.C. (*A.M. 1913*) (*M. 1919*)

BROWN, R. C. C., B.Sc., (Queen's '33), Jr. Aero. Engr., Dept. of National Defence, Ottawa, Ont. (*H*) 699 Acacia Ave., Rockcliffe, Ont. (*S. 1933*)

♂BROWN, Thos. Alan, B.Sc., (Queen's '23), Mgr., Eastern Distribution Dist., Gatineau Power Co., 801 Victoria Bldg., Ottawa, Ont. (*H*) 293 Holmwood Ave. (*Jr. 1925*) (*A.M. 1932*)

BROWN, Wm. Boughton, B.Sc., (N.S.T.C. '31), Can. Gen. Elec. Co. Ltd., 489 King St., Peterborough, Ont. (*H*) Clark's Harbour, N.S. (*S. 1931*) (*Jr. 1936*)

BROWN, Wm. Edward, B.A.Sc., (Tor. '32), The B. Greening Wire Co. Ltd., Hamilton, Ont. (*H*) Apt. 5, 272 Caroline St. S. (*Jr. 1934*)

♂BROWNE, Ernest Frank, Lieut., B.Sc., (Queen's '14), D.L.S., Surveys Engr., Bureau of Geology and Topography, Dept. of Mines and Resources, Ottawa, Ont. (*H*) 249 First Ave. (*S. 1911*) (*Jr. 1918*) (*A.M. 1920*)

♂BROWNE, Geo. Alleyn, Major, Asst. Gen. Supt., Engrg. Br., Dept. Pensions and National Health, 340 Daly Bldg., Ottawa, Ont. (*H*) 55 Delaware Ave. (*S. 1908*) (*A.M. 1920*)

BROWNELL, Harold Ross, B.Sc., (McGill '29), Sales Service Engr., Bailey Meter Co. Ltd., 980 St. Antoine St., Montreal, Que. (*H*) 105 Burnside Drive, Toronto 10, Ont. (*S. 1927*) (*Jr. 1932*)

BROWNIE, F. Austin, B.Sc., (Alta. '34), Asst. Engr., Northwestern Utilities Ltd., Edmonton, Alta. (*H*) 11009-86th Ave. (*S. 1932*) (*Jr. 1935*) (*A.M. 1938*)

BRUCE, Chas., Chief Fisheries Engr., Dept. of Fisheries, Hunter Bldg., Ottawa, Ont. (*H*) 283 Somerset St. W. (*S. 1907*) (*A.M. 1919*)

BRUCE, Rodney, B.Sc., (Queen's '36), Heating Engr., Findlays Ltd., Carleton Place, Ont. (*H*) Brooklyn, P.E.I. (*S. 1936*)

BRUCE, Wm. Jos., C.E., (Tor. '07), Constrn. Engr., Hydro-Electric Power Comm., Ont., 620 University Ave., Toronto, Ont. (*H*) Apt. 43, 15 Sherwood Ave. (*A.M. 1926*)

BRUMBY, Walter Wm., Can. Gen. Elec. Co. Ltd., Toronto, Ont. (*H*) 245 High Park Ave. (*Jr. 1930*) (*A.M. 1932*)

BRUMELL, Orby R., B.Eng., (McGill '34), Asst. Engr., Dom. Oilcloth and Linoleum Co., Montreal, Que. (*H*) Apt. 818, 1455 Drummond St. (*S. 1930*)

♂BRUNNER, Godfrey H., Major, M.Sc., (McGill), Engr., Imperial Chemical Industries, United Alkali Co. Ltd., Fleetwood, Lancs., England. (*H*) Hazeldene, Poulton-le-Fylde, Lancs. (*S. 1904*) (*A.M. 1911*)

BRYANT, Jas. S., B.Sc., (McGill '27), Provincial Electricity Bd., Montreal, Que. (*H*) 8249 St. Gerard St. (*S. 1925*) (*Jr. 1930*) (*A.M. 1936*)

BRYCE, John Bemister, B.A.Sc., (Tor. '35), M.A.Sc., (Tor. '36), Jr. Engr., H.E.P.C. of Ont., Toronto, Ont. (*H*) 2 Highview Crescent. (*Jr. 1937*)

♂BRYCE, William F. McK., Lieut., (Tor. '08), Sewer Engr., City of Ottawa, City Hall, Ottawa, Ont. (*H*) 120 Buena Vista Rd., Rockcliffe Park. (*S. 1909*) (*A.M. 1913*)

BRYDEN, Donald Chas., B.A., B.Sc., (Alta. '28), Power Sales Engr., Winnipeg Hydro-Electric System, Winnipeg, Man. (*H*) 115 Gerard St. (*A.M. 1938*)

BRYDON, Noel Morris, B.Sc., (St. Andrews '22), Chief Engr., Hiram Walker Co., Dumbarton Distillery, Dumbarton, Scotland. (*H*) Dumbreck Hotel, Dumbarton. (*A.M. 1932*)

BRYDONE-JACK, Ernest E., B.A., C.E., (Renss.), D.Sc., (N.B. '26), 369 South Coast Blvd., La Jolla, Calif., U.S.A. (*M. 1906*) (*Life Member*)

BUBBIS, M. I., B.Eng., (McGill '38), 3471 Hutchison St., Montreal, Que. (*S. 1937*)

BUBBIS, Nathan S., B.Sc., (Man. '34), Dftsman., W.W. Dept., City Engrs. Office, Winnipeg, Man. (*H*) 406 Andrews St. (*S. 1934*)

♂BUCHAN, P. H., Lieut., B.A.Sc., (Tor. '08), Asst. Engr., Rly. Dept., B.C. Electric Rly. Co., Ltd., Vancouver, B.C. (*H*) 5762 Cypress St. (*A.M. 1919*) (*M. 1935*)

BUCHANAN, Arnold A., 3472 Montclair Ave., Montreal, Que. (*S. 1938*)

BUCHANAN, Colin Archibald, B.Sc., (McGill '19), Chief Engr., Donnacona Paper Co. Ltd., Donnacona, Que. (*H*) Portneuf, Que. (*A.M. 1919*) (*M. 1937*)

BUCHANAN, Edward Trevor, B.Sc., (McGill '28), Asst. Master Mechanic, Cons. Paper Corp. Ltd., Shawinigan Falls, Que. (*H*) 17 Station Ave. (*S. 1926*) (*Jr. 1938*)

BUCHANAN, Edward Victor, (A.R.T.C., Glasgow), Gen. Mgr., Public Utilities Comm., London, Ont. (*H*) 776 Wellington St. (*M. 1922*)

BUCHANAN, Walter S., Elec. Contr., 407 St. Cyrille St., Quebec, Que. (*A.M. 1930*)

BUCHBACH, Chas. Kelly, Plant Supt., National Light and Power Co., Moose Jaw, Sask. (*1938*)

BUCHMANN, Karl E., B.A.Sc., (Tor. '25), c/o Buffalo Ankerite Mine, Box 533, S. Porcupine, Ont. (*S. 1922*) (*Jr. 1926*) (*A.M. 1930*)

BUCK, Harold W., Ph.B., (Yale '94), E.E., (Columbia '95), Vice-Pres., Viele, Blackwell & Buck, 19 Rector St., New York, N.Y. (*M. 1919*)

BUCK, Leslie Gordon, B.A.Sc., (Tor. '25), Divn. Plant Superv., Bell Telephone Co. of Canada, 76 Adelaide St., Toronto, Ont. (*H*) 902 Avenue Rd. (*A.M. 1935*)

♂BUCK, Richard S., Major, D.S.O., (Renss. '87), 2123 R. St. N.W., Washington, D.C. (*M. 1903*)

BUCKE, Harold L., (R.M.C., Kingston), Dist. Bldg. Engr., H.E.P.C. of Ont., Niagara Falls, Ont. (*H*) R.R. 1, Niagara-on-the-Lake, Ont. (*S. 1900*) (*A.M. 1904*) (*M. 1912*)

BUCKLEY, I. Walter, Oper. Contr., Dom. Coal Co., Glace Bay, N.S. (*H*) 190 Brookland St., Sydney, N.S. (*A.M. 1921*)

BUCKLEY, Rex. E., Engr. i/c Constrn., New-Kanawha Power Co., P.O. Box 122, Glen Ferris, W.Va. (*A.M. 1919*)

BUDDEN, Arthur N., B.Sc., (McGill '28), Sales Dept., Dom. Engineering Co. Ltd., Lachine, Que. (*H*) 1509 MacKay St., Montreal, Que. (*S. 1921*) (*Jr. 1926*) (*A.M. 1930*)

BUDDEN, John Hastings, B.Eng., (McGill '37), Tresco Manor, 48 Aldridge Rd., Perry Bar, Birmingham, England. (*S. 1936*)

BUERK, Jacob Edward, 700 Taylor St., Vancouver, B.C. (*A.M. 1920*)

BULL, Edmund Wm., Supt. Light and Power, City of Regina. (*H*) 2112 Rose St., Regina, Sask. (*1938*)

BULLER, Francis Hamilton, B.Sc., (McGill '23), M.S., (Union '31), Cable Engr., General Electric Co., 1 River Rd., Schenectady, N.Y. (*H*) 242 Union St. (*S. 1920*) (*A.M. 1931*)

BUNNELL, Arthur E. K., B.A.Sc., (Tor. '07), Pres. and Gen. Mgr., Can. Ventilating Shades Ltd., 481 Reid St., Peterborough, Ont. (*S. 1907*) (*A.M. 1911*) (*M. 1925*)

BUNTING, Wm. Lloyd, B.Sc., (Man. '28), Res. Engr., D.P.W. Man., The Pas, Man. (*S. 1927*) (*Jr. 1934*)

♂BUNTING, Wm. Russell, B.A.Sc., (Tor. '23), Power Apparatus Specialist, Northern Electric Co. Ltd., 1600 Notre Dame St. W., Montreal, Que. (*H*) 4550 King Edward Ave., N.D.G. (*S. 1920*) (*Jr. 1925*) (*A.M. 1928*) (*M. 1937*)

♂BURBANK, Jerome Douglas, B.A.Sc., (Tor. '25), Elec. Engr., Buffalo, Niagara and Eastern Power Corpn. (Niagara Lockport Divn.), Buffalo, N.Y. (*H*) 737 Delaware Ave. (*S. 1921*) (*Jr. 1926*) (*A.M. 1931*)

♂BURBIDGE, George Harrison, Lieut., B.A., (Tor.), B.Sc., (McGill '09), Senior Asst. Engr., D.P.W., Box 277, Port Arthur, Ont. (*H*) 28 North Hill St. (*S. 1908*) (*A.M. 1912*) (*M. 1919*)

†BURCHELL, Herbert C., Pres., Eastern Lime Co., Windsor, N.S. (*M. 1887*) (*Life Member*)

♂BURCHILL, Geo. Herbert, B.Sc., (N.S.T.C. '23), Asst. Prof. of Elec. Engrg., N.S. Technical College, Halifax, N.S. (*H*) 202 Jubilee Rd. (*S. 1923*) (*Jr. 1926*) (*A.M. 1931*)

BURGAR, Frederick A., C.E., (Renss. '13), Box 200, Campbellford, Ont. (*A.M. 1920*)

♂BURGESS, Bert I., B.Sc., (N.B. '21), Can. Gen. Elec. Co., Peterborough, Ont. (*H*) 595 King St. (*Jr. 1924*) (*A.M. 1936*)

♂BURGESS, Frederick Victor, Chief Dftsman., Mech. Dept., Dom. Coal Co. Ltd., Bridgeport, N.S. (*H*) Ocean Ave. (*A.M. 1938*)

BURGESS, George Heckman, B.Sc., (Wis.), Partner, Coverdale & Colpitts, 120 Wall St., New York, N.Y. (*H*) 51 Fifth Ave. (*M. 1912*)

BURGESS, James Roy, B.A.Sc., (Tor. '10), Mech. Supt., Staunton's Ltd., Eglinton Ave. E., Leaside, Toronto, Ont. (*H*) 763 Bayview Ave., Leaside. (*A.M. 1921*)

BURKE, John A., B.Sc., (Alta. '34 and '37), Shawinigan Engineering Co., Box 85, La Tuque, Que. (*S. 1934*)

BURKET, Leslie Howard, Str'l. Engr., Dom. Bridge Co. Ltd., Montreal, Que. (*H*) 165 Bedbrook Ave., Montreal West, Que. (*A.M. 1926*)

BURLTON, Geo. Arnold, B.Eng., (N.S.T.C. '35), 21½ Cherry St., Halifax, N.S. (*Jr. 1938*)

BURNETT, F. C. E., 145 Percival Ave., Montreal West, Que. (*M. 1938*)

†BURNETT, Jas. Aubrey, Cons. Engr., 231 St. James St. W., Montreal, Que. (*H*) 228 Prince Albert Ave., Westmount, Que. (*S. 1897*) (*A.M. 1898*) (*M. 1922*)

BURNHAM, D. E., B.Sc., (N.S.T.C. '28), Gen. Del. Station F, Toronto 5, Ont. (*S. 1928*)

BURNS, C. H. McL., Works Mgr., Welland Plants, Canada Foundries and Forgings, Ltd., Welland, Ont. (*H*) 105 Dorothy St. (*A.M. 1920*) (*M. 1937*)

BURNS, Edward Thompson, B.A.Sc., (Tor. '30), Can. Gen. Elec. Co., 212 King St. W., Toronto, Ont. (*S. 1930*)

BURNS, William, 732 McMillan Ave., Winnipeg, Man. (*A.M. 1890*) (*M. 1902*) (*Life Member*)

BURPEE, David Wm., 732 Brunswick St., Fredericton, N.B. (*A.M. 1905*) (*M. 1910*) (*Life Member*)

BURPEE, Geo. Wm., A.B., S.B., Partner, Coverdale & Colpitts, Cons. Engrs., 120 Wall St., New York, N.Y. (*H*) 39 Woodland Ave., Bronxville, N.Y. (*A.M. 1912*) (*M. 1917*)

BURPEE, Lawrence H., B.A.Sc., (Tor. '25), Foundation Co. of Canada, 1538 Sherbrooke St. W., Montreal, Que. (*H*) 22 Rideau Terrace, Ottawa, Ont. (*S. 1924*) (*A.M. 1932*)

BURRI, Henry Wm., B.Eng., (McGill '35), Proposition Engr., Mathews Conveyors Ltd., Port Hope, Ont. (*H*) Brown St. (*S. 1934*) (*Jr. 1937*) (*A.M. 1938*)

BURROWS, Acton, Pres., Acton Burrows Ltd., "Canadian Transportation," 70 Bond St., Toronto 2, Ont. (*H*) 120 Bedford Rd., Toronto 5, Ont. (*Affil. 1906*)

BURY, Bertram Edward, (Liverpool '96), Cons. Engr., Box 292, Vermilion, Alta. (*A.M. 1922*)

†BUSFIELD, James L., B.Sc., (A.C.G.I.), Man'g. Director, Gardner Engines (Eastern Canada), Ltd., Keefer Bldg., 1440 St. Catherine St. W., Montreal, Que. (*S. 1908*) (*A.M. 1913*) (*M. 1922*)

♂BUSH, Clayton E., Major, B.A.Sc., (Tor. '07), D.L.S., O.L.S., A.L.S., Private Practice, 73 Fairlawn Ave., Toronto, Ont. (*A.M. 1921*)

♂BUSS, Paul E., Pres., Spun Rock Wools Ltd., Thorold, Ont., P.O. Box 40. (*H*) 20 Vine St. (*A.M. 1927*)

BUTEAU, Lucien, B.A.Sc., (Ecole Polytech., Montreal '37), Bell Telephone Co. of Canada, Montreal, Que. (*H*) 5948 Chateaubriand St. (*S. 1936*)

BUTLER, Ernest, Designing Engr., Cons. Paper Corp., Three Rivers, Que. (*H*) 530 St. François Xavier St. (*A.M. 1937*)

BUTLER, Ernest W. R., B.Sc., (McGill '24), Western Canada Mgr., Bailey Meter Co., Ltd., 907 McArthur Bldg., Winnipeg, Man. (*H*) 151 Cordova St. (*S. 1924*) (*Jr. 1930*) (*A.M. 1938*)

BUTLER, H. C., B.Sc., (McGill '30), Plant Engr., Can. Industries Ltd., Windsor, Ont. (*H*) 224 California Ave. (*S. 1930*) (*Jr. 1935*)

BUTLER, J. A. T., B.Eng., (McGill '34), Apt. 5, 2168 Sherbrooke St. W., Montreal, Que. (*S. 1931*)

BUTT, Robert Edwards, Steel Co. of Canada, Hamilton, Ont. (*H*) 495 Beach Blvd., Hamilton Beach, Ont. (*A.M. 1922*)

♂BUTTERWORTH, J. V., B.Sc., (N.S.T.C. '23), Topographical Engr., Bureau of Geology and Topography, Dept. of Mines and Resources, Ottawa, Ont. (*H*) 380 First Ave. (*S. 1923*) (*A.M. 1928*)

BUZZELL, Henry Walter, B.Sc., (McGill '24), Str'l. Designer, Dom. Bridge Co. Ltd., Lachine, Que. (*H*) 119–34th Ave. (*S. 1923*) (*A.M. 1930*)

BYERS, Arch'd. F., B.Sc., (McGill '00), Pres., A. F. Byers & Co. Ltd., 1226 University St., Montreal, Que. (*H*) 5606 Queen Mary Rd., Hampstead, Que. (*S. 1899*) (*A.M. 1906*) (*M. 1911*) (*Life Member*)

BYERS, Wm. Caryl, B.Sc., (Man. '34), B.Sc., (Man. '35), Box 555, Kenora, Ont. (*Jr. 1937*)

♂BYRNE, John Herbert, Capt., B.Sc., (McGill '09), Survey and Engrg Br., Dept. of Mines and Resources, Ottawa, Ont. (*H*) 8 Renfrew Ave. (*S. 1909*) (*A.M. 1915*)

♂CADE, John Edwin, Capt., Asst. Chief Engr., Fraser Bros. Ltd., Edmundston, N.B. (*H*) 38–20th Ave. (*A.M. 1933*)

CADRIN, Paul Emile, B.A.Sc., (Ecole Polytech., Montreal '36), St. Anselme, Que. (*S. 1935*)

CAGEORGE, Nicholas, Chief Dftsman., Str'l. Divn., Dominion Bridge Co. Ltd., Montreal, Que. (*H*) 80–44th Ave., Lachine, Que. (*A.M. 1921*)

CAIRNCROSS, A. T., B.Sc., (Queen's '31), 21–35th St., Long Branch, Ont. (*S. 1928*) (*A.M. 1937*)

♂CAIRNS, Harry Lister, Lieut., Locating Engr., P.W.D., B.C., Nakusp, B.C. (*H*) 3481 W. 7th Ave., Vancouver, B.C. (*A.M. 1921*)

CALDER, John, 772 Sherbrooke St. W., Montreal, Que. (*S. 1938*)

CALKINS, Harold A., B.Sc., (McGill '12), Chief Engr., California Packing Corp., 101 California St., San Francisco, Calif. (*H*) 5448 Boyd Ave., Oakland, Calif. (*Jr. 1913*) (*A.M. 1924*)

CALLAGHAN, John, Gen. Mgr., Alberta and Great Waterways Co., Room 315, Macdonald Hotel, Edmonton, Alta. (*M. 1908*)

†CALLANDER, Delmer Wallace, B.Sc., (McGill '11), Elec. Engr., Can. Westinghouse Co. Ltd., Hamilton, Ont. (*H*) 99 Leinster Ave., S. (*A.M. 1927*)

CALLUM, John P., B.Sc., (Queen's '38), 363 Cromwell St., Sarnia, Ont. (*S. 1938*)

♂CALVIN, Jonathan David, Major, B.A., B.Sc., (Queen's '07), Mgr., Tree Line Navigation Co. Ltd., 1010 Common St., Montreal, Que. (*H*) 505 Argyle Ave., Westmount, Que. (*A.M. 1920*)

♂CALVIN, Reginald Marsh, Major, B.A., B.Sc., (Queen's '14), Sales Mgr., Can. Vickers Ltd., Montreal East, Que. (*H*) 685 Grosvenor Ave., Westmount, Que. (*S. 1914*) (*A.M. 1919*)

†CAM, William George Herbert, (A.C.G.I.), Power and Safety Engr., Canada Cement Co. Ltd., Montreal, Que. Box 290, Sta. B. (*H*) 151 Dobie Ave., Town of Mount Royal, Que. (*A.M. 1912*) (*M. 1929*)

CAMERON, Adam K., B.Eng., (McGill '38), 1511 Crescent St., Montreal, Que. (*S. 1938*)

♂CAMERON, Alan Emerson, Lieut., B.Sc., (McGill '13), (M.Sc., '14), D.Sc., (M.I.T. '26), Deputy Minister of P.W. and Mines, N.S., Halifax, N.S. (*H*) 25 Larch St. (*M. 1937*)

CAMERON, Dugald, Vice-Pres. i/c Sales and Engrg., John T. Hepburn Ltd., 18 Van Horne St., Toronto 4, Ont. (*H*) 22 Crang Ave. (*A.M. 1933*)

CAMERON, D. Roy, B.A., (McGill '09), B.Sc.F., (Tor. '11), Dom. Forester, Dept. of Mines and Resources, Ottawa, Ont. (*H*) 98 Stewart St. (*A.M. 1921*) (*M. 1925*)

CAMERON, Evan Guthrie, C.E., (R.M.C. Kingston), Engr., National Harbours Board, Room 302, West Block, Ottawa, Ont. (*H*) 39 Monkland St. (*S. 1906*) (*A.M. 1911*) (*M. 1936*)

CAMERON, Hugh Donald, B.Sc., (McGill '01), Can. Mgr., Locomotive Firebox Co., 803 McGill Bldg., Montreal, Que. (*H*) 745 Upper Belmont Ave., Westmount, Que. (*S. 1899*) (*A.M. 1913*)

CAMERON, Jas. Somerville, B.Sc., (McGill '08), Asst. Gen. Supt., Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*H*) 4467 Montrose Ave., Westmount, Que. (*S. 1906*) (*A.M. 1912*)

CAMERON, John, B.Sc., (N.S.T.C. '27), Asst. Engr., Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*H*) 574 Douglas Ave. (*S. 1927*) (*A.M. 1937*)

CAMERON, John McClellan, B.Sc., (Alta. '35), Can. Cellucotton Products, Niagara Falls, Ont. (*H*) 1051 Morrison St. (*S. 1936*)

♂CAMERON, Kenneth G., B.Sc., (Edinburgh '12), Director of Services, Town of Hampstead, 31 Stratford Rd., Hampstead, Que. (*H*) 38 Dufferin Rd. (*Jr. 1914*) (*A.M. 1920*)

†CAMERON, Kenneth MacKenzie, (R.M.C., Kingston '01), M.Sc., (McGill '03), Chief Engr., D.P.W., Canada, 890 Hunter Bldg., Ottawa, Ont. (*H*) 312–1st Ave. (*S. 1901*) (*A.M. 1907*) (*M. 1920*)

CAMERON, Norman Chas., (Tor. '04), Engr., Imperial Tobacco Co. of Canada, 3810 St. Antoine St., Montreal, Que. (*H*) 466 Mountain Ave., Westmount, Que. (*A.M. 1907*)

♂CAMERON, Norman Keith, Cameron & Phin, Contractors, P.O. Box 95, Welland, Ont. (*H*) 39 Pine St. (*A.M. 1922*)

CAMPBELL, Albert Murray, B.Sc., (Queen's '38), 44 Woodworth Ave., St. Thomas, Ont. (*S. 1938*)

♂CAMPBELL, Alex., M.Sc., (McGill '26), Contracting Engr., Dom. Bridge Co. Ltd., 702 Canada Bldg., Winnipeg, Man. (*H*) 199 Elin St. (*S. 1922*) (*A.M. 1927*)

CAMPBELL, Angus D., B.A.Sc., M.E., (Tor. '11), Safety Engr., McIntyre Porcupine Mines, Ltd., Box 11, Schumacher, Ont. (*M. 1918*)

CAMPBELL, Duncan Chester, B.Sc., (N.B. '34), 210 Winslow St., West Saint John, N.B. (*S. 1935*)

♂CAMPBELL, George Wilfred, Asst. Engr., Reclam. Br., P.W.D., 318 Parliament Bldgs., Winnipeg, Man. (*H*) 27 Kennedy St. (*Jr. 1920*) (*A.M. 1930*)

CAMPBELL, Gerald A., B.Sc., (N.B '38), Beaverbrook Residence, Fredericton, N.B. (*S. 1937*)

♂CAMPBELL, Harold Montgomery, Lt.-Col., M.C., V.D., B.A.Sc., (Tor. '14), Asst. Engr. (Mech.), Welland Canals, Dept. of Transport, St. Catharines, Ont. (*H*) 23 Bellevue Terrace. (*A.M. 1931*)

CAMPBELL, James G., Can. Bridge Co. Ltd., Walkerville, Ont. (*H*) 1841 Chilver Rd. (*A.M. 1919*)

♂CAMPBELL, James M., Lieut., Divn. Engr., C.P.R., Lethbridge, Alta. (*H*) 1222–3rd Ave. S. (*A.M. 1920*)

CAMPBELL, Jas. S., B.Sc., (Queen's '31), (M.Sc., '33), Massey-Harris Co. Ltd., Toronto, Ont. (*H*) 18 Braeside Rd. (*S. 1928*) (*A.M. 1938*)

CAMPBELL, John G. W., C.E., (Ohio Nor.), Res. Engr., Dept. of Highways, N.S., Halifax, N.S. (*H*) 140 Robie St. (*A.M. 1905*) (*M. 1925*) (*Life Member*)

CAMPBELL, John Murdoch, Pres., Gananoque Electric Light and Water Supply Co. Ltd., Kingston, Ont. (*H*) 5 Emily St. (*M. 1907*)

CAMPBELL, Kenneth Wm., B.Sc., (Queen's '38), 44 Woodworth Ave., St. Thomas, Ont. (*S. 1938*)

CAMPBELL, Lorne Argyle, Vice-Pres. and Gen. Mgr., West Kootenay Power and Light Co. Ltd., Trail, B.C. (*H*) Rossland, B.C. (*M. 1935*)

CAMPBELL, Norman McLeod, B.Sc., (McGill), Pres., Engineering Equipment Co. Ltd., 420 New Birks Bldg., Montreal, Que. (*H*) Apt. 18, 1455 Drummond St. (*S. 1899*) (*A.M. 1911*)

♂CAMPBELL, Robert A., E.E., (Tor. '09), Supt., Great Lakes Power Co. Ltd., Sault Ste. Marie, Ont. (*A.M. 1923*)

CAMPBELL, Robert Arthur, Supervisor, Forest Operations, Govt. Ont., Parliament Bldgs., Toronto, Ont. (*1938*)

CAMPBELL, Vincent Henry, Dist. Engr., Reclam. Branch, D.P.W., Man., Winnipeg, Man. (*H*) 683 Strathcona St. (*A.M. 1920*)

CAMPBELL, Wilfred J., B.A.Sc., (Tor. '25), Relay Engr., Detroit Edison Co., Detroit, Mich. (*H*) 4715 Maryland Ave. (*S. 1925*) (*A.M. 1931*)

CAMPBELL, Wm. Fisher, County Engr's. Office, Cayuga, Ont. (*A.M. 1938*)

CAMPION, William, Designing and Mtce. Engr., Lightning Fastener Co., St. Catharines, Ont. (*H*) 102 Queen St. (*A.M. 1922*)

CAMSELL, Charles, C.M.G., LL.D., B.Sc., Deputy Minister, Dept. of Mines and Resources, Langevin Block, Ottawa, Ont. (*H*) 240 Mariposa Ave., Rockcliffe. (*M. 1923*) (*Past-President*)

CANDLISH, Fairlie, B.Eng., (McGill '37), Can. Westinghouse Co., Ltd., Hamilton, Ont. (*H*) 38 Stinson St. (*S. 1936*)

CANDLISH, John Boyd, 460 Rankin Blvd., Sandwich, Ont. (*A.M. 1921*)

CANN, Wm. N., Lennoxville, Que. (*A.M. 1910*)

CANNIFF, S. W., Asst. Gen. Mgr., Ottawa Hydro-Electric Power Comm., Ottawa, Ont. (*H*) 66 Ossington Ave. (*A.M. 1922*)

CANTWELL, Herbert H., B.E., (Union, Tenn. '07), Indust. Engr., 407 McGill St., Montreal, Que. (*H*) 553 Champagneur Ave., Outremont, Que. (*A.M. 1921*)

♂CAPE, E. G. M., Col., D.S.O., B.A.Sc., (McGill '98), Pres., E. G. M. Cape & Co., 960 New Birks Bldg., Montreal, Que. (*H*) 1210 Redpath Crescent. (*S. 1899*) (*A.M. 1902*) (*M. 1909*)

CAPE, John Meredith, (R.M.C., Kingston '32), Engr., E. G. M. Cape & Co., 960 New Birks Bldg., Montreal, Que. (*H*) 6 Redpath Row. (*Jr. 1934*)

CAPELLE, Wm. A., B.Sc., (Man. '32), Engrg. Dept., T. Eaton Co. Ltd., Winnipeg, Man. (*H*) 418 Broadway Court. (*S. 1929*) (*Jr. 1937*)

CAREFOOT, H. R., Flt. Lieut., B.Sc., (Sask. '29), Staff Officer, Tech. Dev., R.C.A.F., Ottawa, Ont. (*H*) 333 Metcalfe St. (*S. 1929*) (*A.M. 1937*)

CAREY, Cyril Jos., Chartered Civil Engr., Tramway Bldg., Halifax, N.S. (*Jr. 1931* (*A.M. 1933*)

CAREY, Edward George, Electrical Contractor, 4353 Harvard Ave., N.D.G., Montreal, Que. (*A.M .1926*)

CAREY, Roger Packard, B.Eng., (N.S.T.C. '35), Instr'man., Dept. of Highways, N.B., Sackville, N.B. (*Jr. 1938*)

CARLEY, Forest Cecil, B.A.Sc., (Tor. '23), Dist. Mgr., Affiliated Engineering Corp. Ltd., 415 Harbour Commrs. Bldg., Toronto, Ont. (*H*) 458 Armadale Ave. (*A.M. 1938*)

CARMEL, Jos. Edward, B.Sc., (Ecole Polytech., Montreal), Supt. of Buildings, City of Montreal, City Hall, Montreal, Que. (*H*) 224 St. Joseph Blvd. East. (*M. 1917*)

CARMICHAEL, Jas. Irving, B.Sc., (Queen's '36), Thunder Bay Paper Co. Ltd., Port Arthur, Ont. (*H*) Royal Edward Hotel, Fort William, Ont. (*S. 1935*)

CARMICHAEL, Ross MacNevin, B.A.Sc., (Tor. '13), 4605 Marcil Ave., N.D.G., Montreal, Que. (*A.M. 1920*)

CARNIEL, Carlo Antonio, Contractor, 832 St. James St., Montreal, Que. (*A.M. 1920*)

CARNWATH, James, B.Sc., (McGill '11), Mgr., Concrete Pipe Ltd., 198 Riddell St., Woodstock, Ont. (*H*) 295 Light St. (*A.M. 1927*)

†CARON, Jos. Georges, Engr. i/c Technical Service, City of Montreal, City Hall, Montreal, Que. (*H*) 559 Letourneux St. (*Jr. 1912*) (*A.M. 1919*)

CARON, Wm. Robert, Asst. Engr., National Harbours Board, Port of Quebec, Pte-a-Cavey, Quebec, Que. (*H*) Apt. 5, 297 St. Foye Rd., Quebec, Que. (*A.M. 1932*)

CARPENTER, Edward Emery, B.S., (Stanford '98), Cons. Engr., B.C. Electric Rly. Co. Ltd., Vancouver, B.C. (*H*) 1689–29th Ave. W. (*M. 1924*)

CARPENTER, Edward Stanley Cameron, B.Sc., (Sask. '29), Dist. Engr., P.R.F.A., Dept. of Agriculture, Regina, Sask. (*H*) 198 Leopold Crescent. (*A.M. 1931*)

†CARPENTER, H. S., B.A.Sc., (Tor. '98), D.L.S., O.L.S., S.L.S., Deputy Minister, Dept. of Highways and Transportation, Sask., Regina, Sask. (*H*) 198 Leopold Crescent. (*A.M. 1904*) (*M. 1922*) (*Life Member*)

♂CARR, David Leonard, Capt., M.C., address unknown. (*A.M. 1926*)

♂CARR, N. Osmond, Col. R.C.A., (Grad. R.M.C.), Director of Mechanization of Artillery, Dept. of National Defence, Woods Bldg., Ottawa, Ont. (*H*) 425 Daly Ave. (*M. 1937*)

♂CARR-HARRIS, G. G. M., Asst. Prof., Royal Military College, Kingston, Ont. (*H*) 113 Earl St. (*A.M. 1930*)

♂CARRIE, G. Milroy, B.A.Sc., (Tor. '13), Gen. Mgr., Can. Refractories Ltd., 1050 Canada Cement Bldg., Montreal, Que. (*H*) 796 Upper Lansdowne Ave., Westmount, Que. (*M. 1934*)

CARRIERE, Murray Francis, B.A.Sc., (Tor. '37), 299 Evelyn Ave., Toronto, Ont. (*S. 1938*)

CARRUTHERS, Alex. Lorraine, Bridge Engr., D.P.W., B.C., Parliament Bldgs., Victoria, B.C. (*H*) 1258 St. Patrick St. (*A.M. 1915*) (*M. 1921*)

CARRUTHERS, Clarence D., B.A.Sc., (Tor. '27), Str'l. Engr., Gordon L. Wallace, 68 Glenwood Ave., Toronto, Ont. (*H*) 253 Castlefield Ave. (*S. 1927*) (*Jr. 1929*) (*A.M. 1935*)

CARSON, J. R., B.Sc., (N.S.T.C. '35), Box 206, Pictou, N.S. (*S. 1932*)

CARSON, M. S., B.Sc., (Sask. '30), Production Engr., Link-Belt Ltd., 791 Eastman Ave., Toronto, Ont. (*H*) 204 Wineva Ave. (*S. 1931*) (*Jr. 1937*)

CARSON, Robt. John, (Grad. R.M.C.), B.Sc., (Queen's '37), Lieut., R.C.E., M.D. 11, Victoria, B.C. (*S. 1937*)

CARSON, William Harvey, C.E., (R.T.C., Glasgow), Dist. Engr., Aids to Navigation Br., Dept. of Transport, Hunter Bldg., Ottawa, Ont. (*H*) 63 Fentiman Ave. (*A.M. 1910*) (*M. 1918*)

CARSWELL, Ernest R., B.A.Sc., Asst. Chief Chemist, Home Oil Distributors Ltd. (Refinery), North Vancouver, B.C. (*H*) 595 N. Kootenay St., Vancouver, B.C. (*S. 1930*)

CARSWELL, John Ballantyne, B.Sc., (Glasgow), Pres., Burlington Steel Co. Ltd., Hamilton, Ont. (*H*) 3 Turner Ave. (*Jr. 1912*) (*A.M. 1915*) (*M. 1928*)

CARTER, Edward Fairbank, C.E., (Renss.), Vice-Pres. and Dir., John S. Metcalf Co. Ltd., 837 West Hastings St., Vancouver, B.C. (*H*) 1712 Cedar Crescent. (*M. 1916*)

CARTER, John Russell, B.A.Sc., (Tor. '31), Room 1010, Central Y.M.C.A., Drummond St., Montreal, Que. (*S. 1931*) (*A.M. 1937*)

CARTER, Thos. Allen, B.Sc., (Queen's '31), Elec. Engr., Saguenay Power Co. Ltd., Arvida, Que. (*H*) 906 Moisson St. (*A.M. 1938*)

CARTER, Wm. Franklin Shaen, B.Eng., (McGill '36), Sales Dept., Can. Ingersoll-Rand Co., Montreal, Que. (*H*) 119 Arlington Ave., Westmount, Que. (*Jr. 1937*)

CARTIER, Leonard, B.A.Sc., (Ecole Polytech., Montreal '38), 1147 Bellechasse E., Montreal, Que. (*S. 1936*)

♂CARTWRIGHT, George Herbert, Lieut., B.Sc., (McGill '22), Supt. Ways and Structures, Quebec Rly., Light, Heat and Power Co., Quebec, Que. (*H*) St. Louis de Courville, Que. (*S. 1920*) (*A.M. 1926*)

♂CARTY, Edward G., Capt., B.Sc., (London '08), Asst. to Deputy Minister, Dept. of Transport, West Block, Ottawa, Ont. (*H*) 160 Waverly St. (*S. 1910*) (*A.M. 1912*)

CARVER, Stanley C., B.A.Sc., (B.C. '29), Asst. Engr., P.W.D., Maseru, Basutoland, South Africa. (*S. 1927*) (*A.M. 1935*)

CASEY, William, Pres. and Gen. Mgr., Canadian Locomotive Co. Ltd., Kingston, Ont. (*H*) 213 King St. (*M. 1922*)

CASGRAIN, Hon. Col. (Senator) Jos. P. B., D.L.S., Q.L.S., 266 St. James St., Montreal, Que. (*H*) 1916 Dorchester St. W. (*A.M. 1895*) (*Life Member*)

♂CASSELS, W. L. L., Capt., B.Sc., (McGill '13), O.L.S., Q.L.S., D.L.S., Farley & Cassels, 18 Rideau St., Ottawa, Ont. (*H*) 366 Daly Ave. (*A.M. 1924*)

CASSIDY, John F., Dftsman., Dept. of Highways, Ont., Room 2627, Parliament Bldgs., Toronto, Ont. (*H*) 622-A Dovercourt Rd. (*Jr. 1918*) (*A.M. 1920*)

CASSIDY, Stanley Bernard, B.Sc., Radio Engr., Jas. S. Neill & Sons Ltd., Fredericton, N.B. (*H*) 294 University Ave. (*Jr. 1936*)

CASTLEDEN, Geoffrey Percy, B.Sc., (Sask. '27), Address unknown. (*A.M. 1934*)

♂†CATE, Carroll Lee, Lieut., B.Sc., (McGill '09), North Hatley, Que. (*A.M. 1911*)

†CATON, Edwin V., Mgr., Elec. Utility, Winnipeg Elec. Rly. Co., 1010 Elec. Rly. Chambers, Winnipeg, Man. (*H*) 71 Brock St. (*M. 1917*)

♂CAVANAGH, A. L., Capt., M.C., B.E.E., (Man. '11), Supt. of Constrn., City of Winnipeg, 223 James St., Winnipeg, Man. (*H*) 331 Baltimore Rd. (*S. 1911*) (*A.M. 1919*)

♂CAWTHRA-ELLIOT, H. M., Major-Gen., C.B., C M.G., Cawthra Lotten, Lakeview, Ont. (*M. 1920*)

CHADILLON, Francois, 2343 St. Antoine St., Montreal, Que. (*S. 1937*)

CHADWICK, Austin Ralph, B.A.Sc., (Tor. '24), Pres., Gunite and Waterproofing Ltd.; Gen. Mgr., Construction Equipment Co. Ltd., 180 Vallee St., Montreal, Que. (*H*) 757 Upper Lansdowne Ave., Westmount, Que. (*S. 1921*) (*A.M. 1930*)

CHADWICK, Douglas Moore, Sales Engr., Can. Bridge Co. Ltd., Rm. 552, New Birks Bldg., Montreal, Que. (*H*) 118 Balfour Rd., Town of Mount Royal, Que. (*A.M. 1912*)

CHADWICK, Richard Ellard Carden, (Tor. '06), Pres., The Foundation Co. of Can., Ltd., 1538 Sherbrooke St. W., Montreal, Que. (*H*) 18 Ramezay Rd. (*A.M. 1913*) (*M. 1921*)

CHALK, Henry E., B.Eng., (McGill '33), Chief Chemist, Walter M. Lowney Co. Ltd., 350 Inspector St., Montreal, Que. (*H*) 4951 Western Ave., Westmount, Que. (*S. 1933*)

†CHALLIES, John Bow, C.E., (Tor. '03), D.Eng., (Tor. '38), Asst. Gen. Mgr., The Shawinigan Water and Power Co., 613 Power Bldg., Montreal, Que. (*H*) 8 Grove Park, Westmount, Que. (*A.M. 1907*) (*M. 1914*) (*President 1938*)

♂CHALMERS, Geo. H., Lieut., B.Sc., (Queen's '18), Sales Engr., The Canada Ingot Iron Co. Ltd., Guelph, Ont. (*H*) 83 Glengrove Ave. W., Toronto, Ont. (*S. 1916*) (*Jr. 1919*) (*A.M. 1924*)

CHALMERS, John, O.L.S., (Tor. '94), 6081 Marguerite St., Vancouver, B.C. (*A.M. 1899*) (*M. 1910*) (*Life Member*)

♂CHAMBERS, E. C. G., Lt.-Col., M.C., R.C.E., Asst. Director, Engr. Services, Dept. National Defence, Slater St., Ottawa, Ont. (*A.M. 1924*)

♂CHAMBERS, Hugh D., Lieut., B.Sc., (McGill '14), Pres., G. D. Peters & Co. of Canada Ltd., Rm. 1021, New Birks Bldg., Montreal, Que. (*H*) 4830 Roslyn Ave. (*S. 1914*) (*A.M. 1922*)

CHAMBERS, Harold J. A., B.A.Sc., (Tor. '24), (M.A.Sc., '25), Asst. Engr., Can. Bridge Co., Ltd., Walkerville, Ont. (*H*) 1287 Kildare Rd. (*S. 1920*) (*A.M. 1930*)

CHAMBERS, Robert, B.Sc., (Alta. '37), Shawinigan Water & Power Co., Power Bldg., Montreal, Que. (*H*) 7619-112 Ave., Edmonton, Alta. (*S. 1937*)

CHAMBERS, Robt. John, B.Sc., (Queen's '33), M.Sc., (Queen's '35), Mech. Engr., Anglo-Canadian Pulp & Paper Co., Quebec, Que. (*Jr. 1936*)

CHAMPION, C. H., B.Sc., (McGill '23), Engr., Can. International Paper Co., Three Rivers, Que. (*H*) 783 Bonaventure St. (*S. 1923*) (*A.M. 1930*)

CHANDLER, Ralph B., B.A.Sc., (Tor. '12), Mgr., Public Utilities Comm., Port Arthur, Ont. (*H*) 24 Rupert St. (*A.M. 1917*) (*M. 1923*)

CHAPAIS, Charles, B.A., B.A.Sc., (Ecole Polytech., Montreal '04), Sales Mgr., Casavant Bros. Ltd., St. Hyacinthe, Que. (*H*) 81 Laframboise Blvd. (*A.M. 1910*)

CHAPLEAU, J. P., B.Sc., C.E., (Ecole Polytech., Montreal '20), National Harbours Bd., Quebec, Que. (*Jr. 1921*) (*A.M. 1923*)

CHAPLEAU, Samuel J., Sr. Engr., D.P.W., Canada, P.O. Box 203, Ottawa, Ont. (*A.M. 1896*) (*M. 1909*) (*Life Member*)

CHAPLIN, Charles John, B.Sc., M.Sc., (McGill '08), Officer i/c, Section Timber Mechanics, Forest Products Research Lab., Princes Risborough, Bucks., England. (*H*) "Lanfranc," Haddenham, Bucks., England. (*S. 1904*) (*A.M. 1912*) (*M. 1917*)

CHAPLIN, Herbert E., B.Eng., (McGill '34), Asst. Factory Engr., Imperial Tobacco Co. Ltd., Montreal, Que. (*H*) Apt. 4, 5275 Cote St. Luc Rd. (*Jr. 1938*)

CHAPMAN, Alfred Saunders, City Engr., City Hall, Calgary, Alta. (*H*) 525-13th Ave. W. (*A.M. 1916*)

♂CHAPMAN, Edward Willard Gordon, S.B., (N.S.T.C. '14), Div. Engr., C.N.R., Box 614, Edmundston, N.B. (*Jr. 1919*) (*A.M. 1925*)

CHAPMAN, Stuart M., B.Eng., (McGill '36), Asst. Research Worker, Can. Pulp & Paper Assoc., 3420 University St., Montreal, Que. (*H*) 2257 Melrose Ave., N.D.G. (*S. 1936*)

CHAPMAN, Walter Peck, 30 Howard St., Toronto, Ont. (*A.M. 1889*) (*M. 1903*) (*Life Member*)

♂†CHAPPELL, Frank, Col., V.D., Director, Industrial and Public Relations, General Motors of Canada Ltd., Oshawa, Ont. (*H*) 45 Connaught St. (*S. 1908*) (*A.M. 1913*) (*M. 1936*)

CHAPPELL, M. R., Vice-Pres. and Mgr., Chappells, Ltd., 62-80 Brookland St., Sydney, N.S. (*H*) 36 Ankerville St. (*Affil. 1928*)

CHAPPELLE, Joseph Walter Sands, (Queen's), Res. Engr., D.P.W., Alta., Edmonton, Alta. (*A.M. 1921*)

CHAPUT, Omer, Jr., B.Sc., (Queen's '36), Aluminum Co. of Canada, Arvida, Que. (*Jr. 1938*)

CHAREST, Pierre Antoine, Dftsman., Fraser Companies Ltd., Edmundston, N.B. (*H*) 38 Rice St. (*Jr. 1937*)

CHARLAND, Roger, 3416 St. Hubert St., Montreal, Que. (*S. 1938*)

♂CHARLES, John Leslie, Major, D.S.O., Supervising Engr., C.N.R., The Pas, Man. (*A.M. 1919*)

CHARLES, Robert S., Jr., B.A., (Amherst '29), Field Engr., International Water Supply Ltd., London, Ont. (*H*) 181 Elmwood Ave. (*A.M. 1938*)

CHARLESWORTH, L. C., (Tor. '93), D.L.S., O.L.S., A.L.S., Chairman, Irrigation Council, Director of Water Resources, Alberta, Administration Bldg., Edmonton, Alta. (*H*) 9930-106th St. (*M. 1918*)

CHARLEWOOD, C. B., (R.M.C., Kingston), B.Sc., (McGill '31), Mech. Engr., Foster Wheeler Ltd., Aldwych, London, W.C.2., c/o British Columbia House, 1-3 Regent St., London, S.W.I, England. (*S. 1931*) (*Jr. 1937*)

CHARLTON, Richard M., Vice-Pres., Leger & Charlton, Ltd., Contrs., 400 Notre Dame St., Lachine, Que. (*A.M. 1905*)

CHARTERS, Stewart A., B.Eng., (McGill '36), Sales Engr., Watson Jack & Co., Montreal, Que. (*H*) 218 Metcalfe Ave., Westmount, Que. (*S. 1936*)

CHARTIER, Albert, Paterson Engineering Co. of Canada, Ltd., Montreal, Que., Sta. R., 8307 St. Denis St, Montreal, Que. (*A.M. 1920*)

CHAUSSEE, Pierre Maurice, Elec. Supt., Montreal Water Bd., Montreal, Que. (*H*) 1612 Blvd. Pie IX. (*S. 1919*) (*Jr. 1922*) (*Affil. 1934*)

CHEESEMAN, Edgar W., 152 Spring Garden Rd., Halifax, N.S. (*S. 1935*)

CHENE, Jean D., B.A.Sc., (Ecole Polytech., Montreal), Sr. Asst. Engr., Engrg. & Constrn. Service, Jackson Bldg., Ottawa, Ont. (*H*) 163 Notre Dame St., Hull, Que. (*S. 1909*) (*A.M. 1914*)

CHENEVERT, Jos. Georges, B.A.Sc., (Ecole Polytech., Montreal '23), Partner, Arthur Surveyer & Co., Cons. Engrs., 1003 Dominion Square Bldg., Montreal, Que. (*H*) 573 Rockland Ave., Outremont, Que. (*M. 1936*)

CHENEY, Wayne Putnam, B.Sc., (Man. '28), 2041 Rae St., Regina, Sask. (*S. 1926*) (*A.M. 1932*)

CHENG, R. K., B.Eng., (McGill '38), 653 Pender St., Vancouver, B.C. (*S. 1937*)

CHENNELL, Alwyn C. S., B.Eng., (McGill '33), Cable Engrg., Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*H*) 611 Bloomfield Ave., Outremont, Que. (*S. 1933*)

CHESHIRE, Wm. Vernon, B.Sc., (Man. '23), Sales Engr., Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*H*) 4 Waverly Rd., Pointe Claire, Que. (*S. 1919*) (*A.M. 1930*)

CHESNUT, Victor Stanley, B.A.Sc., (Tor. '09), Sr. Engr., National Harbours Bd., Port of Saint John, Saint John, N.B. (*H*) 10 Paddock St. (*A.M. 1919*)

CHESTNUT, Kenneth Randolph, B.Eng., (N.B. '04), M.Sc., (N.B. '07), Newfoundland Airport, Hattie's Camp, Newfoundland. (*M. 1938*)

CHEVALIER, J. Emile, B.A.Sc., (Ecole Polytech., Montreal, '28), C.E., D.P.W., Que., P.O. Box 223, Quebec, Que. (*H*) 125 Avenue Cartier. (*A.M. 1936*)

♂CHEVALIER, Philippe, Capt., B.A.Sc., (Ecole Polytech. Montreal '05), Asst. Engr., Technical Service, City Hall, Montreal, Que. (*H*) 4695 Roslyn Ave., Montreal, Que. (*S. 1907*) (*A.M. 1913*)

♂CHISHOLM, A. Harold, B.Sc., (McGill '20), Asst. to Chief Engr., Can. Inter. Power and Paper Co., Montreal, Que. (*H*) Apt. 15, 5551 Queen Mary Rd. (*S. 1920*) (*A.M. 1926*)

CHISHOLM, Donald Alex., B.Sc., (N.S.T.C. '32), Res. Engr., Dept. of Highways, N.S., Halifax, N.S. (*H*) Ross St., Mulgrave, N.S. (*S. 1930*) (*Jr. 1934*) (*A.M. 1938*)

CHISHOLM, Frederick A., Local Mgr., Southern Canada Power Co., Drummondville, Que. (*A.M. 1909*)

♂CHISHOLM, Jos. D., Lieut., B.Sc., (McGill '23), Elec. Engr., Bepco Canada Ltd., 1050 Mountain St., Montreal, Que. (*H*) 4558 Wilson Ave. (*S 1920*) (*Jr. 1925*) (*A.M. 1930*)

CHISHOLM, Wm. Ronald, Antigonish, N.S. (*A.M. 1907*) (*Life Member*)

CHOROLSKY, E., B.A.Sc., (Tor. '26), Can. Bridge Co., Walkerville, Ont. (*H*) 2211 Windermere Rd. (*S. 1926*) (*A.M. 1937*)

CHRISTIAN, J. D., B.A.Sc., (Tor. '37), University of Toronto, Toronto, Ont. (*S. 1935*)

†CHRISTIE, Clarence V., M.A., (Dalhousie '02), B.Sc., (McGill '06), Professor, Elec. Engrg., and Head of Dept. of Elec. Engrg., McGill University, Montreal, Que.; Consulting Engr. (*H*) 87 Holton Ave., Westmount, Que. (*S. 1908*) (*A.M. 1911*) (*M. 1926*)

CHRISTIE, Frank Carl, B.A.Sc., (Tor. '17), Private Practice, 2030 Retallack St., Regina, Sask. (*1938*)

CHRISTIE, Geo. Wm., B.Sc., (N.S.T.C. '24), Asst. Chief Engr., Imperial Oil Ltd., P.O. Box 490, Dartmouth, N.S. (*H*) 101 King St. (*A.M. 1933*)

CHRISTIE, R. Louis, B.Eng., (McGill '35), Engr., Can. Kodak Co., Toronto 6, Ont. (*H*) 21 Marmaduke Ave. (*S. 1932*)

CHRISTIE, Wm., B.A.Sc., (Tor '02), D.L.S., S.L.S., Prince Albert, Sask. (*M. 1922*)

CHUBB, Thomas Alford, Dom. Bridge Co. Ltd., Montreal, Que. (*H*) 18 St. George St., Ste. Anne de Bellevue, Que. (*A.M. 1920*)

♂CHURCH, Charles E., Patent Solicitor, 21 Main St. E., Hamilton, Ont. (*A.M. 1936*)

CIMON, J. M. Hector, B.A., B.A.Sc., C.E., Engr., Price Bros. & Co. Ltd., Price House, Quebec, Que. (*H*) 87 Park Ave. (*S. 1912*) (*A.M. 1919*) (*M. 1930*)

CLAIRMONT, Adolphe, B.Sc., (Ecole Polytech., Montreal '36), Plant Engr., Singer Sewing Machine Co., Thurso, Que. (*S. 1937*)

CLARIDGE, Richard Earl, 40 Lightbourne Ave., Toronto, Ont. (*Affil. 1932*)

♂CLARK, Albert Wm. Gardner, Lieut., B.Sc., (McGill '10), Man'g. Dir., B.C. Concrete Co. Ltd., Vancouver, B.C. (*H*) 5326 Angus Drive. (*S. 1908*) (*Jr. 1913*) (*A.M. 1921*)

CLARK, Geo., Dftsman., C.N.R., 460 Union Sta., Winnipeg, Man. (*H*) 137 Eugenie St., Norwood Grove. (*A.M. 1934*)

CLARK, Geo. Silas, B.Sc., (McGill '22), Chief Engr., Molsons Brewery Ltd., 1670 Notre Dame St. E., Montreal, Que. (*H*) 1753 North Ave., Outremont, Que. (*S. 1919*) (*Jr. 1925*) (*A.M. 1931*)

♂CLARK, Harold S., Lieut., B.A.Sc., (Tor. '11), 427 Gladstone Ave., Windsor, Ont. (*A.M. 1921*)

CLARK, Jas. E., B.Sc., (Queen's '28), Field Engr., Bell Telephone Co. of Canada, Ottawa, Ont. (*H*) 789 Carling Ave. (*S. 1928*) (*Jr. 1932*) (*A.M. 1937*)

CLARKE, Bruce Porteous, B.Eng., (McGill '34), Engrg. Dept., Can. Ingersoll-Rand Co. Ltd., Sherbrooke, Que. (*H*) 17 Montcalm St. (*S. 1934*)

CLARKE, Ernest R., B.A.Sc., Contractor, 278 Douglas Drive, Toronto, Ont. (*A.M. 1906*)

CLARKE, George C., Vice-Pres. and Treas., Fraser, Brace Engineering Co. Ltd., 107 Craig St. W., Montreal, Que. (*H*) The Chateau, 1321 Sherbrooke St. W. (*M. 1914*)

♂CLARKE, Geo. Good, B.Eng., (Liverpool '12), Str'l. Designer, Dom. Bridge Co. Ltd., Lachine, Que. (*A.M. 1925*)

CLARKE, Geo. F., B.Sc., (McGill '31), M.Eng., '35, Prod. Engr., Can. Safety Fuse Co., Brownsburg, Que. (*H*) 3647 University St., Montreal, Que. (*S. 1929*)

CLARKE, G. T., B.Sc., (N.S.T.C. '29), Dept. P. W., Canada, Halifax, N.S. (*Jr. 1930*)

†CLARKE, John Leonard, B.Sc., (London '09), Transm. and Foreign Wire Relations Engr., The Bell Telephone Co. of Canada, Montreal, Que. (*H*) 84-44th Ave., Lachine, Que. (*A.M. 1922*) (*M. 1932*)

CLARKE, O. M., B.Sc., (McGill '31), Asst. Mgr., Worthy Park Estate, Ewarton, Jamaica, B.W.I. (*S. 1929*) (*A.M. 1937*)

CLARKE, Robt. Arthur, Res. Road Engr., D.P.W., Highway Division, Chipman, N.B. (*A.M. 1938*)

CLARKE, Stephen Herbert, 1516 Royal Bank Bldg., Montreal, Que. (*S. 1933*) (*A.M. 1938*)

CLARKE, Wilfred Ernest, Vice-Pres. and Gen. Mgr., The Sydney Foundry and Machine Wks. Ltd., Sydney, N.S. (*H*) 121 Esplanade. (*M. 1923*)

CLARKSON, Arthur Grant, B.A.Sc., (Tor. '38), Algoma Steel Corp., Sault Ste. Marie, Ont. (*H*) 128 Upton Rd. (*Jr. 1938*)

CLEATON, R. Ewart, Cons. Engr., 35 Queens Court, Queens Rd., London, W.2. (*M. 1923*)

CLEMENT, Sheldon Byrne, M.Sc., (McGill '02), Chief Engr., T. & N.O. Ry., North Bay, Ont. (*H*) 127 Durrill St. (*S. 1889*) (*A.M. 1906*) (*M. 1911*)

♂CLENDENING, Clair Addison, Vice-Pres., Northern Public Service Corp. Ltd., 307 Power Bldg., Winnipeg, Man. (*A.M. 1920*)

♂CLENDENING, Chester Scott, Res. Engr., Lethbridge Northern Irrigation Dist., Diamond City, Alta. (*A.M. 1922*)

CLEVELAND, Courtney E., B.A.Sc., (B.C. '34), M.Sc., (McGill '38), 3637 Oxenden Ave., Montreal, Que. (*S. 1937*)

†CLEVELAND, Ernest A., LL.D., Chief Commr., Greater Vancouver Water Dist., Chairman, Vancouver and Districts Joint Sewerage and Drainage Bd., Sun Bldg., Vancouver, B.C. (*H*) 3737 Pine Crescent. (*M. 1914*) (*Past-President*)

CLIMO, Percy Lloyd, B.Sc., (Queen's '32), Hollinger Cons. Gold Mines, Box 1769, Timmins, Ont. (*S. 1928*) (*Jr. 1934*)

CLINE, Carl Gordon, B.A.Sc., (Tor. '11), (C.E. '22), Sr. Asst. Engr., Dom. Water and Power Bureau, Dept. Mines and Resources, Rm. 1, Ontario Power Plant, Niagara Falls, Ont. (*H*) 1784 Dorchester Rd. (*S. 1911*) (*Jr. 1912*) (*A.M. 1914*)

♂COATES, Jas. Percy, Capt., Assessor and Bldg. Inspr., City of Trail, B.C. (*A.M. 1926*)

COBBOLD, Robt. Jas., (A.C.G.I. '29), Asst. Engr., Outside Erection Dept., English Electric Co., Rugby, England. (*Jr. 1930*) (*A.M. 1937*)

♂COCHRANE, Hew Grant, Capt., (R.M.C., Kingston), 8 Maple Ave., Ste. Anne de Bellevue, Que. (*A.M. 1913*)

COCHRANE, John Bray, Asst. Dir., Military Surveys, Dept. of National Defence, Ottawa, Ont. (*H*) 10 Dalhousie St. (*M. 1905*)

COCHRANE, M. Farrar, (Heriot Watt '00), D.L.S., Dom. Water and Power Bureau, Dept. Mines and Resources, Jackson Bldg., Ottawa, Ont. (*H*) Rockcliffe Park. (*A.M. 1905*) (*M. 1926*)

COCKBURN, John M., B.Sc., (Queen's '24), Telephone Equipment Engrg. Dept., Northern Electric Co. Ltd., Montreal, Que. (*H*) 2296 Hampton Ave. (*S. 1922*) (*Jr. 1927*) (*A.M. 1935*)

♂COCKBURN, J. Roy, B.A.Sc., (Tor. '02), Prof. of Descriptive Geometry, University of Toronto, Toronto, Ont. (*H*) 100 Walmer Rd. (*A.M. 1911*) (*M. 1919*)

COCKSHUTT, Clarence F., B.A.Sc., (Tor. '23), Cons. Engr., Minexams Ltd., P.O. Box 306, Port Arthur, Ont. (*S. 1921*) (*A.M. 1928*)

♂COGDELL, Herbert, Engr. Lt. Cmdr. (Retired), Bldg. and Engrg. Supt., Montreal General Hospital. (*H*) 2 Dollard St., Montreal South, Que. (*A.M. 1933*)

COKE-HILL, Lionel, Address unknown. (*M. 1922*)

♂COKE, R. Norman, Lieut., B.Sc., (McGill '14), Vice Chief Engr. and Gen. Supt., Montreal L., H. and P. Cons., Power Bldg., Montreal, Que. (*H*) 305 Strathearn Ave., Montreal West, Que. (*Jr. 1917*) (*A.M. 1923*)

COLE, A. Herman Purkis, B.Eng., (McGill '36), Inspr. Engr., D. W. Ogilvie & Co., 840 Dominion Square Bldg., Montreal, Que. (*H*) Apt. 2, 4900 Cote des Neiges Rd. (*S. 1931*)

COLE, Albert Linniard, Supt., Saskatoon Power Plant, Sask. Power Comm. (*H*) 8-A Cambridge Court, Saskatoon, Sask. (*1938*)

♂COLE, Geo. E., Lt.-Col., B.Sc., (McGill '06), Director of Mines, Mines Branch, Dept. of Mines and Natural Resources, Law Courts, Winnipeg, Man. (*H*) 774 Wellington Crescent. (*S. 1905*) (*A.M. 1912*)

COLE, George Percy, M.Sc., (McGill '06), Technical Engr., Dominion Glass Co., Ltd., 1111 Guarantee Bldg., Montreal, Que. (*H*) 4327 Old Orchard Ave. (*M. 1919*)

COLE, L. Heber, B.Sc., (McGill '06), Divn. of Industrial Minerals, Bureau of Mines, Mines and Geology Br., Dept. of Mines and Resources, Ottawa, Ont. (*H*) 166 Holmwood Ave. (*M. 1920*)

COLEMAN, Sheldon W., B.Sc., (McGill '28), Flt.-Lt., R.C.A.F., Dept. National Defence, Ottawa, Ont. (*S. 1925*) (*A.M. 1936*)

♂COLES, Eric Morrell, Capt., D.F.C., B.A.Sc., (B.C. '22), Can. Westinghouse Co. Ltd., Hamilton, Ont. (*H*) Ste 404, 325 James St. S. (*S. 1922*) (*A.M. 1926*)

COLGAN, Patrick, B.Sc., (N.S.T.C. '34), Cosmos Imperial Mills, Yarmouth N., N.S. (*H*) George's Island, Halifax, N.S. (*S. 1930*) (*Jr. 1937*)

COLHOUN, George A., (Tor. '06), Designing Engr., Hamilton Bridge Co., Hamilton, Ont. (*H*) 84 Dalewood Crescent. (*A.M. 1919*) (*M. 1934*)

COLLE, Samuel S., Air Conditioning Engineering Co., 2040 Union Ave., Montreal Que. (*S. 1919*) (*A.M. 1929*)

COLLET, Aime, C.E., (Ecole Polytech., Montreal '23), Vice-Pres., Collet Frères Ltd., 1978 Parthenais St., Montreal, Que. (*H*) 361 Metcalfe Ave., Westmount, Que. (*A.M. 1929*)

♂COLLIER, Ernest Victor, Lt.-Col., D.S.O., Gen. Mgr., Simplifix Couplings Ltd., 3 Victoria St., London, S.W.1, England. (*H*) 60 Knightsbridge, London, S.W.1. (*S. 1907*) (*A.M. 1909*) (*M. 1923*)

COLLINGWOOD, John C., B.Eng., (McGill '37), 412 Laurier St., St. Johns, Que. (*S. 1937*)

COLLINS, Richard, Asst. Engr., Can. Car and Foundry Co., Montreal, Que. (*H*) 166-44th Ave., Lachine, Que. (*A.M. 1921*)

♂COLLINS, Wm. Henry, B.Sc., (Queen's '20), Sewer Designing Engr., City of Hamilton, Hamilton, Ont. (*H*) 16 Senator Ave. (*Jr. 1920*) (*A.M. 1923*)

♂COLLIS, Willie Orme, D.C.M., C. de G., Field Engr., T. & N.O. Rly., P.O. Box A-7, Englehart, Ont. (*A.M. 1921*)

COLLISON, Lloyd S., B.A.Sc., (Tor. '24), Filtration Plant Operation, City of Hamilton. (*H*) 140 Prospect St. N., Hamilton, Ont. (*S. 1921*) (*A.M. 1938*)

COLLITT, Bernard, Metallurgist, Jenkins Bros. Ltd., 617 St. Remi St., Montreal, Que. (*H*) 1170 Dorchester St. W. (*M. 1934*)

COLPITTS, Cecil Ashton, B.Sc., (Man. '33), Transitman, C.P.R., Calgary, Alta. (*Jr. 1937*)

COLPITTS, Gordon Lloyd, B.Sc., (N.S.T.C. '33), Imperial Oil Ltd., Dartmouth, N.S. (*H*) Imperoyal, N.S. (*Jr. 1934*)

†COLPITTS, Walter Wm., LL.D., M.Sc., (McGill '99), Coverdale & Colpitts, Cons. Engrs., 120 Wall St., New York, N.Y. (*H*) 75 Cleveland Lane, Princeton, N.J. (*S. 1897*) (*A.M. 1899*) (*M. 1905*)

COLTER, Ashley A., B.Sc., (McGill '10), Pres. Diamond Construction Co. Ltd., Box 847, Fredericton, N.B. (*S. 1909*) (*A.M. 1913*)

†COMBE, Frank Aubrey, Cons. Combustion and Steam Engr., 1188 Phillips Place, Montreal, Que. (*H*) 1770 Queen Mary Rd., Hampstead, Que. (*A.M. 1911*) (*M. 1920*)

COMEAU, Jules, C.E. (Ecole Polytech., Montreal '19), Asst. Engr. Technical Service, City of Montreal, City Hall, Montreal, Que. (*H*) 5412 Brodeur Ave., N.D.G. (*S. 1918*) (*Jr. 1921*) (*A.M. 1931*)

CONDON, Frederick Oxley, Office Engr., C.N.R., Moncton, N.B. (*H*) 81 Park St. (*M. 1922*)

CONKLIN, M. W. M., B.E., (Sask. '38), Algoma Steel Corp., Sault Ste. Marie, Ont. (*H*) 18 Putney Rd., Sault Ste. Marie, Ont. (*S. 1938*)

CONN, H. G., B.Sc., (Queen's '31), Lecturer, Mech. Engrg., Queen's University, Kingston, Ont. (*H*) 376 Earl St. (*S. 1931*) (*A.M. 1936*)

CONNELL, Charles, Tech. Apprentice Instructor, C.N.R., Toronto, Ont. (*H*) 14 Spruce St., Oakville, Ont. (*A.M. 1924*)

CONNELL, Chas. H. N., Dist. Engr., C.N.R., Transportation Bldg., North Bay, Ont. (*H*) 349 Main St. W. (*A.M. 1915*) (*M. 1931*)

CONNELL, Edwin A., B.Sc., (N.B. '38), Woodstock, N.B. (*S. 1938*)

CONNELL, Gordon A., B.Sc., (Alta. '37), Jr. Engr., Petroleum and Nat. Gas Divn., Dept. of Lands and Mines, Alta. (*H*) Black Diamond Hotel, Black Diamond, Alta. (*S. 1937*)

CONNELL, Thos. C., Constrn. Accountant, Power Corp. of Canada, Ltd., 355 St. James St., Montreal, Que. (*H*) 278 Oak Ave., St. Lambert, Que. (*A.M. 1917*)

CONNELLY, Alan B., Capt., B.Eng., (McGill '33), R.C.E., Dept. National Defence, Petawawa, Ont. (*S. 1932*)

CONNOLLY, John L., B.Eng., (N.S.T.C. '35), Northern Electric Co. Ltd. (*H*) Apt. 1, 1486 Chomedy St., Montreal, Que. (*S. 1930*)

CONNOR, Arthur William, B.A., C.E., (Tor. '00), A. W. Connor & Co., Cons. Engrs., 301 Metropolitan Bldg., Toronto, Ont. (*H*) 106 Highland Ave. (*A.M. 1899*) (*M. 1922*) (*Life Member*)

CONNOR, Gerald Russell, B.A.Sc., (Tor. '28), Combustion Engr., Spruce Falls Power & Paper Co., Kapuskasing, Ont. (*H*) 6 Dominion Ave. (*A.M. 1937*)

CONROD, Gerald Rhodes, B.Sc., (Dalhousie '31), Wire and Cable Sales Engr., Northern Electric Co. Ltd., 131 Simcoe St., Toronto, Ont. (*A.M. 1938*)

CONWAY, George R. G., Pres., Mexican Light and Power Co. Ltd., Apart. Postal 124 Bis, Mexico, D.F. (*M. 1909*)

♂CONWAY, Gilbert Stanley, Lieut., Chief Engr., British Pacific Properties Ltd., Marine Bldg., Vancouver, B.C. (*H*) 1767 Marine Drive, Hollyburn, W. Vancouver, B.C. (*A.M. 1920*) (*M. 1936*)

COOK, Archibald S., Asst. to Chief Engr., C.N. Telegraphs, 347 Bay St., Toronto, Ont. (*H*) Lakeview Ave., Clarkson, Ont. (*S. 1902*) (*A.M. 1906*) (*M. 1912*) (*Life Member*)

COOK, Clarence A., B.Eng., (Sask. '33), Teacher, Bedford Road Collegiate. (*H*) 301-31st St. W., Saskatoon, Sask. (*A.M. 1938*)

COOK, K. Gilbert, B.Eng., (McGill '38), 381 Prince Albert Ave., Westmount, Que. (*S. 1936*)

COOK, Wm. Albert McMichael, B.A.Sc., (Tor. '07), O.L.S., 232 Rose Park Drive, Toronto, Ont. (*A.M. 1914*)

COOK, Wm. Henry, 3850 Hampton Ave., N.D.G., Montreal, Que. (*A.M. 1924*)

COOKE, Norman Logan, B.Sc., (N.S.T.C. '22), Instructor (Indust. Arts), Halifax Bd. School Commrs., Halifax, N.S. (*H*) 13 Sherwood St. (*A.M. 1930*)

♂COOKE, Norman Melville, Capt., B.Sc., (Queen's), Sales Engr., The Barrett Co. Ltd., Toronto 8, Ont. (*H*) 148 Highbourne Rd. (*Jr. 1921*) (*A.M. 1930*)

COOMBES, David Eaton, B.Sc., (N.B. '35), P.O. Box 1688, Timmins, Ont. (*H*) North Devon, N.B. (*S. 1935*)

COOPER, Ashton B., B.S., in E.E., (Tufts '03), Gen. Mgr., Ferranti Electric Co. Ltd., Mount Dennis, Toronto 9, Ont. (*M. 1921*)

COOPER, Clarence E., (Tor. '99), Municipal Engr., Delta Municipality, Municipal Hall, Ladner, B.C. (*S. 1903*) (*A.M. 1907*)

COOPER, Frank W., Pres., Engineering Materials, Ltd., 1001 Dominion Square Bldg., Montreal, Que. (*A.M. 1907*)

COOPER, John Sidney, B.A.Sc., (Tor. '34), Chief Dftsman, Wabi Iron Works Ltd., New Liskeard, Ont. (*Jr. 1936*)

COOPER, L. O., B.Sc., (McGill '30), (M.Sc., '31), Asst. to Master Mechanic of Mines, International Nickel Co., Copper Cliff, Ont. (*H*) 23 Market St. (*A.M. 1938*)

COOPER, Paul E., B.Sc., (McGill '23), Works Mgr., Thomas Board Mills Ltd., Warrington, Lancs., England. (*H*) Red Hill, Firslane, Appleton, near Warrington, Lancs. (*S. 1920*) (*Jr. 1925*) (*A.M. 1928*)

COOPER, Ross Herbert, B.Sc., (Queen's '09), Electric Tampers and Equipment Co. of Canada Ltd., 801 Keefer Bldg., Montreal, Que. (*H*) Apt. 5, 205 Charlotte St., Ottawa, Ont. (*A.M. 1929*)

COOPER, Wm. Everett, B.Eng., (McGill '35), Saguenay Power Co., Ltd., Arvida, Que. (*H*) 60 Hall St. E., Moose Jaw, Sask. (*S. 1935*)

COPP, Walter Percy, B.Sc., (McGill '08), Prof. of Civil Engrg., Dalhousie University, Halifax, N.S. (*H*) 394 South St. (*S. 1907*) (*A.M. 1913*) (*M. 1925*)

COPPICK, Sydney, B.Eng., (McGill '36), School of Forestry, University of Idaho, Moscow, Idaho, U.S.A. (*H*) 3515 Durocher St., Montreal, Que. (*S. 1936*)

CORBETT, Jas. I., B.S. and E.M., (Mich. C.M.T.), United States Engineer Office, Norfolk, Va., U.S.A. (*A.M. 1929*)

CORBETT, B. S., B.Sc., (Alta '36), M.Sc., (Tor. '37), 57 Regent St. North, Sudbury, Ont. (*S. 1936*)

CORBETT, Horace Kenneth, B.Sc., (N.B. '38), R.R. 2, Fredericton, N.B. (*S. 1938*)

CORKUM, Perry Daniel, B.Sc., (N.S.T.C. '32 and '33), Massey-Harris Co., 1229 King St. W., Toronto, Ont. (*H*) Apt. 16, 235 Vaughan Rd. (*S. 1932*)

CORLESS, Chas. V., B.Sc., M.Sc., LL.D., (McGill), LL.D., (Queen's), Tillsonburg, Ont. (*S. 1903*) (*M. 1910*)

CORMIER, Ernest, B.A.Sc., (Ecole Polytech., Montreal '06), Arch't. and Cons. Engr., 2039 Mansfield St., Montreal, Que. (*S. 1904*) (*A.M. 1909*) (*M. 1935*)

CORNEIL, Frederick Maurice, B.Sc., (Queen's '23), Secy., Sutherland Construction Co., 1440 St. Catherine St. W., Montreal, Que. (*H*) 4043 Melrose Ave., N.D.G. (*S. 1922*) (*Jr. 1925*) (*A.M. 1929*)

CORNER, Edward Ponsonby, Br. Mgr., Hamilton Gear and Machine Co., 1120 Castle Bldg., Montreal, Que. (*H*) 2187 Marcil Ave., N.D.G. (*A.M. 1934*)

CORNISH, Chas. R., B.A.Sc., (B.C. '29), Asst. Engr., Dept. of Mines and Resources, Donald Station, B.C. Address: P.O. Box 505, Banff, Alta. (*S. 1928*) (*Jr. 1932*)

♂CORNISH, John Harold, Lieut., Asst. Mgr., U.S. Sales Dept., Can. Gen. Elec. Co., Ltd., 212 King St. W., Toronto, Ont. (*H*) 160 Cottingham Ave. (*A.M. 1915*)

CORNISH, W. E., B.Sc., (Man. '25), M.Sc., (Alta. '33), Asst. Prof. of Elec. Engrg., University of Alberta, Edmonton, Alta. (*H*) 11139-91st Ave. (*S. 1926*) (*Jr. 1930*) (*A.M. 1934*)

CORRIVEAU, R. de B., Capt., B.Sc., (McGill '00), Asst. Chief Engr., D.P.W., Canada, Hunter Bldg., Ottawa, Ont. (*H*) 21 Broadway Ave. (*S. 1898*) (*A.M. 1904*) (*M. 1918*)

♂COSGROVE, John R., Major, D.S.O., M.C., 54 Priory Rd., High Wycombe, Bucks., England. (*A.M. 1901*) (*M. 1917*)

COSSER, Walter Geoffrey, B.Sc., (McGill '30), Mech. Supt., Sigma Mines (Quebec) Ltd., Bourlamaque, Que. (*S. 1930*) (*Jr. 1936*)

♂COSSITT, Lawrence Sulis, 2nd Lieut., B.Sc., (McGill '24), Can. Car and Foundry Co. Ltd., Montreal, Que. (*H*) 1441 Drummond St. (*S. 1921*) (*Jr. 1926*) (*A.M. 1932*)

COSSITT, Murray Fredric, City Engr., Sydney, N.S. (*H*) 428 Atlantic St. (*Jr. 1920*) (*A.M. 1927*)

COSTIGAN, Jas. P. M., B.Sc., (McGill '26), Manufacturers Mutual Fire Insurance Co., 801 Sterling Tower, Toronto, Ont. (*S. 1925*) (*A.M. 1935*)

†COSTIGAN, James Shearer, B.A.Sc., (McGill '94), Pres. T. Pringle & Son. Ltd., Rm. 706, 485 McGill St., Montreal, Que. (*H*) 494 Grosvenor Ave., Westmount, Que. (*S. 1889*) (*A.M. 1899*) (*M. 1908*)

COTHRAN, Frank Harrison, Pres., Piedmont & Northern Rly., and The Durham & Southern Rly., Charlotte, N.C., U.S.A. (*M. 1926*)

COULTER, Hugh John, B.A.Sc., (Tor. '23), Detroit City Gas Co., 415 Clifford St., Detroit, Mich. (*H*) 46 Elmhurst Ave. (*S. 1921*) (*Jr. 1925*) (*A.M. 1934*)

COULTER, Stanley L., B.A.Sc., (Tor. '24), P.O. Box 776, Badin, N.C., U.S.A. (*S. 1921*) (*Jr. 1926*)

COULTIS, Samuel Geo., Ph.C., (Mich. '09), 606 Second St. W., Calgary, Alta. (*M. 1926*)

COUPIENNE, Gilbert, 2091 Union Ave., Montreal, Que. (*S. 1937*)

COURTICE, E. Dean W., B.A.Sc., (Tor. '14), Head of Drafting Dept., Hamilton Technical Inst., Hamilton, Ont. (*H*) 81 Rosslyn Ave. S. (*A.M. 1919*)

COUSINEAU, Aime, B.A.Sc., (Ecole Polytech., Montreal '09), S.B., (M.I.T. '16), (Harvard), Supt. Engr., Divn. of Sanitation, Dept. of Health, City of Montreal, City Hall, Montreal, Que. (*H*) 4090 Old Orchard Ave. (*S. 1908*) (*A.M. 1915*)

COUSINEAU, Louis Philippe, B.A.Sc., (Ecole Polytech., Montreal '36), Marine Industries Ltd., Sorel, Que. (*S. 1934*)

COUSINEAU, Yvon, B.A.Sc., (Ecole Polytech. '37), 4603 E. St. Catherine St., Montreal, Que. (*S. 1936*)

COUSINS, Edward L., B.A.Sc., C.E., (Tor. '07), Gen. Mgr., The Toronto Harbour Commrs., Harbour Commissioners' Bldg., Toronto, Ont. (*H*) 47 Kingsway, Humber Valley. (*S. 1907*) (*A.M. 1909*) (*M. 1923*)

♂COUTLEE, C. R., (R.M.C. Kingston), 148 Duplex Ave., Toronto, Ont. (*S. 1888*) (*A.M. 1894*) (*M. 1901*) (*Life Member*)

♂COUTLEE, W. F., Lieut., Asst. Engr., D.P.W., Rm. 836, Hunter Bldg., Ottawa, Ont. (*H*) 53 Findlay Ave. (*A.M. 1919*)

♂COUTTS, George, Lieut., M.C., B.Sc., (Glasgow '12), Asst. Engr., Hudson Bay Rly., Dept. of Transport, Churchill, Man. (*A.M. 1920*)

COUTTS, Erskine, B.Eng., (McGill '38), 3469 Montclair Ave., Montreal, Que. (*S. 1936*)

COUTURE, G. A. E., 170 St. Louis Rd., Quebec, Que. (*S. 1938*)

♂COWAN, Edgar C., M.M., B.A.Sc., (Tor. '19), 329-22nd St., Brandon, Man. (*S. 1919*) (*A.M. 1922*)

COWAN, Elijah, B.A.Sc., (Tor. '23), Lake St. John Power and Paper Co., Dolbeau, Que. (*S. 1921*) (*A.M. 1934*)

♂COWARD, George W., Major, Div'l. Engr., Entre Rios Rlys. Co. Ltd. Address: Ferro Carriles de Entre Rios, Basavilbasco, E.R., Argentina. (*A.M. 1910*)

♂COWIE, Alfred Henry, Lt.-Col., M.C., M.Eng., (Liverpool '16), Mgr., Eastern Divn., Dom. Bridge Co. Ltd., P.O. Box 280, Montreal, Que. (*H*) 420 Lansdowne Ave., Westmount, Que. (*M. 1932*)

COWIE, Frederick Wm., B.A.Sc., (McGill '86), Cons. Engr., Port of Montreal, Dept. of Transport, Montreal, Que. (*H*) 3745 The Boulevard, Westmount, Que. (*A.M. 1887*) (*M. 1898*) (*Life Member*)

COWIE, Norman Claude, B.A.Sc., (Tor. '21), Engr., Great Lakes Power Co. Ltd. Sault Ste. Marie, Ont. (*H*) 15 Hearst St. (*Jr. 1931*)

♂COWLEY, Arthur T. N., Wing. Comdr., B.Sc., (McGill '10), Supt., Air Regulations, R.C.A.F., Dept. of Transport, Ottawa, Ont. (*H*) 14 Delaware Ave. (*S. 1909*) (*Jr. 1913*) (*A.M. 1925*)

♂COWLEY, Francis P. V., Major, (R.M.C. Kingston), Asst. Engr., City of Vancouver, City Hall, Vancouver, B.C. (*H*) 1069 Beach Ave. (*S. 1907*) (*Jr. 1913*) (*A.M. 1918*) (*M. 1936*)

♂COX, Archibald, Master Mechanic and Constrn. Engr., The Crow's Nest Pass Coal Co. Ltd., Michel, B.C. (*A.M. 1926*)

♂COX, Leonard M., Capt., C.E, (Renss.), Rutherford, Napa, Calif., U.S.A. (*M. 1926*)

COX, Otis Stanley, S.B., C.E., (N.S.T.C. '13), Dist. Engr., D.P.W. Canada, Federal Bldg., Halifax, N.S. (*H*) 12 Bloomingdale Terrace. (*Jr. 1916*) (*A.M. 1918*)

COX, R. Edward, Northern Electric Co. Ltd , Montreal, Que. (*H*) 1986 Rachel St. E. (*S. 1938*)

COXWORTH, Thos. Walker, B.Sc., (Man. '26), Asst. Engr., Fabrication Divn., Bethlehem Steel Co., Wrigley Bldg., Chicago, Ill., U.S.A. (*H*) 7945 Blackstone Ave. (*A.M. 1935*)

CRAIG, Carleton, B.Eng., (McGill '33), (M.Eng. '34), Lecturer, Dept. of C.E., McGill University, Montreal, Que. (*H*) 3465 Cote des Neiges Rd. (*S. 1931*) (*Jr. 1937*)

CRAIG, Clarence Edward, B.Sc., (Queen's '38), Engrg. Office, Horton Steel Works, Fort Erie North, Ont., P.O. Box 242. (*S. 1938*)

♂CRAIG, Henry Clifford, Lt.-Col., V.D., B.Sc., (Queen's '15), Office of Comptroller of the Treasury, Fed. Govt., Royal Bank Chambers, Ottawa, Ont. (*H*) 340 Second Ave. (*Jr. 1916*) (*A.M. 1917*)

†CRAIG, Hugo B. R., B.Sc., (Queen's '03), 783 Gladstone Ave., Windsor, Ont. (*S. 1902*) (*A.M. 1905*) (*M. 1910*)

CRAIG, Jas. W., B.Sc., (Sask. '27), Ceramic Engr., Can. Refractories Ltd., Montreal, Que. Address: Mines Branch, Sussex St., Ottawa, Ont. (*S. 1928*) (*Jr. 1930*)

CRAIG, Wm. Royce, B.Sc., (Alta. '33), Can. Sugar Factories, Picture Butte, Alta. (*S. 1933*) (*Jr. 1938*)

CRAIN, Harold F., B.Sc., (Queen's '32), Vice-Pres., Crain Printers Ltd., 145 Spruce St., Ottawa, Ont. (*H*) 114 Piccadilly Ave., Ottawa, Ont. (*S. 1932*) (*Jr. 1935*)

CRAM, Haldane Rodger, B.Sc., (McGill '11), Secy., Federal District Comm., Ottawa, Ont. (*H*) 274 Second Ave. (*A.M. 1919*)

CRANSTON, Philip G., B.Sc., (Queen's '29), Engrg. Dept., Bell Telephone Co. of Canada, Beaver Hall Bldg., Montreal, Que. (*S. 1928*)

CRASE, Geo. H., B.C.E., (Mich. '15), Gen. Sales Mgr., Horton Steel Works Ltd., Rm. 1609, Northern Ontario Bldg., Toronto, Ont. (*H*) 440 Durie St. (*A.M. 1930*) (*M. 1938*)

CRASTER, J. E., B.A.Sc., (B.C. '30), Cons. Mining and Smelting Co., Box 1146, Trail, B.C. (*S. 1930*)

♂CRATCHLEY, Reg. H., Office Engr., Dept. of Justice, Penitentiaries Br., Confederation Bldg., Ottawa, Ont. (*H*) 81 James St., Ottawa, Ont. (*Jr. 1925*) (*A.M. 1937*)

♂CRAWFORD, A. W., Lieut., M.M. and Bar, B.A.Sc., (Tor. '14), Director, Minimum Wage Br., Dept. of Labour, Parliament Bldgs., Toronto, Ont. (*H*) 153 Glencairn Ave. (*Jr. 1919*) (*A.M. 1927*)

CRAWFORD, J. Jackson, B.A.Sc., (Tor. '22), Asst. to Tech. Dir., Howard Smith Paper Mills Ltd., 749 Guy St., Montreal, Que. (*H*) 5530 Cote St. Luc Rd. (*S. 1921*) (*A.M. 1927*)

CRAWFORD, Jas. Merrill, B.Sc., (McGill '29), (M.Eng. '32), Asst. Elec. Engr., Shawinigan Water and Power Co., Power Bldg., Montreal, Que. (*H*) 5620 McLynn Ave. (*S. 1928*) (*A.M. 1935*)

CRAWFORD, Kenneth Stewart, B.Eng., (McGill '36), Sales Engr., Union Screw Plate Co. of Canada, Ltd. (*H*) Lennoxville, Que. (*S. 1936*)

♂CRAWLEY, Ed. A., Lieut , B.A., (Acadia '04), County Engr., Cumberland Cty., Dept. of Highways, N.S., Amherst, N.S. (*Jr. 1911*) (*A.M. 1916*)

CREALOCK, Archie B., B.A.Sc., (Tor. '15), Cons. Engr., 44 Dovercourt, Rd., Toronto, Ont. (*H*) 502 Riverside Drive. (*S. 1914*) (*A.M. 1923*) (*M. 1935*)

♂CREASOR, John A., Capt., M.C., B.Sc., (McGill '14), Can. Refractories Ltd., Kilmar, Que. (*S. 1914*) (*Jr. 1919*) (*A.M. 1923*)

CREER, A. D., 1984-45th St., Vancouver, B.C. (*A.M. 1911*) (*M. 1914*)

CREGEEN, Kenneth T., B.Sc., (McGill '23), Res. Engr., Sun Life Assurance Co. of Canada, Montreal, Que. (*H*) 1402 Canora Rd., Town of Mount Royal, Que. (*S. 1921*) (*Jr. 1927*) (*A.M. 1933*)

CREIGHTON, Charles Sydney, B.Sc., (N.S.T.C. '13), Res. Engr., Dept. of Highways, Halifax, N.S. (*H*) 4 Dahlia St., Dartmouth, N.S. (*Jr. 1919*) (*A.M. 1924*)

CREIGHTON, Leslie Lloyd, B.A., B.E., (Sask. '25, '30), Dist. Engr., Dept. of Highways, Sask. (*H*) 354-1st Ave. W., Swift Current, Sask. (*A.M. 1930*)

CREPEAU, Marcel, B.A.Sc., (Ecole Polytech., Montreal '38), 4094 Ethel St., Verdun, Que. (*S. 1936*)

CRIPPS, Bernard H., 136 Lakeshore Rd., Lakeside, Que. (*A.M. 1910*)

♂CROIL, Geo. Mitchell, A.F.C., Air Vice-Marshall, R.C.A.F., Dept. National Defence, Canadian Bldg., Ottawa, Ont. (*H*) 200 Lisgar St. (*A.M. 1924*)

♂CROMBIE, Hugh Arthur, Lieut., B.Sc., (McGill '18), Asst. Mgr., Dom. Engineering Co. Ltd., P.O. Box 220, Montreal, Que. (*H*) 4707 Upper Roslyn Ave. (*Jr. 1921*) (*A.M. 1926*)

CROMBIE, Wm. B., Res. Engr., Great Lakes Power Co. Ltd., Sault Ste. Marie, Ont. (*H*) 7 Coulson Ave. (*A.M. 1919*)

♂CROOK, Wesley, Instrumentman, D.N.R., C.P.R., Brooks, Alta. (*Jr. 1923*)

CROOKSHANK, Allan Robertson, B.A.I., Asst. Engr., D.P.W., Canada, Box 1417, Saint John, N.B. (*H*) 74 Sydney St. (*S. 1905*) (*A.M. 1910*) (*M. 1915*)

CROPPER, Wm. Chas. McDonald, B.Sc., (McGill '05), Apparatus Engr., Northern Electric Co. Ltd., Montreal, Que. (*H*) 1251 Gouin Blvd. W. (*M. 1927*)

CROSBY, Irving B., S.M., (M.I.T.), A.M., (Harvard), Cons. Engrg. Geologist, 6 Beacon St., Boston, Mass. (*H*) 12 Prescott St., Cambridge, Mass. (*Affil. 1930*)

CROSBY, N. Leroi, B.A.Sc., (Tor.), Sales Engr., Hamilton Bridge Co. Ltd., Hamilton, Ont. (*H*) 76 Barclay St. (*S. 1902*) (*A.M. 1909*)

♂CROSS, Edgar Algernon, B.Sc., (Birmingham, '09), Cons. Strl. Engr., 991 Bay St., Toronto, Ont. (*H*) 25 Ferndale Ave. (*A.M. 1925*) (*M. 1935*)

♂CROSS, Frederick George, Major, Supt., Irrigation Project, Dept. Nat. Res., C.P.R., Lethbridge, Alta. (*A.M. 1912*) (*M. 1932*)

CROSS, George E., B.Sc., (McGill '23), Prof., Montreal Technical School, Montreal, Que. (*H*) 434 Clarke Ave., Westmount, Que. (*S. 1921*) (*Jr. 1928*) (*A.M. 1933*)

CROSS, Douglas Henry, B.Eng., (McGill '34), Dom. Engineering Co. Ltd., P.O. Box 220, Montreal, Que. (*S. 1934*)

♂CROSSE, Claude S. C., H.E.P.C. of Ont., Box 413, Niagara Falls S., Ont. (*Affil. 1937*)

♂CROSSING, Wm. Berkley, Instr'man., Dept. Highways, Ont., Temagami, Ont. (*H*) 359 N. Syndicate Ave., Fort William, Ont. (*Jr. 1918*) (*A.M. 1924*)

CROSSLAND, Charles W., B.Sc., (McGill '31), M.Sc., (M.I.T. '32), Asst. Engr., Aeronautical Br., Dept. National Defence, 412 Canadian Bldg., Ottawa, Ont. (*H*) 19 Findlay Ave. (*S. 1928*) (*Jr. 1934*)

†CROSSLEY, Thos. Linsey, Consultant Chem. Engr., 263 Adelaide St. W., Toronto, Ont. (*H*) 28 Lonsdale Rd. (*A.M. 1916*)

CROTHERS, Donald C., B.Sc., (Queen's '37), Sales Engr., Can. Ingersoll-Rand Co. Ltd., 950 Richards St., Vancouver, B.C. (*H*) 3841 W. 20th Ave. (*S. 1935*) (*Jr. 1938*)

CROUCH, W. W., Jr., B.Sc., (Man. '16), Partner, Carrothers & Crouch, 7449 Broadway, Kansas City, Mo. (*H*) 7331 Summit St. (*S. 1916*) (*Jr. 1920*) (*A.M. 1922*)

CROWE, Fred. Ernest, B.Sc., (N.B. '34), Address unknown. (*S. 1934*)

CROWELL, Seth W., B.A., (Dalhousie '09), N.S.L.S., Res. Engr., Dept. of Highways, N.S., Amherst, N.S. (*Jr. 1912*) (*A.M. 1918*)

CROWLEY, Charles James, 141 Crescent Rd., Toronto, Ont. (*A.M. 1887*) (*M. 1899*) (*Life Member*)

CROWLEY, J. F., Pres. and Mgr., The J. F. Crowley Co., 151-153 King St. W., Dundas, Ont. (*H*) 51 Cayley St. (*Affil. 1929*)

CRUDGE, Harry J., Bldg. Engr., C.N.R., Moncton, N.B. (*H*) 145 Cameron St. (*S. 1904*) (*A.M. 1910*)

CRUMP, Norris R., B.Sc., (Purdue '29), C.P.R. (*H*) 2923 College Ave., Regina, Sask. (*S. 1928*) (*Jr. 1931*)

CRUTHERS, Wm. Maurice, B.A.Sc., (Tor. '12), Asst. Swbd. Engr., Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*H*) 561 King St. (*A.M. 1920*)

CRYER, Edward, Engr., Town of Hampstead, 31 Stratford Rd., Hampstead, Que. (*H*) 5161 Queen Mary Rd. (*A.M. 1932*)

♂CRYSDALE, Cecil Rainsford, Major, M.C., Cons. Engr., 33 Commerce Bldg., Vancouver, B.C. (*H*) 1237 Cardero St. (*A.M. 1911*) (*M. 1919*)

♂CRYSLER, Roy Alan, Lieut., B.A.Sc., (Tor. '20), Sales Engr., Canada Cement Co. Ltd., 803 Northern Ontario Bldg., Toronto, Ont. (*H*) 94 Snowden Ave. (*Jr. 1921*) (*A.M. 1924*)

CUDWORTH, W. O., Asst. Engr., Mtce. of Way, C.P.R., Toronto, Ont. (*H*) 305 Inglewood Drive. (*A.M. 1920*)

CULLWICK, Ernest Geoffrey, M.A., (Cantab.), Prof. and Head of Dept. of Elec. Engrg., University of Alberta, Edmonton, Alta. (*H*) 11615 Saskatchewan Drive. (*Jr. 1926*) (*A.M. 1938*)

♂CULPEPER, Bernard Armel, B.Sc., in C.E., (McGill '23), Chief Engr., C. D. Howe & Co. Ltd., Utilities Bldg., Port Arthur, Ont. (*H*) 252 St. James St. (*S. 1920*) (*Jr. 1925*) (*A.M. 1929*)

CUMMIFORD, Shirley A., Dept. of Highways, Ont., Owen Sound, Ont. (*Jr. 1914*) (*A.M. 1917*) (*M. 1923*)

♂CUMMING, Robt. Egerton, Lieut., Spec. Agent for Protestant Colonization, Dept. of Colonization, Quebec, Que. (*H*) 70 Rue d'Artigny. (*A.M. 1927*)

CUNHA, Stanley Herbert, B.Sc., (McGill '05), Elec. Engr., Montreal L., H. and P. Cons., Montreal, Que. Address: 2007 Union Ave. (*A.M. 1922*)

♂CUNNINGHAM, Adam, B.Sc., (Edinburgh '23), Plant Engr., Price Bros. & Co. Ltd., Kenogami, Que. (*H*) 8 Oak St. (*Jr. 1925*) (*A.M. 1927*)

♂CUNNINGHAM, A. Irwin, Capt., B.Sc., (McGill '14), Supt. of Properties and Constrn., Aluminum Co. of Canada, Arvida, Que. (*S. 1914*) (*A.M. 1925*)

CUNNINGHAM, Donald David MacC., B.Sc., (N.B '36), Jr. Engr., N.B. Electric Power Comm., Newcastle Creek, N.B. (Grand Lake Power Plant). (*S. 1937*) (*Jr. 1938*)

CUNNINGHAM, Geo. Allin, B.A.Sc., (Tor. '29), Dist. Mgr., Imperial Oil Ltd., Peterborough, Ont. (*H*) 588 Park St. N. (*S. 1927*) (*A.M. 1935*)

CUNNINGHAM, Harold E., B.Sc., (McGill '31), Dom. Engineering Co. Ltd., P.O. Box 220, Montreal, Que. (*H*) 455 Elm Ave., Westmount, Que. (*S. 1929*)

♂CUNNINGHAM, John F., M.M., Sr. Insp. of Dredges, D.P.W. Canada, Selkirk Shipyard. Address: P.O. Box 173, Selkirk, Man. (*Affil. 1928*) (*A.M. 1932*)

♂CURREY, Allan Robert, B.A., (Queen's '25), Address unkdown. (*Jr. 1927*) (*A.M. 1934*)

CURRIE, Geo. Jas., B.Sc., (N.S.T.C. '31), P.L.S., Engr., N.S. Light and Power Co. Ltd., P.O. Box 770, Halifax, N.S. (*H*) 23 MacDonald St. (*S. 1931*) (*A.M. 1936*)

♂CURRIE, Homer Lindsay, B.Sc., (N.B. '13), Superv. of Bldgs., C.N.R., 360 McGill St., Montreal, Que. (*H*) 55 Cornwall Ave., Town of Mount Royal, Que. (*A.M. 1921*)

CURRIE, Victor Robert, B.Sc., (Queen's '23), Asst. Engr., Trent Canal, Dept. of Transport, Bank of Commerce Bldg., Peterborough, Ont. (*H*) 32 Benson St. (*S. 1922*) (*Jr. 1925*) (*A.M. 1931*)

♂CURRY, Angus D. M., Engr. Cmdr., R.C.N., Director of Naval Engrg., Dept. of National Defence, Ottawa, Ont. (*H*) Sylvan Rd., Rockcliffe Park. (*M. 1926*)

CURRY, Herbert N., B.E., (N.S.T.C. '37), Cariboo-Hudson Gold Mine, Barkerville, B.C. (*H*) 40 King St., Windsor, N.S. (*S. 1931*)

♂CUSHING, Arthur Gibb, B.Sc., (McGill '12), A. G. Cushing, Ltd., Builder, 3227 Cedar Ave., Westmount, Que. (*A.M. 1922*)

CUTHBERTSON, W. B., B.Sc., (N.B. '35), Instr'man., Dept. P.W., N.B., Edmundston, N.B. (*H*) Sub. P.O. 4, Saint John, N.B. (*S. 1936*)

CYR, Seraphin A., Supt., Eastern Steel Products Ltd., 1335 Delorimier Ave., Montreal, Que. (*H*) 4395 St. Andre St. (*Jr. 1931*) (*A.M. 1932*)

D'AETH, John Bancroft, B.Sc., (McGill '08), Engr., Dufresne Construction Co., Montreal, Que. (*H*) 4660 Roslyn Ave. (*A.M. 1916*) (*M. 1924*)

DAIGNAULT, Lawrence G., B.Eng., (McGill '34), Industrial Engr., Dufresne, McLagan and Associates, Bank of N.S. Bldg., Montreal, Que. (*H*) 2067 Church Ave., Verdun, Que. (*S. 1933*)

DALE, John Clapham, B.Sc., (Alta. '32), Canadian Utilities Ltd., 215-6th Ave. W., Calgary, Alta. (*H*) 531-19th Ave. (*S. 1930*) (*Jr. 1937*)

DALE, J. Munroe, B.Sc., (Man. '35), B.Eng., (McGill '36), Engr., Manitoba Bridge & Iron Wks., Winnipeg, Man. (*H*) 955 Lipton St. (*S. 1936*)

♂DALE, Wm. P., B.A.Sc., (Tor. '20), Plant Engr. and Purchasing Agent, Dale Estate Ltd., Brampton, Ont. (*H*) 12 William St. (*A.M. 1922*)

♂DALKIN, George Robert, Asst. Chief Engr., Port of Montreal, Dept. of Transport, Montreal, Que. (*H*) 9 Willow Ave., Westmount, Que. (*A.M. 1920*)

♂DALLYN, Frederick Alfred, Capt., B.A.Sc., C.E., (Tor. '13), Cons. Engr., F. A. Dallyn & Co., Toronto, Ont. Address: Whiteside P.O., Ont. (*A.M. 1915*) (*M. 1922*)

DALTON, Peter Dudley, B.Sc., (McGill '28), Constrn. Mgr., Geo. A. Fuller Co. of Canada Ltd., Metropolitan Bldg., Toronto, Ont. (*S. 1926*) (*A.M. 1937*)

DALZELL, Arthur George, Traffic Engr., City Planning Dept., City of Toronto, Room 333, City Hall, Toronto, Ont. (*H*) 14 DeSavery Crescent. (*A.M. 1911*) (*M. 1921*) (*Life Member*)

DALZIEL, Norman Pearson, Holetown, Sampford Spiney, Horrabridge, Devon, England. (*A.M. 1906*) (*M. 1918*)

DALZIEL, William, B.Sc., (Queen's '13), Mgr., St. Thomas Bronze Co., St. Thomas, Ont. (*S. 1911*) (*Jr. 1913*) (*A.M. 1919*)

DANCER, Chas. Henry, 371 Assiniboine Ave., Winnipeg, Man. (*M. 1888*) (*Life Member*)

DANN, Norman Leslie, Cable Engr., Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*H*) 463 Wiseman Ave., Outremont, Que. (*A.M. 1927*)

DANSEREAU, Jean A. L., (R.M.C. Kingston), Office 21, Mount Royal Hotel, Montreal, Que. (*S. 1909*) (*A.M. 1913*)

D'AOUST, J. G., B.A.Sc., (B.C. '27), Engrg. Dftsman., Powell River Co. Ltd., Powell River, B.C. (*Jr. 1930*)

DARLING, Edward, B.Sc., (McGill '94), Pres., Darling Bros. Ltd., 140 Prince St., Montreal, Que. (*H*) 4303 Montrose Ave., Westmount, Que. (*M. 1925*)

DARLING, Ernest Howard, M.E., (Tor. '13), Cons. Engr., 513 Pigott Bldg., Hamilton, Ont. (*H*) 21 Stanley Ave. (*A.M. 1904*) (*M. 1919*)

DARLING, F. S. (*q*), Hampton, N.H., U.S.A. (*M. 1904*) (*Life Member*)

DARLING, T. C., B.Sc., (McGill '27), Sales Engr., Can. Gen. Elec. Co. Ltd., 1000 Beaver Hall Hill, Montreal, Que. (*H*) 554 Grosvenor Ave., Westmount, Que. (*S. 1925*) (*A.M. 1937*)

DARWIN, Bascom Herman, (R.M.C., Kingston '34), B.Sc., (Queen's '35), Lieut., R.C.E., School of Military Engineering, Chatham, Kent, England. (*S. 1935*)

DAUBNEY, James Edwin, B.Sc., (McGill '10), Engrg. Dept., Ford Co. of Canada, Windsor, Ont. (*H*) 336 Sunset Ave., Windsor, Ont. (*A.M. 1917*)

DAVEY, Eric, B.A.Sc., (Tor. '35), H.E.P.C. of Ont., Toronto, Ont. (*H*) Apt. 12, 2453 Queen St. E. (*S. 1935*)

DAVIDSON, Arthur C., B.Sc., (Man. '36), Anglin-Norcross Ontario Ltd., 57 Bloor St. W., Torodto, Ont. (*H*) 609 Avenue Rd. (*S. 1935*) (*Jr. 1937*)

DAVIDSON, Cecil Alexander, Partner: Mannix & Davidson, Gen. Contrs., 1610 Royal Bank Bldg., Vancouver, B.C. (*H*) Ste. 305, 1591 W. 16th Ave. (*M. 1936*)

DAVIDSON, Geo. Ross, (R.M.C., Kingston '35), B.A.Sc., (Tor. '36), Lieut., R.C.A.S.C., Work Point Barracks, Victoria, B.C. (*S. 1934*)

DAVIDSON, John Knox, B.Sc., (St. Andrew's), Asst. Mgr., Electric Reduction Co. of Canada, Ltd., Buckingham, Que. (*Jr. 1930*) (*A.M. 1935*)

♂DAVIDSON, Robert Cheves, Lieut., Roadmaster, C.N.R., Smithers, B.C., P.O. Box 142. (*A.M. 1920*)

DAVIDSON, W. M., B.Sc., (Alta. '25), Weald Rd., Uplands, Victoria, B.C. (*S. 1924*) (*Jr. 1929*)

DAVIES, Clarence Ebenezer, M.E., (Renss. '14), Secretary, The American Society of Mechanical Engineers, New York, N.Y. For Mail: 32 West 40 St., New York, N.Y. (*M. 1937*)

♂DAVIES, David C. M., Supt. of Ferries, Dept. of Highways, Sask. (*H*) 2250 Garnet St., Regina, Sask. (*Jr. 1920*) (*A.M. 1922*)

DAVIES, Ewart J., B.Sc., (N.S.T.C. '23), Principal, Port Arthur Technical and Commercial High School, Port Arthur, Ont. (*H*) 30 Prospect Ave. (*S. 1923*) (*Jr. 1927*) (*A.M. 1936*)

DAVIES, George Victor, Mech. Engr., Can. Bridge Co. Ltd., Walkerville, Ont. (*H*) 647 Windermere Rd. (*A.M. 1918*)

†DAVIES, Percy Trevor, (C.G.I. '23), Vice-Pres. and Comm. Mgr., Southern Canada Power Co. Ltd., 355 St. James St. W., Montreal, Que. (*H*) 4612 Cedar Cres. (*M. 1925*)

♂DAVIES, Stanley J., Capt., M.C. and Bar, (A.R.S.M. '21), Cons. Engr., Oban, Sask. (*H*) 1128 Prospect Ave., Calgary, Alta. (*A.M. 1925*)

♂DAVIES, Vernon Russell, Lieut., M.C., B.Sc., M.Sc., (McGill '23), M.C.E., (Man.), D.L.S., Vice-Pres., Vibration Engineering Co., 5415 Cote St. Paul Rd., Montreal, Que. (*H*) 23 York Ave., Westmount, Que. (*Jr. 1921*) (*A.M. 1923*)

DAVIS, Clinton Harold, B.Sc., (Sir George Williams '37), Chief Engr., Robb Wave Organ Co. Ltd., Belleville, Ont. (*Jr. 1932*)

DAVIS, Edgar H., B.Sc., (Alta. '38), 10160-112th St. N., Edmonton, Alta. (*S. 1938*)

DAVIS, Eliot R., B.Sc., (Man. '36), B.Eng., (McGill '37), Dom. Engineering Co. Ltd., Lachine Que. (*H*) 611 St. Joseph St., Lachine, Que. (*S. 1936*)

†DAVIS, Ernest, Asst. Comptroller of Water Rights, Water Rights Br., Dept. of Lands, Parliament Bldgs., Victoria, B.C. (*H*) 1070 St. David St. (*M. 1914*)

♂DAVIS, Frank L., Lieut., Dist. Airways Engr., Dept. of Transport, Civil Aviation, Nakina, Ont. (*A.M. 1924*)

DAVIS, Geo. Clarke, B.Sc., (Man. '33), Sales Engr., Northern Public Service Corp. Ltd., 307 Power Bldg., Winnipeg, Man. (*H*) 923 Somerset Ave. (*A.M. 1936*)

DAVIS, Geo. Roland, B.Sc., (Queen's '27), Supt. of Sub-Stations, Ottawa Hydro Electric Comm., 109 Bank St., Ottawa, Ont. (*H*) 243 Carling Ave. (*S. 1927*) (*Jr. 1930*) (*A.M. 1936*)

DAVIS, George Sanford, Asst. Elec. Engr., Dept. of National Defence, Ottawa, Ont. (*H*) Apt. 17, 415 Elgin St., Ottawa, Ont. (*A.M. 1921*) (*M. 1928*)

DAVIS, Samuel, B.Sc., (N.B. '38), Graduate House, M.I.T., 305 Memorial Drive, Cambridge, Mass., U.S.A. (*S. 1938*)

♂DAVIS, Sydney Herbert, B.Sc., (McGill '23), Supt., Taylor Windfall Gold Mining Co., Hall Bldg., Vancouver, B.C. (*H*) Ritz Apts. (*S. 1921*) (*Jr. 1924*) (*A.M. 1927*)

DAVIS, Wm. Roe, Jr., B.Sc., (Alta. '34), Montreal Engineering Co. Ltd., 244 St. James St., Montreal, Que. (*Jr. 1935*)

♂DAVISON, C. Fraser, B.Sc., (Queen's '26), Supt. of Chemicals, Windsor Works, Can. Industries Ltd., Windsor, Ont. (*H*) 966 Victoria Ave. (*A.M. 1932*)

DAVISON, Harold Doran, B.A.Sc. '13, Welland Electric Steel Foundry, 123 Victoria St., Welland, Ont. (*H*) 102 Parkway. (*A.M. 1920*)

DAVY, A. C. M., Lt. Cmdr. (E), 642 Victoria Ave., Westmount, Que. (*A.M. 1933*)

DAVY, R. F., 1321 Point St., Victoria, B.C. (*A.M. 1907*)

♂DAWES, A. Sidney, Major, M.C., B.Sc., (McGill '10), Pres. and Mgr. Dir., The Atlas Construction Co., Ltd., 679 Belmont St., Montreal, Que. (*H*) 1725 Cedar Ave. (*A.M. 1914*) (*M. 1921*)

DAWSON, Alex. Scott, B.A.Sc., C.E., (McGill '93), c/o Mr. Trevor S. Newby, Newby & Brown Inc., 201 Ocean Blvd., Daytona Beach, Fla., U.S.A. (*S. 1889*) (*A.M. 1895*) (*M. 1909*) (*Life Member*)

P.†DAWSON, Kenneth Lockhart, B.Sc., (N.S.T.C. '17), Supt., Gas Dept., N.S. Light & Power Co. Ltd., Capitol Theatre Bldg., Halifax, N.S. (*H*) 286 South St. (*Jr. 1919*) (*A.M. 1921*) (*M. 1929*)

DAWSON, Sydney George, B.Sc., (Queen's '12), Sr. Asst. Engr., Dom. Water and Power Bureau, Dept. of Mines and Resources, Ottawa, Ont. (*H*) Apt. 3, 192 Maclaren St. (*Jr. 1913*) (*A.M. 1918*)

DAWSON, Wm. A., B.Sc., (Queen's '23), Plant Mgr., E. Long Engineering Wks. Ltd., Orillia, Ont. (*H*) 112 Peter St. (*S. 1921*) (*A.M. 1925*)

†DAWSON, Wm. Bell, M.A., M.Sc., D.Sc., 7 Grove Park, Westmount, Que. (*M. 1887*) (*Life Member*)

DAY, J. Charles, B.Sc., (McGill '14), Consulting Engr., 630 Dorchester St. W., Montreal, Que. (*H*) 4546 Wilson Ave., N.D.G. (*S. 1914*) (*A.M. 1920*) (*M. 1928*)

♂DAYNES, Leonard Starling, Capt., D.C.M., R.M.D., Sidney, V.I., B.C. (*A.M. 1920*)

DEAN, Clayton D., B.A.Sc., (Tor. '11), Vice-Pres. and Mgr., Imperial Pipe Line Co. Ltd., Rm. 615, 56 Church St., Toronto, Ont. (*H*) 16 Dewbourne Ave., Forest Hill Village. (*A.M. 1919*)

♂DEAN, Curtis Milford, B.A.Sc., (B.C. '23), Mgr., Martinez Refinery, Shell Oil Co., Martinez, Calif., U.S.A. (*M. 1936*)

DEAN, Maurice F., (Dalhousie '37), 31 Larch St., Halifax, N.S. (*S. 1938*)

DEAN, W. W. H., B.Eng., ('37), Trans-Canada Airlines, Stevenson Airport, Winnipeg, Man. (*S. 1936*)

DEANS, Chas. W., B.A.Sc., (B.C. '30), M.Sc., (Iowa State '33), Estimator, Western Bridge Co. Ltd., Vancouver, B.C. (*H*) 3049 West 27th Ave. (*S. 1928*) (*A.M. 1937*)

♂DEBNEY, Philip Lawrence, Lt.-Col., M.M., Constrn. Engr., City Hall, City of Edmonton, Alta. (*H*) 10123 Clifton Place. (*A.M. 1936*)

DECARIE, Yves, 5211 Cote St. Antoine Rd., Montreal, Que. (*S. 1937*)

†deCARTERET, S. Laurence, Ph.B., (C.E.), (Yale '08), Gen. Mgr., Can. International Paper Co., Sun Life Bldg., Montreal, Que. (*A.M. 1919*) (*M. 1926*)

DECARY, Albert R., D.A.Sc., (*q*), Supt'g. Engr., Province of Quebec, P.W., Canada, Quebec, P.Q. (*A.M. 1900*) (*M. 1907*) (*Past President*)

DeCEW, Judson Albert, B.A.Sc., (Tor. '01), Pres., Process Engineers, Inc., 9 Prospect Ave., Mt. Vernon, N.Y. (*H*) 290 Claremont Ave. (*A.M. 1906*) (*M. 1919*)

DECHENE, Theo. Miville, Major, B.Sc., (Ecole Polytech., Montreal '27), Bridge Engr., D.P.W., Quebec, Que. (*H*) 96 Bougainville Ave. (*S. 1922*) (*A.M. 1927*)

DeGUISE, Yvon, B.A.Sc., (Ecole Polytech. Montreal '37) Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*H*) 221 Park Ave. (*S. 1936*)

P.deHART, Jos. B., M.Sc., (McGill '12), i/c Coal Mining Courses, The Provincial Inst. of Technology and Art, Calgary, Alta. (*H*) 3214-7th St. S.W. (*A.M. 1925*) (*M. 1926*)

deJONG, Sybren Henry, B.Sc., (Man. '31), Bureau of Geology and Topography, Dept. of Mines and Resources, Victoria Memorial Museum, Ottawa, Ont. (*H*) 20 Regent Ave. (*Jr. 1936*) (*A.M. 1937*) deLAMIRANDE, Paul, B.A.Sc., (Ecole Polytech. Montreal) Dept. of Roads, Parliament Bldg., Quebec, Que. (*S. 1936*)

DELANEY, Wm. Victor, 122 Maple St., Black River, N.Y. (*S. 1921*) (*Jr. 1929*)

♂DELAUTE Frederick J., Major, O.B.E., P.O. Box 784, St. Petersburg, Fla., U.S.A.. (*A.M. 1908*)

DELGADO, P. G., City Engr., City of Westmount, City Hall, Westmount, Que (*H*) 4564 Harvard Ave., Montreal, Que. (*A.M. 1930*)

DELISLE, J. L., B.A.Sc., (Tor. '16), Lavoie & Delisle, Racine St., Chicoutimi, Que. (*H*) 33½ Begin Ave. (*A.M. 1924*)

DELISLE, Lucien, 4598 Christophe Colomb St., Montreal, Que. (*S. 1936*)

DeMAIO, Alexander, B.A.Sc., (Tor. '37), Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*H*) 149 Rubidge St. (*S. 1937*)

DEMBITZKY, Thos., B.A.Sc., (Tor. '36), M.Sc., (Tor. '37), Dom. Bridge Co Ltd., Lachine, Que. (*H*) 622 St. Joseph St. (*S. 1934*)

DEMCOE, John Wm., Univ. of Manitoba, Fort Garry, Winnipeg, Man. (*S. 1938*)

DEMERS, Georges, B.A.Sc., (Ecole Polytech., Montreal '35), Asst. Divn Engr., Dept. of Roads, Que., Carleton, Que. (*H*) 7810 Rue Foucher. (*Jr. 1936*)

DEMPSEY, Francis Craig, B.Sc., (Man. '30), Asphalt Engr., British American Oil Co. Ltd., Regina, Sask. (*H*) 24 Cornwall Court. (*1938*)

DEMPSEY, Wesley Thos., B.Sc., (Sask. '34), Central Y.M.C.A., 1441 Drummond St., Montreal, Que. (*A.M. 1934*)

DEMPSTER, Geo. Henry Lawrence, B.E., (Sask. '34), M.Sc., Parks Engr., Prince Albert National Park, Prince Albert, Sask. (*1938*)

DENEAU, Gaston, B.Sc., (McGill '20), 6233 St. Hubert St., Montreal, Que. (*S. 1919*) (*A.M. 1927*)

DENIS, Leopold Germain, B.Sc., (McGill '99), Dist. Chief Engr., Dom. Water and Power Bureau, Dept. of Mines and Resources, 680 St. Catherine St. W., Montreal, Que. (*H*) 4231 Wilson Ave. (*M. 1919*)

DENIS, Louis Valmore, B.A.Sc., (Ecole Polytech., Montreal '01), Engr., D.P.W., Canada, Hunter Bldg., Ottawa, Ont. (*H*) 150 Argyle Ave. (*S. 1899*) (*A.M. 1909*)

♂DENLEY, William Edward, Major, M.C., Dist. Engr., Dept. of Highways, Sask., Carlyle, Sask. (*A.M. 1921*)

DENNIS, Earle Munro, B.Sc., (Queen's '04), D.L.S., Chief Administration, Hydrographic and Map Service, Dept. of Mines and Resources, Ottawa, Ont (*H*) 64 Aylmer Ave. (*A.M. 1921*)

DENNIS, Wm. Melbern, B.Sc., (McGill '09), D.L.S., Geodetic Survey of Canada, Dept. of Mines and Resources, Ottawa, Ont (*H*) 261 Powell Ave (*A.M. 1920*) (*M. 1923*)

DENNISON, G. H. E., (R.M.C., Kingston '20), Engr., Can. Carborundum Co Ltd., Niagara Falls, Ont. (*H*) 2127 Lundy's Lane. (*Jr. 1926*) (*A.M. 1932*)

DENOVAN, John J., Box 255, Asbestos, Que. (*S. 1938*)

DENTON, A. Leslie, B.Sc., (N.B. '32), Office Mgr., Lamaque Mining Co. Ltd., Bourlamaque, Que. (*H*) R.R. 2, Ripples, N.B. (*S. 1932*) (*Jr. 1937*)

DERY, Jacques Louis, (R.M.C. '34), Jr. Engr., D.P.W. Canada. (*H*) 509 Stuart Ave., Outremont, Que. (*Jr. 1936*)

deSAVIGNY, Herbert Jas., Dist. Engr., P.F.R.A., Sask., Federal Govt., Estevan, Sask. (*H*) 34 Qu'Appelle Apts., Regina, Sask. (*A.M. 1920*)

DESBAILLETS, Charles Jules, Chief Engr., Montreal Water Board, and Elec. and Mech. Engr., City of Montreal, City Hall, Montreal, Que. (*H*) 509 Argyle Ave., Westmount, Que. (*A.M. 1917*) (*M. 1920*)

♂DESBARATS, G. H., Engr. Lieut. Cmdr., R.C.N.V.R., B.Sc., (McGill '22), Station Supt., Paugan Power Plant, Gatineau Power Co., Low, Que. (*S. 1919*) (*Jr. 1926*) (*A.M. 1933*)

DesBRISAY, A. W. Y., B.Sc., (McGill '27), Ph.D., (London '37), Capt., R.C.S., Dept. National Defence. (*H*) 102 Bagot St., Kingston, Ont. (*S. 1926*) (*Jr. 1931*) (*A.M. 1938*)

DESCOTEAUX, Paul R., B.A.Sc., (Ecole Polytech., Montreal '34), Engr., Divn. No. 5, Dept. of Roads, Cap de la Madeleine, Que. (*S. 1934*)

DESJARDINS, Olivier, B.A.Sc., C.E., (Ecole Polytech., Montreal '19), Chief Engr., D.P.W., Que., Parliament Bldgs., Quebec, Que. (*H*) 159 Brown Ave. (*S. 1919*) (*A.M. 1922*)

DESJARDINS, Roger, 1621 St. Hubert St., Montreal, Que. (*S. 1937*)

DesLAURIERS, Louis Wilfrid, Asst. Engr., C.P.R., Rm. 401, Windsor Sta., Montreal, Que. (*H*) 8611 De Gaspe St. (*Jr. 1914*) (*A.M. 1922*)

DESLOOVER, Jean Raymond, B.Sc., (McGill '23), Engr., Provincial Electricity Board, 132 St. James St., Montreal, Que. (*A.M. 1938*)

DESMARAIS, Jean R., B.A.Sc., (Ecole Polytech., Montreal '37), Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*H*) 351 Charlotte St. (*S. 1936*)

DESMEULES, S. A. Address unknown. (*S. 1905*) (*A.M. 1909*)

DesORMEAUX, Dollard, B.A.Sc., (Ecole Polytech., Montreal, '37), Engr., Technical Service, D.P.W., City of Montreal, City Hall, Montreal, Que. (*H*) 1826 Champlain St. (*S. 1936*)

DESSERUD, Anton, Grad., (Trond.), Power Corp. of Canada Ltd., Montreal, Que. (*H*) 52 Alexander Ave., St. Lambert, Que. (*A.M. 1932*)

DeSTEFANO, Frank J., B.Sc., (Mich. M. & T. '35), Field Engr., International Nickel Co. Ltd., Copper Cliff, Ont. (*H*) 9 Florence St. (*Jr. 1936*)

DETHRIDGE, Stanley Geo., Chief Engr., Light and Power Dept., City of Regina, Sask. (*H*) 2507 Winnipeg St., Regina, Sask. (*1938*)

DEWAR, C. Leonard, B.Sc., (McGill '21), M.Sc., (McGill '22), Outside Plant and Trans. Engr., Bell Telephone Co. of Canada, Montreal, Que. (*H*) 104 Dufferin Rd., Hampstead, Que. (*A.M. 1937*)

DEWEY, Philip Andrew, B.S., C.E., (Vermont '09), Dist. Engr., Ramapo Ajax Corp., Niagara Falls, Ont. (*H*) 1224 Ontario Ave. (*A.M. 1928*)

DEWIS, Clifford Sayre, Chief Engr., Canmore Coal Co. Ltd., Box 337, Canmore, Alta. (*A.M. 1917*)

DeWOLFE, Wm. Joseph, Asst. City Engr., City of Halifax, City Hall, Halifax, N.S. (*H*) 106 Henry St. (*A.M. 1906*)

DEY, Victor A. G., Div. Engr., Bruce Div., C.P.R., Rm. 341, Union Sta., Toronto, Ont. (*H*) 64 Westmount Ave. (*S. 1904*) (*A.M. 1909*) (*M. 1928*)

DIBBLEE, Frederick Allan, B.Sc., (N.B. '37), 601 Lansdowne Ave., Westmount, Que. (*S. 1937*)

DIBBLEE, Harrie Miles, 589 Queen's Hotel, Montreal, Que. (*S. 1895*) (*A.M. 1906*)

DICK, Arthur, 115 Brown Ave., Quebec, Que. (*S. 1905*) (*A.M. 1909*)

DICK, Geo. M., B.Sc., (McGill '24), Designer, Can. Ingersoll-Rand Co. Ltd., Sherbrooke, Que. (*H*) 24 Walton Ave. (*S. 1922*) (*A.M. 1928*)

DICK, James, Vice-Pres., Morrow & Beatty Ltd., Peterborough, Ont. (*H*) 142 Aylmer Ave., Ottawa, Ont. (*S. 1906*) (*A.M. 1909*)

DICK, Victor Wm., B.Sc., E.E., (Man. '21), Jr. Engr., Winnipeg Electric Co., Winnipeg, Man. (*H*) 509 Stradbrook Ave. (*S. 1920*) (*Jr. 1922*) (*A.M. 1930*)

DICK, Wm. Arthur, B.Eng., (McGill '37), 4962 Grosvenor Ave., Montreal, Que. (*S. 1937*)

†DICK, W. J., B.Sc., M.Sc., Pres. and Gen. Mgr., Cadomin Coal Co. Ltd., 311 McLeod Bldg., Edmonton, Alta. (*H*) 11326–99th Ave. (*A.M. 1911*) (*M. 1918*)

♂DICKENS, Harry Blundell, Lieut., Co-ordinating Officer, War Office, Royal Arsenal, Woolwich, S.E. 18, England. (*H*) 20 The Grove, North Gray, Kent, England. (*A.M. 1925*) (*M. 1938*)

DICKENSON, J. G., B.A., B.Sc., (McGill '07), Vice-Pres. and Gen. Mgr., Cline Lake Gold Mines; Gen. Mines Mgr., M. J. O'Brien, Ltd.; Vice-Pres., O'Brien & Fowler Ltd.; Gen. Mgr. and Vice-Pres., O'Brien Gold Mines Ltd., 140 Wellington St., Ottawa, Ont. (*H*) 318 Lisgar Rd., Rockcliffe. (*S. 1905*) (*A.M. 1912*) (*M. 1919*)

♂DICKIESON, Arthur Logan, M.Sc., (McGill '10), Elec. Engr., Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*H*) 385 Reid St. (*A.M. 1920*)

DICKINSON, Ernest, Chief Engr. (Bolivia, S.A.), Montreal Engineering Co. Ltd., Regina, Sask. (*1938*)

DICKSON, Archibald, Dftsman., Dom. Bridge Co. Ltd., Vancouver, B.C. (*H*) 3760 W. 16th Ave. (*A.M. 1934*)

DICKSON, Garnet Horace, B.Sc., (McGill '09), Sales Engr., Babcock-Wilcox & Goldie-McCulloch Ltd., 312 Canada Cement Bldg., Montreal, Que. (*H*) 373 Prince Albert Ave., Westmount, Que. (*S. 1911*) (*A.M. 1916*)

DICKSON, Geo. Leslie, M.A., (Acadia '00), Elec. and Signal Engr., C.N.R., Moncton, N.B. (*H*) 78 Gordon St. (*A.M. 1923*)

♂DICKSON, Thomas H., B.Sc., (N.S.T.C. '22), Supervisor of Unit Cars, C.N.R., Moncton, N.B. (*H*) 21 John St. (*Jr. 1920*) (*A.M. 1929*)

DICKSON, Wallace, B.Sc., (McGill '07), Asst. Engr., City of Montreal, City Hall, Montreal, Que. (*H*) 5759 Hochelaga St. (*A.M. 1915*) (*M. 1920*)

DICKSON, Wm. Leslie, B.Sc., (N.S.T.C. '29), 78 Gordon St., Moncton, N.B. (*S. 1930*) (*Jr. 1936*)

DICKSON, Wm. Lochead, B.A.Sc., (Tor.' 15), 317½ Oakwood Ave., Toronto, Ont. (*S. 1914*) (*A.M. 1924*)

DILL, Edwin W., B.A.Sc., (Tor. '28), Engr., The Carborundum Co., Niagara Falls, N.Y. (*H*) 436 John St., Niagara Falls, Ont. (*S. 1929*) (*A.M. 1938*)

♂DILLON, Murray, Consulting Structural Engr., 489 Richmond St., London, Ont. (*A.M. 1938*)

♂DIMSDALE, Henry George, Capt., M.C., Consulting Engr., McLennan, Alta. (*A.M. 1908*) (*M. 1923*)

♂DINGWALL, Robert M., (A.R.T.C. '14), Mgr. and Dir., Standard Iron Works Ltd., 121st St. and 106th Ave., Edmonton, Alta. (*H*) 10224–131st St. (*A.M. 1923*) (*M. 1937*)

DION, J. E., B.Sc., (McGill '23), Plant Supt., Laurentian Laboratories Ltd., 442 St. Gabriel St., Montreal, Que. (*H*) 371 Redfern Ave., Westmount, Que. (*S. 1922*) (*Jr. 1927*) (*A.M. 1932*)

♂DIXON, G. Bruce, B.Sc., (N.B. '12), Dyking Commr., Dykes Dept., B.C., Court House, New Westminster, B.C. (*H*) 526–4th St. (*Jr. 1914*) (*A.M. 1923*)

DIXON, Howard Alex., B.A.Sc., (Tor. '01), O.L.S., M.L.S., Chief Engr., Western Lines, C.N.R., Winnipeg, Man. (*A.M. 1908*)

♂DIXON, Keith, Engrg. Dept., Esquimalt & Nanaimo Rly., Victoria, B.C. (*A.M. 1935*)

DIXON, Leon Snell, M.E., Cons. Engr., Box 329, Station B, Montreal, Que. (*A.M. 1921*) (*M. 1923*)

♂DOANE, Francis W. W., Lt.-Col., Cons. Engr., Doane Engineering Co., Halifax, N.S. (*H*) 25 Young Ave. (*S. 1887*) (*A.M. 1889*) (*M. 1892*) (*Life Member*)

♂DOANE, H. W. L., Major, B.Sc., (N.S.T.C. '13), Mgr., Standard Paving (Maritime) Ltd., Capitol Theatre Bldg., Halifax, N.S. Address: Bedford, N.S. (*A.M. 1919*) (*M. 1923*)

DOBBIN, Davin C., B.Eng., (McGill '32), Dom. Rubber Co. Ltd., P.O. Box 457, St. Jerome, Que. (*S. 1931*) (*Jr. 1938*)

DOBBIN, Ross Leonard, B.A.Sc., (Tor. '11), Gen. Mgr., Utilities Comm., 223 Aylmer St., Peterborough, Ont. (*H*) 295 Reid St. (*S. 1910*) (*A.M. 1914*) (*M. 1919*)

♂DOBBIN, W. Leslie, Capt., B.A.Sc., (Tor. '16), Vice-Pres., The Grant Contracting Co. Ltd., 47 Wellington St. E., Toronto, Ont. (*H*) 145 Strathallen Blvd. (*S. 1915*) (*A.M. 1921*)

DOBRIDGE, Ronald Wemyss, B.Sc., (McGill '28), (M.Sc. '29), Trans. Engr., Can. Marconi Co., Town of Mt. Royal, Que. (*H*) 1017 Canora Rd., Town of Mt. Royal, Que. (*S. 1928*) (*A.M. 1935*)

DOBSON, R. Nesbitt, B.Eng., (McGill '35), Dom. Engineering Co. Ltd., Lachine, Que. (*H*) 266 Lansdowne Ave., Westmount, Que. (*S. 1933*)

DOBSON, Wm. Percy, B.A.Sc., M.A.Sc., (Tor. '11), Chief Testing Engr., H.E.P.C. of Ont., 620 University Ave., Toronto, Ont. (*H*) 241 Riverside Drive. (*M. 1920*)

DOBSON-SMITH, C. F., 39 Classic Ave., Toronto, Ont. (*H*) Rosctown, Sask. (*S. 1935*)

♂DODD, Geoffrey Johnstone, Lieut., M.Sc., (McGill '22), Assoc. Prof. of C.E., McGill University, Montreal, Que. (*H*) 209 Carlyle Ave., Town of Mount Royal, Que. (*S. 1910*) (*Jr. 1913*) (*A.M. 1920*)

DODDRIDGE, P. W., B.Sc., (N.B. '28), Can. Gen. Elec. Co. Ltd., 212 King St. W., Toronto, Ont. (*H*) 39 Wineva Ave. (*S. 1928*) (*Jr. 1936*)

DODGE, Clinton Lowell, B.Sc., (C. and I.E., Colorado State), Cons. Engr., 1516–A 7th Ave., Lethbridge, Alta. (*Jr. 1916*) (*A.M. 1921*)

†DODGE, G. Blanchard, D.L.S., Chief Control Surveys Div., Bureau of Geology and Topography, Dept. of Mines and Resources, Ottawa, Ont. (*H*) 26 Broadway. (*A.M. 1907*) (*M. 1911*) (*Life Member*)

♂DOHERTY, Chas. Alexander, Major, Chief Engr., Royal Air Force, Hdqrs., Middle East Command, Villa Victoria, Cairo, Egypt. (*S. 1914*) (*A.M. 1922*)

DOHERTY, Thos. Hugh, B.Sc., (McGill '29), The Coca-Cola Co. of Canada, Winnipeg, Man. (*H*) 738 Dorchester St. (*S. 1928*) (*A.M. 1936*)

DOLAN, M. A., B.Sc., (Queen's '37), 1 Aberdeen Ave., Kingston, Ont. (*S. 1937*)

DOLMAGE, Victor, B.A., (Man. '12), Ph.D., (M.I.T. '17), Consulting Geologist, 1318 Marine Bldg., Vancouver, B.C. (*M. 1936*)

P.DONALD, James Richardson, B.A., B.Sc., (McGill '13), Pres., Donald Inspection Ltd.; Man'g. Director, J. T. Donald & Co. Ltd., 1181 Guy St., Montreal, Que. (*H*) 714 Grosvenor Ave. (*A.M. 1921*) (*M. 1927*)

DONALDSON, Christopher Storrar, Mine Mgr., Lethbridge Collieries Ltd., Lethbridge, Alta. (*H*) 924–7th Ave. S. (*A.M. 1925*)

♂DONCASTER, Purcell Eli, Lieut., Dist. Engr., D.P.W., Canada, Post Office Bldg., Fort William, Ont. (*H*) 98 Winnipeg Ave., Port Arthur, Ont. (*A.M. 1911*) (*M. 1918*)

♂DONKIN, Charles Harold Foster, Private Practice, 73 Spring St., Amherst, N.S. (*A.M. 1921*)

♂DONNELLY, Harold H., Major, Associated Screen News Co., 5271 Western Ave., Montreal, Que. (*H*) 4599 Harvard Ave. (*S. 1908*) (*A.M. 1913*)

DONNELLY, Wm. David, B.Sc., (Queen's '25), Mech. Dftsman., Ford Motor Co. of Canada, Windsor, Ont. (*H*) Apt. 3, Sharon Apts., 558 Partington Ave. (*S. 1924*) (*Jr. 1936*) (*A.M. 1938*)

DONOHOE, G. M., B.Sc., (N.B. '31), 102 Guilford St., Saint John, N.B. (*S. 1931*) (*Jr. 1938*)

DOODY, Cyril Wm., Traffic Engr. (Telephones), Gov't. Sask. (*H*) 2200 Angus St., Regina, Sask. (*1938*)

DORAN, Henry T., Mgr., Montreal Office, Dom. Flow Meter Co. Ltd.; Whiting Corp. (Canada) Ltd.; Diesel Power Ltd., Rm. 11, 1188 Phillips Place, Montreal, Que. (*H*) 24 Springfield Ave., Westmount, Que. (*A.M. 1925*)

DORAIS, Gabriel, B.A.Sc., (Ecole Polytech., Montreal '35), Ernest Gohier, Cons. Engr., Room 35, 10 St. James St. E., Montreal, Que. (*H*) 3659 Northcliffe Ave. (*Jr. 1937*)

DORE, Richard F., B.Sc., (Queen's '32), Bureau of Geology and Topography, Dept. of Mines and Resources, Ottawa, Ont. (*H*) 16 Aylmer Ave. (*S. 1932*) (*A.M. 1937*)

♂DOREY, Geo. B., Lieut., Continental Transport Appliances Ltd., 407 McGill St., Montreal, Que. (*A.M. 1921*)

♂DORION, Robert, B.A.Sc., (Ecole Polytech., Montreal '22), City Engr., Lachine, Que. (*H*) 169–A 18th Ave. (*S. 1920*) (*A.M. 1926*)

♂DORMER, Wm. John Smylie, B.Sc., (McGill '23), Dist. Engr., The Bell Telephone Co. of Canada, Beaver Hall Bldg., Montreal, Que. (*H*) 4038 Beaconsfield Ave., N.D.G. (*S. 1920*) (*Jr. 1927*) (*A.M. 1933*) (*M. 1935*)

DORRANCE, Frank Young, C.E., (Renss. '06), Div. Engr., Montreal Water Bd., Joseph St., Verdun, Que. (*H*) 5250 Connaught Ave., Montreal, Que. (*A.M. 1915*)

†DOTY, John W., C.E., (Renss.), Pres., The Foundation Co., 120 Liberty St., New York, N.Y. (*H*) New Canaan, Conn. (*A.M. 1913*) (*M. 1913*)

DOUCET, Jean, B.Sc., The Plessisville Foundry, Plessisville, Que. (*H*) 10841 Berthelet St., Montreal, Que. (*S. 1935*)

DOUGLAS, Arnold Howard, B.Sc., (Sask. '31), Bridge Office, Dept. of Highways. (*H*) Apt. 302, 28 Macpherson Ave., Toronto, Ont. (*S. 1931*) (*Jr. 1937*)

♂DOUGLAS, George Vibert, Capt., M.C., M.Sc., (McGill '20), Prof. of Geology, Dalhousie University, Halifax, N.S. (*H*) 23 Connaught Ave. (*Jr. 1920*) (*A.M. 1921*)

DOUGLAS, Lloyd Robt., B.Sc., (Man. '38), 310 Pearl Ave., Peterborough, Ont. (*S. 1938*)

DOULL, Robert Morse, B.Sc., (McGill '29), Asst. Mgr., Construction Equipment Co. Ltd.; Mgr., Gunite & Waterproofing Ltd., 180 Vallee St., Montreal, Que. (*H*) 4820 Grosvenor Ave. (*S. 1927*) (*Jr. 1934*) (*A.M. 1934*)

DOUVILLE, Paul-Emile, 7857 Berri St., Montreal, Que. (*S. 1938*)

DOVE, Allan Burgess, B.Sc., (Queen's '32), Chem. Engr., Steel Co. of Canada, Ltd., 525 Dominion St., Montreal, Que. (*H*) 4592 Hampton Ave., N.D.G. (*S. 1932*) (*Jr. 1934*) (*A.M. 1936*)

DOW, John, Plant Dept., Alberta Government Telephones, Calgary, Alta. (*H*) 609–22nd Ave. W. (*M. 1922*)

DOW, Gordon Young, B.Sc., (N.B. '32), Engr., Refrigeration Sales Co. Ltd., 84 King St., Saint John, N.B. (*H*) 101 St. James St. (*S. 1934*)

DOW, Walter K., B.A.Sc., (Toronto '37), Aluminum Co. of Canada, Ltd., Toronto, Ont. (*H*) 415 Jarvis St., Toronto, Ont. (*Jr. 1938*)

DOWD, Frank V., Asst. Supt. Engr., Water and Sewerage Divn., D.P.W., City of Montreal, City Hall, Montreal, Que. (*H*) 5348 Duquette Ave. (*Jr. 1915*) (*A.M. 1920*)

DOWLING, Harry Lawson, B.A.Sc., (Tor. '19), Can. and General Finance Co. Ltd., 25 King St. W., Toronto, Ont. (*S. 1919*) (*A.M. 1922*)

DOWNES, M. Augustine, B.Sc., (McGill '12), Asst. Engr., Technical Service, City of Montreal. (*H*) 3985 Laval Ave., Montreal, Que. (*S. 1911*) (*Jr. 1917*) (*A.M. 1930*)

♂DOYE, Marius, Consolidated Marine Companies, Ltd., Marine Bldg., 1405 Peel St., Montreal, Que. (*H*) 2540 St. Catherine Rd. (*A.M. 1925*)

♂DRAKE, Robert Ludlow, Jr. Engr., Reclam. Service, Dept. Mines and Resources, Ottawa, Ont. (*Jr. 1923*)

DRAKE, Thos. S., B.Eng., (McGill '37), Engr., Can. Atlas Steels Ltd., Welland, Ont. (*H*) 151 Ontario St., St. Catharines, Ont. (*S. 1937*)

DREW, Arthur Edward, B.Sc., (Sask. '27), 3300 Girard Ave. So., Minneapolis, Minn., U.S.A. (*A.M. 1930*)

DREWRY, William Stewart, D.L.S., O.L.S., B.C.L.S., 727 Linden Ave., Victoria, B.C. (*A.M. 1887*) (*Life Member*)

DRIEDGER, Edwin Wilfrid, B.Engr., (Sask. '33), Dftsman, Can. Bridge Co. Ltd., Walkerville, Ont. (*H*) 1087 Windermere Rd., Windsor, Ont. (*Jr. 1938*)

DRURY, C. H., Grad., (R.M.C. '38), R.M.C., Kingston, Ont. (*S. 1937*)

DRYDEN, John Granville, Asst. Engr., C.N.R., Moncton, N.B. (*A.M. 1919*)

DRYDEN, L. E., B.Sc., (N.B. '34), 298 Aberdeen St., Fredericton, N.B. (*S. 1937*)

DRYNAN, D Alan, B.Sc., (Man. '35), Can. Gen. Elec. Co. Ltd., Peterborough, Ont., P.O. Box 807. (*S. 1936*)

DRYSDALE, William F., B.Sc., (McGill '04), Vice-Pres., Montreal Locomotive Works, Ltd.; Vice-Pres., Can. Steel Tire and Wheel Co., 215 St. James St., Montreal, Que. (*H*) 418 Pine Ave. W. (*S. 1904*) (*A.M. 1911*) (*M. 1919*)

DUBESKY, Wm., B.Sc., (Man. '32), Supt., Radio Oil Refineries Ltd., E. Kildonan, Man. (*H*) 162 Yale Ave., W. Transcona, Man. (*Jr. 1937*)

DUBOIS, N. Warren, B.Sc., (Minn. '26), Distribution Supt., Dom. Electric Power Ltd. (*H*) Estevan, Sask. (*1938*)

DuBOSE, McNeely, B.E. and E.E., (North Carolina S.C. '12), Gen. Supt., Saguenay Power Co. Ltd., Arvida, Que. (*M. 1938*)

DUBREUIL, L. Adrian, B.A.Sc., (Ecole Polytech., Montreal '16), Cons. Engr., Room 412, Canada Cement Bldg., Montreal, Que. (*H*) 1212 St. Matthew St. (*S. 1913*) (*A.M. 1921*)

♂DUBUC, Arthur Edouard, Col., D.S.O. and Bar, V.D., Chevalier de la Légion d'Honneur, etc., B.A.Sc., Vice-Chairman and Chief Engr., National Harbours Board, West Block, Ottawa, Ont. (*H*) 510 Mayfair Apts. (*S. 1899*) (*A.M. 1906*) (*M. 1917*)

♂DuCANE, Charles George, Lt.-Col., O.B.E., Sir John Wolfe Barry & Partners, 164 Grosvenor Gardens House, Grosvenor Gardens, London, S.W.1. (*H*) 24 Christchurch St., Chelsea, London, S.W.3, England. (*A.M. 1912*) (*M. 1931*)

DUCHASTEL de MONTROUGE, Leon A., B.A.Sc., (Ecole Polytech., Montreal '27), Power Sales Engr., Shawinigan Water and Power Co., 107 Craig St. W., Montreal, Que. (*H*) 4582 Oxford Ave., N.D.G. (*S. 1925*) (*Jr. 1933*)

DUCHASTEL de MONTROUGE, Pierre A., B.Eng., (McGill '38), 640 Dunlop Ave., Outremont, Que. (*S. 1937*)

DUCKETT, Wm. Anderson, B.Eng., (McGill '37), Bell Telephone Co. of Canada, Montreal, Que. (*H*) 13 Dollard Ave., Montreal South, Que. (*S. 1935*)

DUCKWORTH, Walter R., Plant Engr. and Asst. Supt., Dom. Bridge Co. Ltd., 275 W. 1st Ave., Vancouver, B.C. (*H*) 3337–3rd Ave. W. (*A.M. 1902*)

♂DUCLOS, L. Murray, Divn. Engr., C.P.R., Sudbury, Ont. (*Jr. 1921*) (*A.M. 1926*)

DUFF, Clemens V., B.Sc., (N.S.T.C. '33), Tropical Oil Co., Barranca Bermeja, Colombia State, S.A. (*H*) Stellarton, N.S. (*S. 1933*) (*Jr. 1937*)

DUFF, Wm. Alexander, (Tor. '01), Engr. of Bridges and Roadways, C.N.R., 355 McGill St., Montreal, Que. (*S. 1900*) (*A.M. 1905*) (*M. 1919*)

DUFFY, David Auriel, City of Saint John, City Hall, Saint John, N.B. (*A.M. 1920*)

DUFOUR, Gaston, B.A.Sc., (Ecole Polytech., Montreal '37), Mech. Engr., Brown Corp., La Tuque, Que. (*S. 1936*)

DUFRESNE, Alphonse Olivier, B.A.Sc., (Ecole Polytech., Montreal '11), B.Sc., M.Sc., (McGill '13), Director, Quebec Bureau of Mines, Parliament Bldg., Quebec, Que. (*H*) 96 Lachevrotiere St. (*M. 1935*)

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♂DUGUID, A. Fortescue, Col., D.S.O., B.Sc., (McGill '12), Dir., Historical Section G.S., Dept. National Defence, Ottawa, Ont. (*H*) 72 Buena Vista Rd., Rockcliffe Park. (*S. 1912*) (*A.M. 1923*)

DUMAS, Albert Victor, B.Sc., (M.I.T. '20), Prof., Ecole Technique de Québec, 185 Langelier Blvd., Quebec, Que. (*H*) 1092¼ St. Valier St. (*A.M. 1929*)

DUMONT, G. H., B.A.Sc., (Ecole Polytech. '36), Amos, Que. (*S. 1935*)

DUMONT, Joseph, Field Engr., Paradis Mining Corp., Amos, Que. (*A.M. 1920*)

♂DUNBAR, Jas. Bevan Plenderleath, Lt.-Col., (R.M.C. Kingston '09), A.A. and Q.M.G., M.D. No. 6, Dept. National Defence, Halifax, N.S. (*H*) 117 Inglis St. (*A.M. 1925*)

†DUNBAR, John R., B.Sc., (McGill '20), Elec. Engr., Can. Westinghouse Co., Hamilton, Ont. (*H*) 20 Fairleigh Ave. S. (*S. 1917*) (*Jr. 1922*) (*A.M. 1927*)

♂DUNBAR, William Bowie, Lieut., B.A.Sc., (Tor. '12), Asst. Prof. of Engrg. Drawing, University of Toronto, Toronto, Ont. (*H*) 241 Glebeholme Blvd. (*A.M. 1921*)

DUNCAN, Conrad Munro, B.Sc., (Man. '32), Compiler, Bureau of Geology and Topography, Dept. of Mines and Resources, Ottawa, Ont. (*H*) Apt. 4, 28 Gilmour St. (*Jr. 1936*) (*A.M. 1937*)

♂DUNCAN, Geo. Marr, Designing Engr., P.W.D., B.C., Victoria, B.C. (*H*) 2528 Cavendish Ave. (*M. 1934*)

DUNCAN, G. Paterson, B.Sc., (Man. '38), 601 Rosedale Ave., Winnipeg, Man. (*S. 1938*)

DUNCAN, Gaylen R., Jr., B.Eng., (McGill '35), 318 S. Archibald St., Fort William, Ont. (*S. 1935*)

DUNCAN, G. Rupert, M.Sc., (McGill '01), Mgr., G. R. Duncan & Co., 426 Victoria Ave., Fort William, Ont. (*S. 1899*) (*A.M. 1902*)

♂DUNCAN, Jas. Edgar, B.Sc., (Man. '23), Consultant, 970 McMillan Ave., Winnipeg, Man. (*S. 1922*) (*Jr. 1925*) (*A.M. 1931*)

DUNCAN, John D., B.A.Sc., (B.C. '28), Sales Engr., Can. Gen. Elec. Co. Ltd., 212 King St. W., Toronto, Ont. (*H*) 2400 Queen St. E. (*S. 1928*)

♂DUNCAN, John Moyle, Engr. Lieut., B.A.Sc., (Tor. '10), Engr., The Solvay Process Co., Hopewell, Va., U.S.A. (*H*) 1578 Berkeley Ave., Petersburg, Va. (*A.M. 1924*)

♂DUNCAN, W. E. P., Major, B.Sc., (Glasgow '13), Engr. of Structures, Toronto Transportation Comm., 35 Yonge St., Toronto, Ont. (*H*) 19 Rochester Ave. (*S. 1911*) (*A.M. 1919*) (*M. 1936*)

DUNLAP, Clarence R., B.Sc., (N.S.T.C. '28), Flt. Lieut., R.C.A., Manby, Louth, Lincs., England. (*S. 1928*) (*A.M. 1936*)

DUNLOP, Duthie MacI., B.Sc., (Man. '34), 128 Arlington St., Winnipeg, Man. (*S. 1934*)

DUNLOP, J. Russell, B.Eng., (McGill '35), Mech. Dftsman, Can. Intern. Paper Co., Gatineau, Que. (*H*) 184 Primrose Ave., Ottawa, Ont. (*S. 1935*) (*Jr. 1937*)

DUNLOP, Robt. J. F., B.Eng., (McGill '32), Belding-Corticelli Ltd., Montreal, Que. (*H*) Apt. 9, 2259 Prudhomme Ave. (*S. 1930*)

DUNLOP, Ronald Wm., B.A.Sc., (Tor. '27), Imperial Oil Ltd., Sarnia, Ont. (*Jr. 1928*) (*A.M. 1936*)

†DUNN, Guy C., P.O. Box 103, Perth, Ont. (*A.M. 1887*) (*M. 1897*) (*Life Member*)

♂DUNN, Harold Stewart, Lieut., Supt. Construction, William Cooke Co., North Sydney, N.S. (*H*) 4 Cromarty St., Sydney, N.S. (*A.M. 1931*)

DUNN, John Thos., B.A.Sc., (Tor. '37), Chem. Engr., Dom. Rubber Co. Ltd., 1665 Notre Dame St. E., Montreal, Que. (*H*) 3617 Decarie Blvd., Apt. 31, Montreal, Que. (*S. 1937*)

DUNN, Thos. Hamilton, (Tor.), C.E., O.L.S., D.L.S., 181 Gilmour St., Ottawa, Ont. (*M. 1916*) (*Life Member*)

DUNNE, Chas. Vincent, B.Eng., (McGill '35), Constrn. Engr., E. B. Eddy Co., Hull, Que. (*H*) 499 Clarence St., Ottawa, Ont. (*Jr. 1937*)

DUNNE, Hugh Joseph, Asst. Engr., D.P.W., Ottawa, Ont. (*H*) 10 Russell Ave. (*A.M. 1921*)

DUNPHY, Kenneth Austin, B.Sc., (N.B. '07), Div. Engr., C.P.R., Fort William, Ont. (*H*) 315 Catherine St. (*A.M. 1920*)

DUNPHY, K. R., B.Sc., (N.B. '38), 315 Catherine St., Fort William, Ont. (*S. 1938*)

♂DUNSMORE, Robt. Lionel, Major, B.Sc., (Queen's '15), Supt., Halifax Refinery, Imperial Oil Ltd., P.O. Box 490, Dartmouth, N.S. (*H*) Imperoyal, N.S. (*A.M. 1924*)

DUPERRON, Arthur, B.A.Sc., (Ecole Polytech., Montreal '11), Chief Engr., Montreal Tramways Co., Room 1012, 159 Craig St. W., Montreal, Que. (*H*) Apt. 1, 1833 Sherbrooke St. E. (*A.M. 1919*) (*M. 1928*)

♂DUPRE, Henry Augustus, Lieut., M.C., Asst. Dir., Elec. and Gas Inspection, Elec. Stds. Lab., Dept. of Trade and Commerce, Ottawa, Ont. (*H*) 319 McLeod St. (*A.M. 1914*) (*M. 1920*)

DUPUIS, Louis Charles, Div. Engr., C.N.R., Levis, Que. (*H*) 11 deSalaberry Ave., Quebec, Que. (*Jr. 1912*) (*A.M. 1919*)

DUPUIS, Phil. Aug., B.A.Sc., (Ecole Polytech., Montreal '21), Sr. Engr., D.P.W., Rm. 7, Parliament Bldg., Quebec, Que. (*A.M. 1934*) (*M. 1936*)

DUPUIS, René, B.A., Supt. Power Divn., Quebec Power Co., Quebec, Que. (*H*) 111 Marquette St. (*A.M. 1934*)

DUPUY, Harry E. G., B.Eng., (McGill '38), Babcock-Wilcox & Goldie-McCulloch Ltd., Galt, Ont. *(S. 1938)*

DUPUY, Rene, B.Sc., (Ecole Polytech., Montreal '35), Quebec North Shore Paper Co., Baie Comeau, Que. *(H)* 1310 Maisonneuve St., Montreal, Que. *(S. 1936)*

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DURANT, Selwyn Eld., C.P.R., Box 117, Lloydminster, Sask. *(A.M. 1921)*

DURDAN, F. S., B.Sc., (Queen's '33), 349 Niagara St., Welland, Ont. *(S. 1933)*

†DURLEY, Richard John, Ma.E., Secretary Emeritus, The Engineering Institute of Canada, 2050 Mansfield St., Montreal, Que. *(H)* 3174 The Boulevard, Westmount, Que. *(A.M. 1897)* *(M. 1904)*

DURLEY, Thos. Richard, B.Sc., (McGill '28), Canada Cement Co. Ltd., Canada Cement Bldg., Montreal, Que. *(S. 1926)* *(Jr. 1931)* *(A.M. 1936)*

DURNIN, Edward Jas., B.Sc., (Man. '28), 2049 Robinson St., Regina, Sask. *(Jr. 1930)*

DUSSAULT, Jean, B.A.Sc., (Ecole Polytech., Montreal '38), 74 Laurendeau Ave., Montreal East, Que. *(S. 1937)*

♂DUSTAN, Ernest Bruce, B.A.Sc., (Tor. '20), Station Design Dept., H.E.P.C. of Ont., Toronto, Ont. *(Jr. 1921)* *(A.M. 1926)*

†DUTCHER, Howard K., B.Sc., M.Sc., H. K. Dutcher and Associates, Cons. Engrs., 700 Royal Bank Bldg., Toronto, Ont. *(S. 1904)* *(A.M. 1907)* *(M. 1914)*

DUTTON, Wm. L., B.A.Sc., (Tor. '31), O.L.S., Engr., Union Natural Gas Co., Chatham, Ont. *(H)* 392 King St. W. *(S. 1930)* *(Jr. 1935)*

DWYER, Michael, The Hon., Minister of P.W.M. and L., Province House, Halifax, N.S. *(A.M. 1925)*

DYER, Frederick Charles, B.A.Sc., (Tor. '09), Prof., Dept. of Mining Engineering, University of Toronto, Toronto, Ont. *(H)* 164 Colin Ave. *(M. 1920)*

DYER, John Henry, B.Sc., (N.S.T.C. '28), English Electric Co. Ltd., St. Catharines, Ont. *(H)* 16 Merkle St., Halifax, N.S. *(S. 1928)* *(Jr. 1937)*

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♂DYER, Walter Gerald, B.Sc., (Sask. '25), Road Master, C.P.R., Prince Albert, Sask. *(H)* 301 Carlton Apts. *(A.M. 1934)*

♂DYKE, Fred. Stanley, Capt., Asst. Engr., W.W. Dept., City of Calgary, City Hall, Calgary, Alta. *(H)* 211-38th Ave., S.W. *(A.M. 1915)*

DYKE, Wm. Edgar, B.A.Sc., (Tor. '34), Designer, Dom. Bridge Co. Ltd., Lachine, Que. *(H)* 622 St. Joseph St., Lachine, Que. *(Jr. 1937)*

DYMENT, John T., B.A.Sc., (Tor. '29), Aeronautical Engr., Trans-Canada Air Lines, Winnipeg, Man. *(S. 1925)* *(A.M. 1936)*

♂EADIE, Robert Scott, Lieut., B.Sc., M.Sc., (McGill '22), Asst. Chief Engr., Dominion Bridge Co. Ltd., Box 280, Montreal, Que. *(H)* 4380 Mayfair Ave. *(S. 1914)* *(Jr. 1920)* *(A.M. 1926)* *(M. 1936)*

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EAGLES, Norman Borden, B.Sc., (N.B. '35), Asst. City Elec. Engr., Corp. of City of Moncton. *(H)* 110 Cornhill St., Moncton, N.B. *(S. 1935)*

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EASTON, Frank Stewart, B.Sc. (Eng.), (Glasgow '06), (A.R.T.C., Glasgow '03), Chief Engr., Mexican Light and Power, and Mexico Tramways Co., Apartado 124 Bis, Mexico, D.F. *(H)* Calle Colima No. 125. *(A.M. 1915)* *(M. 1922)*

G. ♂EATON, Milton, B.Sc., (McGill '21), Elec. Engr., Shawinigan Chemicals Ltd., Shawinigan Falls, Que. *(H)* 41-9th St. *(S. 1920)* *(A.M. 1925)*

ECKENFELDER, George, B.Sc., (Alta. '33), Calgary Power Co., Seebe, Alta. *(S. 1932)* *(Jr. 1937)*

♂EDDY, A. C., Capt., Chief Engr., Rly. Dept., B.C. Electric Rly., Vancouver, B.C. *(H)* 1620 Burnaby St. *(M. 1914)*

♂EDGAR, John H., Major, V.D., B.Sc., (McGill '03), Inspr. of Materials, C.N.R., P.O. Box 300, Winnipeg Man. *(H)* 576 Stradbrooke Ave. *(S. 1903)* *(A.M. 1910)*

♂EDMONDS, Chas. Wm., B.A.Sc., (Tor. '19), Plant Supt., Canada Cement Co. Ltd., Fort Whyte, Man. *(S. 1914)* *(Jr. 1921)* *(A.M. 1924)*

EDSON, Ralph Everett, B.Eng., (McGill '36), Can. Gen. Elec. Co. Ltd., Peterborough, Ont. *(H)* 489 King St. *(S. 1937)*

♂EDWARDS, Charles Peter, Lt.-Comdr., O.B.E., Director, Civil Air Services, Dept. of Transport, Ottawa, Ont. *(H)* 454 Cloverdale Rd., Rockcliffe, Ont. *(A.M. 1916)*

EDWARDS, Milton C., B.Sc., (Alta. '37), Can. Westinghouse Co. Ltd., Hamilton, Ont. *(H)* 789 King St. E. *(S. 1937)*

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EHLY, L. J., 10041-111th St., Edmonton, Alta. *(S. 1930)*

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ELFORD, Wesley F., B.Sc., (Alta. '37), 97 Empress Crescent, Toronto, Ont. *(H)* Foremost, Alta. *(S. 1937)*

♂ELGEE, H. A., Capt., B.A., B.A.I., (T.C.D.), 9 Copplestone Rd., Budleigh Salterton, Devon, England. *(M. 1914)*

ELKINGTON, G. E., B.Sc., (McGill '23), Gen. Mgr., East Kootenay Power Co. Ltd., P.O. Box 67, Fernie, B.C. *(S. 1919)* *(Jr. 1928)* *(A.M. 1933)*

ELLACOTT, Chas. Herbert, B.Sc., (McGill), B.C.L.S., D.L.S., Spencerville, Ont. *(S. 1888)* *(A.M. 1899)* *(M. 1921)* *(Life Member)*

ELLIOT, Donald Geo., B.Sc., (Edinburgh '30), Asst. Mill Engr., Anglo-Newfoundland Development Co., Grand Falls, Nfld. *(S. 1930)* *(Jr. 1934)* *(A.M. 1937)*

ELLIOT, G. B., B.Sc., (McGill '23), Carrier Corp. of Canada, 620 Cathcart St., Montreal, Que. *(H)* 4971 Victoria Ave. *(S. 1922)* *(Jr. 1926)* *(A.M. 1930)*

ELLIOT, Laurie B., B.Sc., (Dalhousie '03), Sr. Asst. Engr., D.P.W., Canada, New Westminster, B.C. *(H)* 521-3rd St. *(S. 1902)* *(A.M. 1909)* *(M. 1919)*

ELLIOTT, Chas. C., Gen. Delivery, Brooks, Alta. *(A.M. 1919)*

ELLIOTT, Clarence W., B.Sc., (Alta. '38), Seebe, Alta. *(S. 1938)*

ELLIOTT, J. Courtney, B.Sc., (Queen's '34), Southern Ontario Gas Co., Box 419, Leamington, Ont. *(H)* 12 White St. *(S. 1934)*

ELLIOTT, John M., 80 Chedoke Ave., Hamilton, Ont. *(S. 1936)*

ELLIOTT, Lisgar Webster, B.Sc., (Alta. '33), Apt. 7, 3720 Queen Mary Rd., Montreal, Que. *(S. 1933)* *(Jr. 1935)*

♂ELLIS, Douglas Stewart, Lt.-Col., D.S.O., M.C., M.A., B.Sc., (Queen's '10), D.L.S., O.L.S., Prof. of C.E., Queen's University, Kingston, Ont. *(H)* 418 Earl St. *(S. 1909)* *(Jr. 1913)* *(A.M. 1919)*

ELLIS, John Attwill, Asst. Engr., C.N.R., Rm. 603, Can. Express Bldg., McGill St., Montreal, Que. *(H)* 61 Nelson Ave., Montreal West, Que. *(A.M. 1921)*

ELMSLEY, C. M. R., B.A., B.Sc., (Queen's '37), Ordnance Mech. Engr., R.C.O.C., Dept. of National Defence, H.Q.M.D. No. 3, Kingston, Ont. *(H)* 30 Sydenham St. *(S. 1935)*

EMERSON, Robert Alton, B.Sc., (Man. '30), Transitman, C.P.R., Regina, Sask. *(H)* 3031 Retallack St. *(S. 1929)* *(Jr. 1932)*

EMERY, Donald Jos., B.A.Sc., (B.C. '29), Design Engr., Can. Gen. Elec. Co. Ltd., Peterborough, Ont. *(H)* 595 Douglas Ave. *(S. 1927)* *(A.M. 1937)*

EMERY, Roy Wm., B.A.Sc., (Tor. '32), Trinidad Leaseholds Ltd., Pointe-a-Pierre, Trinidad, B.W.I. *(A.M. 1938)*

EMMERSON, Robert H., Chief Engr's Office, C.N.R., Moncton, N.B. *(H)* 231 Highfield St. *(S. 1908)* *(A.M. 1913)*

♂EMRA, Frederic H., Lieut.-Col., O.B.E., F. H. Emra and Partners, Civil Cons. Engrs., 604 Hope Chambers, Ottawa, Ont. *(H)* 87 Catherine St. *(S. 1908)* *(A.M. 1912)* *(M. 1919)*

♂EMREY, Desmond Joseph, Capt., M.C., M.M., B.Sc., (Queen's '22), County Engr., Corp. County of Waterloo, Court House, Kitchener, Ont. *(H)* 37-B Ahrens St. W. *(S. 1914)* *(Jr. 1920)* *(A.M. 1922)*

ENGEL, Nathan Louis, B.Sc., (McGill '07), Montreal L. H. and P. Cons., Power Bldg., Montreal, Que. *(A.M. 1921)*

ENGHOLM, F. G., Gen. Mgr. and Engr., The Macotta Co. of Canada, 371 Bay St., Toronto, Ont. *(H)* 538 Sherbourne St. *(A.M. 1914)*

ENGLER, Chas. R., B.Sc., (Queen's '34), Designer, Can. Johns-Manville Co., Ashestos, Que. Box 133, Danville, Que. *(Jr. 1937)*

ENNIS, Leo. E., B.Sc., (Queen's '23), Exchange Engr., E.A., The Bell Telephone Co. of Canada, Montreal, Qûe. *(H)* 4417 Coolbrooke Ave., N.D.G. *(S. 1922)* *(A.M. 1931)*

ENOUY, Wm. Geo., B.A.Sc., (Toronto '27), Mgr., Montreal Dist., H. H. Robertson Co. Ltd., 526 Confederation Bldg., Montreal, Que. *(H)* 4774 Grosvenor Ave. *(A.M. 1938)*

ERICSON, Charles G., LL.B., (Valparaiso '04), Mech. Engr., Canada Machinery Corp., Ltd., 76 Wellington St. W., Toronto, Ont. *(H)* 58 Alvin Ave., Toronto, Ont. *(A.M. 1921)*

ERIKSEN, Gudmund, (Grad. Oslo), Asst. Engr., City Engr.'s Dept., Port Arthur, Ont. *(H)* 41 Elm St. *(A.M. 1932)*

ESDAILE, H. M., B.Eng., (McGill '35), Combustion Engineering Corp. Ltd., 540 Dominion Square Bldg., Montreal, Que. *(H)* 3450 Melrose Ave., N.D.G., Montreal, Que. *(S. 1934)*

ESMOND, Douglas C., B.Eng., (McGill '33), Can. Marconi Co., Town of Mount Royal, Que. *(H)* 3592 University St., Montreal, Que. *(S. 1934)* *(Jr. 1936)*

EVANS, Beverley Abbott, B.Sc., (Sask. '30), M.Sc., ('36), Engrg. Dept., Canadian Industries Ltd., Beaver Hall Hill, Montreal, Que. *(A.M. 1937)*

EVANS, Chas. D., B.Sc., (McGill '24), Sales Mgr., Can. Gypsum Co. Ltd., 1108 Dominion Square Bldg., Montreal, Que. *(H)* Apt. 20, 5540 Queen Mary Rd., N.D.G. *(Jr. 1930)* *(A.M. 1936)*

EVANS, D. Arthur, Res. Mgr., Powell River Paper Co. Ltd., Powell River, B.C. *(S. 1909)* *(A.M. 1914)* *(M. 1920)*

EVANS, D. E., B.Sc., (McGill '30), M.Eng. '33, Designer, Dom. Engineering Co. Ltd., Lachine, Que. *(H)* Apt. 4, 1466 Mansfield St., Montreal, Que. *(S. 1930)* *(A.M. 1938)*

EVANS, Edward A., 37 Ave. Genevieve, Quebec, Que. *(M. 1887)* *(Life Member)*

EVANS, Edward N., B.Sc., Maritimes repres., Champion Spark Plugs Co. of Canada. *(H)* 352 Kitchener Ave., Westmount, Que. *(S. 1930)*

EVANS, Edwin George, Box 462, Sussex, N.B. *(M. 1908)* *(Life Member)*

♂EVANS, Edwin Ronald, Capt., M.C., Engr. and Bldg. Supt., Parsons Construction Co., Moncton, N.B. *(H)* Lewisville, N.B. *(A.M. 1920)* *(M. 1934)*

EVANS, Geo. Ed., B.A., LL.B., (T.C.D. '81), Advisory, Dom. Bridge Co. Ltd., Toronto, Ont. *(H)* 76 Lyndhurst Ave., Toronto, Ont. *(A.M. 1907)*

EVANS, John Maurice, B.Sc., (McGill '29), Sales Engr., Shawinigan Water & Power Co., Power Bldg., Montreal, Que. *(H)* 936 Pratt Ave., Outremont, Que. *(S. 1929)* *(Jr. 1931)* *(A.M. 1937)*

EVANS, Leslie Murray, 357 Lampson St., Esquimalt, B.C. *(S. 1936)*

EVANS, Maurice John (R.M.C., Kingston '20), Dir. and Secy., Gulf Logging Co. Ltd., Fredrick's Arm, via Vancouver, B.C. *(S. 1921)* *(Jr. 1922)* *(A.M. 1932)*

EVANS, Owen Allen, B.Sc., (Queen's '33), Assayer, Mines Dept., Algoma Central Rly., Sault Ste. Marie, Ont. *(H)* 179 Denis St. *(Jr. 1934)*

EVANS, Philip N., B.Eng., (McGill '33), Can. Industries Ltd., Shawinigan Falls, Que. *(H)* 17-A Station Ave. *(S. 1933)*

EVANS, Thos. Owen, B.Sc., (McGill '27), Asst. Supt., Back River Plant, Montreal Island Power Co., St. Vincent de Paul, Que. *(A.M. 1935)*

♂EWART, Cecil, Major, D.S.O., Div. Engr., C.N.R., Rm. 459, Union Depot, Winnipeg, Man. *(H)* 22 Rochester Apts., Edmonton St. *(A.M. 1907)* *(M. 1911)* *(Life Member)*

EWART, Frank Richard, B.A.Sc., (Tor. '08), Partner, Ewart, Armer & Byam, Ltd., 909 Excelsior Life Bldg., Toronto, Ont. *(H)* 165 Grenadier Rd. *(M. 1921)*

†EWART, George R., Jr., B.Sc., (McGill '00), Mgr., Cebu Sugar Co. Inc., Cebu, P.O. Box 195, Philippine Islands. *(S. 1898)* *(A.M. 1909)*

EWART, Henry Edward, Supt., Royal Canadian Mint, Ottawa, Ont. *(H)* 243 First Ave. *(M. 1935)*

EWART, J. Albert, B.A.Sc., (Tor. '95), Architect, 900 Jackson Bldg., Ottawa, Ont. *(H)* 114 Cameron St. *(A.M. 1907)*

EXELROD, Bert, B.Eng., (McGill '37), c/o B. Kushner, 5160 Esplanade Ave., Montreal, Que. (*S. 1937*)

EYFORD, Cornell T., B.Sc., (Man. '23), Distribution Engr., Winnipeg Electric Co., Winnipeg, Man. (*H*) 581 Valour Rd. (*S. 1922*) (*A.M. 1930*)

FAGAN, James Wilfrid, B.Sc., (McGill '23), Asst. Gen. Supt., Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*H*) 600 Victoria Ave., Westmount, Que. (*S. 1920*) (*A.M. 1930*)

FAHEY, Jas. Vincent, B.Sc., (Queen's '21), 138 James St., St. Catharines, Ont. (*Jr. 1922*) (*A.M. 1927*)

FAIRBAIRN, John Macfarlane, B.Sc., (McGill '24), Vice-Pres., Chas. Warnock & Co., 1000 McGill Bldg., 485 McGill St., Montreal, Que. (*H*) 2359 Grand Blvd. (*S. 1921*) (*A.M. 1931*)

FAIRBAIRN, John M. R., (Tor. '93), D.Sc., Chief Engr., C.P.R., Windsor Station, Montreal, Que. (*H*) 1939 St. Luke St. (*A.M. 1899*) (*M. 1908*) (*Past President*)

FAIRLIE, Howard Wallace, (Tor. '10), Pres., Electric Switchgear Ltd., 3550 St. Antoine St., Montreal, Que. (*H*) 155 Edison Ave., St. Lambert, Que. (*A.M. 1920*)

FALKNER, John Wm., Asst. Engr., H.E.P.C. of Ont., 620 University Ave., Toronto, Ont. (*H*) 172 Blythwood Rd. (*A.M. 1922*)

FALLS, Orville Mervon, B.A.Sc., (Tor.), O.L.S., Commr. of Works, Township of York, 40 Jarvis St., Toronto, Ont. (*H*) 173 Arlington Ave. (*Jr. 1920*) (*A.M. 1921*)

FANJOY, Wm. T., B.Sc., (Alta. '24), Indust. Control Engrg. Dept., Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*H*) 627 Homewood Ave. (*S. 1925*) (*Jr. 1929*) (*A.M. 1936*)

FARLEY, Sydney E., Q.L.S., O.L.S., Farley & Cassels, 45 Rideau St., Ottawa, Ont. (*H*) 3 Third Ave. (*S. 1905*) (*A.M. 1911*)

FARMER, Eric Westover, B.Sc., (McGill '24), Elec. Engr., Can. Marconi Co., Ltd., Town of Mount Royal, Que. Box 111, Ste. Therese, Que. (*S. 1922*) (*A.M. 1928*)

G.†FARMER, John Taylor, M.Sc., (Liverpool), M.A.Sc., (McGill), Mech. Engr., Montreal Engineering Co. Ltd., 244 St. James St., Montreal, Que. (*H*) 30 Maple Ave., Ste. Anne de Bellevue, Que. (*S. 1897*) (*A.M. 1905*) (*M. 1919*)

FARMER, Rupert Whitley, B.Sc., (McGill '21), 136 Hillcrest Ave., Montreal West, Que. (*A.M. 1930*)

♂FARNSWORTH, Arthur Leslie, B.Sc., (McGill '23), Howard Smith Paper Mills, Cornwall, Ont. (*H*) 206 Fifth St. W. (*S. 1921*) (*Jr. 1925*) (*A.M. 1929*)

♂FARNSWORTH, F. D., City Mgr. and City Engr., City Hall, City of Brewer, Maine. (*H*) 39 School St. (*A.M. 1923*)

♂FARNSWORTH, Raymond H., Lieut., B.Sc., (Queen's '16), Engrg. Dept., Anglo-Canadian Pulp and Paper Mills, Ltd., Quebec, Que. (*H*) 2 Lemesurier Ave. (*Jr. 1921*) (*A.M. 1930*)

♂FARQUHARSON, Stanley, 876 Jervis St., Vancouver, B.C. (*A.M. 1928*)

FARRELL, Alfred J., B.Sc., (McGill '24), Superv. of Property, Royal Trust Co., Montreal, Que. (*H*) 5088 Cote St. Antoine Rd. (*S. 1924*) (*Jr. 1926*) (*A.M. 1938*)

♂FARRELL, J. W. D., Capt., B.Sc., (Queen's '15), Supt. of Waterworks, City of Regina, City Hall. (*H*) 3025 Rae St., Regina, Sask. (*Jr. 1920*) (*A.M. 1921*) (*M. 1935*)

♂FARROW, Richard Charles, B.C.L.S., Chief Hydraulic Engr., Water Rights Br., B.C., Parliament Bldgs., Victoria, B.C. (*A.M. 1933*) (*M. 1938*)

FAST, Morris, 1005-13th St. W., Saskatoon, Sask. (*S. 1937*)

FAULKNER, Chas. F. P., D.P.W. Canada, Brit. Col.-Yukon Dist., New Westminster, B.C. (*A.M. 1921*)

FAWCETT, Sydney Dawson, D.L.S., Surveys and Engrg. Br., Dept. of Mines and Resources, Ottawa, Ont. (*H*) 120 Belmont Ave. (*S. 1907*) (*Jr. 1915*) (*A.M. 1922*)

FAWKES, Arthur Walter Ellson, City Engr., Moose Jaw, Sask. (*H*) 1022 Redland Ave. (*1938*)

FAY, Frederick H., S.B., M.Sc., (M.I.T.), Fay, Spofford & Thorndike, Cons. Engrs., 11 Beacon St., Boston, Mass. (*H*) 227 Savin Hill Ave., Dorchester, Mass. (*M. 1909*)

FELL, Arthur Thornton, B.A.Sc., Works Lab. Chemist, Can. Industries Ltd., McMasterville, Que. (*H*) 921 Foul Bay Rd., Victoria, B.C. (*S. 1928*)

FELLOWS, Howard, B.Sc., (McGill '21), Asst. Chief Engr., Nova Scotia Power Comm., Provincial Administration Bldg., Halifax, N.S. (*H*) 87 Cambridge St. (*A.M. 1930*)

FENNER, Thos. Henry, Mgr. Engrg. Dept., General Accident Assurance Co. of Canada, 357 Bay St., Toronto 2, Ont. (*H*) 98 Highbourne Rd. (*A.M. 1922*)

FENNIS, Albert M., c/o North American Cyanamid Co., Niagara Falls, Ont. (*A.M. 1931*)

FENWICK, Jas. Reid, B.A.Sc., (Tor. '22), Research Products Sales Mgr., Northern Electric Co. Ltd., Montreal, Que. (*H*) 4808 Grosvenor Ave. (*S. 1922*) (*A.M. 1927*)

FERGUSON, Alexander, Port Mgr., Montreal Harbour, National Harbours Board, 357 Common St., Montreal, Que. (*H*) 642 Murray Hill Ave., Westmount, Que. (*S. 1905*) (*A.M. 1907*) (*M. 1914*)

FERGUSON, A. A., B.Sc., (Dalhousie '29), B.Sc., (McGill '31), Reed, Shaw & McNaught, Royal Bank Bldg., Montreal, Que. (*H*) 1106 Graham Blvd., Town of Mount Royal, Que. (*S. 1929*) (*A.M. 1938*)

♂FERGUSON, Andrew Welsh, R.R. 1, Victoria, B.C. (*S. 1910*) (*Jr. 1914*) (*A.M. 1921*)

FERGUSON, David H., Apt. 2, 1458 Mackay St., Montreal, Que. (*S. 1937*)

♂FERGUSON, Geo. Hendry, Capt., M.C., B.A.Sc., (Tor. '06), D.L.S., Chief Public Health Engrg. Divn., Dept. of Pensions and National Health, 326 Daly Bldg., Ottawa, Ont. (*H*) 296 Buena Vista Rd., Rockcliffe, Ont. (*S. 1906*) (*A.M. 1909*) (*M. 1919*)

FERGUSON, Hardy S., (*q*), B.S., C.E., Cons. Engr., Hardy S. Ferguson & Co., 200 Fifth Ave., New York, N.Y. (*H*) 20 Clinton Ave., Dobbs Ferry, N.Y. (*M. 1903*)

FERGUSON, Jack A., Port Stanley, Ont. (*S. 1936*)

♂FERGUSON, James, Lieut., Div. Engr., C.N.R., London, Ont. (*H*) 96 Windsor Ave. (*Jr. 1913*) (*A.M. 1916*)

FERGUSON, Jas. Bell, B.Sc., (McGill '35), Asst. Mgr., Pictou Foundry and Machine Co., P.O. Box 260, Pictou, N.S. (*S. 1932*)

FERGUSON, John Henry, B.Sc., (Man. '29), Flt. Lieut., R.C.A.F., Dept. National Defence, 407 Canadian Bldg., Ottawa, Ont. (*H*) Apt. 2, 437 Albert St. (*Jr. 1931*)

FERGUSON, R. Norman, Apt. 2, 1458 Mackay St., Montreal, Que. (*S. 1937*)

FERGUSON, Wm. Patterson, B.Sc., (McGill '24), Mgr., Peacock Brothers, Ltd., 325 Howe St., Vancouver, B.C. (*H*) 4661 Drummond Drive (*A.M. 1930*)

♂FERGUSSON, Hugh Boscawen, Mgr., G. A. Harvey & Co. Ltd., Greenwich, London, England. (*H*) 32 St. John's Park, Blackheath, London, S.E.3. (*A.M. 1910*) (*M. 1915*)

♂FERRIER, Alan, M.C., B.Sc., (McGill '20), S/L., Chief Aeronautical Engr., Dept. of Transport, Hunter Bldg., Ottawa, Ont. (*H*) 370 Driveway. (*S. 1919*)

♂FETHERSTONHAUGH, Edward P., Lt.-Col., M.C., B.Sc., (McGill '99), Dean of the Faculty of Engrg. and Arch., and Prof. of Elec. Engrg., University of Manitoba, Winnipeg, Man. (*H*) 801 Dorchester Ave. (*S. 1899*) (*A.M. 1908*) (*M. 1920*)

♂FETHERSTONHAUGH, Wm. S., Lt.-Col., C.B.E., Div. Engr., C.N.R., Calgary, Alta. (*H*) 810 Royal Ave. (*A.M. 1907*) (*M. 1914*)

♂FETTERLY, Philip Austin, Lieut., B.Sc., (McGill '09), Dom. Water and Power Bureau, Dept. of Mines and Resources, 423 Public Bldg., Calgary, Alta. (*H*) 639-14th Ave. W. (*Jr. 1912*) (*A.M. 1913*)

FIELD, Geo. Lewis, C.N.R., Montreal, Que. (*H*) 57 Ainslie Rd., Montreal West, Que. (*S. 1935*)

FIELD, Reginald Hugh, (Liverpool '13), Superv., Physical Testing Lab., Dept. Physics and Engrg., National Research Council, Ottawa, Ont. (*H*) 12 Rockcliffe Way. (*A.M. 1922*)

♂FIFE, W. M., Lieut., B.Sc., (Alta. '13), S.M., (M.I.T.), Assoc. Prof. Massachusetts Institute of Technology, Cambridge, Mass. (*H*) 44 Lakewood Rd., Newton Highlands, Mass. (*Jr. 1914*) (*A.M. 1927*)

FILION, Paul, B.Eng., (McGill '36), Inspr., Can. Underwriters' Assoc., Montreal, Que. (*H*) 5586 Phillips Ave., Montreal, Que. (*S. 1936*)

♂FINDLATER, Richard Hamilton, Mgr., Montreal and E. Canada Divn., Bruce Ross Ltd., 201 Bd. of Trade Bldg., Montreal, Que. (*M. 1935*)

FINDLAY, Allan C., Dom. Bridge Co. Ltd., Lachine, Que. (*H*) 72 Somerville Ave., Westmount, Que. (*S. 1937*)

FINDLAY, Frank P., B.Sc., (Man. '36), Assessment Dept., City of Winnipeg, Winnipeg, Man. (*H*) 987 McMillan Ave. (*S. 1936*)

FINDLAY, Reginald Hudson, (A.R.T.C.), Mech. Engr., Dom. Bridge Co. Ltd., Box 280, Montreal, Que. (*H*) 6 Monette Ave., Dorval, Que. (*A.M. 1920*) (*M. 1932*)

FINLAYSON, A. W., B.Sc., (McGill '24), Pressure Pipe Co. of Canada, 760 Victoria Sq., Montreal, Que. (*H*) 4450 Coronation Ave. (*S. 1922*) (*A.M. 1930*)

FINLAYSON, John N., M.Sc., (McGill '09), Dean, Faculty of Applied Science, University of British Columbia, Vancouver, B.C. (*S. 1908*) (*A.M. 1912*) (*M. 1919*)

FINNEMORE, Harold Forsyth, B.Sc., (Queen's '17), Elec. Engr., C.N.R., 702 C.N. Express Bldg., Montreal, Que. (*H*) 112 Balfour Ave., Town of Mt. Royal, Que. (*A.M. 1921*)

FINNIE, Oswald Sterling, B.Sc., (McGill '97), D.L.S., 346 Queen St., Ottawa, Ont. (*A.M. 1912*) (*M. 1921*)

FISH, Abe, 2012 Ontario St. E., Montreal, Que. (*S. 1937*)

FISHER, Chas. B., B.Sc., (Tor. '30), Northern Electric Co., 1261 Shearer St., Montreal, Que. (*H*) 4440 Oxford Ave., N.D.G. (*S. 1927*) (*A.M. 1936*)

FISHER, Fred. Sorley, B.Sc., (Alta., '24), Gen. Equipment Engr., Communications Engrg. Dept., C.P.R., Montreal, Que. (*H*) 5 Ingleside Ave., Westmount, Que. (*Jr. 1926*)

FISHER, Seymour J., B.Sc., (McGill '10), Gen. Supt., Price Bros. & Co. Ltd., Riverbend, Que. (*A.M. 1915*) (*M. 1919*)

FISHER, Sidney Thomson, B.A.Sc., (Tor. '30), Engr., Northern Electric Co., 1261 Shearer St., Montreal, Que. (*H*) 4440 Oxford Ave., N.D.G., (*S. 1927*) (*Jr. 1935*)

FITZGERALD, Geo. G., Superv. Manual Training, Regina Public School Board. (*H*) 2321 Garnet St., Regina, Sask. (*A.M. 1924*)

FITZ-JAMES, H. C., Vice-Pres. and Mgr., Pacific Coast Pipe Co., 1551 Granville St., Vancouver, B.C. (*H*) 2090 S.W. Marine Drive. (*A.M. 1919*)

FLAHAULT, Jean, Jr., B.A.Sc., (Ecole Polytech., Montreal '38), 4205 Northcliffe Ave., N.D.G., Montreal, Que. (*S. 1936*)

FLAHERTY, B. G., B.S., (Washington '16), Chief Engr., Marine Industries Ltd., 1405 Peel St., Montreal, Que. (*H*) 6657 Monkland Ave. (*M. 1932*)

FLANAGAN, Oliver L., B.A.Sc., (Tor. '10), 921 St. Clair Ave. W., Toronto, Ont. (*A.M. 1913*)

FLAY, William H. G., Br. Mgr., Dom. Reinforcing Steel Co., 396 Somerset St. W., Ottawa, Ont. (*H*) 386 Sunnyside Ave. (*A.M. 1921*)

*P.*FLEMING, Alex. Greig, B.A., (Queen's '04), Chief Chemist, Canada Cement Co. Ltd., Canada Cement Bldg., Montreal, Que. (*H*) 2105 Grey Ave. (*M. 1928*)

FLEMING, C. D., B.Sc., (McGill '24), Sales Engr., Alexander Murray & Co. Ltd., Ft. of Morse St., Toronto, Ont. (*H*) 9 Dale Ave. (*S. 1924*) (*Jr. 1928*) (*A.M. 1932*)

FLEMING, Fred. A., B.A.Sc., (Tor. '36), Asst. Meter Engr., Can. Gen. Elec. Co., Ltd., Peterborough, Ont. (*H*) 255 Reid St. (*Jr. 1938*)

FLEMING, John M., B.Sc., (Man. '21), Pres. and Gen. Mgr., C. D. Howe & Co., 710 Whalen Bldg., Port Arthur, Ont. (*H*) 114 Prospect Ave. (*S. 1919*) (*A.M. 1928*) (*M. 1938*)

♂FLEMING, Robert, C.E., Vice-Pres., Wood, Fleming & Co., 700 Royal Bank Bldg., Toronto, Ont. (*H*) 61 Foxbar Rd. (*M. 1921*)

♂FLETCHER, Hugh Murray, Lieut., (Tor. '06), 377 Hess St. S., Hamilton, Ont. (*A.M. 1922*)

♂FLETCHER, W. J., Lieut., B.Sc., (Queen's '10), O.L.S., Gen. Practice, Municipal Engrg. and Surveying, 610 Security Bldg., Windsor, Ont. (*H*) 147 Partington Ave. (*A.M. 1919*)

FLEURY, Maurice, B.A.Sc., (Ecole Polytech. Montreal '34), 644 St. Germain Ave., Outremont, Que. (*S. 1934*) (*Jr. 1937*)

FLITTON, Ralph Cyril, B.Sc., (McGill '14), Supt., Industrial Shops, Can. Vickers, Ltd., Box 550, Montreal, Que. (*H*) 571 Chester Ave., Town of Mount Royal, Que. (*Jr. 1914*) (*A.M. 1920*)

FLOOD, John N., B.Sc., (N.B. '16), Pres., John Flood & Sons, Ltd., 111 Princess St., Saint John, N.B. (*H*) 96 Coburg St. (*Jr. 1920*) (*A.M. 1923*)

FLOOK, Samuel Everett, B.A.Sc., (Tor. '12), O.L.S., D.L.S., LL.B., City Engr., Public Utilities Bldg., Port Arthur, Ont. (*H*) 430 Ambrose St. (*M. 1936*)

FOGARTY, J. William P., B.Sc., (McGill '31), Instr. in Physics, St. Francis Xavier University, Antigonish, N.S. (*H*) 124 Weldon St., Moncton, N.B. (*S. 1929*)

FOGARTY, Orville Alden, Chief Engr., Rivers Salvage Co. Ltd., 2245 St. James St. W., Montreal, Que. (*H*) Rigaud, Que. (*M. 1922*)

FONG, W. H., B.Sc., (McGill '28), Montreal L. H. & P. Cons., Power Bldg., Montreal, Que. (*H*) 123 Dorchester St. W. (*S. 1926*) (*A.M. 1938*)

FORBES, Donald A., B.E., (Sask. '34), Asst. Divn. Engr., Cons. Paper Corp. Ltd., Port Alfred, Que. (*Jr. 1936*)

FORBES, Jas. MacGregor, Dist. Engr., Highways Br., Dept. P.W., Alta., Edmonton, Alta. (*H*) 10547-125th St. (*A.M. 1920*)

♂FORBES, John Hunter, Major, B.Sc., (McGill '08), Asst. Right of Way Agent, C.P.R., Montreal, Que. (*H*) 420 Wiseman Ave., Outremont, Que. (*A.M. 1919*)

FORBES-ROBERTS, Herbert, Mgr., Montreal Engineering Co. Ltd., Regina, Sask. (*H*) 2840 Angus St. (*1938*)

FORD, J. William H., B.A.Sc., (Tor. '15), Constrn. Supt., Shawinigan Engineering Co. Ltd., Power Bldg., Montreal, Que. Address: Box 85, La Tuque, Que. (*S. 1911*) (*Jr. 1916*) (*A.M. 1919*)

♂FORD, Robert, B.Sc., (McGill '22), Chief Engr., Footwear and Mech. Mfg., Dom. Rubber Co. Ltd., Montreal, Que. (*H*) Apt. 3, Sherbrooke Apts., 1374 Sherbrooke St. W. (*S. 1921*) (*Jr. 1923*) (*A.M. 1925*)

FORD, William B., O.L.S., Can. Engineering and Contracting Co. Ltd., 506 Imperial Bldg., Hamilton, Ont. (*H*) 42 Ontario St., Burlington, Ont. (*A.M. 1899*) (*Life Member*)

†FORDE, John Preston, 1705-W. 10th Ave., Vancouver, B.C. (*M. 1905*)

FORD-SMITH, Percy, Pres. and Chief Engr., The Ford-Smith Machine Co. Ltd., Hamilton, Ont. (*H*) Ancaster, Ont. (*A.M. 1928*) (*M. 1930*)

†FOREMAN, Alvah E., B.Sc., (McGill '03), Cons. Engr., 448 Seymour St., Vancouver, B.C. (*H*) 4553-W. 8th Ave. (*S. 1903*) (*A.M. 1909*) (*M. 1918*) (*Life Member*)

♂FOREMAN, John Leonard, Lieut., B.A.Sc., (Tor. '14), Hydrographic Surveyor, Dept. of Transport, Confederation Bldg., Ottawa, Ont. (*H*) 587 MacLaren St. (*S. 1914*) (*A.M. 1921*)

♂FORGAN, David, Capt., Dept. Head, Constrn. Engr., H.E.P.C. Ont., 620 University Ave., Toronto, Ont. (*H*) 55 Highland Cres., R.R. 2, York Mills, Ont. (*A.M. 1932*)

FORGIE, James, Cons. Engr., 15 William St., New York, N.Y. (*M. 1910*)

FORSBERG, C. R., B.Sc., (Sask. '31), Jr. Engr., Underwood & McLellan, Western Hotel, Saskatoon, Sask. (*H*) Dunblanc, Sask. (*S. 1931*)

FORSTER, Alfred Manning, B.E., (N.S.T.C. '38), Fld. Engr., Montreal L. H. & P. Cons., Montreal, Que. (*H*) 1490 McKay St. (*S. 1938*)

FORSYTHE, Marshall A., B.Sc., (Alta '37), Shawinigan Engineering Co. Ltd., Power Bldg., Montreal, Que. (*H*) 1315 Dorchester St. W. (*S. 1937*)

FORTIN, Eugene, 13 Ste. Anne, Pointe-aux-Trembles, Que. (*A.M. 1923*)

FORTIN, Joachim, 103 Chemin St., Quebec, Que. (*S. 1908*) (*A.M. 1913*)

FORTIN, Jean Julien, B.Sc., (Queen's '34), Elec. Engr., Saguenay Power Co. Ltd., Arvida, Que. (*H*) 48 Ave. Begin, Chicoutimi, Que. (*Jr. 1935*)

†FOSNESS, Arthur Williams, E.M., (Minn. '11), Chief Engr., Carter-Halls Aldinger Co., 515 Union Bank Bldg., Winnipeg, Man. (*A.M. 1921*) (*M. 1927*)

FOSS, Wallace Leland, B.Sc., (Sask. '30), Dist. Engr., Dom. Govt., P.F.R.A., Regina, Sask. (*1938*)

FOSTER, Ian McL., Brown Corp., La Tuque, Que. (*S. 1937*)

FOSTER, Vernon Simons, B.Sc., (Kansas '10), M.Sc., (Penn. State '16), Induction Motor Engr., Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*H*) 510 Gilmour St. (*A.M. 1920*)

FOTHERINGHAM, W. W., B.Sc., (Man. '33), Standard Iron Wks., Ltd., Edmonton, Alta. (*H*) 9913–114th St. (*Jr. 1937*)

FOULIS, A. D., B.Sc., (N.S.T.C. '29), Mgr., Can. Fairbanks Morse Co. Ltd., 164–66 Granville St., Halifax, N.S. (*Jr. 1931*)

FOULKES, Thos., B.Sc., (N.B. '26), Supt. of Material Handling, J. R. Booth Ltd., Ottawa, Ont. (*H*) 289 Bayswater Ave. (*S. 1925*) (*Jr. 1929*) (*A.M. 1937*)

FOURNIER, Victor A., B.A., (Laval '11), Chief Engr., Dansereau Ltd., 1387 Bernard Ave., Outremont, Que. (*H*) 860 Dunlop Ave., Outremont, Que. (*S. 1913*) (*A.M. 1923*)

FOWLER, C. A. DeW., B.Sc., (N.S.T.C. '14), C. A. Fowler & Co., Engrs. and Arch'ts., Capitol Bldg., Halifax, N.S. (*H*) 67 Norwood St. (*A.M. 1919*) (*M. 1923*)

FOWLER, Charles E., M.Sc., Cons. Engr., 5 West 63rd St., New York, N.Y. (*M. 1904*) (*Life Member*)

♂FOWLER, Frank Scott, Capt., M.C., B.Sc., (McGill '10), Dir., Nelson River Construction Co. Ltd., 607 Union Trust Bldg., Winnipeg, Man. (*A.M. 1915*)

♂FOX, C. Harry, Lieut., M.Sc., (McGill '10), Engr. of Water Service, C.P.R., Winnepeg, Man. (*H*) Royal Alexandra Hotel. (*S. 1907*) (*A.M. 1913*) (*M. 1921*)

♂FOX, E. C. Evans, Field Engr., John T. Hepburn Ltd., Toronto, Ont. (*H*) Wyndmoor, York Mills, Toronto, Ont. (*S. 1921*) (*Jr. 1923*)

FOX, John Holloway, B.A.Sc., (Tor. '27), Engr., Minneapolis Honeywell Regulator Co. Ltd., 117 Peter St., Toronto, Ont. (*H*) 37 Macdonell Ave. (*S. 1926*) (*Jr. 1930*) (*A.M. 1935*)

FOY, Albert J. B., B.Sc., (McGill '24), Inspr., Can. Underwriters' Assn., 628 Coristine Bldg., Montreal, Que. (*H*) 71 Clandeboye Ave., Westmount, Que. (*S. 1925*) (*A.M. 1931*)

FRAME, Stanley H., Hydraulic Engr., Water Rights Br., Dept. of Lands, Parliament Bldgs., Victoria, B.C. (*H*) 1724 Coronation Ave. (*S. 1903*) (*A.M. 1911*) (*M. 1936*)

FRANCIS, John Barton, B.Sc., (McGill '30), Can. Industries Ltd., Montreal, Que. (*H*) Apt. 1, 1546 Crescent St. (*S. 1928*) (*Jr. 1937*)

♂FRANCIS, Thos. Frederick, Lieut., Dist. Engr., Dept. of Highways, Ont. (*H*) 2 Governors Rd., Toronto, Ont. (*A.M. 1920*) (*M. 1936*)

FRANKLIN, R. Laurence, B.Sc., (Queen's '30), Lieut., R.C.O.C., Dept. of National Defence, M.D. No. 3, Kingston, Ont. (*H*) Maxville, Ont. (*S. 1928*) (*Jr. 1934*)

FRASER, Allan D. W., B.Eng., (McGill '34), 1239 Van Horne Ave., Montreal, Que. (*S. 1934*) (*Jr. 1937*)

♂FRASER, Andrew Stockwell, Lieut., B.Sc., (McGill '22), Plant Supt., Canada Starch Co. Ltd., Cardinal, Ont (*A.M. 1925*)

♂FRASER, Archibald N., Lieut., B.Sc., (McGill '09), Chief Engr., Radio Br., Dept. of Transport, Ottawa, Ont. (*H*) 11 Rockcliffe Way. (*A.M. 1926*)

FRASER, Campbell, (Dalhousie '32), B.Sc., (Queen's '34), Asst. Divn. Engr., Dept. of Highways, Port Arthur, Ont. (*H*) 383 Van Norman St. (*S. 1930*) (*Jr. 1936*)

FRASER, Charles E., B.Sc., (McGill '99), Pres., Fraser, Brace & Co., Inc., 10 East 40th St., New York, N.Y., and Fraser-Brace Engineering Co., 107 Craig St. W., Montreal, Que. (*H*) 83-26 Abingdon Rd., Kew Gardens, L.I., N.Y. (*S. 1899*) (*M. 1909*)

♂FRASER, Christopher Edwin, Capt., B.Sc., (Queen's '16), Engr., McNamara Construction Co. Ltd., 53 Yonge St., Toronto 2, Ont. (*H*) 78 Falcon St. (*S. 1916*) (*Jr. 1920*) (*A.M. 1922*)

FRASER, Daniel Macfarlane, Pres. and Gen. Mgr., D. M. Fraser, Ltd., and Leland Electric Canada, Ltd., 53 Richmond St. E., Toronto, Ont. (*H*) 82 Hillsdale Ave. W. (*M. 1920*)

FRASER, Innes Martell, B.Sc., (N.S.T.C. '34), Imperial Oil Ltd., Imperoyal, N.S. (*Jr. 1935*)

FRASER, I. Matheson, B.Sc., (McGill '19), Prof., Mech. Engrg. and Head of Dept., University of Saskatchewan, Saskatoon, Sask. (*H*) 115 Albert Ave. (*Jr. 1920*) (*A.M. 1928*)

FRASER, J. Douglas, B.Sc., (Dalhousie), B.Sc., (McGill '25), Chief Engr., Acadia Sugar Refining Co. Ltd., Box 400, Dartmouth, N.S. (*H*) Woodside, N.S. (*S. 1925*) (*Jr. 1929*) (*A.M. 1930*)

FRASER, John Philip, B.E.E., (Man. '14), Gen. Supt., Manitoba Power Comm., Winnipeg, Man. (*H*) 391 Oxford St. (*A.M. 1929*) (*M. 1936*)

FRASER, Ralph Percy, B.Sc., (Man. '31), Winnipeg Electric Co., Winnipeg, Man. (*H*) 8 Allison Apts., Wolseley Ave. (*S. 1930*) (*Jr. 1937*)

FRASER, T. Bryant, Quebec North Shore Paper Co. Ltd., Franquelin, Que. (*S. 1922*)

FRASER, William Thomas, Mgr., Vancouver Machinery Depot and Vancouver Iron Works, Ltd., 1155 West 6th Ave., Vancouver, B.C. (*H*) 2020–35th Ave. W. (*M. 1936*)

FREELAND, John Anderson, B.Sc., (Penna. '03), 2425 Madison Ave., N.D.G., Montreal, Que. (*A.M. 1908*)

FREELAND, John James, B.Sc., (McGill '15), Engr., Can. International Paper Co., Temiskaming, Que. (*A.M. 1927*)

FREEMAN, Geo. Leonard, B.S., (Maine '03), Moran, Proctor and Freeman, Cons. Engrs., 420 Lexington Ave., New York, N.Y. (*H*) 335 Rich Ave., Mt. Vernon, N.Y. (*M. 1920*)

FREEMAN, J. Reginald, Sr. Asst. Engr., D.P.W., Canada, P.O. Drawer 1417, Saint John, N.B. (*H*) 58 Orange St. (*S. 1904*) (*A.M. 1910*) (*M. 1918*)

♂FREEMAN, James Roy, B.A.Sc., (Tor. '12), Asst. Engr., Chief Engr.'s Office, C.N.R., Moncton, N.B. (*H*) 112 Mountain Rd. (*A.M. 1921*)

♂FREEMAN, Robert P., Lieut., B.Sc., (N.S.T.C. '15), Apt. 11, 1525 St. Mark St., Montreal, Que. (*A.M. 1919*)

FREGEAU, John Henry, B.Sc., (McGill '10), Mgr., North Divn. Comm. and Distribution Dept., Shawinigan Water and Power Co., Three Rivers, Que. (*H*) 669 Notre Dame St. (*A.M. 1928*)

G.†FRENCH, Roger DeLand, B.Sc., C.E., (Worcester), Prof. of Highway and Municipal Engrg., McGill University, Montreal, Que., and Cons. Engr. (*H*) 456 Pine Ave. W. (*A.M. 1913*) (*M. 1918*)

FRENCH, Philip B., B.Eng., (McGill '34), Sales Engr., Can. S.K.F. Co. Ltd., 1075 Beaver Hall Hill, Montreal, Que. (*H*) 5191 Coolbrook Ave. (*S. 1934*)

FRÉCHETTE, Gaston, 5216 Chambord St., Montreal, Que. (*S. 1938*)

♂FRIEDMAN, Ferdinand J., B.Sc., (M.I.T. '08), Mech. Engr., McDougall & Friedman, Cons. Engrs., 1221 Osborne St., Montreal, Que. (*H*) 1260 Mackay St. (*A.M. 1920*) (*M. 1923*)

FRIGON, A., D.Sc., (Paris), B.Sc., Asst. Gen. Mgr., Can. Broadcasting Corp., Room 298, 1231 St. Catherine St. W., Montreal, Que. (*H*) 125 Pagnuelo Ave., Outremont, Que. (*S. 1907*) (*A.M. 1913*) (*M. 1931*)

FRIGON, Raymond A., 125 Pagnuelo Ave., Outremont, Que. (*S. 1937*)

FRIGON, Rosario, B.A.Sc., (Ecole Polytech., Montreal '37), 227–4th St., Shawinigan Falls, Que. (*S. 1935*)

FRIPP, Fred. Bowles, 101 Alma St., Moncton, N.B. (*A.M. 1892*) (*Life Member*)

FRISKEN, O. J., B.Sc., (Queen's '29), Asst. Engr., The De Laval Co. Ltd., Peterborough, Ont. (*H*) 317 Elias Ave. (*S. 1928*) (*Jr. 1937*)

FRITH, Hugh W., Chief Engr., National Harbours Board, Vancouver, B.C. (*H*) 5488 Granville St. (*A.M. 1912*) (*M. 1926*)

FRIZZLE, H. R., B.Sc., (N.S.T.C. '33), Phillips Electrical Works Ltd., Brockville, Ont. (*H*) 389 King St. W. (*S. 1935*)

FROMSON, Sam., B.Eng., (McGill '38), Howey Gold Mines Ltd., Red Lake, Ont. (*S. 1937*)

FROST, Clifford Earl, B.Sc., (McGill '31), Asst. Engr., Bell Telephone Co. of Canada, Plateau Bldg., Montreal, Que. (*H*) 19–17th Ave., Lachine, Que. (*A.M. 1936*)

FROST, Stanley R., Sales Director, North American Cyanamid Ltd., Royal Bank Bldg., Toronto, Ont. (*H*) 77 Wells Hill. (*A.M. 1919*)

FRY, Albert Edward, Mech. Engr., Dom. Glass Co. Ltd., Montreal, Que. (*H*) 37 Dufferin Rd., Hampstead, Que. (*A.M. 1928*)

FRY, Edmund Botterell, B.Sc., (McGill '25), Dom. Bridge Co. Ltd., Montreal, Que. (*H*) 900 Sherbrooke St. W. (*A.M. 1935*)

FRY, Geo. F., B.A.Sc., (Tor. '33), Asst. Divn. Engr., Shell Oil Co. of Canada, Ltd., London, Ont. (*H*) 109 Windsor Ave. (*A.M. 1937*)

FRY J. D., B.Sc., (McGill '22), Asst., McDougall & Friedman, 1221 Osborne St., Montreal, Que. (*H*) 16 Thornhill Ave., Westmount, Que. (*S. 1919*) (*Jr. 1924*) (*A.M. 1934*)

FULLER, Allan F. S., B.Sc., (Sask. '33), 2345 Smith St., Regina, Sask. (*Jr. 1934*)

FULLER, Harold Paul, Roadmaster, C.N.R. (H.B. Rly.), Box 446, The Pas, Man. (*A.M. 1919*)

FULLER, Royden John, B.A.Sc., (Tor. '12), Private Practice, Str'l. Engr., 243 Confederation Life Bldg., Toronto, Ont. (*H*) 399 St. Clements Ave. (*A.M. 1921*)

FULLERTON, Roland M., B.Sc., (N.S.T.C. '33), Saguenay Power Co. Ltd., Arvida, Que. (*S. 1931*) (*Jr. 1937*)

♂FULTON, William, 148 Lawndale Ave., Norwood, Winnipeg, Man. (*A.M. 1920*) (*Life Member*)

♂FULTZ, Stephen Lloyd, B.Sc., (N.S.T.C. '20), Constrn. Engr., N.S. Power Comm., Liverpool, N.S. (*H*) 16 Cherry St., Halifax, N.S. (*S. 1919*) (*Jr. 1922*) (*A.M. 1926*)

FURLONG, Henry Walter, B.Sc., (London '08), Strl. Engr., Stone & Webster Engrg. Corp., 49 Federal St., Boston, Mass., U.S.A. (*H*) 67 Cedar St., Wollaston. Mass. (*A.M. 1924*)

FYFE, Herbert Dixon, (Tor. '11), c/o Semet Solvay Co., Ashland, Kentucky, U.S.A. (*Jr. 1912*) (*A.M. 1920*)

♂FYFE, Robert John, Lieut., Mgr., R. J. Fyfe Equipment, 618 Broder Bldg., Regina, Sask. (*H*) 21 Angus Cres. (*A.M. 1930*)

FYSHE, Thos. Maxwell, B.Sc., (McGill '05), Gen. Mgr., Keewaydin Investments Ltd., 132 St. James St. W., Montreal, Que. (*H*) 2944 Viewmount Ave. (*M. 1935*)

GABY, Frederick A., D.Sc., B.A.Sc., M.E., (Tor. '04), Executive Vice-Pres., British American Oil Co., 14th Floor, Royal Bank Bldg., Toronto, Ont. (*H*) 480 Spadina Rd. (*M. 1919*) (*Past President*)

GADS, Leonard, University of Alberta, Edmonton, Alta. (*S. 1937*)

GAGE, E. V., B.Sc., (McGill '15), Supt., A. F. Byers Co. Ltd., 1226 University St., Montreal, Que. (*H*) 5600 Queen Mary Rd., Hampstead, Que. (*S. 1914*) (*A.M. 1919*)

GAGE, Ramsay Gray, B.Sc., (Queen's '05), Chief Elec'l. Engr., C.N.R., Montreal, Que. (*H*) Apt. 14, 3488 Cote des Neiges Rd., Montreal, Que. (*M. 1920*)

GAGNON, Elmore G., B.Sc., (McGill '28), Equipment Service Supt., Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*H*) 1045 Mount Royal Blvd., Outremont, Que. (*S. 1925*) (*A.M. 1937*)

GAGNON, Ludger, B.A.Sc., (Ecole Polytech., Montreal '27), S.B., (M.I.T. '28), Asst. City Engr., City of Quebec, Quebec, Que. (*A M. 1935*)

GAHAN, Hugh N., Dftsman, P.W. Dept. B.C., Parliament Bldgs., Victoria, B.C. (*H*) 265 Moss St. (*A.M. 1909*)

♂GAHERTY, Geoffrey Abbott, Capt., B.E., (Dalhousie '09), Pres., Montreal Engineering Co. Ltd., 244 St. James St. W., Montreal, Que. (*H*) 3019 Cedar Ave. (*A.M. 1921*) (*M. 1934*)

♂GALBRAITH, John Stupart, Lieut., M.C., B.A.Sc., R.R. No. 1, York Mills, Ont. (*S. 1910*) (*A.M. 1917*)

GALE, Alfred Valiant, Vice-Pres. and Gen. Mgr., Hull Electric Co. Ltd., 117 Main St., Hull, Que. (*A.M. 1916*)

GALE, George Gordon, M.Sc., (McGill '05), Pres., Gatineau Power Co., 140 Wellington St., P.O. Box 88, Ottawa, Ont. (*H*) 385 Laurier Ave. E. (*A.M. 1908*) (*M. 1916*)

GALE, Melvin Lambeth, B.Sc., (Alta. '27), Armstrong & Monteith Construction Co. Ltd., 1383 Hornby St., Vancouver, B.C. (*H*) 3140-W. 3rd Ave. (*A.M. 1935*)

GALILEE, J. A. M., Asst. Adv. Mgr., Can. Westinghouse Co., Hamilton, Ont (*H*) 5 Rockwood Place. (*Affil. 1930*)

GALLER, Leo, C.E., (Vienna '17), Constrn. Supt., The Atlas Construction Co., Ltd., 679 Belmont St., Montreal, Que. (*H*) 5622 Somerled Ave., N.D.G (*A.M. 1927*)

GALLETLY, Jas Simpson, B.A.Sc., (Tor. '11), D.L.S., Engr., R. H. McGregor Construction Co., 280 Sammon Ave., Toronto 6, Ont. (*H*) 107-27th St., Long Branch, Ont. (*A.M. 1918*)

♂GAMBLE, Clarke William, Lieut., B.Sc., (McGill '07), Cons. Engr., Union Club, Victoria, B.C. (*S. 1906*) (*A.M. 1909*) (*M. 1928*)

GAMBLE, Samuel Gill, (R.M.C. Kingston '32), B.Eng., (McGill '33), Geodetic Survey, Dept. of Mines and Resources, Ottawa, Ont. (*H*) 269 Somerset St. W. (*S. 1933*)

GARDEN, Jos. M. Address unknown. (*S. 1935*)

GARDNER, Albert Chas., Dist. Engr., D.P.W., Parliament Bldgs., Court House, Medicine Hat, Alta. (*A.M. 1922*)

♂GARDNER, Wm. McG., B.Sc., (McGill '17), Supt., Constrn. and Mtce., Montreal Tramways Co., Tramways Bldg., 159 Craig St. W., Montreal, Que. (*H*) 313 Grosvenor Ave., Westmount, Que. (*S. 1916*) (*Jr. 1919*) (*A.M. 1923*)

GAREY, John Dennis, Chief Engr., N.B. Power Co., Saint John, N.B. (*H*) 401 Douglas Ave. (*A.M. 1924*)

♂GARNER, Albert Coleman, Col., D.S.O., V.D., D.L.S., S.L.S., A.L.S., Chief Surveyor, Land Titles Offices, Sask., Regina, Sask. (*H*) 2133 Cameron St. (*S. 1904*) (*A.M. 1908*) (*M. 1916*) (*Life Member*)

♂GARNETT, Chas. Ernest, Lieut., Pres., Gorman's Ltd., 10238-104th St., Edmonton, Alta. (*H*) 10344-132nd St. (*A.M. 1931*) (*M. 1936*)

GARRETT, Julian, A.B., (Harvard '04), Gen. Mgr., Northwestern Utilities, Ltd., 10124-104th St., Edmonton, Alta. (*H*) 10408 Park Rd. (*A.M. 1907*) (*M. 1935*)

♂GARRETT, R. W., Capt., Asst. City Engr., City of London, City Hall, London, Ont. (*H*) 77 Thornton Ave. (*A.M. 1923*)

GARVOCK, Alex. Graham, B.Eng., (McGill '33), B.Com., (McGill '36), 136 Lewis St., Ottawa, Ont. (*S. 1933*)

GASKILL, Frank, Sales Engr., Industrial Engineering Co., 58 Wellington St. E., Toronto, Ont. (*A.M. 1908*)

GATES, Archie B., B.Sc., (Queen's '11), Gen. Engr., Can. Gen. Elec. Co., Peterborough, Ont. (*H*) 307 Margaret Ave. (*A.M. 1919*)

GATES, Grant Gordon, Constrn. Engr., Steel Co. of Canada, Ltd., Hamilton, Ont. (*H*) 198 Fairleigh Ave. S. (*Jr. 1922*)

GATHERCOLE, John Wm., B.Sc., (Queen's '27), Steam Plant Engr., Price Bros & Co. Ltd., Box 103, Kenogami, Que. (*S. 1927*) (*Jr. 1931*) (*A.M. 1936*)

♂GAUDET, Frederick Mondelet, Col., C.M.G., (R.M.C. Kingston), 1455 Drummond St., Montreal, Que. (*M. 1903*) (*Life Member*)

GAUER, Edward, B.Sc., (Man. '26), L.S. and Municipal Engr., 275 Evanson St., Winnipeg, Man. (*S. 1924*) (*A.M. 1935*)

GAUTHIER, Paul Gilles, B.Sc., (McGill '21), Q.L.S., Townsite Engr., Quebec North Shore Paper Co., Baie Comeau, Que. (*H*) 645 Querbes Ave., Outremont, Que. (*S. 1919*) (*Jr. 1922*) (*A.M. 1928*) (*M. 1935*)

GAUTHIER, René, B.A.Sc., (Ecole Polytech., Montreal '38), Provincial Electricity Bd., 67 Grande Allée, Quebec, Que. (*S. 1936*)

GAUVIN, Hervé A., B.Sc., (Sask. '22), B.Sc., (McGill '26), Asst. Supt., Belanger Ltd., Montmagny, Que. (*S. 1925*) (*Jr. 1928*)(*A.M. 1937*)

♂GAYFER, Arthur John, Major, Asst. Divn. Engr., C.N.R., Edmonton, Alta. (*H*) 9917-108th St. (*A.M. 1905*) (*M. 1916*) (*Life Member*)

♂GEALE, Chas. Norman, Capt., B.A.Sc., (Tor. '15), Asst. Engr., Southern Divn., Welland Ship Canal, Dept. of Transport, Port Colborne, Ont. (*S. 1915*) (*A.M. 1930*)

GEIGER, D. G., B.Sc., (Queen's '22), Transm. Engr., W.A., Bell Telephone Co. of Canada, 76 Adelaide St. W., Toronto, Ont. (*H*) 90 Dunloe Rd. (*S. 1922*) (*A.M. 1928*) (*M. 1938*)

GELDARD, P. W., B.A.Sc., (Tor. '29), Supt., Street Dept., Consumers' Gas Co., 19 Toronto St., Toronto, Ont. (*H*) 432 Walmer Rd. (*Jr. 1928*) (*A.M. 1932*)

GENDERS, Percy Robert, Examiner, Surveys Branch, Land Titles Offices, Regina, Sask. (*H*) 2243 Albert St. (*A.M. 1917*)

♂GENET, John Ernest, Major, M.C., Vimy Barracks, Kingston, Ont. (*A.M 1936*)

GENTLES, Allan Summerhayes, B.Sc., (McGill '14), Mgr., Pacific Divn., Dom. Bridge Co. Ltd., 275 First Ave. W., Vancouver, B.C. (*H*) 1525-W 25th Ave. (*M. 1930*)

GEORGE, Jos. David, B.E., (Sask. '33), Jr. Engr., P.F.R.A., Dept. of Agriculture, Regina, Sask. (*H*) 1331 Henry St., North Battleford, Sask. (*Jr. 1937*)

GERIN, Maurice, B.Sc., (Ecole Polytech., Montreal '20), M.Sc., (M.I.T. '21), Dept. Mgr., Can. Fairbanks-Morse Co., 980 St. Antoine St., Montreal, Que. (*H*) 1740 Ducharme Ave., Outremont, Que. (*Jr. 1923*) (*A.M. 1932*)

♂GERMAN, Alan Macdonnell, Capt., B.A.Sc., (Tor. '14), Asst. Mgr. and Gen. Supt., Can. Dredging Co. Ltd., 302 Harbour Commission Bldg., Toronto, Ont. (*M. 1934*)

♂GEROW, Carlyle, B.Sc., (Queen's '22), Dist Mgr. Coal Sales, Ont., Dom. Coal Co. Ltd., and Dom. Steel & Coal Co., 159 Bay St., Toronto, Ont. (*H*) 57 Elderwood Drive. (*A.M. 1931*)

GERSOVITZ, Frank, B.Eng., (McGill '32), 3980 Cote des Neiges Rd., Montreal, Que. (*S. 1930*) (*Jr. 1938*)

GERSHFIELD, Max, B.Sc., (Man. '37), Refinery Engr., Radio Oil Refineries Ltd., Winnipeg, Man. (*H*) 371 College Ave. (*S. 1937*)

GERVAIS, Aime, B.A.Sc., (Ecole Polytech., Montreal '38), 480 Sherbrooke St. E., Montreal, Que. (*S. 1936*)

♂GIBB, Hugh M., Major, Balfour Beatty & Co. Ltd., 58-60 Cannon St., London, E.C.4. (*A.M. 1910*)

GIBB, Robert J., Commr. of Utilities, Civic Block, Edmonton, Alta. (*H*) 9837-93rd Ave., Edmonton South, Alta. (*A.M. 1910*) (*M. 1914*)

GIBBON, H. S. V., Traffic Asst., The Bell Telephone Co. of Canada, Ottawa, Ont. (*H*) 101 Ruskin St. (*Jr. 1927*)

GIBBS, C. R., B.Sc., (McGill '16), Chief Engr., Kalamazoo Vegetable Parchment Co., Kalamazoo, Mich. (*H*) 295 Glendale Blvd., Parchment, Mich. (*S. 1914*) (*A.M. 1927*)

GIBEAU, Henri Adelard, C.E., (Renss. '08), Asst. Chief City Engr., City of Montreal, City Hall, Montreal, Que. (*H*) 5618 Phillips Ave. (*A.M. 1915*)

GIBSON, Alfred, B.A.Sc., (Tor. '03), Kilmer & Barber, Fleet St. and Spadina Ave., Toronto, Ont. (*A.M. 1906*)

♂GIBSON, John McI., Lt.-Col., D.S.O., B.A.Sc., (Tor. '10), Private Practice (Str'l), 154 Wright Ave., Toronto, Ont. (*Jr. 1914*) (*A.M. 1919*)

†GIBSON, Norman R., D.Eng., B.A.Sc., (Tor. '04), Vice-Pres. and Chief Engr., Buffalo, Niagara & Eastern Power Corp., 600 Electric Bldg., Buffalo, N.Y. (*H*) Mountain View Drive, Lewiston Heights, Lewiston, N.Y. (*A.M. 1907*) (*M. 1921*)

♂GIFFORD, F. Darrell, Major, M.C., Municipal Engr., Sutcliffe Co. Ltd., Box 543, New Liskeard, Ont. (*Jr. 1922*) (*A.M. 1927*)

♂GILBERT, Edgar V., B.Sc., (McGill '23), Strl. Engr., Penitentiaries Br., Dept. of Justice, Room 520, Justice Bldg., Ottawa, Ont. (*H*) 85 Grove Ave. (*S. 1920*) (*Jr. 1924*) (*A.M. 1928*)

♂GILBERT, Gordon McD., B.Sc., (Man. '26), A/Engr. and Supt., Vancouver and District Joint Sewerage and Drainage Bd., Sun Bldg., Vancouver, B.C. (*A.M. 1934*) (*M. 1935*)

♂GILCHRIST, Jas. MacD., Lieut., R.N.V.R., St. Joseph d'Alma, Que. (*S. 1908*) (*A.M. 1914*)

GILCHRIST, John, B.Sc., (N.B. '32), Spruce Falls Power & Paper Co., Kapuskasing, Ont. (*Jr. 1934*) (*A.M. 1937*)

GILCHRIST, T. E., B.Sc., (McGill '10), Works Engrg. Dept., Can. Gen. Elec. Co., Peterborough, Ont. (*H*) 168 Brock St. (*A.M. 1919*)

GILDEA, W. F. P., B.Eng., (McGill '36), Dom. Rubber Co. Ltd., Montreal, Que. (*H*) 3647 University St. (*S. 1935*)

GILES, B. H. D., B.Sc., (McGill '27), Can. S.K.F. Co. Ltd., 1101 Beaver Hall Hill, Montreal, Que. (*Jr. 1929*)

GILES, John Oscar, B.Sc., (Queen's '37), Combustion Dept., Imperial Oil Ltd., Sarnia, Ont. (*H*) 111 Kathleen Ave. (*S. 1937*)

♂GILL, L. W., Lt.-Col., M.Sc., Principal, Technical Institute, Bd. of Education, Hamilton, Ont. (*H*) Waterdown, Ont. (*A.M. 1901*) (*M. 1912*)

GILLETT, Geo. Herbert, B.Sc., (McGill '24), Sales Engr., Can. Gen. Elec. Co. Ltd., 1000 Beaver Hall Hill, Montreal, Que. (*H*) Apt. 92, 4870 Cote des Neiges. (*S. 1924*) (*A.M. 1936*)

GILMORE, Ross Earlby, B.A., M.A., (McMaster '13), M.Sc., (Illinois '16), Sr. Engr., Fuels Divn., Fuel Research Lab., Dept. Mines and Resources, Ottawa, Ont. (*H*) 334 First Ave. (*M. 1926*)

GILMOUR, W. A. T., B.Sc., (McGill '26), Engr., The Smart-Turner Machine Co. Ltd., Hamilton, Ont. (*H*) 49 St. James Place. (*S. 1924*) (*Jr. 1930*) (*A.M. 1936*)

GIRDWOOD, Arthur J., B.A.Sc., (Tor. '34), A.C. Engrg. Dept., Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*H*) 582 Sherbrooke St. (*S. 1931*) (*Jr. 1936*)

GISBORNE, Hartley, 288 E. 23rd Ave., Vancouver, B.C. (*A.M. 1887*) (*M. 1892*) (*Life Member*)

GISBORNE, Lionel L., B.Sc., (McGill '99), Works Supt., Niagara Parks Comm., Queen Victoria Park, Niagara Falls, Ont. (*H*) 1811 Prince Edward Ave. (*A.M. 1919*)

GISLASON, Stefan Ingnor, B.Sc., (Man. '31), Dept. of Highways, Ont. (*H*) 118 Rupert Rd., Kenora, Ont. (*Jr. 1938*)

GLIDDON, W. G. C., B.Sc., (McGill '21), M.Sc., '22, Chief Engr., Gatineau Power Co., P.O. Box 88, Sta. A., Ottawa, Ont. (*H*) 430 Nelson St. (*A.M. 1930*)

♂GLOVER, T. Stanley, Lieut., M.C., B.A.Sc., (Tor. '22), Mgr., Indust. Dept., Russell T. Kelley Ltd. (Advertising), 150 Main St. E., Hamilton, Ont. (*H*) 88 Glenfern Ave. (*S. 1914*) (*Jr. 1922*) (*A.M. 1926*)

♂GNAEDINGER, F. Theo., Lieut., M.M., B.Sc., (McGill '12), 451 Mt. Pleasant Ave., Westmount, Que. (*S. 1911*) (*Jr. 1916*) (*A.M. 1921*)

♂GOBY, Thomas, B.Sc., (Tri-State '25), Sales Engr., Armco Culvert Mfg. Assoc., W. Q. O'Neall Co., Crawfordsville, Ind. (*H*) 923 E. Hunter, Bloomington, Ind., U.S.A. (*S. 1921*) (*Jr. 1931*) (*A.M. 1934*)

GODARD, Hugh Phillips, B.A.Sc., M.A.Sc., (B.C. '36), Cons. Copper and Sulphur Co., Eustis, Que. (*S. 1938*)

GODDARD, Albert Reginald, 696 Strathcona St., Winnipeg, Man. (*S. 1937*)

GODFREY, Wm. R., B.Sc., (N.B. '35), Asst. Highway Engr., D.P.W. of N.B., P.O. Box 107, Chatham, N.B. (*Jr. 1938*)

GODIN, Chas., C.E., (Ecole Polytech., Montreal '15), Q.L.S., Engr., Technical Service, City of Montreal, City Hall, Montreal, Que. (*H*) 6835 St. Denis St. (*A.M. 1925*)

♂GODSON, Reginald Gilbert, Capt., Harkness & Hertzberg, 57 Bloor St. W., Toronto, Ont. (*H*) 92 Glengrove Ave. W. (*A.M. 1935*) (*M. 1936*)

GODWIN, Harold B., B.Sc., (McGill '28), S/L., R.C.A.F., Officer Commanding Wireless School, Trenton, Ont. (*H*) 221 John St., Belleville, Ont. (*S. 1925*) (*A.M. 1936*)

GOEDIKE, Frederick B., B.Sc., (Queen's '10), 201 Humberside Ave., Toronto 9, Ont. (*S. 1910*) (*A.M. 1913*) (*M. 1936*)

GOHIER, Jas. A. E., B.Sc., (McGill '13), D.L.S., Cons. Engr., 10 St. James St. E., Montreal, Que. (*H*) 821 Wilder Ave., Outremont, Que. (*M. 1934*)

GOHIER, Roch Edward, (R.M.C. Kingston '37), Apt C-51, 1321 Sherbrooke St. W., Montreal, Que. (*S. 1937*)

GOLD, Wm. John, B.Sc., (Alta. '33), Asst. Constrn. Engr., Calgary Power Co., Calgary, Alta. (*S. 1933*) (*Jr. 1936*)

GOLDMAN, Hyman A., C.E., (Valparaiso '12), Apt. 2, 1125 Lajoie Ave., Outremont, Que. (*Jr. 1915*) (*A.M. 1918*)

GOOD, E. F., B.A.Sc., (Tor. '24), Strl. Engr., Can. Kodak Co., Toronto, Ont. (*H*) 2520 Bloor St. W. (*S. 1920*) (*A.M. 1930*)

GOODALL, E. Lorne, B.Sc., (McGill '24), Res. Engr., Provincial Paper Ltd., Port Arthur, Ont. (*H*) 18 Winnipeg Ave. (*S. 1924*) (*Jr. 1929*) (*A.M.1934*)

♂GOODCHILD, Ralph Henry, Lieut., 3817-7A St. W., Calgary, Alta. (*A.M. 1920*)

GOODMAN, Hyman B., 5653 Hutchisod St., Montreal, Que. (*S. 1928*) (*Jr. 1937*)

♂GOODMAN, H. Meyer, B.A.Sc., (Tor.), Imperial Bank Bldg., 171 Yonge St., Toronto, Ont. (*Jr. 1915*) (*A.M. 1917*)

GOODMAN, J. E., B.Sc., (Queen's '31), Engr. Country Rds., County of Frontenac, Court House, Kingston, Ont. (*H*) 131 King St. (*Jr. 1931*) (*A.M. 1934*)

♂†GOODRICH, Chauncey M., Major, M.A., C.E., (Vermont), A.M., (Harvard), Chief Engr., Can. Bridge Co., Ltd., Walkerville, Ont. (*H*) 30 Moy Ave., Windsor, Ont. (*A.M. 1907*) (*M. 1916*)

GOODSPEED, Frederic G., M.A., B.Sc., (N.B. '04), Supt'g Engr., D.P.W. Canada, Ottawa, Ont. (*A.M. 1909*) (*M. 1918*)

GOODSPEED, Herbert N., B.Sc., (N.B. '34), 745 George St., Fredericton, N.B. (*S. 1934*)

♂GOODWIN, Edward Arthur, Major, Montreal Engineering Co., 244 St. James St., Montreal, Que. (*A.M. 1934*)

♂GOODWIN, Leo Frank, Lt.-Col., Ph.D., (A.C.G.I.), Prof. Chem. Engrg., Queen's University, Kingston, Ont. (*H*) 311 King St. W. (*M. 1922*)

GORDON, Chas. Howard, B.Sc., (McGill '24), (R.M.C. Kingston '22), Vice-Pres., The Atlas Construction Co., 679 Belmont St., Montreal, Que. (*Jr. 1925*) (*A.M. 1931*)

GORDON, Harry J., B.Sc., (McGill '23), Sales Engr., Thomson Electrical Wks. Ltd., Montreal, Que. (*H*) Apt. 19, 5145 Cote St. Luc Rd. (*A.M. 1937*)

GORDON, H. C. M., B.Sc., (McGill '23), Dom. Steel & Coal Corp., Sydney, N.S. (*Jr. 1924*)

GORDON, Hugh John, B.Eng., (McGill '33), Engrg. Dept., C.P.R., Room 401, Windsor Station, Montreal, Que. (*S. 1933*) (*Jr. 1938*)

♂GORDON, Jas. Lindsay, Air Vice-Marshall, D.F.C., D.O.C., M.D. No. 10, Dept. National Defence, Fort Osborne Barracks, Winnipeg, Man. (*A.M. 1924*)

GORDON, James MacKendrick, Sales Mgr., The Warren Bituminous Paving Co., 437 Fleet St. W., Toronto, Ont. (*H*) 29 Woodlawn Ave. W. (*Jr. 1918*) (*A.M. 1919*)

GORDON, James P., (Tor. '04), Engr., City of Hamilton, Ont. (*H*) 133 Hyde Park Ave., Hamilton, Ont. (*S. 1907*) (*A.M. 1913*)

GORDON, John, Elect. Engr., C.N.R., Union Sta., Winnipeg, Man. (*H*) 252 Niagara St. (*A.M. 1920*)

GORDON, John Edward, B.Sc., (Queen's '37), John Bertram & Sons Co., Dundas, Ont. (*H*) 320 King St. W., Dundas, Ont. (*S. 1935*)

GORMAN, David Donald, B.Sc., (N.B. '34), 188 O'Dell Ave., Fredericton, N.B. (*S. 1934*)

GOUGH, R. W., B.Sc., (N.B., '26 and '32), 63 Shore St., Fredericton, N.B. (*S. 1926*)

♂GRAHAM, Andrew Geo., (R.T.C., Glasgow), City Engr., City Hall, Nanaimo, B.C. (*H*) 315 Kennedy St. (*A.M. 1919*)

GRAHAM, Frank Charles, Asst. City Engr., Port Arthur, Ont. (*H*) 157 College St. (*A.M. 1921*)

GRAHAM, George, B.Sc., (Sask. '33), Can. Underwriters' Assoc., Montreal, Que. (*H*) Apt. 12, 5891 Sherbrooke St. W., Westmount, Que. (*Jr. 1937*)

GRAHAM, Walter White, B.Sc., (McGill '25), Engr., Shawinigan Engineering Co., Power Bldg., Montreal, Que. (*H*) 4565 Hampton Ave., N.D.G. (*S. 1923*) (*Jr. 1928*) (*A.M. 1935*)

GRAHAME, Dallas F., B.Sc., (McGill '10), Chief Engr., Atwood Ltd., 1627 University Tower, Montreal, Que. (*H*) 532 Grosvenor Ave., Westmount, Que. (*A.M. 1925*)

GRANDMONT, Bruno, B.A.Sc., C.E., Dist. Engr., Dept. P.W., Canada, Rimouski, Que. (*S. 1913*) (*A.M. 1917*)

♂GRANGE, Edward Rochfort, Capt., D.S.C., C. de G., B.A.Sc., (Tor. '15), Vice-Pres., Delamere & Williams, Ltd.; Pres., Delamere, Williams, Grange, Ltd.; Sec.-Treas., Vacu-Draft, Ltd, 18-32 Hook Ave., Toronto 2, Ont. (*H*) 34 Chicora Ave. (*S. 1914*) (*A.M. 1922*)

GRANGER, Andrew Scott, Dom. Bridge Co. Ltd., Vancouver, B.C. (*H*) 1266 Haro St. (*A.M. 1921*)

GRANSAULL, L. R., Land Surveyor, St. Joseph, Trinidad, B.W.I. (*S. 1905*) (*A.M. 1911*)

GRANSAULL, Paul R., Rd. Officer, Tacariqua Local Rd. Bd., Tunapuna, Trinidad, B.W.I. (*H*) "Paspebiac," Tunapuna, Trinidad, B.W.I. (*S. 1905*) (*A.M. 1911*)

GRANT, Alex. Geo., B.A.Sc., (Tor. '27), 54 Golfdale Rd., Toronto 12, Ont. (*S. 1927*) (*Jr. 1930*) (*A.M. 1938*)

✠GRANT, A. J., 16 Hillcrest Ave., St. Catharines, Ont. (*A.M. 1891*) (*M. 1901*) (*Past President*)

GRANT, Alex. J., Jr., B.Sc., (McGill '29), Angus Robertson Ltd., University Tower, Montreal, Que. (*H*) 3847 Wilson Ave., N.D.G. (*S. 1925*) (*Jr. 1931*) (*A.M. 1938*)

GRANT, Clifford Gordon, N.B.L.S., Res. Engr., Dept. of Highways, N.B., Fredericton, N.B. (*A.M. 1920*)

GRANT, Eric, 3645 Jeanne Mance St., Montreal, Que. (*Jr. 1935*) (*A.M. 1938*)

GRANT, Gordon, 334 Russell Hill Rd., Toronto 5, Ont. (*A.M. 1898*) (*M. 1906*) (*Life Member*)

♂GRANT, John R., Major, M.C., B.Sc., (Queen's '04), Cons. Engr., 1203 Sun Bldg., Vancouver, B.C. (*H*) 2960 W. 44th Ave. (*S. 1903*) (*A.M. 1911*) (*M. 1914*)

GRANT, Lawford Stanley Foster, Pres. and Man. Dir., Phillips Electrical Works, Ltd., Brockville, Ont. (*H*) High View, Brockville, Ont. (*A.M. 1912*)

♂GRANT, LeRoy Fraser, Lt.-Col., (R.M.C., Kingston '05), B.Sc., (Queen's '25), B.C.L.S., Assoc. Prof. of Engrg., Royal Military College, Kingston, Ont. (*H*) 83 Gore St. (*S. 1908*) (*A.M. 1913*) (*M. 1927*)

♂GRANT, Wm. Roy, B.Sc., (McGill '15), Pres., Burnett-McQueen Co. Ltd., Box 39, Fort William, Ont. (*M. 1938*)

GRANVILLE, Francis X., B.Sc., (N.S.T.C. '34), 83 Dresden Row, Halifax, N.S. (*S. 1930*)

GRATTON, Alphonse, B.A.Sc., (Ecole Polytech., Montreal '12), Q.L.S., Dist. Engr., Quebec Roads Dept., Parliament Bldgs., Quebec, Que.; Prof. of Highway Engrg., University of Montreal. (*H*) Apt. 6, 83 St. Louis Rd., Quebec, Que. (*M. 1935*)

GRAV, Bjarne, M.E., (Oslo. '13), Mech. and Res. Engr., Can. International Paper Co., P.O. Box 32, Temiskaming, Que. (*A.M. 1927*)

GRAVEL, Arthur L., B.Sc., (McGill '24), Bell Telephone Co. of Canada, Room 1411, Beaver Hall Bldg., Montreal, Que. (*Jr. 1929*)

GRAVEL, L. P., B.Sc., (Ecole Polytech. Montreal '27), Dept. P.W., Parliament Bldgs., Quebec, Que. (*H*) 498 Royale Ave., Beauport, Que. (*S. 1923*) (*Jr. 1932*)

GRAY, Alexander, Chief Engr. and Port Mgr., National Harbours Bd., Saint John, N.B. (*H*) 28 Garden St. (*A.M. 1907*) (*M. 1916*)

♂GRAY, Andrew Jack, Lieut., B.A.Sc., (Tor. '13), Mech. Engr., Marine Iron Wks. Ltd., 515 Pembroke St., Victoria, B.C. (*H*) 1066 St. Patrick St. (*A.M. 1919*)

♂GRAY-DONALD, E. D., B.Sc., (McGill '26), M.Sc., (Laval '34), Asst. Gen. Supt., Power Divn., Quebec Power Co., Box 730, Quebec, Que. (*H*) 12 St. Denis Ave. (*S. 1922*) (*Jr. 1926*) (*A.M. 1934*)

GRAY, Francis Wm., LL.D., Asst. Gen. Mgr., Dom. Steel and Coal Corp., Sydney, N.S. (*A.M. 1921*) (*M. 1924*)

GRAY, Harry Alden, B.Sc., (Man. '35), Knowlton P.O., Que. (*Jr. 1937*)

GRAY, John Hamilton, R.M.D.I., Albert Head, V.I., B.C. (*M. 1906*) (*Life Member*)

GRAY, J. Lorne, M.Sc., (Sask. '38), Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*H*) 426 Park St. (*S. 1938*)

♂GRAY, Samuel Wilson, B.Sc., (N.S.T.C. '14), Asst. Hydr. Engr., N.S. Power Comm., Province Bldg., Halifax, N.S. (*H*) 4 Waterloo St. (*A.M. 1920*)

GREEN, F. C., B.A., (N.B.), D.L.S., B.C.L.S., Surveyor General of B.C., Parliament Bldgs., Victoria, B.C. (*H*) 347 Foul Bay Rd. (*M. 1914*)

♂GREEN, F. Gordon, B.Sc., (McGill '21), Divn. of Chemistry, National Research Council, Ottawa, Ont. (*H*) 130 Cochrane Rd., Rockcliffe Park. (*S. 1920*) (*Jr. 1924*) (*A.M. 1929*)

♂GREEN, John, Cons. Engr., 1915-W 14th Ave., Vancouver, B.C. (*M. 1936*)

GREEN, John S., B.A.Sc., (Tor. '34), Wm. Jessop & Sons Ltd., 59 Frederick St., Toronto, Ont. (*H*) 40 College St. (*S. 1931*)

GREEN, Leonard, Sales Engr., Calgary Br., Crane Ltd., Calgary, Alta. (*H*) 535-12th Ave. N.E. (*A.M. 1923*)

GREENBERG, Louis, B.Sc., (McGill '93), Engr. and Contractor, 7 E. 42nd St., New York, N.Y. (*H*) 123 W. 57th St. (*S. 1892*) (*A.M. 1899*)

GREENE, John F., B.A., (M.I.T.), Ford, Bacon & Davis, Inc., 39 Broadway, New York, N.Y. (*H*) A-1 N. Fullerton Ave., Montclair, N.J. (*A.M. 1918*) (*M. 1919*)

♂†GREENE, Philip Weston, Capt., B.A.Sc., (Tor. '09), D.L.S., Sales Engr., United States Steel Products Co., 30 Church St., New York, N.Y. (*H*) 9 Laurel Hill Rd., Moudtain Lakes, N.J. (*S. 1908*) (*A.M. 1912*)

♂GREENING, Edward Owen, Capt., 7303-104th St., Edmonton, Alta. (*A.M. 1931*)

GREENWOOD, F. D., B.Sc., (Queen's '31), Mech. Dftsman, Hollinger Gold Mines Ltd., Box 2400, Timmins, Ont. (*S. 1928*) (*Jr. 1935*)

GREENWOOD, Wm., B.Sc., (Queen's '22), 395 Beach Blvd., Hamilton Beach, Ont. (*S. 1921*) (*A.M. 1926*)

GREGOIRE, Armann E., B.A.Sc., (Ecole Polytech. Montreal '35), 6349 St. Denis St., Montreal, Que. (*S. 1935*)

♂GREGORY, Alex. Watson, Capt., M.C., Asst. Engr., Dept. P.W., Canada, Federal Bldg., Halifax, N.S. (*Jr. 1912*) (*A.M. 1919*)

GREGORY, P. S., B.A., B.A.Sc., (McGill '11), Asst. Gen. Mgr., The Shawinigan Water and Power Co., 611 Power Bldg., Montreal, Que. (*H*) 4081 Highland Ave. (*A.M. 1920*) (*M. 1925*)

GREIG, Alex. R., B.Sc., (McGill '95), Prof. Emeritus, Mech. Engrg., University of Saskatchewan, Saskatoon, Sask. (*S. 1895*) (*A.M. 1909*) (*M. 1919*) (*Life Member*)

GREIG, J. M. M., (R.T.C. Glasgow), Designer, Sanborn & Bogert, 30 Church St., New York, N.Y. (*H*) 101 Fairview Ave., Port Washington, L.I., N.Y. (*A.M. 1913*)

GREIG, Wm. B., Asst. City Engr., City of Vancouver, City Hall, Vancouver, B.C. (*H*) 5874 Larch St. (*A.M. 1911*)

GRENON, John F., B.A., (Laval), Cons. Engr., 75 Ave. Manrese, Quebec, Que. (*S. 1907*) (*A.M. 1909*)

♂GRENZEBACH, Sylvester Leslie, B.A.Sc., (Tor. '24), 91 MacLaren St., Ottawa, Ont. (*S. 1920*) (*A.M. 1927*)

GRIESBACH, Robt. Jas., B.A.Sc., (Tor. '24), Engr., The Foundation Co. of Canada Ltd., 1538 Sherbrooke St. W., Montreal, Que. (*S. 1923*) (*A.M. 1927*)

GRIESBACH, Walter, B.Sc., (Queen's '12), Chief Engr., The Foundation Co. of Canada Ltd., 1538 Sherbrooke St. W., Montreal, Que. (*H*) 522 Victoria Ave., Westmount, Que. (*S. 1912*) (*Jr. 1916*) (*A.M. 1922*)

GRIEVE, John, Sales Promotion Mgr., Imperial Varnish & Color Co. Ltd., Toronto, Ont. (*H*) 159 Forest Hill Rd. (*S. 1909*) (*A.M. 1915*) (*M. 1923*)

GRIFFIN, Augustus, B.Sc., (Calif. '06), Chief Engr., D.N.R., C.P.R., Calgary, Alta. (*H*) Strathmore, Alta. (*M. 1925*)

♂GRIFFIN, Frank F., B.Sc., Winnipeg Electric Co., Winnipeg Electric Rly. Chambers, Winnipeg, Man. (*H*) 183 Yale Ave. (*S. 1907*) (*A.M. 1913*)

GRIFFITH, John, Bron Seiont, Segontium Terrace, Caernarvon, N. Wales. (*A.M. 1919*)

GRIFFITH, John Edgar, 1229 Oliver St., Oak Bay, Victoria, B.C. (*M. 1912*)

♂GRIFFITHS, Geo. Ewart, B.A.Sc., (Tor. '15), Asst. Dist. Meter Engr., H.E.P.C. of Ont., Box 385, Thorold, Ont. (*A.M. 1933*)

GRIFFITHS, Geo. H., B.Sc., (Man. '35), M.Eng., (McGill '38), 1210 Bishop St., Montreal, Que. (*H*) 212 Forest Ave., W. Kildonan, Man. (*S. 1935*)

GRIFFITHS, W. E., B.Sc., (McGill '31), Engr., C.N.R., Montreal, Que. Address: Gorham, N.H. (*Jr. 1930*)

GRIME, Leonard, B.A.Sc., (Tor. '26), Hamilton Bridge Co. Ltd., Hamilton, Ont. (*H*) Apt. 11, Norfolk Apts., 145 Hess St. S. (*Jr. 1928*) (*A.M. 1937*)

GRIMMER, Allan K., B.A.I., M.Sc., (N.B. '07), Mgr., Town Dept., Can. International Paper Co., Temiskaming, Que. (*H*) 293 Kipawa Rd. (*A.M. 1910*) (*M. 1920*)

GRINDLEY, Frank L., B.Sc., (Alta. '26), Hydr. Engr., Water Resources Br., Alta. (*H*) 10942-80th Ave., Edmonton, Alta. (*S. 1925*) (*Jr. 1928*) (*A.M. 1938*)

GROLEAU, A. J., B.Sc., (McGill '28), Gen. Traffic Dept., Bell Telephone Co. of Canada, 1050 Beaver Hall Hill, Montreal, Que. (*H*) 4876 Westmount Ave., Westmount, Que. (*S. 1928*) (*Jr. 1937*)

GROSS, Philip Norcross, B.Sc., (McGill '26), Vice-Pres. and Mgr., Anglin-Norcross Ontario Ltd., 57 Bloor St. W., Toronto, Ont. (*H*) 523 Lyttod Blvd. (*A.M. 1932*)

GROUT, Raymond E., B.Sc., (Alta. '36), Shawinigan Water & Power Co. Ltd., Power Bldg., Montreal, Que. (*H*) 4063 Dorchester St. W. (*S. 1936*)

GROVE, Humphrey S., B.Sc., (McGill '09), Designing Engr., Power Corpn. of Canada, Ltd., 355 St. James St., Montreal, Que. (*H*) 135 Brock Ave. S. (*Jr. 1913*) (*A.M. 1918*)

GROVES, F. W., B.C.L.S., Cons. Engr., Box 136, Kelowna, B.C. (*M. 1913*)

GRUENIG, Ernest, Designing Engr., The Montreal Water Bd., 3161 Joseph St., Montreal, Que. (*H*) 520 Ville Marie, Viauville. (*A.M. 1929*)

♂GRUMMITT, Edmund, Dom. Bridge Co. Ltd., Montreal, Que. (*H*) 14 Elm St., St. Catharines, Ont. (*A.M. 1917*)

GRUNSTEN, A. W., B.A.Sc., (Tor. '28), Can. Industries, Ltd., P.O. Box 1260, Montreal, Que. (*H*) 945 Caledonia Rd., Town of Mount Royal, Que. (*Jr. 1928*)

GUAY, Jean F., Blvd. Vallée, Beauport, Que. (*A.M. 1887*) (*M. 1907*) (*Life Member*)

GUÉNETTE, Paul, 5787 Cartier St., Montreal, Que. (*S. 1936*)

GUIHAN, W. B., Can. Celanese Ltd., 24 Celanese Rd., Drummondville, Que. (*H*) 13 Dumoulin St. (*S. 1936*)

GUILDFORD, Jos. R., Private Practice, 412 Westman Chambers, Regina, Sask. (*H*) 2906-19th Ave. (*1938*)

GUIMONT, Michael L., B.Sc., Deputy-Director, Unemployment Relief, D.P.W. & L., Parliament Bldgs., Quebec, Que. (*H*) 192 Maisonneuve Ave. (*S. 1906*) (*A.M. 1912*)

GUMLEY, F. Stewart, Mgr., Strl. and Bridge Wrks., Burn & Co. Ltd., Howrah, Bengal, India. (*H*) 22 Belvedere Rd., Alipore, Calcutta, India. (*A.M. 1931*)

♂GUNN, Angus Stirling, Lieut., M.C., Right of Way Engr., C.N.R., Moncton, N.B. (*H*) 76 John St. (*A.M. 1921*)

GUNN, William W., B.A.Sc., (Tor. '10), Engr., Ont. Divn., Dom. Bridge Co. Ltd., Reford Bldg., Toronto, Ont. (*H*) 251 Lytton Blvd., Toronto 12, Ont. (*A.M. 1917*)

GUNNING, M. P., B.Eng., (McGill '35), Northern Electric Co. Ltd., Montreal, Que. (*H*) 40 Aberdeen Ave., St. Lambert, Que. (*S. 1935*)

GURNHAM. Robt. Allan, Works Mgr., Darling Bros., Ltd., 140 Prince St., Montreal, Que. (*H*) 5811 Notre Dame de Grace Ave. (*A.M. 1925*)

♂GUY, Richard W., M.M., B.Sc., (McGill '15), Sr. Examiner, Dept. Trade and Commerce, Rm. 124 West Block, Ottawa, Ont. (*H*) 451 Echo Drive. (*S. 1914*) (*Jr. 1926*) (*A.M. 1930*)

GWYER, W. K., Location and Constrn. Engr., Govt. of B.C., Yale, B.C. (*A.M. 1909*) (*M. 1913*)

GZOWSKI, Casimir Stanislaus, Chief Engr., Constrn. Dept., C.N.R., 360 McGill St., Montreal, Que. (*H*) 6 Belvedere Rd., Westmount, Que. (*S. 1897*) (*A.M. 1904*) (*M. 1909*)

♂GZOWSKI, Harold N., Lt.-Col., Pres., Toronto Ignition Co. Ltd., 1366 Yonge St., Toronto, Ont. (*H*) 63 Wells Hill Ave. (*S. 1907*) (*A.M. 1911*)

G.†HAANEL, Benj. F. C., B.Sc., (Syracuse '99), Chief, Divn. of Fuels, Bureau Mines, Dept. of Mines and Resources, Ottawa, Ont. (*H*) 236 First Ave. (*M. 1918*)

HADDIN, John, Haddin & M les, Ltd., Gen. Cons. Practice, 9 Argyle Court, Calgary, Alta. (*A.M. 1911*) (*M. 1913*)

HADDOW, A. W., B.Sc., (Queen's '09), City Engr., Edmonton, Alta. (*H*) 10635-125th St. (*A.M. 1916*)

♂HADLEY, Arthur, Designing Dftsman, H.E.P.C. of Ont., Toronto, Ont. (*H*) 25 Webb Ave. (*A.M. 1921*)

♂HADLEY, W. F., Lt.-Col., (R.M.C., Kingston '14), Mgr., Scott Estate, 17 Main Street, Hull, Que. (*H*) 28 Aylmer Rd. (*S. 1914*) (*Jr. 1919*) (*A.M. 1930*)

HAGERMAN, Bernard Harrison, B.Sc., (N.B. '23), Asst. Bridge Engr., D.P.W., N.B. (*H*) 74 Lansdowne St., Fredericton, N.B. (*Jr. 1923*) (*A.M. 1936*)

HAGUE, Edward Cousins, B.Sc., (McGill '23), Director, Chief Engr., Quadrant Carbon and Metal Products Ltd., Cumberland Rd., Stanmore, Middlesex, England. (*S. 1922*) (*A.M. 1930*)

HAIGHT, Harry Vercoe, B.A.Sc., (Tor. '97), Cons. Engr., Ingersoll-Rand Co., Ltd., Wyburn, Kingsway, Gerrards Cross, Bucks., England. (*H*) 165 Queen Victoria Rd., London. (*M. 1920*)

♂HAIMES, Jas., City Engr., City of Lethbridge, City Hall, Lethbridge, Alta. (*H*) 818-15th St. So. (*A.M. 1925*)

HAINES, N. S., B.A.Sc., (Tor. '35), Chaput-Hughes, Ont. (*Jr. 1938*)

HAIRSINE, Sydney' Asst. Engr. (Elec.), Welland Ship Canal, Dept. of Transport, St. Catharines, Ont. (*H*) 70 Ontario St. S. (*A.M. 1932*)

HALE, Geo. Raymond, S.B., (Harvard '12), M.Sc., Elec. Engr., Shawinigan Water and Power Co., Power Bldg., Montreal, Que. (*H*) 38 Lazard Rd., Town of Mt. Royal, Que. (*A.M. 1927*)

HALL. Gordon Hudson, (R.M.C., Kingston' 38), 88 London St., Peterborough, Ont. (*S. 1937*)

HALL, John G., B.Sc., (McGill '21), Asst. to Vice-Pres., Combustion Engineering Corp., Ltd., 540 Dominion Square Bldg., Montreal, Que. (*H*) 870 Hartland Ave. (*S. 1919*) (*A.M. 1924*) (*M. 1931*)

HALL, John Herbert, 2559 de la Salle Ave., Montreal East, Que. (*S. 1937*)

♂HALL, Norman MacL., Major, O.B.E., B.Sc., (McGill '07), Prof. Mech. Engrg., University of Manitoba, Winnipeg, Man., also Consulting Engr. (*H*) 22 Dundurn Place, Winnipeg, Man. (*S. 1907*) (*A.M. 1913*) (*M. 1923*)

HALL, Stewart Wm., B.A.Sc., (Tor. '28), Plan Examiner, Arch't.'s Dept., City of Toronto, City Hall, Toronto, Ont. (*H*) 9 Willow Ave., Ward's Island, Toronto, Ont. (*Jr. 1929*) (*A.M. 1934*)

HALL, Walter Elten Logan, Private Practice, P.O. Box 277, Windsor, N.S. (*A.M. 1921*)

HALLÉ, Paul, B.A.Sc., (Ecole Polytech., Montreal '38), 1470 Ontario St. E., Montreal, Que. (*S. 1937*)

HALLIDAY, John C., Master Mechanic, Beaver Wood Fibre Co. Ltd., Thorold, Ont., P.O. Box 231. (*Affil. 1936*)

HALPENNY, M. B., B.Sc., (McGill '26), Estimator, Dominion Bridge Co. Ltd., Box 280, Montreal, Que. (*H*) 4935 Connaught Ave., Montreal, Que. (*S. 1923*) (*A.M. 1931*)

HALTALIN, Clifford P., B.Sc., (Man. '29), Asst. Engr., Winnipeg Electric Co., Winnipeg, Man. (*H*) 636 Toronto St. (*S. 1927*) (*A.M. 1934*)

HAMEL, J. Albert, B.Sc., (McGill '27), Prof., Ecole Technique et de Papeterie, 642 Notre Dame St., Three Rivers, Que. (*S. 1920*) (*A.M. 1927*)

HAMELIN, J. C. Roger, 7609 de Gaspe St., Montreal, Que. (*S. 1937*)

HAMILTON, Cecil R., B.Sc., (N.S.T.C. '34), 3223-7th St. S.W., Calgary, Alta. (*S. 1930*)

HAMILTON, Chas. Thomas, B.A.Sc., (Tor. '09), D.L.S., B.C.L.S., Cons. Engr., 76-615 Hastings St. W., Vancouver, B.C. (*H*) 2044-44th Ave., W. (*A.M. 1917*)

HAMILTON, Chester B., Jr., B.A.Sc., (Tor. '07), M.E., Pres. and Owner, The Hamilton Gear and Machine Co., 76 Van Horne St., Toronto, Ont. (*H*) 6 Frank Crescent. (*M. 1918*)

HAMILTON, Jas. Bruce, B.A.Sc., (Tor. '21), Private Practice, 41-18th St. W., Prince Albert, Sask. (*1938*)

♂HAMILTON, John Brown, Lieut. Mgr., Western Securities Ltd., 200 Lancaster Bldg., Calgary, Alta. (*H*) 153-18th St. E., North Vancouver, B.C. (*A.M 1921*)

HAMILTON, Parker C., B.Sc., (N.S.T.C. '33), Dist. Engr., Gunite & Waterprofing Ltd. and Construction Co. Ltd., 135 Lower Water St., Halifax, N.S. (*H*) 242 Oxford St. (*S. 1932*) (*Jr. 1937*)

HAMILTON, Robt. Wm., B.Sc., (McGill '29), Elec. Engr., Dom. Electric Protection Co., 2040 Clarke St., Montreal, Que. (*H*) 113 Brock Ave. S., Montreal West, Que. (*S. 1925*) (*A.M. 1935*)

HAMILTON, Vesey Courthope, (R.M.C., Kingston '24), Supt., Canada Cement Co. Ltd., Exshaw, Alta. (*A.M. 1935*)

HAMILTON, W. Garrison, B.E., (N.S.T.C. '35), Mgr., Avon Gold Mines Ltd., Oldham, N.S. (*H*) 39½ Fenwick St., Halifax, N.S. (*S. 1930*) (*Jr. 1938*)

♂HAMMERSLEY-HEENAN, John, Capt., Cons. Engr., 7521 Lexington Ave., Hollywood, Calif., U.S.A. (*A.M. 1911*)

HAMMOND, R. E., B.A.Sc., (Tor. '33), M.A.Sc., '34, Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*H*) 1216 St. Matthew St. (*S. 1931*)

♂HANCOX, Frederick Jas., Chief Designer, Sewer Section, City of Toronto, Toronto, Ont. (*H*) 119 Neville Park Blvd. (*A.M. 1920*)

♂HANDLEY, John, Lt.-Col., M.E., Dip.A., (Cantab.), P.O. Box 54, Noranda, Que. (*S. 1904*) (*A.M. 1907*)

HANGO, J. R., B.Sc., (Alta. '29), Saguenay Power Co. Ltd., Box 318, Arvida, Que. (*H*) 207 Radin Rd. (*S. 1928*) (*A.M. 1935*)

HANKIN, Edmund Alfred, B.Eng., (McGill '34), Sales Engr., Francis Hankin & Co. Ltd., 2028 Union Ave., Montreal, Que. (*H*) 4855 Harvard Ave., N.D.G. (*S. 1934*)

HANKIN, Francis, B.C.L., Pres., Francis Hankin & Co., 2028 Union Ave., Montreal, Que. (*H*) 648 Murray Hill. (*Affil. 1920*)

HANLY, Arthur F., P.O. Box 1124, Place d'Armes Station, Montreal, Que. (*A.M. 1920*)

HANLY, John Bruce, B.A.Sc., (Tor. '31), Canada Cement Co. Ltd., Belleville, Ont. (*H*) 78 Grosvenor St., Toronto, Ont. (*S. 1930*)

HANNA, Harold B., B.Sc., (Queen's '24), Can. Industries Ltd., Montreal, Que. (*H*) 4836 Westmore Ave., N.D.G. (*S. 1922*) (*Jr. 1926*) (*A.M. 1931*)

♂HANNA, John Jeffery, Capt., B.A.Sc., (Tor. '14), Asst. Supt., Imperial Oil Ltd., Ogden Rd., Calgary, Alta. (*H*) 1122 Frontenac Ave. (*A.M. 1917*)

HANNAFORD, Arthur R., Office and Designing Engr., City Engr.'s Dept., Corp. of the City of Hamilton, Hamilton, Ont. (*H*) 354 Herkimer St. (*A.M. 1920*)

HANNING, George Foster, (Tor. '99), Grimsby, Ont. (*A.M. 1897*)

HANSEN, Darrel Adrian, B.Sc., (Alta. '28), Engr., Calgary Power Co., Edmonton, Alta. (*H*) 11023-64th A. St. (*A.M. 1934*)

HANSON, Myron W., C.E., (Ohio Nor. '10), Designing Engr., Aluminum Co. of America, 801 Gulf Bldg., Pittsburgh, Pa. (*M. 1927*)

HANSON, Ralph Ellis, B.Sc., (N.S.T.C. '28), D.L.S., Hydrographic and Map Service, Dept. Mines and Resources, Hunter Bldg., Ottawa, Ont. (*H*) 341 MacLaren St. (*A.M. 1933*)

HARBERT, Edward Thomas, B.Sc., (McGill '23), Mech. Engr., Can. Ingersoll-Rand Co. Ltd., Box 728, Sherbrooke, Que. (*H*) 25 Magog St. (*S. 1920*) (*Jr. 1928*) (*A.M. 1936*)

HARDCASTLE, Sydney, B.A.Sc., (Tor. '24), 115 Sunnyside Ave., Ottawa, Ont. (*S. 1920*) (*A.M. 1931*)

HARDING, C. P., 69-A St. Germain Blvd., St. Laurent, Que. (*Affil. 1925*) (*M. 1938*)

HARDING, C. M., B.Sc., (Alta. '36), 513-34th Ave. W., Calgary, Alta. (*S. 1936*)

HARDING, Sidney, S.L.S. Private Practice, Punnichy, Sask. (*A.M. 1921*)

♂HARDOUIN, Jos., D.L.S., Bureau of Geology and Topography, Dept. of Mines and Resources, Ottawa, Ont. (*H*) 87 Maisonneuve St., Hull, Que. (*A.M. 1922*)

HARDY, George F., B.S., Sc.D. (Dartmouth), 305 Broadway, New York, N.Y. (*H*) Crydero Court, White Stone, N.Y. (*M. 1902*)

HARDY, R. M., B.Sc., (Man. '29), M.Sc., (McGill '30), D.L.S., A.L.S., Asst. Prof. of C.E., University of Alberta, Edmonton, Alta. (*S. 1928*) (*Jr. 1934*) (*A.M. 1937*)

♂HARDY, Wm. Gathorne, Capt., B.Sc., (N.S.T.C. '20), N.S.L.S., Can. International Paper Co., Temiskaming, Que. (*A.M. 1935*)

HARE, Chas. M., B.Sc., (McGill '29), Arntfield Gold Mines Ltd., Arntfield, Que. (*S. 1928*)

†HARE, G. G., B.A.Sc., (McGill '96), 264 St. James St., Saint John, N.B. (*S. 1894*) (*A.M. 1908*) (*M. 1920*) (*Life Member*)

HARE, W. L., B.Sc., (Queen's '35), Dom. Rubber Co. Ltd., Montreal, Que. (*H*) 1283 Mt. Royal Ave. (*S. 1935*)

HARGROVE, Paul, B.Sc., (Alta. '28), D.P.W., Edmonton, Alta. (*H*) Ste E, 8625-109th St. (*S. 1927*) (*Jr. 1931*)

HARKNESS, Aleck L., B.A.Sc., (Tor. '08), 9835 LaSalle Rd., LaSalle, Que. (*S. 1907*) (*A.M. 1911*)

K.HARKNESS, Andrew Harkness, B.A.Sc., (Tor. '08), D.Eng., (Tor. '37), Harkness & Hertzberg, Rms. 620-622 Bloor Bldg., 57 Bloor St. W., Toronto, Ont. (*H*) 185 Glencairn Ave. (*A.M. 1912*) (*M. 1917*)

HARKNESS, Harold W., B.Sc., (Queen's), M.Sc., Ph.D., (McGill), Physics Lab., Queen's University, Kingston, Ont. (*A.M. 1920*) (*M. 1931*)

HARKNETT, Stewart Geo., Mgr., Elec. Dept., Mumford, Medland, Ltd., Winnipeg, Man. (*H*) 982 Garfield St. (*A.M. 1934*)

♂HARKOM, John Frederick, Capt., M.C., B.Sc., (McGill '14), Forest Products Laboratories of Canada, Dept. Mines and Resources, Ottawa, Ont. (*S. 1912*) (*Jr. 1918*) (*A.M. 1925*)

HARLAND, Robt. Thompson, B.Sc., (Man. '38), City of Winnipeg Hydro-Electric System, 51 King St., Winnipeg, Man. (*H*) 241 Waverley St. (*S. 1938*)

HARLEY, Gordon G., 477 Prince Arthur St. W., Montreal, Que. (*S. 1936*)

HARLING, F. Norman, B.Sc., (McGill '23), Engr., Can. Industries Ltd., Montreal, Que. (*H*) 60 Chesterfield Ave., Westmount, Que. (*A.M. 1937*)

HARRIGAN, Mayo, B.Sc., (Dalhousie '30), B.Sc., (N.S.T.C. '33), 244½ Barrington St., Halifax, N.S. (*S. 1930*)

HARRINGTON, Arthur Russell, B.Sc., (N.S.T.C. '36), Engr., N.S. Light & Power Co. Ltd., Halifax, N.S. (*H*) 82 Cambridge St., Halifax, N.S. (*S. 1932*)

HARRINGTON, Arthur W., C.E., (Cornell '09), Dist. Engr., U.S. Geological Survey, 526 Federal Bldg., P.O. Box 948, Albany, N.Y. (*H*) Elsmere, N.Y. (*M. 1937*)

†HARRINGTON, J. Lyle, B.A., M.Sc., (McGill), C.E., (Kansas), D.Eng., (Case), Harrington & Cortelyou, Cons. Engrs., 1004 Baltimore Ave., Kansas City, Mo. (*H*) 111 West Armour. (*M. 1905*)

HARRIS, Richard Crosby, Div. Engr., C P.R., Calgary, Alta. (*H*) 1016–15th Ave. W. (*A.M. 1919*) (*M. 1926*)

HARRIS, Wallace R., Wisconsin Works Progress Administration, Milwaukee, Wis. (*H*) 2824 W. Juneau Ave., Milwaukee, Wis., U.S.A. (*M. 1916*)

♂HARRISON, Edward Harrison, Capt., M.C., 121 Sloane St., London, S.W.1, England. (*A.M. 1906*) (*M. 1920*)

HARRISON, Noel F., Cons. Engr., Private Practice, Bri Cualann, County Wicklow, Ireland. (*H*) "Sliab Fana," Bray Head. (*A.M. 1922*)

♂HARRISON, Ronald, Lieut., B.A.Sc., (Tor. '20), Mgr. and Sec.-Treas., Hydro and Water Depts., Scarboro Public Utilities Comm., 1666 Kingston Rd., Toronto, Ont. (*H*) 1859 Kingston Rd., Birchcliff, Ont. (*S. 1919*) (*Jr. 1921*) (*A.M. 1925*) (*M. 1936*)

HARRISON, Ronald Dex, B.Eng., (McGill '34), Address unknown. (*S. 1934*)

♂HARRY, Wilmot Earl, Capt., M.C., Deer Lodge Hospital, Winnipeg, Man. (*A.M. 1920*)

HARSHAW, F. Norman, B.Sc., (Sask. '33), Sales Engr., Crouse-Hinds of Canada, 7-21 Labatt Ave., Toronto, Ont. (*H*) 58 Hewitt Ave. (*Jr. 1938*)

HART, Herbert Trench, B.Eng., (McGill '32), c/o The Jamaica Theatres. Ltd., Box 211, Kingston, Jamaica, B.W.I. (*S. 1930*)

HART, W. O., B.Sc., (Queen's '29), Sales and Adv. Mgr., Oshawa Dairy Ltd. Oshawa, Ont. (*H*) 431 Simcoe St. S. (*S. 1928*) (*Jr. 1935*)

HARTLEY, Eric L., B.Sc., (Queen's '33), Western Bridge Co. Ltd., Vancouver, B.C. (*H*) 4963 Marguerite Ave. (*S. 1933*)

HARTMANN, Nicholas L., M.E., (Stuttgart), Dftsman, Steel Co. of Canada, Ltd., Hamilton, Ont. (*H*) Apt. 17, 1522 King St. E. (*A.M. 1938*)

HARTNEY, Jas. R., B.Sc., (McGill '30), Inspr., Willis Faber & Co. Canada Ltd., Board of Trade, Montreal, Que. (*S. 1930*) (*A.M. 1937*)

♂HARVEY, Chas., B.A.Sc., (Tor. '01), D.L.S., 210 Kent Manor Apts., Chatham, Ont. (*A.M. 1921*)

HARVEY, D. W., B.A.Sc., (Tor. '10), Gen. Mgr., Toronto Transportation Commrs., Toronto, Ont. (*H*) 10 Shorncliffe Ave. (*S. 1909*) (*A.M. 1914*) (*M. 1932*)

HARVEY, E. Allan, B.Sc., (Man. '38), c/o The Maytag Co. Ltd., 268 Van Horne St., Toronto, Ont. (*S. 1937*)

HARVEY, St. George, Sec.-Treas., The Kennedy Construction Co. Ltd., 407 McGill St., Montreal, Que. (*H*) 722 Roslyn Ave., Westmount, Que. (*A.M. 1905*)

HARVEY, W. M., B.Sc., (Queen's '24), Mech. Engr., Noranda Mines Ltd., Noranda, Que. (*S. 1922*) (*A.M. 1936*)

HARVIE, A. C., B.Sc., (Queen's '23), Box 602, Port Colborne, Ont. (*S. 1922*) (*Jr. 1927*)

HARVIE, Thomas White, 633 Cote St. Antoine Rd., Westmount, Que. (*A.M. 1911*) (*M. 1923*)

HARZA, LeRoy Francis, B.S., (S. Dakota State '01), B.S., (Wis. '08), Gen. Cons. Engr., Pres., Harza Engineering Co., 205 W. Wacker Drive, Chicago, Ill., U.S.A. (*H*) 2299 Pierce Rd., Highland Park, Ill. (*M. 1928*)

HASELTON, W. B., B.Sc., (N.B. '34), Beebe, Que. (*S. 1934*)

HASTIE, Frank J., B.Sc., (Alta. '36), Asst. Engr., Canada Packers, Ltd. (*H*) 9739–86th Ave., Edmonton, Alta. (*S. 1936*)

HASTINGS, Meredith H., B.Sc., (Queen's '31), 57 Church St., Weston, Ont. (*S. 1928*)

HASTINGS, Walter Hindson, B.Sc., (McGill '22), Engr., Dept. of Natural Resources, Sask., Parliament Bldgs., Regina, Sask. (*H*) 152 Connaught Cres. (*A.M. 1927*)

HATFIELD, Geo. N., Road Engr., Corpn. of the City of Saint John, N.B. (*H*) 122 Broad St. (*S. 1909*) (*A.M. 1915*)

HATHAWAY, Jos Dean, Vice-Pres., Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*M. 1920*)

HAULTAIN, H. E. T., C.E., (Tor.), University of Toronto, Toronto, Ont. (*M. 1901*)

HAVENS, Verne Leroy, Superv. Engr. Inspr., Federal Public Works Administration, P.O. Box 599, Ogallala, Neb., U.S.A. (*M. 1922*)

HAWKE, Chas. Edison, B.A.Sc., (Tor. '34), Jr. Engr., P.W.D., Canada, 24 Adelaide St. E., Toronto, Ont. (*H*) 93 Delaware Ave. (*S. 1903*) (*A.M. 1937*)

HAWKES, Horace H., Str'l. Designer, Dom. Bridge Co., Ltd., Lachine, Que (*H*) 75 Percival Ave., Montreal West, Que. (*A.M. 1921*)

HAWKEY, B. J., B.Sc., (Alta. '36), Fernie, B.C. (*S. 1936*)

HAWKINS, Jas. E., B.Sc., (Alta. '32), Geophysics Dept., Colorado School of Mines, P.O. Box 345, Golden, Colorado, U.S.A. (*S. 1932*) (*Jr. 1936*)

♂HAWKINS, Stanley H., Capt., M.C., Dist. Engr., P.F.R.A., Dept. of Agriculture, Eastend, Sask. (*S. 1909*) (*A.M. 1920*)

HAWLEY, Geo. P., 10844 St. Hubert St., Montreal, Que. (*M. 1920*)

HAWLEY, Eric Farwell, B.Sc., (McGill '31), Bury, Que. (*S. 1930*) (*A.M. 1937*)

♂HAWTHORNE, George, Asst. Engr., Turbine Erection, H.E.P.C. of Ont., Fraserdale, Ont. (*H*) Box 328, Campbellford, Ont. (*A.M. 1926*)

HAY, Adam, Chief Dftsman, Dept. of Highways, Ont., Parliament Bldgs., Toronto, Ont. (*H*) 479 Dovercourt Rd. (*A.M. 1921*) (*M. 1936*)

♂HAY, Alan K., Lieut., B.Sc., (McGill '14), Ottawa, Suburban Roads Comm., 279 Carling St., Ottawa, Ont. (*H*) 20 Lakeview Terrace. (*S. 1914*) (*A.M. 1919*)

HAY, Alexander Loudon, Asst. Mining Engr., Dom. Coal Co., Box 643, Glace Bay, N.S. (*H*) 702 Official Row. (*A.M. 1921*) (*M. 1925*)

HAY, Edward Campbell, B.A.Sc., (B.C. '30), Sales Engr., Can. Westinghouse Co. Ltd., Regina, Sask. (*H*) 3 Balfour Apts. (*S. 1928*) (*Jr. 1936*)

♂HAY, Marshall Neil, B.Sc., (Queen's '23), Supt., Aluminum Co. of Canada, Ltd., 158 Stirling Rd., Toronto 3, Ont. (*H*) 22 Austin Cres. (*Jr. 1924*) (*A.M. 1927*)

♂HAY, Wm. Wren, B.Sc., C.E., (Vermont '10), H. Cassel & Co., 61 Broadway, New York, N.Y. (*H*) 511 West 112th St. (*S 1910*) (*Jr. 1914*) (*A.M. 1919*)

HAYES, Elbert Harvey, B.Sc., (N.B. '28), Northern Electric Co. Ltd., Montreal, Que. (*H*) 4605 Harvard Ave., N.D.G. (*S. 1927*) (*A.M. 1937*)

HAYES, Gerald Jos., B.Sc., (N.S.T.C. '33), Chatham, N.B. (*S. 1933*)

HAYES, Herman R., B.Sc., (Alta. '31), Indust. Engr., Burns & Co., Edmonton, Alta. (*H*) 7102–111th Ave. (*S. 1933*) (*Jr. 1938*)

♂HAYES, Jas. Bertram, B.Sc., (Dalhousie '13), S.B. (C.E.), (N.S.T.C. '16), Mgr., N.S. Light & Power Co. Ltd., Capitol Bldg., Halifax, N.S. (*H*) 'Kelavi," Armdale P.O., N.S. (*A.M. 1920*)

HAYES, Roland Earle, B.Sc., (McGill '24), Mgr., Engrg. Dept., General Supply Co. of Canada, Ltd., 360 Sparks St., Ottawa, Ont. (*H*) 267 Powell Ave. (*Jr. 1928*) (*A.M. 1936*)

HAYES, Ronald A. H., B.Sc., (McGill '28), Aluminum Co. of Canada, Montreal, Que. (*H*) 5207 Dalou Ave., N.D.G. (*S. 1922*)

HAYES, St. Clair J., B.S., (N.S.T.C. '23), Assoc. Prof. Engrg., Memorial University College, St. John's, Nfld. (*S. 1923*) (*Jr. 1926*) (*A.M. 1936*)

HAYMAN, Howard L., B.A.Sc., (Tor. '23), Supt., John Hayman & Sons. Co. Ltd., 432 Wellington St., London, Ont. (*H*) 114 Base Line Rd. (*A.M. 1933*)

♂HAYNE, Harry Louis, Capt., M.C., Dist. Engr., D.P.W., B.C., Pouce Coupe, B.C. (*A.M. 1920*)

HAYS, David Walker, B.Sc., (Nevada), Gen. Mgr., Canada Land and Irrigation Co. Ltd., Box 677, Medicine Hat, Alta. (*M. 1918*)

HAYWARD, Vernon A., B.Sc., (Alta. '38), 10523–127th St., Edmonton, Alta. (*S. 1938*)

♂HAZEL, Frederick Brackenridge, B.Sc., (St. Andrews, '11), Bldg. Inspr., Man., Rm. 29, Parliament Bldg., Winnipeg, Man. (*H*) 152 Genthon St., Norwood, Man. (*A.M. 1920*)

HAZEN, Hugh T., Lewin Apts., Lancaster, W. Saint John, N.B. (*A.M. 1896*) (*M. 1906*)

†HEAMAN, John Andrew, B.Sc., (McGill '02), Office Engr., C.N.R., 360 McGill St., Montreal, Que. (*H*) 1469 Drummond St. (*S. 1901*) (*A.M. 1909*) (*M. 1916*)

HEARN, Richard L., B.A.Sc., (Tor. '13), Chief Engr., H. G. Acres & Co. Ltd., Niagara Falls, Ont. (*H*) 875 Roberts St. (*A.M. 1920*) (*M. 1925*)

♂HEARTZ, Richard Edgar, Lieut., B.Sc., (McGill '17), Asst. Chief Engr., Shawinigan Engineering Co., Power Bldg., Montreal, Que. (*H*) 208 Portland Ave., Town of Mount Royal, Que. (*S. 1917*) (*A.M. 1926*) (*M. 1933*)

HEATH, Frederick Johnston, B.Sc., (Alta. '38), 10122-124th St., Edmonton, Alta. (*S. 1938*)

♂HEATLEY, Albert Harold, B.A.Sc., M.A., (Tor. '23), Ph.D., (Tor. '37), Research Chemist, Shawinigan Chemicals, Ltd., Shawinigan Falls, Que. (*H*) 40 George St. (*S. 1921*) (*Jr. 1926*) (*A.M. 1931*)

HEAVYSEGE, Bruce Reid, B.Eng., (McGill '33), Hollinger Cons. Gold Mines, Ltd., P.O. Box 310, Timmins, Ont. (*S. 1933*)

HEBERT, Camille Raymond, B.A.Sc., (Ecole Polytech., Montreal '36), Engr., Lord & Cie Ltd., Montreal, Que. (*H*) 4079 St. Hubert St. (*S. 1935*)

HECKLE, George R., Cons. Engr., 50 Church St., New York, N.Y. (*M. 1914*)

HEENEY, Carden Thos., B.Sc., (McGill '26), Res. Engr., Ottawa Water Purification Plant, Transportation Bldg., Ottawa, Ont. (*H*) 3 River St., Lemieux Island. (*S. 1927*) (*A.M. 1938*)

HEMMERICK, George, B.Sc., (Queen's '16), Can. Sales Engr., Dow Chemical Co., 159 Bay St., Toronto, Ont. (*H*) 157 Colin Ave. (*S. 1916*) (*A.M. 1918*)

HENDERSON, Henry Banks, B.S., M.E., M.M.E., (Cornell '95), Mgr., Cowin & Co., Ltd., 1137 Pacific St., Winnipeg, Man. (*H*) 125 Hargrave St. (*M. 1921*)

HENDERSON, Ian Gordon, B.Sc., (McGill '26), Williamstown, Ont. (*S. 1925*) (*Jr. 1928*) (*A.M. 1936*)

♂HENDERSON, John Archibald Hamilton, B.Sc., (Queen's '22), Can. International Paper Co., Sun Life Bldg., Montreal, Que. (*H*) 469 Lansdowne Ave., Westmount, Que. (*Jr. 1921*) (*A.M. 1923*)

HENDERSON, Judson Pulford, M.A., (Tor. '15), Astronomer, Dominion Observatory, Ottawa, Ont. (*H*) Box 204, Westboro, Ont. (*A.M. 1923*)

HENDERSON, Robt. Morton, Supt. of Distribution, National Light and Power Co., Moose Jaw, Sask. (*H*) 1094–5th Ave., N.W. (*1938*)

HENDERSON, Roy Manwaring, B.S. in E.E., (Armour '07), (E.E., '06), Midwest Mgr., United Engineers and Constructors Inc., 111 W. Washington St., Chicago, Ill., U.S.A. (*H*) 1200 Judson Ave., Evanston, Ill. (*M. 1929*)

HENDRICK, M. M., B.A.Sc., (Tor. '32), Flt.-Lieut., Wireless School, R.C.A.F., Dept. Nat. Defence, Officers' Mess, Trenton, Ont. (*S. 1932*) (*Jr. 1938*)

HENDRY, Murray Calder, B.A.Sc., (Tor. '09), H.E.P.C. of Ontario, 620 University Ave., Toronto, Ont. (*A.M. 1908*) (*M. 1920*)

HENHAM, Robt., Vice-Pres., Dom. Reinforcing Steel Co. Ltd., 57 Bloor St. W., Toronto, Ont. (*H*) 376 St. Clements Ave., Toronto, Ont. (*A.M. 1916*)

HENRIKSON, G. J., B.Sc., (Man. '36), Winnipeg Electric Co., Winnipeg, Man. (*H*) 157 Morris Ave., Selkirk, Man. (*Jr. 1937*)

HENRY, G. R. Stirling, 1508 Crescent St., Montreal, Que. (*S. 1937*)

†HENRY, R. A. C., B.A., B.Sc., (McGill '12), Vice-Pres. and Gen. Mgr., Beauharnois Power Corp., Ltd., 405 Power Bldg., Montreal, Que. (*S. 1910*) (*A.M. 1913*) (*M. 1920*)

♂HENRY, Thomas Haliburton, B.Sc., (McGill '14), Engr., J. Chas. Day, M.E.I.C., Gatehouse Bldg., Montreal Que. (*H*) Apt. 1, 440 Mount Stephen, Ave., Westmount, Que. (*Jr. 1922*) (*A.M. 1927*)

HENSELWOOD, Edward W., B.Sc., (Man. '37), Can. Gen. Elec. Co. Ltd., Toronto, Ont. (*H*) 1508 Dufferin St. (*S. 1936*)

♂HENSHAW, Fred. Robt., Major, R.C.E., (R.M.C., Kingston '11), M.D. No. 6, Halifax, N.S. (*A.M. 1925*)

HENSON, Geo. S. G., B.Sc., (Man. '35), Dftsman, Winnipeg Electric Co., Winnipeg, Man. (*H*) Ste. 9, Ladywood Apts., 172 Edmonton St. (*Jr. 1937*)

HEPINSTALL, R. R., B.Sc., (Queen's '14), Pres., R. R. Hepinstall Steel Works Inc., 600 Market St., New Orleans, La., U.S.A. (*H*) 1205 State St. (*S. 1914*) (*A.M. 1919*)

HERBERT, A. C., B.Sc., (Alta. '35), Engrg. Dept., C.N. Telegraphs, Room 1101, 347 Bay St., Toronto, Ont. (*H*) Apt. 15, 2 Spadina Rd. (*S. 1935*)

♂HERBISON, Robt. M., Designing Engr., Glenfield & Kennedy Ltd. (*H*) Clinic Place, Kilmarnock, Scotland. (*A.M. 1926*)

HERBISON, Wm., Designer, Dom. Bridge Co. Ltd., P.O. Box 280, Montreal. Que. (*H*) Apt. 3-A, 3–15th Ave., Lachine, Que. (*A.M. 1935*)

HERD, Chas. E., Mech. Engr., Hydraulic Dept., Dom. Engineering Co. Ltd., Lachine, Que. (*H*) 4110 Oxford Ave., Montreal, Que. (*A.M. 1920*)

HERMANSON, Henning Jones, B.Sc., (Sask. '25), Dist. Engr., Govt. Sask., Prince Albert, Sask. (*1938*)

HEROLD, Wm. H., B.A.Sc., (Tor. '21), Drfting. Instructor, Arthur Voaden Vocational School, St. Thomas, Ont. (*H*) 40 Metcalfe St. (*A.M. 1936*)

HEROUX, Georges, B.A.Sc., (Ecole Polytech., Montreal '34), Asst. City Mgr., Three Rivers, Que. (*H*) 387 St. Roch St. (*Jr. 1937*)

HERR, Arthur George, Mech. Engr. and Chief Dftsman., Packard Electric Co. Ltd., St. Catharines, Ont. (*H*) 131 York St. (*A.M. 1935*)

†HERRIOT, Geo. H., B.Sc., (Queen's '07), D.L.S., M.L.S., A.L.S., Prof., Dept. of C.E., University of Manitoba, Winnipeg, Man. (*H*) 325 Waverly St. (*A.M. 1910*) (*M. 1919*)

HERRMANN, Geo. E., Gen. Mgr., Western Region, Canada Creosoting Co. Ltd., P.O. Drawer 2408, N., Vancouver, B.C. (*Affil. 1927*)

HERSHFIELD, Chas., B.Sc., (Man. '30), Engr., Standard Iron and Steel Wks., 3402 Dundas St. W., Toronto, Ont. (*H*) 863 College St. (*Jr. 1935*)

HERTEL, A. F., B.Sc., (Queen's '37), J. W. Tyrrell & Co. (*H*) 8 Dundas St. W., London, Ont. (*S. 1937*)

♂HERTZBERG, Chas. S. L., Lt.-Col., M.C., V.D., (Tor. '05), Harkness & Hertzberg, Rms. 620-622 Bloor Bldg., 57 Bloor St. W., Toronto, Ont. (*H*) 9 Barton Ave. (*A.M. 1911*) (*M. 1917*)

HESLOP, Wilfrid Gibson, B.A.Sc., (Tor. '30), Res. Engr., Dept. of Highways, Ont. (*H*) 46-B Patience Blvd., Timmins, Ont. (*A.M. 1935*)

HEUPERMAN, Fred. Justinus, D.L.S., A.L.S., Engr., Can. Western Natural Gas, Light, Heat and Power Co. Ltd., Calgary, Alta. (*H*) 211–6th Ave. N.E. (*A.M. 1925*)

HEWARD, F. S. B., B.Sc., (McGill '12), Pres., F. S. B. Heward & Co. Ltd. and Vice-Pres., Rust Engineering Co. Canada, Ltd., 661 New Birks Bldg., Montreal, Que. (*H*) 1614 Selkirk Ave. (*A.M. 1923*)

HEWITT, Herbert Eugene, B.Sc., (Alta. '36), Asst. Engr., Sudbury Hydro-Electric Comm., Sudbury, Ont. (*H*) 373 Morris St. (*S. 1936*)

HEWITT, Harold L., B.A.Sc., (Tor. '27), Bridge Section, Dept. of Highways, Ont. (*H*) 46 Humberside Ave., Toronto, Ont. (*Jr. 1927*)

HEWITT, Robert, B.A.Sc., (Tor. '35), Asst. Res. Engr., Dufferin Paving Co. Ltd., Kenora, Ont. (*H*) 56 Roncesvalles Ave., Toronto, Ont. (*S. 1933*)

HEWSON, Ewart G., Office Engr., C.R., C.N.R., 436 Union Sta., Toronto, Ont. (*H*) 41 Hewitt Ave. (*S. 1907*) (*Jr. 1914*) (*M. 1917*)

HEWSON, Jos. Seldon, B.Sc., (N.S.T.C. '24), Gen. Contr., Room 1616, University Tower Bldg., Montreal, Que. (*H*) 16 Kilburn Cres., Hampstead, Que. (*A.M. 1932*)

HEWSON, William Geale, B.A.Sc., (Tor. '06), Asst. Mgr., Hamilton Street Rly., 18 Wentworth St. N., Hamilton, Ont. (*H*) 125 Aberdeen Ave. (*M. 1920*)

♂HEYWOOD, Herbert P., Engr. Agent, J. L. Eve Construction Co. Ltd., 272 Vauxhall Bridge Rd., Victoria, London, S.W.1. (*H*) 2 Rosebery Ave., Lincoln, England. (*Jr. 1917*) (*A.M. 1920*)

HIBBARD, A. G., 59 Quebec St., Sherbrooke, Que. (*S. 1937*)

HIBBARD, F. H., Chief Engr., Quebec Central Rly., Sherbrooke, Que. (*H*) 59 Quebec St. (*S. 1909*) (*Jr. 1912*) (*A.M. 1919*)

HICKS, Ben. C., B.Sc., (McGill '27), Relay Engr., Shawinigan Water and Power Co., Montreal, Que. (*H*) 3455 Prudhomme Ave. (*S. 1921*) (*Jr. 1928*) (*A.M. 1935*)

♂HICKS, Henry B., Major, 6388 Adera St., Vancouver, B.C. (*A.M. 1920*)

HIGGINS, Edgar Clarence, Asst. Engr., H.E.P.C. of Ont., Toronto, Ont. (*H*) 2100 Gerrard St. E. (*Jr. 1921*)

HIGGINS, Frank Chipman, B.Sc., (Acadia '14), S/L., R.C.A.F., Dept. National Defence, Ottawa, Ont. (*A.M. 1920*)

HILL, Burton M., M.P., B.Sc., (N.B. '07), Mgr., Consolidated Diversified Standard Securities, Rm. 805, 414 St. James St., Montreal, Que. (*S. 1907*) (*A.M. 1912*) (*M. 1919*)

HILL, G. Rixon, Dist. Airway Engr., Civil Aviation Divn., Dept. of Transport, Box 69, Sioux Lookout, Ont. (*H*) Front St. (*Jr. 1917*) (*A.M. 1931*)

HILL, Stanley C., B.Sc., (McGill '21), Protection Engr., The Shawinigan Water and Power Co., Power Bldg., Montreal, Que. Address: P.O. Box 205, Victoriaville, Que. (*S. 1919*) (*A.M. 1930*)

HILLIER, Cecil H., B.Sc., (Queen's '34), Mech. Supt., Kellogg Co. of Canada, London, Ont. (*H*) Apt. 3, 791 Richmond St. (*S. 1933*)

♂HILLMAN, Daniel, Lieut.-Col., D.S.O., Dist. Engr., C.P.R., Rm. 148, Windsor Sta., Montreal, Que. (*H*) 157 Ballantyne Ave. N., Montreal West, Que. (*M. 1914*)

HINCHLIFFE, Jos. F., B.Sc., (McGill '26), Can. Bridge Co. Ltd., Walkerville, Ont. Address: P.O. Box 69, Amherstburg, Ont. (*S. 1924*) (*Jr. 1928*) (*A.M. 1934*)

HINDLE, Walter, B.Sc., (Alta. '37), Can. Westinghouse Co. Ltd., Hamilton, Ont (*S. 1937*)

HINTON, Eric, Hydraulic Engr., International Power and Paper Co., Deer Lake, Nfld. (*Jr. 1932*)

HINTON, Robert E., B.Sc., (Queen's '13), Asst. Engr., Can. Gen. Elec. Co., Peterborough, Ont. (*H*) 526 Homewood Ave. (*Jr. 1919*) (*A.M. 1925*)

HOBA, Jos. G., Thorold South, Ont. (*S. 1938*)

♂HOBBS, Wilfrid E., Capt., D.L.S., M.L.S., Asst. to Mgr., Land Dept., Hudson's Bay Co., 93 Main St., Winnipeg, Man. (*H*) Lot 59, Kildonan R.R. 1. (*S. 1910*) (*Jr. 1912*) (*A.M. 1919*)

♂HODGINS, A. E., Lt.-Col., (R.M.C., Kingston), 1471 Fairfield Rd., Victoria, B.C. (*A.M. 1887*) (*M. 1904*) (*Life Member*)

HODGSON, Ernest A., B.A., (Tor. '12), M.A. '13, Ph.D., (St. Louis '32), Chief, Divn. of Seismology, Dom. Observatory, Ottawa, Ont. (*H*) 156 Third Ave. (*M. 1938*)

♂HODSDON, Donald Wilbur, Lieut., B.C.L.S., Chief Engr., St. Lawrence Paper Co., Three Rivers, Que. (*A.M. 1919*)

♂HOGARTH, Bruce Bowers, B.A.Sc., (Tor. '14), Engr., Water Power and Water Rights, Dept. of Mines and Nat. Res., Man., Legislative Bldg., Winnipeg, Man. (*H*) 366 Brock St. (*S. 1913*) (*Jr. 1915*) (*A.M. 1919*)

♂HOGARTH, C. Earle, Lieut., B.A.Sc., (Tor. '15), Dist. Repres., Toronto Iron Works, Ltd., Room 309, 1502 St. Catherine St. W., Montreal, Que. (*H*) 4599 Royal Ave., N.D.G. (*S. 1914*) (*Jr. 1916*) (*A.M. 1919*)

HOGG, Allan Douglas, B.Sc., (Sask. '35), M.A.Sc., (Tor. '38), 67 Balsam St., Ottawa, Ont. (*Jr. 1937*)

HOGG, Sidney, Designing Engr., Saint John Drydock Co. Ltd., Saint John, N.B. (*H*) 61 Lancaster Ave. (*A.M. 1931*)

HOGG, Thos., Chief Dftsman., Water Rights Br., Dept. of Nat. Res., 501 Leader-Post Bldg., Regina, Sask. (*H*) 1839 Retallack St. (*A.M. 1937*)

HOGG, Thos. H., B.A.Sc., C.E., (Tor. '07), D.Eng., '27, Chairman, H.E.P.C. of Ont., 620 University Ave., Toronto, Ont. (*H*) R.R. No. 2, York Mills, Ont. (*S. 1904*) (*A.M. 1912*) (*M. 1922*)

♂HOLDCROFT, John Barber, Lieut., Hydr. Engr. and Asst. Mgr., Pacific Coast Pipe Co. Ltd., 1551 Granville St., Vancouver, B.C. (*H*) 832 Cumberland Cres. (*Jr. 1912*) (*A.M. 1913*) (*M. 1936*)

HOLDEN, John C., (R.M.C., Kingston '96), Dist. Engr., C.P.R., Winnipeg, Man. (*H*) 111 Gerard St. (*A.M. 1908*) (*M. 1919*)

HOLDEN, J. Hastie, B.Sc., (McGill '23), Mgr., Geo. W. Reed & Co. Ltd., 4107 Richelieu St., Montreal, Que. (*H*) 4335 Montrose Ave., Westmount, Que. (*S. 1921*) (*Jr. 1930*) (*A.M. 1935*)

HOLDEN, Otto, B.A.Sc., (Tor. '13), Chief Hydraulic Engr., H.E.P.C. of Ont., Toronto, Ont. (*H*) R.R. No. 2, York Mills, Ont. (*A.M. 1921*)

HOLDER, A. S., B.Sc., (N.S.T.C. '34), Can. Industries Ltd., Shawinigan Falls, Que. (*H*) 61 Maple Ave. (*S. 1931*)

HOLDER, George Wm., Mgr., S.F. Divn., Abitibi Power and Paper Co., Sturgeon Falls, Ont., Box 306. (*Jr. 1921*) (*A.M. 1930*)

HOLE, Jack H., B.Sc., (Alta. '38), 9412–108-A Ave., Edmonton, Alta. (*S. 1938*)

HOLE, John, Engr., Parks Dept., City Hall, Toronto, Ont. (*H*) 153 Indian Rd. (*A.M. 1923*) (*M. 1931*)

HOLE, W. G., B.Sc., (Alta. '33), 9421–108 A Ave., Edmonton, Alta. (*S. 1932*)

HOLGATE, W. T., B.Sc., (Alta. '30), Sales Engr., Can. Gen. Elec. Co. Ltd., 214 King St. W., Toronto, Ont. (*H*) 85 Thompson Ave. (*Jr. 1931*)

♂HOLLAND, Albert, Lieut., Colonial Engr. and Surveyor General, P.W.D., Roseau, Dominica, Leeward Islands, B.W.I. (*S. 1908*) (*A.M. 1915*)

♂HOLLAND, Franklin E., Lieut., C.E., (Cornell '12), Sales Engr., Sherwin Williams Co. of Canada, Ltd., Montreal, Que. (*H*) 2182 Lincoln Ave. (*A.M. 1922*)

HOLLAND, Trevor, B.Eng., (McGill '32), Vice-Pres., Brandram-Henderson Co., Box M, Station E, Montreal, Que. (*H*) 3749 The Boulevard, Westmount, Que. (*S. 1929*)

HOLLINGWORTH, Wilfrid, Pres. and Mgr., Hamilton Contracting Co. Ltd., 506 Imperial Bldg., Hamilton, Ont. (*H*) 180 Hillcrest Ave. (*A.M. 1909*) (*M. 1914*)

♂HOLLOWAY, Edward S., B.Sc., (McGill '08), 2036 Grey Ave., N.D.G., Montreal, Que. (*S. 1905*) (*A.M. 1910*) (*M. 1928*)

HOLMAN, Clive W., Technical and Commercial High School, Sault Ste. Marie, Ont. (*H*) 113 Lansdowne Ave. (*A.M. 1934*)

HOLMES, Arch. R., B.Eng., (King's '95), Cons. Engr., 203 Douglas Drive, Toronto, Ont. (*S. 1895*) (*A.M. 1901*) (*M. 1919*) (*Life Member*)

HOLMES, J. R., B.Sc., (McGill '29), Dist. Mgr., Robbins & Myers of Canada, Ltd., 1106 Beaver Hall Hill, Montreal, Que. (*H*) 11-A Querbes Ave. (*S. 1929*) (*A.M. 1936*)

HOLT, W. G. H., B.A.Sc., (Tor. '36), Mech. Designer, Dom. Bridge Co. Ltd., Lachine, Que. (*H*) 2510 Mariette Ave., Montreal, Que. (*Jr. 1937*)

HOLT, Sir Herbert S., D.C.L., LL.D., Chairman, Montreal Light, Heat and Power Cons., Montreal, Que. (*H*) 1459 Stanley St. (*A.M. 1889*) (*M. 1889*)

HOOD, G. Leslie, B.Sc., (Man. '32), Demonstrator, Univ. of Toronto, Toronto, Ont. (*H*) 252 College St. (*S. 1930*)

HOOGSTRATEN, Jack, B.Sc., (Man. '29), Lecturer in C.E., University of Manitoba, Winnipeg, Man. (*H*) 162 Oakwood Ave. (*A.M. 1937*)

HOOPER, Wm. Henry, (McGill '27), Canada Wire and Cable Co. Ltd., P.O. Box 340, Toronto, Ont. (*H*) 14 Macnaughton Rd. (*S. 1928*) (*Jr. 1929*) (*A.M. 1936*)

♂HOOVER, Owen Hugo, B.A.Sc., (Tor. '12), Engr. i/c., Dom. Water and Power Bureau, Dept. Mines and Resources, 423 Public Bldg., Calgary, Alta. (*H*) 1411–4th-A St. N.W. (*A.M. 1921*) (*M. 1935*)

HOPKINS, Albert P. E., B.A.Sc., (Tor.), 16 Queens Gate Terrace, London, S.W.7. (*S. 1937*)

HOPKINS, Alfred, B.E., (N.S.T.C. '36), Can. Westinghouse Co. Ltd., Hamilton, Ont. (*H*) 789 King St. E. (*S. 1937*)

HOPKINS, Peter McMillan, (R.M.C., Kingston '38), Climax, Sask. (*S. 1938*)

HOPPER, Alfred Edward, Prin. Inspr., Steamship and Inspr. Br., Dept. of Transport, Ottawa, Ont. (*H*) Alonzo Ave., Highland Park, Westboro, Ont. (*M. 1923*)

HORN, Jas. Gordon, B.Sc., (Man. '36), A. Reyrolle & Co., Hebburn-on-Tyne, England. (*H*) 26 Jesmond Rd., Newcastle-on-Tyne. (*Jr. 1938*)

HORNBACK, Michael Edwin, B.Sc., (Missouri '12), 2535 Montclair Ave., Montreal, Que. (*M. 1938*)

HORSEY, Geo. Frederick, Sr. Asst. Engr., Nat. Parks Bureau, Dept. of Mines and Resources, Ottawa, Ont. Address: Radium Hot Springs, B.C. (*M. 1920*)

HORSFALL, Herbert, Pres. and Man'g. Dir., Canada Wire and Cable Co., Box 340, Toronto, Ont. (*H*) 126 Forest Hill Rd. (*A.M. 1918*) (*M. 1921*)

HORTON, Everall Blackwell, B.A.Sc., (Tor. '31), Dftsman., Price Bros. & Co. Ltd., Riverbend, Que. (*Jr. 1936*) (*A.M. 1938*)

HORWOOD, W. O., B.Eng., (McGill '37), Crane Co., Montreal, Que. (*H*) 5806 Notre Dame de Grace Ave. (*S. 1937*)

HOUGHTON, Jas. Scott, 730 Upper Belmont Ave., Westmount, Que. (*S. 1938*)

HOUGHTON, John R., B.Eng., (McGill '35), Northern Electric Co. Ltd., Montreal, Que. (*H*) 730 Upper Belmont Ave., Westmount, Que. (*S. 1935*)

♂HOUGHTON, John William, Lieut., Director, Bosch Ltd., Larden Rd., Acton, London, W.3. (*H*) "Arlington," Allandale Ave., Finchley, London, N.3. (*A.M. 1919*)

HOUGHTON, T. Walter, B.Eng., (McGill '32), Dftsman., Canada Paper Co. Ltd., P.O. Box 203, Windsor Mills, Que. (*S. 1931*) (*Jr. 1937*)

HOULDEN, J. W., B.Sc., (Queen's '27), Ballistic Engr., Can. Industries Ltd., P.O. Box 172, Brownsburg, Que. (*S. 1927*) (*Jr. 1929*) (*A.M. 1937*)

HOUSTON, David Waters, B.Sc., (Queen's '07), Supt., Street Rly. Dept., City of Regina, Sask. (*H*) 2246 Cameron St. (*M. 1936*)

HOUSTON, Gavin N., Olds, Alta. (*M. 1914*)

HOVEY, Chas. M., Supt. of Testing Labs., University of Manitoba, Fort Garry, Man. (*H*) Ste. 3, Ludlow Apts. (*Jr. 1937*)

HOVEY, L. M., B.Sc., (McGill '25), Winnipeg Electric Co., 1010 Electric Rly. Chambers, Winnipeg, Man. (*H*) 836 Dorchester Ave. (*S. 1921*) (*A.M. 1931*)

HOWARD, Albert Warren, B.A.Sc., (Tor. '35), Asst. Engr., Calgary Power Co., Calgary, Alta. (*H*) 2132 Hope St. (*S. 1931*)

HOWARD, L. J. M., Supt'g. Engr., Beechwood Cemetery Co. of the City of Ottawa, 202 Beechwood Ave., Rockcliffe Park, Ottawa, Ont. (*A.M. 1917*)

HOWARD, Rupert Fortescue, B.Sc., (McGill '01), Mgr., Power Sales, Gatineau Power Co., 140 Wellington St., Ottawa, Ont. (*H*) 377 Daly Ave. (*M. 1922*)

G. †HOWARD, Stuart, Major, Apt. 3, 456 Pine Ave. W., Montreal, Que. (*M. 1887*) (*Life Member*)

HOWE, H. B., B.Sc., (Queen's '36), Can. Johns-Manville Co., Asbestos, Que. (*H*) Aultsville, Ont. (*S. 1935*)

HOWRIGAN, Clyde P., Mgr. and Chief Engr., Aranka Gold Mines, Georgetown, British Guiana. (*H*) Bakersfield, Vt., U.S.A. (*A.M. 1917*) (*M. 1937*)

♂HUBBARD, Edward Beane, B.A.Sc., (Tor. '25), H.E.P.C. of Ont., 620 University Ave., Toronto 2, Ont. (*H*) 105 Kenwood Ave. (*S. 1920*) (*A.M. 1927*)

HUBBARD, Frederick William, Engr., Dom. Construction Co., 101 Catharine St. So., Hamilton, Ont. (*H*) 127 Fairleigh Ave. So. (*A.M. 1919*)

HUBBARD, S. F., B.Eng., (McGill '38), 303 Grande Allée, Quebec, Que. (*S. 1938*)

♂HUBER, Albert Lloyd, Chief Engr., E.D., Link-Belt Ltd., 934 Inspector St., Montreal, Que. (*H*) 4331 Harvard Ave., N.D.G. (*A.M. 1938*)

♂HUDSON, Arthur Magennis, Capt., Dept. of Highways, Ont., 3502 Parliament Bldgs., Toronto, Ont. (*H*) 231 Riverside Drive. (*A.M. 1935*)

♂HUDSON, Geo. M., Capt., Engr. of Constrn. Methods, Bell Telephone Co. of Canada, Montreal, Que. (*H*) 4248 Wilson Ave. (*Jr. 1912*) (*M. 1919*)

HUESTIS, Harry E., B.Sc., (McGill '96), Asst. Gen. Mgr. and Chief Engr., Quebec Harbour Commrs., Quebec, Que. (*A.M. 1905*)

HUGGARD, J. Harold, B.Sc., (N.B. '35), Instr'man., Dept. of Highways, Ont., New Liskeard, Ont. (*H*) Norton, Kings Co., N.B. (*S. 1935*)

HUGGINS, Mark Wm., M.A.Sc., (Tor. '33), Lecturer in C.E., Queen's University, Kingston, Ont. (*H*) 109 Wellington St. (*Jr. 1935*)

♂HUGHES, B. H., Asst. Engr., Trunk Rd. Surveys, Dorset County Council. (*H*) "Trescore," Portcothan Bay, Padstow, N. Cornwall, England. (*S. 1914*) (*Jr. 1921*) (*A.M. 1923*)

♂HUGHES, Henry Thorsby, Brig.-Gen., C.M.G., D.S.O., Chief Engr., Canadian Battlefields Memorials Comm. (*H*) East Saanich Rd., Royal Oak, V.I., B.C. (*A.M. 1899*) (*M. 1925*)

HUGHES, Jas. W., Elec. Engr., E.L., C.P.R., Rm. 244, Union Station, Toronto, Ont. (*H*) 68 Pacific Ave. (*A.M. 1924*)

HUGHES, Philip Bernard, B.Sc., (McGill '26), Can. International Paper Co., Three Rivers, Que. (*S. 1927*) (*A.M. 1936*)

HUGHES, Wm. Fraser, 2038 Marlowe Ave., N.D.G., Montreal, Que. (*S. 1937*)

♂HUGHSON, John Warn, Capt., B.Sc., (McGill '12), 293 Stewart St., Ottawa, Ont. (*A.M. 1921*)

HUGHSON, Thos. Leo, B.Sc., (Queen's '16), Constrn. Engr., Can. Niagara Power Co., Niagara Falls, Ont. (*H*) Apt. 5, Bessey Apts., Lundy's Lane, Niagara Falls, Ont. (*A.M. 1919*

♂HUGHSON, William R., B.A., B.Sc., (Queen's '17), 4 Wolseley Ave., St. Catharines, Ont. (*A.M. 1921*)

♂HUGLI, Edwin E. H., B.A.Sc., (Tor. '14), Strl. Designing Engr., H.E.P.C. of Ont., 620 University Ave., Toronto, Ont. (*H*) 356-A Kingswood Rd. (*S. 1914*) (*Jr. 1920*) (*A.M. 1923*)

HULBURD, Wm. Chauncey, B.Sc., (McGill '22), Engrg. Dftsman., Dom. Engineering Co. Ltd., Lachine, Que. (*H*) 2493 Mayfair Ave., Montreal, Que. (*S. 1921*) (*A.M. 1927*)

HULL, Roland S., B.Sc., (N.S.T.C. '32), Engr., Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*H*) 255 Rubidge St. (*S. 1931*) (*Jr. 1936*)

HULME, Gordon D., B.Sc., (McGill '31), Shawinigan Water and Power Co., Montreal, Que. (*H*) 3411 Grey Ave. (*S. 1928*) (*A.M. 1937*)

♂HUMBLE, Archibald Marshall, Capt., Designing Dftsman., Toronto Harbour Commrs., Harbour St., Toronto, Ont. (*H*) 25 Bingham Ave. (*A.M. 1930*)

♂HUME, D. C. M., Wing Cmdr., O.C., Technical Training School, R.C.A.F., Trenton, Ont. (*A.M. 1923*)

HUMPHRIES, Geo. Edward, Mgr., Mining Dept., Can. Comstock Co., Room 2206, 80 King St. W., Toronto, Ont. (*Jr. 1930*)

HUNT, Albert Brewer, B.A.Sc., (Tor. '28), Spec. Products Supt., Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*H*) 4727 Grosvenor Ave. (*S. 1926*) (*Jr. 1931*) (*A.M. 1936*)

HUNT, Edward Victor, B.Sc., (Man. '31), Can. Gen. Elec. Co. Ltd., Davenport Wks., Toronto, Ont. (*H*) 309 Chaplin Cres. (*S. 1928*) (*Jr. 1934*)

HUNT, John, B.Sc., (St. Andrews '27), Chief Mech. Engr., Falconbridge Nickel Mines, Falconbridge, Ont. (*Jr. 1930*)

HUNT, Walter George, B.Sc., (C.E.), (McGill '17), Pres., Walter G. Hunt Co. Ltd., 1405 Bishop St., Montreal, Que. (*H*) 5178 Cote St. Antoine Rd. (*S. 1916*) (*Jr. 1919*) (*A.M. 1922*) (*M. 1932*)

♂HUNT, William Henry, Major, M.C., Superv. Engr., Ministry of Transport, Roads Dept., Portree, Isle of Skye. (*A.M. 1910*) (*M. 1925*)

HUNT, Wm. M., B.Sc., (N.S.T.C. '33), Maritime Tel. and Tel. Co. Ltd., Halifax, N.S. (*H*) 39 Spring Garden Rd. (*S. 1934*)

HUNT, Wm. Sinclair, B.Sc., (Acadia '34), Dom. Rubber Co. Ltd., 1665 Notre Dame St. E., Montreal, Que. (*S. 1936*)

HUNTER, Henry G., Asst. to W. S. Lea, Cons. Engr., 1226 University St., Montreal, Que. (*M. 1914*)

HUNTER, James Henderson, Gen. Supt. and Chief Engr., Canada Starch Co., Montreal, Que. (*H*) 731 Upper Belmont Ave., Westmount, Que. (*A.M. 1908*) (*M. 1923*)

HUNTER, John Wm., B.Sc., (McGill '96), 81 Gore St., Kingston, Ont. (*A.M. 1907*)

HUNTER, Lawrence M., B.Sc., (Queen's '36), Engr., Coca-Cola Co. of Canada, Ltd., 90 Broadview Ave., Toronto, Ont. (*H*) 931 College St. (*S. 1936*)

HUNTER, L. McLaren, Asst. Engr., City Engr.'s Dept., Corp. of City of Ottawa, Ottawa, Ont. (*H*) 7 Willard Ave. (*Jr. 1913*) (*A.M. 1932*)

HURDLE, Harold Lancelot, B.Sc., (Alta. '33), Calgary Power Co. Ltd., Insurance Exchange Bldg., Calgary, Alta. (*S. 1933*) (*Jr. 1938*)

HURST, Albert D., Mech. Supt., National Sanitarium Assoc., Gravenhurst, Ont. (*Affil. 1936*)

HURST, C. K., B.Sc., (Alta. '37), 10160–112th St., Edmonton, Alta. (*S. 1937*)

HURST, Wm. D., B.Sc., (Man. '30), Waterworks Engr., City of Winnipeg, 223 James Ave., Winnipeg, Man. (*H*) 78 Queenston St. (*S. 1927*) (*A.M. 1935*)

HURST, Wm., Pres. and Mgr., Hurst Engineering and Construction Co. Ltd., 101 Hurst Block, Winnipeg, Man. (*H*) 74 Ethelbert St. (*Affil. 1928*)

HURTER, Alfred Theodore, C.E., (Ecole Polytech., Zurich '19), Engr. i/c Constrn., Lake Sulphite Pulp Co. Ltd., Red Rock, Ont. (*M. 1937*)

HURTUBISE, J. E., B.A., I.C., B.Sc.A., Baulne & Leonard, St. Catherine St. E., Montreal, Que. (*H*) 340 Kensington Ave., Westmount, Que. (*S. 1934*)

HURTUBISE, Louis, B.A.Sc., Cons. Engr., 360 St. James St. W., Montreal, Que. (*H*) 3778 Vendome Ave., N.D.G. (*S. 1903*) (*A.M. 1909*)

HURTUBISE, Marc, 5290 McKenna Ave., Montreal, Que. (*S. 1938*)

HUSSEY, Erwin H., (Maine '07), 182 N. Bridge St., Somerville, N.J., U.S.A. (*M. 1923*)

HUTCHEON, Neil Barron, B.Sc., (Sask. '33), M.Sc., (Sask. '35), Asst. Prof. in Mech. Engrg., Univ. of Saskatchewan, Saskatoon, Sask. (*H*) 103 Albert Ave. (*A.M. 1938*)

♂HUTCHESON, Walter B., Lieut., Asst. Engr., Dept. of Highways, Toronto, Ont. (*H*) Apt. 109, 400 Avenue Rd. (*Jr. 1916*) (*A.M. 1920*)

HUTCHISON, Alexander, B.Sc., (Glasgow), Vice-Pres., Drummond, McCall & Co., Ltd., 930 Wellington St., Montreal, Que. (*H*) 4294 Montrose Ave., Westmount, Que. (*S. 1908*) (*A.M. 1914*)

HUTCHISON, David, B.Sc., (Queen's '24), Mgr., Mackenzie River Transport, Hudson Bay Co., Winnipeg, Man. (*A.M. 1932*)

HUTTON, Chas. Hyde, B.A.Sc., (Tor. '08), Chief Engr., Hydro-Electric Comm. of Hamilton, 12 King St. E., Hamilton, Ont. (*H*) 47 Undermount Ave. (*M. 1938*)

HUTTON, Francis S., B.A.Sc., (Tor. '36), 47 Undermount Ave., Hamilton, Ont. (*Jr. 1938*)

HUTTON, John R., B.Sc., (N.S.T.C. '27), Can Westinghouse Co., Ltd., Hamilton, Ont. (*H*) Apt. 20, 123 Bold St. (*S. 1925*) (*Jr. 1935*)

♂HUTTON, L. A. B., Spec. Radio Rep., C.P.R. and C.N.R., 3047-A, National Research Bldg., Ottawa, Ont. (*H*) 375 Hamilton Ave. (*A.M. 1922*)

HYDE, Arthur E., B.Sc., (Queen's '37), 101 Newlands Ave., Hamilton, Ont. (*S. 1934*)

HYMAN, Ernest Roy, B.Sc., (Man. '34), (R.M.C., Kingston '38), 954 Dorchester Ave., Winnipeg, Man. (*S. 1936*)

HYMAN, H. Davison, B.Sc., (McGill '25), Production Mgr., J. R. Booth Ltd., Ottawa, Ont. (*H*) 302 Second Ave. (*Jr. 1926*)

HYMMEN, Edmond B., M.A.Sc., Babcock-Wilcox & Goldie-McCulloch Ltd., Galt, Ont. (*H*) 41 Brant Rd. (*S. 1930*)

IDSARDI, Harold, B.Sc., (McGill '05), B.C.L.S., Engr., Mech. Dftsman., McIntyre Porcupine Mines, P.O. Box 425, Schumacher, Ont. (*S. 1902*) (*A.M. 1910*)

INGHAM, J. H., B.Eng., (McGill '35), Dom. Bridge Co. Ltd., P.O. Box 280, Montreal, Que. (*H*) 4034 Dorchester St. W., Westmount, Que. (*S. 1933*) (*A.M. 1937*)

INGLES, Chas. L., B.Sc., (Queen's '34), Lieut., R.C.E., c/o Canada House, Trafalgar Sq., London, England. (*H*) 393 Parkside Drive, Toronto, Canada. (*S. 1932*) (*Jr. 1937*)

INGS, Jasper H., B.A.Sc., (Tor. '25), (C.E. '31), Engr., H. G. Acres & Co., Niagara Falls, Ont. (*H*) 1815 Dorchester Rd. (*S. 1920*) (*Jr. 1927*) (*A.M. 1930*)

INNES, E. P. N., B.Eng., (McGill '34), i/c Engrg. Dept., Can. Canners Ltd., Hamilton, Ont. (*H*) 80 Robinson St. (*S. 1935*) (*A.M. 1938*)

IRETON, Jos. Maurice, B.Sc., (Queen's '28), Calgary Technical High School, Calgary School Bd. Address: 536–15th Ave. W., Calgary, Alta. (*Jr. 1929*) (*A.M. 1932*)

♂IRVINE, Frederick, Engr. Sub-Lieut., P.O. Box 6070, Montreal, Que. (*H*) 8496 de Gaspe Ave. (*A.M. 1922*)

♂IRVINE, Joseph Holmes, Capt., B.Sc., (Man.), Office and Designing Engr., City of Ottawa, Transportation Bldg., Ottawa, Ont. (*H*) 236 Holmwood Ave. (*S. 1911*) (*A.M. 1917*)

†IRVING, T. T., B.Sc., (McGill '98), Chief Engr., Central Region, C.N.R., 436 New Union Sta., Toronto 2, Ont. (*H*) 625 Avenue Rd. (*S. 1898*) (*A.M. 1902*)

♂IRWIN, Gifford Melville, Lieut., B.Sc., (McGill '19), B.C.L.S., City Engr. and Water Commr., City of Victoria, City Hall, Victoria, B.C. (*H*) 1642 Hollywood Cres. (*M. 1935*)

IRWIN, Karl Webster, M.A.Sc., C.E., Asst. Toll Engr. (C.N. Div.), Bell Telephone Co. of Canada, Toronto, Ont. (*H*) 23 Elmsthorpe Ave. (S. *1923*) (*Jr. 1928*)

IZARD, Edward Whitaker, Wks. Mgr., Yarrows Ltd., Victoria, B.C (*H*) "Slindon," Arundel Drive. (*M. 1937*)

JACK, Grant R., Commr. of Works, The Corp. of the Township of East York, 443 Sammon Ave., Toronto 6, Ont. (*H*) 787 Coxwell Ave. (*A.M. 1918*)

♂JACKSON, Arthur, Capt., B.Sc., (Queen's '16), Prof. of Drawing, Queen's University, Kingston, Ont. (*H*) 317 King St. W. (*A.M. 1920*)

JACKSON, Carl Henry, B.Sc., (McGill '21), Engr., Can. Industries Ltd., P.O. Box 1260, Montreal, Que. (*H*) 2317 Wilson Ave. (*S. 1921*) (*Jr. 1923*) (*A.M. 1934*)

JACKSON, Charles H., B.A.Sc., (Tor. '23), Prod. Mgr., Ammun. Divn., Can. Industries Ltd., Brownsburg, Que. (*Jr. 1928*) (*A.M. 1935*)

JACKSON, John E., H.E. Establishment, Royal Arsenal, Woolwich, London, S.E., England. (*S. 1929*)

JACKSON, John H., O.L.S., 159 Colin Ave., Toronto, Ont. (*S. 1899*) (*A.M. 1905*) (*M. 1932*)

JACKSON, K. A., B.Sc., (Alta. '32), (M.Sc. '34), Rogers-Majestic Corp., Toronto, Ont. (*H*) 66 Melbourne Ave. (*S. 1932*) (*Jr. 1937*)

JACKSON, Walter, B.A.Sc., (Tor. '09), Dist. Civil Engr., H.E.P.C. of Ontario, Box 237, Niagara Falls, Ont. (*H*) 700 Eastwood Crescent. (*S. 1907*) (*A.M. 1913*) (*M. 1923*)

JACKSON, William, Apt. 1, 895 Dollard Ave., Outremont, Que. (*A.M. 1928*)

JACOBS, D. S., B.Eng., (McGill '37), 146 Wolseley Ave., Montreal West, Que. (*S. 1937*)

JACOBS, Lionel Leslie, Vice-Pres., Electrol Inc., 934 Main Ave., Clifton, N.J. (*H*) 153 Hudson Ave., Penafly, N.J. (*A.M. 1919*)

JACOBS, Llewellyn C., B.A., (Man. '05), Constrn. Mgr., Power Corp. of Canada, Ltd., 355 St. James St., Montreal, Que. (*H*) 146 Wolseley Ave., Montreal West, Que. (*S. 1908*) (*Jr. 1911*) (*A.M. 1912*) (*M. 1921*)

JACOBS, Milton, B.S., (Norwich '12), Chief Engr., Brown Co., Berlin, N.H. (*H*) 155 Prospect St. (*M. 1931*)

JACOBSEN, E. R., B.Sc., (McGill '29), (M.Eng. '32), Strl. Designer., Dom. Bridge Co. Ltd., P.O. Box 280, Montreal, Que. (*H*) 4935 Queen Mary Rd. (*S. 1928*) (*A.M. 1935*)

JACQUES, A. Geo., B.Sc., (McGill '17), Mill Mgr., Lake St. John Power and Paper Co., Dolbeau, Que. (*A.M. 1936*)

♂JAMES, David Harries, Bronygaer, Llanfyrnach, Pem., South Wales. (*A.M. 1926*)

JAMES, Harold H., Strl. Designer and Dftsman., Aluminum Co. of America, Massena, N.Y., U.S.A. (*H*) 8 Warren Ave. (*A.M. 1924*)

JAMES, Wm. Albert, B.Sc., (McGill '27), Imperial Tobacco Co. of Canada, Montreal, Que. (*H*) 4547 Draper Ave. (*A.M. 1936*)

JAMES, William Atlee, Asst. Chief Engr., C.P.Ry., Lydiatt, Man. (*M. 1909*) (*Life Member*)

G.†JAMIESON, James A., Cons. Engr., Board of Trade Bldg., Montreal, Que. (*H*) 268 Wood Ave., Westmount, Que. (*M. 1903*) (*Life Member*)

♂JAMIESON, Robert Edwards, Lieut., M.Sc., (McGill '20), Prof. of C.E., McGill University, Montreal, Que. (*H*) 234 Metcalfe Ave., Westmount, Que. (*A.M. 1921*) (*M. 1932*)

JAMIESON, Wm., (Liverpool '95), Fld. Engr., Powell River Pulp and Paper Co., Box 414, Powell River, B.C. (*M. 1925*)

JAMIESON, Wm. T., Asst. Engr., City of Montreal, City Hall, Montreal, Que. (*H*) 3821 Hampton Ave. (*Jr. 1912*) (*A.M. 1918*)

JAPP, Sir Henry, K.B.E., Chief Engr. and Wks. Director, John Mowlem & Co., Ltd., 91 Ebury Bridge Rd., London, S.W.1, England. (*H*) 10, The Orchard, Bedford Park, London, W.4. (*M. 1914*)

†JAQUAYS, Homer Morton, M.A., M.Sc., (McGill '95), Vice-Pres., Steel Co. of Canada, Ltd., 525 Dominion St., Montreal, Que. (*H*) 3457 Ontario Ave. (*S. 1898*) (*A.M. 1898*) (*M. 1909*)

JARAND, Wm. Henry, Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*H*) 4442 Harvard Ave. (*A.M. 1929*)

♂JARDINE, Ernest Ian Walter, Capt., Engr., H.E. Constrn. Dept., B.C. Electric Rly. Co., 425 Carrall St., Victoria, B.C. (*H*) 1530 Despard Ave. (*A.M. 1920*)

JARMAN, Percy Edward, Gen. Mgr., City of Westmount, City Hall, Westmount, Que. (*H*) 78 Chesterfield Ave., Westmount, Que. (*S. 1909*) (*Jr. 1914*) (*A.M. 1917*) (*M. 1936*)

JARRELL, Gordon Jas, B.A.Sc., (Tor '35), Willard Storage Battery Co. of Canada, Ltd., Toronto, Ont. (*H*) 43 Pearson Ave. (*Jr. 1937*)

JARRETT, W. F., 474 Agnes St., Winnipeg, Man. (*S. 1936*)

JARVIS, Gerald W., B.Sc., (Queen's '30), McColl Frontenac Oil Co. Ltd., 360 St. James St., Montreal, Que. (*H*) 93 Hyde Park Ave., Hamilton, Ont. (*S. 1931*) (*Jr. 1938*)

JEFFREY, Jas. Stewart, B.Eng., (McGill '35), Dom. Engineering Co. Ltd., Montreal, Que. (*H*) 4224 Melrose Ave., N.D.G. (*S. 1935*)

JEHU, Llewellyn, B.Sc., M.Eng., (McGill '34), Designer, Dom. Bridge Co. Ltd., Lachine, Que. (*H*) 5-B Riverside Drive, Lachine, Que. (*S. 1928*) (*A.M. 1937*)

♂JEMMETT, Douglas Mill, Lieut., D.C.M., M.A., B.Sc., (Queen's '13), Prof. Elec'l. Engrg., Queen's University, Kingston, Ont. (*H*) "Elmhurst," Centre St. (*A.M. 1921*)

JENKINS, George Aubrey, B.Sc., (Queen's '09), Research Engr., Warren Bros. Co., P.O. Box 1869, Boston, Mass. (*H*) 5 Lewis Rd., Winchester, Mass. (*S. 1908*) (*Jr. 1911*) (*A.M. 1922*)

JENKINS, Thos. H., B.A.Sc., (Tor. '25), Designing Engr., Bridges and Bldgs., G.T.W. R.R. Co., Detroit, Mich. (*H*) 472 Rosedale Blvd., Sandwich, Ont. (*S. 1922*) (*Jr. 1927*) (*A.M. 1932*)

JENKINS, William Ernest, B.Sc., (Queen's '07), Pres. and Gen. Mgr., Columbia Bitulithic Ltd., Granville Island, B.C. (*H*) 2415 West First Ave., Vancouver, B.C. (*S. 1907*) (*A.M. 1917*)

JENNINGS, Michael Wallace, B.Sc., (N.B., '11), Supt of Constrn., Alberta Wheat Pool, 628 Lougheed Bldg., Calgary, Alta (*H*) 3044-3rd St. W. (*A.M. 1922*)

♂JENNINGS, Percy John, Major, O.B.E., Supt., Banff National Park, P.O. Box 547, Banff, Alta. (*A.M. 1911*) (*M. 1920*)

♂JENNINGS, Robert Bernard, Major, 4196 Beaconsfield Ave., Montreal, Que. (*A.M. 1921*) (*M. 1926*)

JENSSEN, Lawrence N., Grad. (Trond.), c/o Box 154, Westmount, Que. (*H*) 4215 Western Ave., Westmount, Que. (*A.M. 1904*) (*M. 1911*)

JEPSEN, Viggo, Grad. (Horsens T.C. '27), Chief Dftsman., Cons. Paper Co., Grand'Mere, Que. (*Jr. 1932*) (*A.M. 1938*)

JESS, Robt E., 3592 University St., Montreal, Que. (*S. 1938*)

JETTE, Chas. Herve, B.A.Sc., C.E., (Ecole Polytech., Montreal '12), Divn. Engr., Cons. Paper Corp. Ltd., Port Alfred, Que. (*S. 1911*) (*Jr. 1917*) (*A.M. 1918*)

JETTE, J. Arthur, B.A.Sc., Supt. Engr., Canalization Dept., City of Montreal, City Hall. (*H*) 5601 Phillips Ave., Montreal, Que. (*A.M. 1920*) (*M. 1925*)

JEWETT, Frederick C., B.Sc., (McGill '05), Chief Engr., Newfoundland Airport, Hattie's Camp, Nfld. (*H*) 16 Ontario St. S., St. Catharines, Ont. (*S. 1902*) (*A.M. 1910*)

JEWITT, Wm. Gladstone, B.Sc., (Alta. '23), Dev. Engr., Cons. Mining and Smelting Co., Goldfields, Sask. (*1938*)

JICKLING, Robert William, B.Sc., E.E., (Man., '20), Operating Supt., Sask. Power Comm., Regina, Sask. (*H*) 2124 Argyle St. (*S. 1919*) (*Jr. 1922*) (*A.M. 1931*)

JOB, Stanley Robt., 129 Markland St., Hamilton, Ont. (*Jr. 1922*) (*A.M. 1928*)

JOHNS, Chas. F., B.Sc. (Mt. Allison '28), Cons. and Heating Engr., Enterprise Foundry Co. Ltd., Box 386, Sackville, N.B. (*S. 1924*) (*Jr. 1930*)

JOHNSEN, Hagbart, (Trond. '26), Designing Engr., Montreal Locomotive Works, Ltd., Longue Pointe, Que. (*H*) 5245 Grenier Ave., N.D.G. (*A.M. 1936*)

JOHNSON, Claude Vernon, Cons. Engr., Apt. 3, 144 Grande Allée, Quebec, Que. (*S. 1907*) (*A.M. 1910*) (*M. 1918*)

JOHNSON, F. Paul, 9924-87th Ave., Edmonton, Alta. (*S. 1938*)

♂JOHNSON, Geo. Owen, Group-Capt., R.C.A.F. Station, Dept. National Defence, Vancouver, B.C. (*A.M. 1924*)

JOHNSON, Jas. Henry, M.E., (Syracuse '15), Chief Engr., The Borden Co. of Canada, Box 336, Tillsonburg, Ont. (*H*) Lisgar Ave. (*M. 1937*)

JOHNSON, Jas. Richard, B.Eng., (McGill '34), Asst. Chief Engr., Dom. Rubber Co. Ltd., 1665 Notre Dame St. E., Montreal, Que. (*S. 1933*) (*Jr. 1938*)

JOHNSON, John David, Pres. and Gen. Mgr., Canada Cement Co. Ltd., Canada Cement Bldg., Montreal, Que. (*H*) 638 Clarke Ave., Westmount, Que. (*Affil. 1925*)

JOHNSON, Robert, B.Sc., M.Sc., (Sask. '36), Dom. Bridge Co. Ltd., Montreal, Que. (*H*) 595 Notre Dame St., Lachine, Que. (*Jr. 1937*)

JOHNSON, R. W., 276 Oxford St., Moose Jaw, Sask. (*1938*)

JOHNSON, Wm. James, B.Sc., (McGill '23), c/o Johnson Co., Thetford Mines, Que. (*S. 1921*) (*A.M. 1930*)

JOHNSTON, Alex. Chas., Elec. Supt., Aluminum Co. of Canada Ltd., Box 14, Arvida, Que. (*A.M. 1935*)

JOHNSTON, Chas., B.A.Sc., C.E., (Tor. '07), Chief Engr., Dufferin Paving Co., Fleet St., Toronto, Ont. (*H*) 70 Dundas St., Oakville, Ont. (*M. 1918*)

♂JOHNSTON, Clifford M., B.Sc., (Queen's '20), Vice-Pres., Welch & Johnston, Ltd., 474 Bank St., Ottawa, Ont. (*H*) 30 Sunset Blvd. (*S. 1920*) (*Jr. 1923*) (*A.M. 1930*)

JOHNSTON, E. M., Dom. Steel and Coal Corp., Sydney, N.S. (*H*) Dominion, C.B., N.S. (*S. 1936*)

♂JOHNSTON, Geo. Wm. Frederick, B.A.Sc., (Tor. '15), Strl. Engr., Montreal L. H. and P. Cons., Box 100, Beauharnois, Que. (*H*) 4429 Old Orchard Ave., N.D.G. Montreal, Que. (*S. 1914*) (*Jr. 1919*) (*A.M. 1922*)

JOHNSTON, Harold Chapman, B.A.Sc., (Tor. '10), Pres. and Mgr., H. C. Johnston Co. Ltd., Contracting Engrs., 1502 St. Catherine St. W., Montreal, Que. (*H*) 1081 Caledonia Rd., Town of Mt. Royal, Que. (*A.M. 1920*)

♂JOHNSTON, H. Lloyd, Jr., Lieut., M.C., B.Sc., (McGill '27), B.C.L.S., Engr., Can. Industries Ltd., Windsor, Ont. (*H*) 1334 Victoria Ave. (*Jr. 1926*) (*A.M. 1930*)

JOHNSTON, Harold S., B.Sc., (McGill '09), Chief Engr., N.S. Power Comm., Provincial Administration Bldg., Halifax, N.S. (*H*) 108 Oakland Rd. (*S. 1907*) (*A.M. 1911*) (*M. 1922*)

♂JOHNSTON, H. Wyatt, Col., B.Sc., (McGill '21), M.Sc., Ph.D., Officer in in Charge, Pulp and Paper Divn., Forest Products Labs. of Canada, 3420 University St., Montreal, Que. (*H*) 4048 Gage Rd. (*S. 1914*) (*A.M. 1925*)

JOHNSTON, Jas. Homer, D.L.S., A.L.S., Dist. Engr., P.W.D., Alta., Peace River, Alta. (*A.M. 1932*)

JOHNSTON, John T., B.A.Sc., C.E., (Tor. '10), Controller and Chief Engr., Dom. Water and Power Bureau, Dept. of Mines and Resources, Ottawa, Ont. (*H*) Apt. 4, 311 Lisgar St. (*S. 1908*) (*A.M. 1912*) (*M. 1917*)

JOHNSTON, Orval Ellsworth, B.A.Sc., (Tor. '34), Asst. Engr., H.E.P.C. of Ont. (*H*) 86 East Lynn Ave., Toronto, Ont. (*Jr. 1936*)

JOHNSTON, Wallace John, B.Sc., (Sask. '25), Graves-Quinn Corp., Grand Central Terminal, New York, N.Y. (*1938*)

♂JOHNSTON, Wm. Jas., B.Sc., (N.B. '13), Sr. Asst. Engr., D.P.W., Canada, 3rd Floor, Custom House, Winnipeg, Man. (*H*) 660 Strathcona St. (*A.M. 1920*)

JOHNSTON, Wm. D., B.A.Sc. (Tor. '35), Sales Engr., Dom. Bridge Co. Ltd., Toronto. Ont. (*H*) 37 Concord Ave. (*S. 1935*)

♂JOHNSTONE, Jas, Cameron, Major, Asst. Engr., B.C.E. Rly. Co., Ruskin Dam, Ruskin, B.C. (*H*) 3884-W. 10th Ave., Vancouver, B.C. (*A.M. 1936*)

JOHNSTONE, Ralph Geo., B.Sc., (N.S.T.C. '24), Prod. Mgr., E. B. Eddy Co., Hull, Que. (*H*) 221 Gladstone, Ottawa, Ont. (*Jr. 1925*) (*A.M. 1930*)

JOHNSTONE, William Morrison, B.Sc., (Queen's '13), Asst. Commr. of Wks., City of Ottawa, 703 Transportation Bldg., Ottawa, Ont. (*H*) 226 Clemow Ave. (*A.M. 1921*)

JOHRE, S. G., Asst. Engr., Public Utilities Comm., London, Ont. (*H*) 153 Kent St. (*A.M. 1934*)

JOLLEY, Malcolm P., Lieut., B.Eng., (McGill '33), R.C.O.C., Dept. National Defence, Ottawa, Ont. (*H*) 215 Metcalfe St. (*S. 1932*) (*Jr. 1938*)

JOMINI, John L., Cons. Paper Corp., Grand'Mere, Que., P.O. Box 283. (*Jr. 1937*)

JONCAS, J. P. P., B.A.Sc., (Ecole Polytech., Montreal '08), Q.L.S., Cons. Engr., Joncas & Malouin, Quebec Rly. Room 505, Merger Bldg., Quebec, Que. (*H*) 1216 St. Foye Rd. (*A.M. 1913*)

JONES, Allan J., B.A.Sc., (B.C. '29), Engr., B.C. Bridge and Dredging Co. Ltd., 1114 Standard Bank Bldg., Vancouver B.C. (*H*) Cypress Park, Caulfield P.O., B.C. (*A.M. 1938*)

JONES, A. M. S., B.Sc., (N.B. '34), Forest Engr., Gaspesia Sulphite Co. Ltd., Chandler, Que. (*H*) 72 Casot St., Quebec, Que. (*S. 1934*) (*A.M. 1937*)

JONES, Arthur R., B.Sc., (Alta. '28), Designing Engr., Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*Jr. 1930*)

♂JONES, Chas. Hugh LePailleur, Col., O.B.E., V.D., Pres. and Mang. Dir., Mersey Paper Co. Ltd., Box 485, Liverpool, N.S., also Price Bros. & Co. Ltd., Quebec, Que. (*M. 1926*)

JONES, D. Carlton, B.Eng., (McGill '37), 418-10th Ave. N.W., Calgary, Alta. (*S. 1937*)

JONES, Frank P., Pres., Consumers Glass Co. Ltd., Rm. 324, Canada Cement Bldg., Montreal, Que. (*Affil. 1910*)

♂JONES, F. S., Capt., M.C., B.Sc., (N.B., '13), Asst. Chief Engr., River St. Lawrence Ship Channel, Dept. of Transport, 400 Youville Sq., Montreal, Que. (*H*) 4844 Harvard Ave., N.D.G. (*A.M. 1919*)

JONES, Harry A., B.Sc., (Sask. '29), Asst. Engr., City Engr.'s Dept., Regina, Sask. (*H*) 1421 Elphinstone St. (*S. 1927*) (*A.M. 1930*)

JONES, H. Cecil, B.Sc., (Man. '26), 66 Harshaw Ave., Toronto, Ont. (*S. 1926*) (*Jr. 1928*)

JONES, Harold Wm., B.Sc., (McGill '03), i/c Tidal and Current Survey Divn., Dept. of Mines and Resources, Confederation Bldg., Ottawa, Ont. (*H*) Box 86, Westboro, Ont. (*S. 1902*) (*A.M. 1910*) (*M. 1922*)

JONES, J. H. Mowbray, B.A.Sc., (Tor. '27), Chief Engr. and Mill Mgr., Mersey Paper Co. Ltd., P.O. Box 483, Liverpool, N.S. (*S. 1925*) (*Jr. 1930*) (*A.M. 1932*)

JONES, Lee Morgan, Vice-Pres. and Gen. Mgr., Warren Bituminous Paving Co., 437 Fleet St. W., Toronto, Ont. (*H*) 75 Dunvegan Rd. (*A.M. 1908*) (*M. 1918*)

JONES, Llewellyn Edward, B.Sc., (Man.), M.A.Sc., (Tor. '33), Dept. of Applied Physics, University of Toronto, Toronto, Ont. (*S. 1929*)

♂JONES, Louis Elgin, Col., C.M.G., D.S.O. and Bar., B.A., (Tor. '11), Vice-Pres. and Gen. Mgr., The Can. Ingot Iron Co. Ltd., 35 George St., Guelph, Ont. (*H*) 6 Delhi St. (*M. 1922*)

JONES, Morris Herbert, Dip. in M.E., (Cardiff '12), Mtce. and Constrn. Engr., Ontario Paper Co., Thorold, Ont. (*H*) 48 Monck St., St. Catharines, Ont. (*A.M. 1924*)

JONES, Reginald Elsdon, Asst. Engr., H.E.P.C. of Ont., Toronto, Ont. (*H*) 66 Humbercrest Blvd. (*M. 1938*)

♂JONES, Robert Bolton, Lieut., Asst. Engr., C.P.R., Rm. 401, Windsor Sta., Montreal, Que. (*H*) 5421 Grovehill Place. (*A.M. 1928*)

JONES, Stuart, B. Eng., (McGill '38), 47 Strathearn Ave., Montreal West, Que. (*S. 1937*)

♂JONES, Vernon C., B.Sc., (Queen's '23), Trans. and Outside Plant Engr., C.P.R. Communications, 368 Main St., Winnipeg, Man. (*S. 1922*) (*A.M. 1926*)

JONSSON, Junius, City Engr., Prince Albert, Sask. (*1938*)

JORDAN, J. M., B.A.Sc., (Tor. '34), 180 Wychwood Ave., Toronto, Ont. (*S. 1934*) (*Jr. 1938*)

JORON, Rodolphe Emile, B.A.Sc., Q.L.S., Private Practice, Chicoutimi, Que. (*A.M. 1925*)

JOST, Edward B., B.Sc., (McGill), Gen. Supt. of Canals, Dept. of Transport, West Block, Ottawa, Ont. (*H*) 19 Woodlawn Ave. (*S. 1902*) (*A.M. 1913*)

JOST, Leslie Gordon, B.Sc., (Acadia), B.Sc., (McGill '10), 8342 Kirkwood Drive, Los Angeles, Calif., U.S.A. (*S. 1909*) (*A.M. 1913*) (*M. 1938*)

JOST, V. A., B.S., (Penn. State '34), 55 S. Bradford St., Dover, Delaware, U.S.A. (*S. 1930*)

JOYAL, Jules, B.A.Sc., (Ecole Polytech. Montreal '20), Logging Engr., Cons. Paper Corp. Ltd., Escoumains, Que. (*Jr. 1923*) (*A.M. 1925*) (*M. 1936*)

JOYCE, Alex. Geo., Chief Operator, Aluminum Co. of Canada, Box 15, Arvida, Que. (*Affil. 1936*)

JOYCE, Walter Edward, Ph.B., C.E., (Yale '11), 375 Albany Ave., Kingston, N.Y. (*A.M. 1918*)

JOYCE, Wm. Anderson, (R.M.C. Kingston '38), R.M.C., Kingston, Ont. (*S. 1937*)

JUBIEN, Ernest B., B.Sc., (McGill '26), Engrg. Dept., Canadian Industries Ltd., P.O. Box 1260, Montreal, Que. (*H*) 4679 Cote St. Catherine Rd. (*S. 1922*) (*A.M. 1935*)

♂JULIAN, Fennell Thompson, B.A.Sc., (Tor. '20), Supt., J. A. Vance, Contractor, Woodstock, Ont. (*H*) 591 King St. (*Jr. 1921*) (*A.M. 1930*)

JUNKINS, Sydney Edwin, B.A., (Dartmouth '87), M.A., (Dartmouth '90), Dr. Engrg., ('27), Cons. Engr., President, The Sydney E. Junkins Co. Ltd.; The Sydney E. Junkins Co. B.C., Ltd.; Bus. add.: Hanover Engineering and Development Co., 225 Broadway, N.Y. Offices: 555 Howe St., Vancouver; Rm. N., Royal Alexandra Hotel, Winnipeg, Man. (*H*) 29 Rope Ferry Rd., Hanover, N.H. (*M. 1913*)

JUSTICE, C. W., B.Sc., (Man. '26), Asst. to Plant Engr., Noranda Mines, Ltd., Box, 14, Noranda, Que. (*H*) 83 Second Ave. (*S. 1925*) (*Jr. 1929*) (*A.M. 1935*)

KAELIN, Frederick Thomas, M.E., (Fed. Polytech., Zurich), Advisory Engr., Shawinigan Water and Power Co., Montreal, Que. (*H*) 4002 Grey Ave., N.D.G. (*S. 1904*) (*A.M. 1904*) (*M. 1920*) (*Life Member*)

KANE, Chas. S., Sales Mgr., E.D., Dom. Bridge Co. Ltd., Lachine, Que. (*H*) 653 Grosvenor Ave., Westmount, Que. (*Jr. 1920*) (*A.M. 1923*)

KARN, Herbert Christopher, B.A.Sc., (Tor. '16), Engr., Can. Industries Ltd., Box 10, Montreal, Que. (*H*) 4251 Hampton Ave. (*A.M. 1928*)

KATZ, Leon, B.Sc., (Queen's '34) M.Sc., (Queen's '37). (*H*) 189 Earl St., Kingston, Ont. (*Jr. 1935*)

KATZ, Morris, B.Sc., M.Sc., (McGill '27), Ph.D., '29, Chemist, National Research Council, Ottawa, Ont. (*S. 1924*) (*A.M. 1930*)

KAUTH, Carl G., B.Sc., (Queen's '34), Plant Engr., Dom. Oxygen Co., Ltd. Sault Ste Marie, Ont. (*H*) 123 March St. (*S. 1934*) (*Jr. 1937*)

KAY, Bruce E. A., Apt. 16, 1390 Sherbrooke St. W., Montreal, Que. (*S. 1938*)

KAYE, John R., B.Sc., (McGill '24), Pres., Engineering Service Co. Ltd., P.O. 263, Halifax, N.S. (*H*) 12 Walnut St. (*S. 1924*) (*A.M. 1932*)

KAYSER, Jas. N., B.Eng., (McGill '38), 317 Claremont Ave., Mt. Vernon, N.Y. (*S. 1938*)

KAZAKOFF, John, B.Eng., (McGill '35), Bolivian Power Co., La Paz, Bolivia, S.A. (*S. 1935*)

KEAN, David Jacques, (Tor. '09), County Engineer, P.O. Box 579, Whitby, Ont. (*A.M. 1920*) (*M. 1937*)

KEARNEY, Graham, B.Sc., (McGill '11), Dist. Mgr., English Electric Co. of Canada Ltd., 1241-3 University St., Montreal, Que. (*H*) 3465 Cote des Neiges Rd. (*M. 1927*)

KEARNS, James Alfred, B.Sc., (McGill '12), Cons. Engr., 620 Cathcart St., Montreal, Que. (*H*) 44 Anwoth Rd., Westmount, Que. (*S. 1912*) (*A.M. 1925*)

KEATING, R. V. H., Res. Engr., Que. Divn., Ontario Paper Co. Ltd., Thorold, Ont. (*H*) 4 Thairs Ave., St. Catharines, Ont. (*A.M. 1925*)

†KEAY, Herbert O., B.Sc., (M.I.T. '00), Mgr., Research Lab., Consolidated Paper Corp. Ltd., Three Rivers, Que. (*M. 1909*)

†KEITH, Fraser Sanderson, B.Sc., (McGill '03), Mgr., Dept. of Development, The Shawinigan Water and Power Co. Ltd., Power Bldg., Montreal, Que. (*H*) P.O. Box 268, Ste. Anne de Bellevue, Que. (*S. 1902*) (*A.M. 1909*) (*M. 1921*)

KEITH, Homer P., C.E., (Tor. '07), D.L.S., A.L.S., 10028-89th Ave., Edmonton, Alta. (*A.M. 1922*)

KEITH, John B. Clark, B.A.Sc., (Tor. '11), Gen. Mgr., Windsor Utilities Comm., 607 Canada Bldg., Windsor, Ont. (*H*) 1241 Kildare Rd., Walkerville, Ont. (*A.M. 1917*)

KEITH, W. H., B.A.Sc., (Tor. '24), County Engr., County of Wellington, Court House, Guelph, Ont. (*H*) 126 Glasgow St. (*S. 1921*) (*Jr. 1927*) (*A.M. 1928*)

KELLAM, Geo. Douglas, B.Sc., (Man. '33), Asst. Engr., Can. Western G.L.H. and P. Co., Calgary, Alta. (*H*) 819-12th Ave. W. (*S. 1933*) (*Jr. 1937*)

KELLY, Edward Arthur, (Tor. '11), Divn. Engr., Dept. of Highways, Box 979, Kenora, Ont. (*A.M. 1924*) (*M. 1926*)

KELLY, Sydney Foster, Dom. Bridge Co. Ltd., Montreal, Que. (*H*) 108 Pointe Claire Ave., Pointe Claire, Que. (*Affil. 1929*)

KELLY, Wm. Henry, B.Sc., (McGill '16), Supt. i/c Logging Operations, Buckingham, Que. (*A.M. 1937*)

KELLY, Wm. Nielson, Cons. Engr. and Marine Surveyor, 837 W. Hastings St., Vancouver, B.C. (*H*) 1552 Davie St. (*M. 1936*)

†KELSCH, R. S. (*q*), Apt. 112, 1227 Sherbrooke St. W., Montreal, Que. (*M. 1898*)

KELSEY, E. S., B.Sc., (Man. '21), M.Eng., (McGill '33), Engr., Northern Electric Co., 1261 Shearer St., Montreal, Que. (*H*) 125-34th Ave., Lachine, Que. (*S. 1919*) (*Jr. 1925*) (*A.M. 1931*)

♂KEMP, Cecil Geo., Engr. and Constrn. Supt., Consumers Glass Co. Ltd., Ville St. Pierre, Que. (*H*) Apt. 5, 3415 King Edward Ave., N.D.G., Montreal, Que. (*A.M. 1935*)

♂KEMP, J. Colin, Major, D.S.O., M.C., B.A., (Oxon), B.Sc., (McGill '08), Executive Director, Home Improvement Plan, Room 1512, 1135 Beaver Hall Hill, Montreal, Que. (*H*) 70 Forden Ave., Westmount, Que. (*S. 1907*) (*A.M. 1912*)

♂KENDALL, Herbert Crosby, B.Sc., (Queen's '17), Bldg. and Mech. Supt., Toronto Terminals Rly. Co., 402 New Union Sta., Toronto, Ont. (*H*) 22 Valleyview Gardens. (*A.M. 1921*)

KENNEDY, Duncan, Res. Engr., Companhia do Porto da Beira, Beira Wks. Ltd. Address: P.O. Box 12, Beira, Portuguese E. Africa (*A.M. 1926*)

KENNEDY, Harold E., B.Sc., (Queen's '37), Shawinigan Engineering Co., Power Bldg., Montreal, Que. (*S. 1937*)

♂KENNEDY, Henry C., Lieut., Montreal Repres., Wm. Kennedy & Sons, Ltd., Room 338, Canada Cement Bldg., Montreal, Que. (*H*) 40 Edgehill Rd., Westmount, Que. (*S. 1904*) (*A.M. 1910*)

♂KENNEDY, Howard, Capt., M.C., B.Sc., (McGill '14), Mgr., Quebec Forest Industries Assoc. Ltd., Price House, Quebec, Que. (*H*) 211 Brown Ave. (*A.M. 1921*) (*M. 1928*)

KENNEDY, T. Dowsley, Vice-Pres. and Man'g. Dir., The William Kennedy & Sons, Ltd., Owen Sound, Ont. (*H*) 645 Second Ave. W. (*A.M. 1911*)

†KENNEDY, William, Apt. 101, 1469 Drummond St., Montreal, Que. (*M. 1887*) (*Life Member*)

♂KENNY, Walter Robert, D.F.C., Group-Capt., Chairman, Dev. Comm., Air Force Station, Dept. National Defence, Canadian Bldg., Ottawa, Ont. (*H*) 195 Acacia Ave., Rockcliffe. (*A.M. 1924*)

KENRICK, Robert B., 3525 Vendome Ave., Montreal, Que. (*A.M. 1888*) (*M. 1898*) (*Life Member*)

♂KENSIT, H. E. M., Cons. Engr., 155 Fifth Ave., Ottawa, Ont. (*M. 1914*)

KENT, A. Douglas, B.Sc., (Queen's '37), General Steel Wares (McClary Divn.), 554 King St., London, Ont. (*S. 1935*)

KENT, Cecil C., Mgr., Wpg. Office, Fetherstonhaugh & Co., 36-37 C.P.R. Bldg., Winnipeg, Man. (*H*) The Blackstone, Roslyn Rd. (*Affil. 1938*)

♂KENT, Edward Sherburn, Lieut., B.Sc., (N.S.T.C. '10), Chief Engr., Cowin & Co., Ltd., Pacific and Yeoman Sts., Winnipeg, Man. (*H*) 321 Overdale St. (*A.M. 1918*)

KENT, Geo. E., B.Sc., (N.S.T.C. '28), Refinery Supt., International Petroleum Co., Talara, Peru, S.A. (*S. 1926*) (*A.M. 1934*)

KENT, Wm. Leslie, B.Sc., (Alta. '31), Jr. Asst. Engr., Stuart Cameron & Co. Ltd., Marine Bldg., Vancouver, B.C. (*H*) 865-E 22nd Ave. (*S. 1929*) (*Jr. 1937*)

KENYON, Lot Amos, B.Sc., (McGill '08), Asst. Engr., Elec. Dept., Montreal L.H. and P. Cons., Rm. 310, Power Bldg., Montreal, Que. (*H*) 4926 Mira Rd. (*S. 1908*) (*A.M. 1914*)

KER, Frederick Innes, B.Sc., (McGill '09), Man'g. Dir. and Editor, "The Hamilton Spectator," Hamilton, Ont. (*H*) "Staplehurst," Dundas, Ont. (*A.M. 1918*) (*M. 1929*)

KER, Merle F., B.Sc., (Queen's '18), Township Engr., Township of Stamford, 1810 Ferry St., Niagara Falls, Ont. (*H*) 2057 Drummond Rd. (*Jr. 1920*) (*A.M. 1927*)

KER, Newton James, 3989 Angus Drive, Vancouver, B.C. (*A.M. 1893*) (*M. 1905*) (*Life Member*)

KERFOOT, John Grenville, B.Sc., (Queen's '36), Asst. Supt., Phillips Electrical Wks., Brockville, Ont. (*H*) Box 473, Prescott, Ont. (*S. 1936*)

KERR, Adam Thomas, 3141 W. 36th Ave., Vancouver, B.C. (*A.M. 1901*) (*M. 1922*) (*Life Member*)

KERR, Robt. A., B.Eng., (McGill '34), Price Bros. & Co., Kenogami, Que. (*S. 1932*)

KERR, S. Logan, B.S., (Penn. '21), M.E., '24, Mgr., Chem. Engrg. Divn., United Engineers and Constructors, Inc., 1401 Arch St., Philadelphia, Pa. (*H*) 30 E. Mt. Pleasant Ave. (*M. 1935*)

KERRY, Armine John, (R.M.C., Kingston '27), B.Sc., (McGill '29), Major, R.C.E., Dept. National Defence, M.D. 4, 1254 Bishop St., Montreal, Que. (*Jr. 1931*) (*A.M. 1934*)

KERRY, Frank Geo., B.Eng., (McGill '35), Service Engr., Can. Liquid Air Co., 1111 Beaver Hall Hill, Montreal, Que. (*Jr. 1937*)

†KERRY, John G. G., M.Sc., Pres., Kerry & Chace, Ltd., 550 Confederation Life Bldg., Toronto, Ont. (*H*) 12 Algonquin Ave. (*S. 1888*) (*A.M. 1894*) (*M. 1904*)

KERSHAW, Norman Wm., B.Sc., (Sask. '33), Asst. Mgr., Eagle Pencil Co. of Canada Ltd., Drummondville, Que. (*S. 1935*) (*Jr. 1937*)

♂KERSON, M. Wm., M.S.M., Can. Industries Ltd., Room 1124, Bell Telephone Bldg., Montreal, Que. (*H*) 4594 Earnscliffe Ave. (*A.M. 1931*)

†KESTER, Fred. Henry, Vice-Pres., The Can. Bridge Co., Ltd., Walkerville, Ont. (*H*) 1130 Parker Ave., Detroit, Mich. (*A.M. 1918*) (*M. 1926*)

KESTER, Wm. H., 904 Windermere Rd., Walkerville, Ont. (*S. 1934*)

KETCHEN, W. A., B.Sc., (McGill '28), Chief Chemist, Fraser Companies Ltd., Rm. 520, 1010 St. Catherine St. W., Montreal, Que. (*H*) 241 Lazard Ave., Town of Mt. Royal, Que. (*S. 1924*) (*Jr. 1928*) (*A.M. 1933*)

♂KETTERSON, Andrew Robert, Major, D.S.O., A.R.T.C., (Glasgow), Engr. of Bridges, C.P.R., Montreal, Que. (*H*) 3652 Northcliffe Ave. (*A.M. 1908*) (*M. 1938*)

♂KEYT, Warren Earnscliffe, Capt., M.C., Asst. Engr., D.P.W., Canada, P.O. Bldg., New Westminster, B.C. (*H*) 221 Royal Ave. (*A.M. 1920*)

♂KIDD, Wm. Sidney, B.A.Sc., (Tor. '20), Director, E. B. Eddy Co., Hull, Que. (*H*) 89 Aylmer Ave., Ottawa, Ont. (*Jr. 1921*) (*A.M. 1928*)

KILBOURN, Frederick Binns, Vice-Pres. and Gen. Supt., Canada Cement Co., Canada Cement Bldg., Montreal, Que. (*H*) 3755 Westmount Blvd., Westmount, Que. (*A.M. 1924*) (*M. 1927*)

KILBURN, Daniel Geo., B.Sc., (Queen's '07), Divn. Engr., Board of Transport Commrs., Ottawa, Ont. (*S. 1907*) (*A.M. 1913*) (*M. 1936*)

KILLALY, A. Laurence, Supt'g. Engr., Trent Canal, Dept. of Transport, Bank of Commerce Bldg., Peterborough, Ont. (*H*) 502 Weller St. (*S. 1900*) (*A.M. 1910*)

KILLAM, D. A., B.Sc., (McGill '27), Designing Engr., Can. Industries Ltd., Montreal, Que. (*H*) 5797 Plantagenet St. (*S. 1925*) (*Jr. 1928*) (*A.M. 1935*)

KILLAM, F. R., B.Eng., (McGill '37), Fraser Companies Ltd., Edmundston, N.B. (*S. 1937*)

KIMPTON, Geoffrey H., B.Eng., (McGill '35), Apt. 17, 5530 Cote St. Luke Rd., Montreal, Que. (*S. 1934*)

KING, Donald, B.Eng., (McGill '37), 2242 Coursol St., Montreal, Que. (*S. 1937*)

KING, Eric Chas., Churchill River Power Co., Island Falls, Sask., Via Flin Flon, Man. (*Jr. 1935*) (*A.M. 1937*)

KING, Harry Molyneux, Opr. Supt., Ontario Power Plant, H.E.P.C. of Ontario, P.O. Box 237, Niagara Falls, Ont. (*H*) 434 Philip St. (*M. 1926*)

KING, Hector J., B.Sc., (N.B. '37), Bathurst Power and Paper Co. Ltd., Bathurst, N.B. (*S. 1938*)

KING, John David, Mgr., Detroit Stoker Co. of Canada, Rm. 555, New Birks Bldg., Montreal, Que. (*H*) 3436 Durocher St. (*Affil. 1935*)

KING, Peter C., B.Sc., (Queen's '31), 2/Lieut., R.C.O.C., M.D. No. 6, Halifax, N.S. (*H*) 21 Brock Crescent, Toronto, Ont. (*S. 1928*) (*A.M. 1937*)

KING, Wensley, B.Sc., (Queen's '36), Can. Industries Ltd., Montreal, Que. (*H*) 655 Murray Hill, Westmount, Que. (*S. 1935*)

KINGHORN, Andrew A., B.A.Sc., (Tor. '07), Pres. and Mgr., Kinghorn Construction Co. Ltd., 614 Excelsior Life Bldg., Toronto, Ont. (*H*) 2 Highland Ave. (*M. 1933*)

KINGSLAND, E. N., B.Eng., (McGill '37), Williams & Wilson Ltd., Montreal, Que. (*H*) 544 Lansdowne Ave., Westmount, Que. (*S. 1937*)

KINGSMILL, Chas. Grange, B.A.Sc., (Tor. '24), 25 Mitchell St., Guelph, Ont. (*Jr. 1927*) (*A.M. 1931*)

†KINGSTON, Charles B., B.A., B.A.Sc., LL.D., Cons. Engr., Globe and Phœnix Gold Mining Co. Ltd., 35 Old Jewry, London E.C.2, England. (*H*) Cherry Croft, Forest Row, Sussex. (*S. 1890*) (*A.M. 1896*) (*M. 1903*)

KINGSTON, Edgar Lloyd, B.Eng., (McGill '34), Box 149, Prescott, Ont. (*S. 1934*)

KINGSTON, G. H., B.Sc., (McGill '27), Prescott, Ont. (*S. 1925*) (*Jr. 1930*)

♂KINGSTON, Laurence B., Capt., M.C., B.Sc., (McGill '08), Engr., Gulf Pulp and Paper Co., Rm. 1010, 65 St. Anne St., Quebec, Que. (*H*) 316 Laurier Ave. (*S. 1905*) (*A.M. 1912*) (*M. 1934*)

KINGSTON, T. M. S., B.A.Sc., (Tor '24), City Engr.-Mgr., City of Chatham, Harrison Hall, Chatham, Ont. (*S. 1921*) (*Jr. 1927*) (*A.M. 1931*) (*M. 1938*)

KINNEAR, Clifford Rutherford, Asst. Engr. of Way, Toronto Transportation Comm., 35 Yonge St., Toronto, Ont. (*H*) 209 Strathallen Blvd. (*A.M. 1921*) (*M. 1936*)

KIPP, Theodore, Jr., Man. Dir., Kipp-Kelly, Ltd., 68 Higgins Ave., Winnipeg, Man. (*H*) 1030 Wellington Crescent. (*M. 1918*)

KIRBY, Charles C., Dist. Engr., C.P.R., N.B., Saint John, N.B. (*H*) 186 Germain St. (*A.M. 1908*) (*M. 1920*)

♂KIRBY, Guy Hurlston, B.Sc., (McGill '22), Elect. Supt., Price Bros. & Co., Ltd., Riverbend, Que. (*S. 1919*) (*A.M. 1923*)

KIRBY, Thos. Halder, B.Sc., (McGill '13), Vice-Pres., Filer-Smith Machinery Co., Ltd., 703 Confederation Life Bldg., Winnipeg, Man. (*H*) 250 Waverley St. (*A.M. 1919*)

KIRK, W. Douglas, B.Sc., (Queen's '28), M.Eng., (McGill '36), E. G. M. Cape & Co., Montreal, Que. (*H*) Apt. 26, 4982 Queen Mary Rd., Montreal, Que. (*S. 1927*) (*A.M. 1937*)

KIRKBRIDE, David Spencer, B.Sc., (Sask. '34), M.Sc., (Sask. '37), Apt. 5, 902 Burnside Place, Montreal, Que. (*Jr. 1937*)

KIRKLAND, W. D., B.Sc., (Alta. '37), 73 Tranby Ave., Toronto, Ont. (*S. 1937*)

♂KIRKPATRICK, Alex. M., B.Sc., (Queen's '11), Dist. Engr., D.P.W. Canada, 3rd Floor, Customs Bldg., Winnipeg, Man. (*H*) 11 Brentwood Lodge. (*Jr. 1914*) (*A.M. 1919*)

KIRKPATRICK, Everett Chas., B.Sc., (McGill '06), Works Mgr., The Steel Co. of Canada, 525 Dominion St., Montreal, Que. (*H*) 47 Ainslie Rd., Montreal West, Que. (*S. 1906*) (*A.M. 1913*) (*M. 1926*)

KIRKPATRICK, Paul Chester, B.Sc., (McGill '16), Res. Engr., Fraser Brace Ltd., Montreal, Que. Address: Balmoral Hotel, Sudbury, Ont. (*S. 1915*) (*A.M. 1919*)

KIRKPATRICK, R. E., B.Eng., (McGill '37), Dom. Engineering Co., Lachine, Que. (*H*) 47 Ainslie Rd., Montreal West, Que. (*S. 1937*)

KIRSCH, Leonard, B.Eng., (McGill '36), 12 Windsor Ave., Westmount, Que. (*S. 1936*)

KIRSH, Harry, B.Sc., (McGill '25), Apt. 7, 5891 Sherbrooke St. W., Montreal, Que. (*Jr. 1926*)

KITTO, Franklin H., D.L.S., O.L.S., 16 Main St. S., Brampton, Ont. (*S. 1905*) (*A.M. 1912*) (*M. 1921*)

KLEIN, Edward, A.B., E.E., (Columbia '09), Treas., Can. Laco Lamps Co., 1511 St. James St., Montreal, Que. (*H*) 8017 Western Ave., Montreal West, Que. (*A.M. 1920*)

KLEIN, Herman, B.Sc., (McGill '30), 5139 St. Urbain St., Apt. 3, Montreal, Que. (*S. 1929*)

KLODNISKI, Nickolas, B.Sc., (Alta. '37), International Nickel Co. of Canada Ltd., Copper Cliff, Ont. (*H*) 215 Elm St. W., Sudbury, Ont. (*S. 1937*)

KLOTZ, C. O. P., B.Sc., (Queen's '34), Engrg. Staff, Kingston Penitentiary, P.O. Box 22, Kingston, Ont. (*S. 1933*)

♂KNAPP, Edward Winslow, B.Sc., (McGill '23), Elec. Engr., Shawinigan Water and Power Co., Power Bldg., Montreal, Que. (*H*) 4385 Melrose Ave. (*Jr. 1923*) (*A.M. 1930*)

KNIGHT, Clarence Archibald, B.Sc., (N.S.T.C. '35), Engrg. Staff, Dept. of Public Utilities, St. John's, Nfld. (*H*) 18 Henry St. (*Jr. 1936*)

♂KNIGHT, Jas. A., Capt., M.C., B.A.Sc., (Tor. '14), Ont. Sales Engr., Brunner Mond Canada Ltd., 1312 Star Bldg., Toronto, Ont. (*H*) 28 Hepbourne St. (*S. 1914*) (*A.M. 1920*) (*M. 1930*)

KOBYLNYK, D. F., B.Sc., (Alta. '38), 11046-88th Ave., Edmonton, Alta. (*S. 1938*)

KOEHLER, J. W., B.Sc., (McGill '30), Can. Gen. Elec. Co. Ltd., Montreal, Que. (*H*) 5530 Cote St. Luke Rd. (*S. 1929*) (*Jr. 1937*)

♂KOHL, Geo. H., Major, B.Sc., (McGill '10), Beardmore Leathers, Ltd., Acton, Ont. (*Jr. 1913*) (*A.M. 1919*) (*M. 1927*)

KORCHESKI, Wm. B., 609 McPherson St., Fort William, Ont. (*S. 1937*)

KOSNAR, V. G., B.Sc., (McGill '38), 216-32nd St. W., Saskatoon, Sask. (*S. 1937*)

KREBSER, E. M., B.Sc., (Vermont '24), Supt., Plant No. 2, The Can. Bridge Co. Ltd., Walkerville, Ont. (*H*) 1155 Kildare Rd. (*A.M. 1930*)

KREBSER, Louis E., Can. Industries Ltd., 1140 Beaver Hall Bldg., Montreal, Que. (*A.M. 1932*)

KRENDEL, Conrad John, B.Sc., (Man. '38), Constrn. Engr., Highway Paving Co., Nantel, Que. (*H*) 323 Vaughan Rd., Toronto, Ont. (*Jr. 1938*)

KRIBS, W. Herbert, B.A.Sc., (Tor. '26), Sec.-Treas., Bd. of Education, Niagara Falls, Ont. (*H*) 2176 Culp St. (*S. 1926*) (*Jr. 1929*)

KUGEL, Emil, C.E., (Vienna), Contracting Engr., 1472 MacKay St., Montreal, Que. (*A.M. 1929*)

♂KUHRING, Paul Ludwig, Engr., River St. Lawrence Ship Channel, Dept. of Marine, Montreal, Que. (*H*) 16 Dobie Ave., Town of Mt. Royal, Que. (*Jr. 1922*) (*A.M. 1925*)

KURTZ, Harold J., B.Sc., (Queen's '26), Ontario Refining Co., Copper Cliff, Ont. (*H*) Apt. 11, 284 Cedar St., Sudbury, Ont. (*S. 1925*) (*Jr. 1928*) (*A.M. 1934*)

KYDD, Geo., B.Sc., (McGill '05), Res. Engr., Hudson Bay Terminals, Dept. of Transport, Churchill, Man. (*H*) 466 MacLaren St., Ottawa, Ont. (*S. 1902*) (*Jr. 1911*) (*A.M. 1914*)

KYLE, John Sheridan, B.Sc., (Alta. '28), Can. Gen. Elec. Co. Ltd., Toronto, Ont. (*H*) 99 Jameson Ave. (*S. 1929*) (*Jr. 1930*)

KYLE, Willard Hugh, B.Sc., (McGill '26), Asst. Engr., C.N.R., Montreal, Que. (*H*) 4982 Connaught Ave. (*S. 1926*) (*A.M. 1931*)

LACOMBE, Jean, B.Eng., (McGill '37), 5586 Phillips St. ,Montreal, Que. (*S. 1937*)

LACROIX, Emile, B.A.Sc., (Ecole Polytech., Montreal '10), City Engr. and Mgr., City of Outremont, 543 Cote St. Catherine Road, Outremont, Que. (*H*) 1785 Van Horne Ave. (*A.M. 1921*)

LACROIX, Jean, 1785 Van Horne Ave., Montreal, Que. (*S. 1937*)

♂LAFERME, Leopold, 2850 Willowdale Ave., Montreal, Que. (*Jr. 1920*) (*A.M. 1921*)

LAFLAMME, Marcel, B.A.Sc., (Ecole Polytech., Montreal '36), Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*H*) 333 Reid St. (*S. 1936*)

LAFONTAINE, D. J., B.Sc., (Queen's '33), Tweed, Ont. (*S. 1931*)

LaFOREST, J. M. M., B.Sc., (Queen's '13), Montreal Harbour, National Harbours Bd., Montreal, Que. (*H*) 1433 Lajoie Ave., Outremont, Que. (*A.M. 1916*)

LAFRAMBOISE, Adhemar, B.A., B.Sc., C.E., Chief Engr., Eastern Canada Steel and Iron Works, Ltd., P.O. Box 400, Quebec, Que. (*H*) Apt. 4, 297 Chemin Ste. Foy. (*S. 1911*) (*A.M. 1916*)

LAFRENIERE, Theo. J., B.A.Sc., (Ecole Polytech., Montreal '09), M.Sc., (M.I.T. '12), D.Sc., Chief Engr., Ministry of Health, 89 Notre Dame St. East, Montreal, Que. (*H*) 418 Pine Ave. W. (*M. 1920*)

LAIDLAW, Douglas S., B.A.Sc., (Tor. '28), 35 Highview Cres., Toronto, Ont. (*Jr. 1930*) (*A.M. 1935*)

LAING, Addison K., B.Sc., (McGill '30), Lighthouse Service, Aids to Navigation Br., Dept. of Transport, Ottawa, Ont. (*H*) 137 Hinton Ave. (*S. 1926*) (*A.M. 1934*)

LAING, D. A. S., B.Sc., (McGill '30), Mech. Engr., Northern Electric Co. Ltd., Montreal, Que. (*H*) Apt. 28, 3025 Sherbrooke St. W. (*S. 1930*) (*A.M. 1937*)

♂LAKIN, John Thos., Lieut., M.C., Engr., Wabasso Cotton Co. Ltd., Three Rivers, Que. (*H*) 1237 St. Louis Blvd. (*A.M. 1932*)

L'ALLIER, Lucien, B.Eng., (McGill '35), Bell Telephone Co. of Canada, Quebec, Que. (*H*) 8 Haldimand St. (*S. 1934*)

LALONDE, J. Antonio, B.A.Sc., (Ecole Polytech., Montreal '12), Chief Engr., A. Janin & Co. Ltd., and Mgr., A. Janin Paving Co. Ltd., 1460 Sherbrooke St. W., Montreal, Que. (*H*) 958 Dunlop Ave., Outremont, Que. (*S. 1910*) (*Jr. 1915*) (*A.M. 1920*)

LALONDE, Jean A., 958 Dunlop Ave., Outremont, Que. (*S. 1937*)

LALONDE, Jean Paul, B.Sc., (Ecole Polytech., Montreal '26), Partner, Lalonde & Valois, Cons. Engrs., Room 527, Canada Cement Bldg., Montreal, Que. (*H*) 2042 Marlowe Ave. (*S. 1925*) (*A.M. 1935*)

LAMARCHE, Marcel, 1891 Sherbrooke St. E., Montreal, Que. (*S. 1937*)

♂LAMB, Henry John, Lt.-Col., D.S.O., (R.M.C., Kingston), Dist. Superv. Engr., D.P.W., Canada, Toronto, Ont. Address: G.P.O. Box 434, 36 Adelaide St. E., Toronto, Ont. (*A.M. 1899*) (*M. 1905*)

LAMB, Hugh, Jr., 415 Aqueduct St., Montreal, Que. (*S. 1936*)

LAMB, John Alexander, B.Eng., (Sask. '37), 520 Markham St., Toronto, Ont. (*Jr. 1938*)

LAMBART, Howard F. J., B.Sc., (McGill '04), D.L.S., 315 Stewart St., Ottawa, Ont. (*S. 1902*) (*A.M. 1907*)

LAMBERT, John Bain, Asst. Engr., D.P.W., Canada, P.O. Box 40, New Westminster, B.C. (*H*) 1545-14th Ave. W. (*A.M. 1920*)

♂LaMOTHE, George Edmond, Capt., M.C., B.A.Sc., (Ecole Polytech., Montreal '13), Engr., Woods Dept., Price Bros. & Co. Ltd., Chicoutimi, Que. (*S. 1910*) (*Jr. 1916*) (*A.M. 1920*)

LAMOUREUX, Joseph A., B.Sc., (Ecole Polytech., Montreal '98), 7160 Christophe Colomb St., Montreal, Que. (*A.M. 1909*)

LAMOUREUX, Marcel, B.Eng., (McGill '32), Dist. Engr.'s Office, D.P.W., Canada, 1254 Bishop St., Montreal, Que. (*Jr. 1934*)

LANDRY, Jos. H., B.A., B.Sc., (Laval '13). Dist. Engr., D.P.W., Canada, P.O. Box 129, Station H, Montreal, Que. (*H*) 4056 Marcil Ave. (*A.M. 1919*)

LANG, Eugene C., B.Sc., (Armour), Canavan & Lang, Cons. Engr., Rm. 1584, 231 So. La Salle St., Chicago, Ill. (*H*) Geneva Rd., St. Charles, Ill. (*M. 1931*)

♂LANG, John Leiper, B.A.Sc., Major, (Tor. '07), D.L.S., O.L.S., Partner, Lang & Ross, Ltd., Sault Ste. Marie, Ont. (*H*) 1085 Queen St. (*M. 1921*)

LANG, J. T., B.Sc., (N.S.T.C. '32), Mech. Engr., Mine Apprentice Project, Dept. of Labour, N.S. Address: Lacey Gold Mine, Chester Basin, N.S. (*S. 1930*) (*Jr. 1931*)

LANGFORD, J. A., B.Sc., (Tor. '22), Elec. Engr., Can. and General Finance Co., 25 King St. W., Toronto, Ont. (*H*) 141 Brookdale Ave. (*A.M. 1929*)

LANGLEY, G. R., B.E., (Union '07), Works Engr., Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*H*) 239 Burnham St., Peterborough, Ont. (*M. 1919*)

LANGLOIS, Amedee, B.A.Sc., (Ecole Polytech., Montreal), Asst. Commr. Patent, P.O. Box 619, Station B, Ottawa, Ont. (*S. 1909*) (*A.M. 1913*)

LANGLOIS, Raoul, B.A.Sc., (Ecole Polytech., Montreal '12), Asst. Chief Engr., Montreal Tramways Comm., 159 Craig St. W., Montreal, Que. (*A.M. 1928*)

LANGLOIS, W. Lawrence, B.A.Sc., (Tor. '23), 287 Foster Ave., Belleville, Ont. (*S. 1923*) (*Jr. 1925*) (*A.M. 1935*)

LANGSTON, John Francis, B.Sc., (Alta. '37), Lane-Wells Co., Okotoks, Alta. (*H*) 504-3rd Ave. W., Calgary, Alta. (*S. 1937*) (*Jr. 1938*)

♂LANGSTROTH, Cecil Craven, Lieut., B.Sc., (McGill '21), Asst. Mgr., Dom. Hoist and Shovel Co. Ltd., Box 3150, Montreal, Que. (*H*) 4859 Wilson Ave. (*S. 1921*) (*A.M. 1927*)

LANTIER, Dunn, Grad., (R.M.C., Kingston '38), R.M.C., Kingston, Ont. (*S. 1938*)

♂La PLANT, Jno. F., Simcoe, Ont. (*A.M. 1932*)

LAPLANTE, J. H. Arthur, B.Sc., (Ecole Polytech., Montreal '33), Engr. and Vice-Pres., Union Quarries and Paving Ltd., Quebec, Que. (*H*) 3 Charest Blvd. (*S. 1934*) (*A.M. 1936*)

LAPLANTE, Rene, B.A., B.A.Sc., (Ecole Polytech., Montreal '29), Quebec Electricity Bd., P.O. Box 1200, Transportation Bldg., Montreal, Que. (*H*) P.O. Box 2670, Valleyfield, Que. (*A.M. 1935*)

LAPOINTE, G. A., B.A.Sc., (Ecole Polytech., Montreal '38), 2608 St. Catherine Rd., Montreal, Que. (*S. 1936*)

LARIVIERE, Alex., B.A.Sc., (Ecole Polytech., Montreal '13), Commr., Quebec Public Service Comm., Court House, Quebec, Que. (*H*) 174 Aberdeen St. (*S. 1910*) (*Jr. 1914*) (*A.M. 1917*) (*M. 1932*)

LaRIVIERE, M. G., B.Eng., (McGill '36), A. Janin & Co., 12 Cote du Palais, Palace Hill Hotel, Quebec, Que. (*S. 1935*)

LARNER, C. W., Pres., The Larner Engineering Co., Lincoln-Liberty Bldg., Philadelphia, Pa. (*M. 1913*)

LAROCHELLE, Joseph E., Mech. Supt., Engrs. Br., D.P.W., Hunter Bldg., O'Connor St., Ottawa, Ont. (*A.M. 1903*)

LASH, Alfred Wm., M.Eng., (Sheffield '21), Hydraulic Engr., Ontario Paper Co. Ltd., Thorold, Ont. (*H*) 62 Yates St., St. Catharines, Ont. (*A.M. 1936*)

LASH, Stanley Dale, B.Sc., (A.C.G.I. '28), M.Sc., (D.I.C. '29), Ph.D., (Birmingham '33), Jr. Engr., National Research Council, Ottawa, Ont. (*A.M. 1938*)

LATIMER, Frank Herbert, (R.M.C., Kingston '82), D.L.S., B.C.L.S., Private Practice, 102 Eckhardt Ave. W., Penticton, B.C. (*M. 1917*)

LATTA, W. S. B., Alberni Pacific Lumber Co. Ltd., Port Alberni, B.C. (*H*) 2653 Dalhousie St., Victoria, B.C. (*S. 1930*)

LAUCHLAND, L. S., B.A.Sc., (Tor. '34), (M.A.Sc. '38), Instructor, Elec. Engr'g., University of Toronto. Address: Box 330, Dundas, Ont. (*S. 1929*)

LAUGHLIN, W. H. M., B.A.Sc., (Tor. '27), M.A.Sc., C.E., Designing Engr., Dom. Bridge Co. Ltd., 1139 Shaw St., Toronto, Ont. (*H*) 61 Braemore Gardens. (*A.M. 1929*)

LAUGHTON, Jas. Alex., B.Sc., (Man. '35), 79 Merritt St., St. Catharines, Ont. (*Jr. 1937*)

LAURENCE, Emile, B.A.Sc., (Ecole Polytech., Montreal '26), Bridge Engr., D.W.P., Quebec, Parliament Bldg., Quebec, Que. (*H*) 118 Brown St. (*Jr. 1930*) (*A.M. 1934*)

LAURENCE, Harold F., Inspn. Engr., Dept. of Highways, Prov. N.S., Halifax, N.S. (*A.M. 1906*) (*M. 1910*)

LAURENCE, Jacques, B.A.Sc., (Ecole Polytech., Montreal '38), 3068 Maplewood Ave., Apt. 1, Montreal, Que. (*S. 1936*)

LAURIE, Albert, B.A.Sc., (McGill '98), Laurie & Lamb, Transportation Bldg., Montreal, Que. (*H*) 653 Victoria Ave., Westmount, Que. (*M. 1921*)

LAURIE, Wm. Little, B.A.Sc., (Tor. '24), Major, Chief Technical Officer, R.C.S., Dept. of National Defence, Elgin Bldg., Ottawa, Ont. (*H*) 215 Metcalfe St. (*Jr. 1924*) (*A.M. 1931*)

LAVALLÉE, Jean, 132 St. Denis St., Apt. 9, Montreal, Que. (*S. 1938*)

LAVERGNE, Emile D., B.S., (Mich. '37), Can. Industries, Ltd., Shawinigan Falls, Que. (*S. 1937*)

LAVERTY, Clarence Alvin, B.Sc., (Alta. '28), Boiler Insurance and Inspection Co. of Canada, 807 Bank of N.S. Bldg., Montreal, Que. (*H*) Apt. 3, 301 St. Louis Sq. (*A.M. 1937*)

LAVOIE, Edouard, B.A., (Laval), B.Sc., (Queen's '07), Lavoie & Delisle, Box 178, Chicoutimi, Que. (*M. 1923*)

LAW, Ernest G., B.Sc., (Man. '38), 830 Hillcrest Ave., Calgary, Alta. (*S. 1938*)

♂LAWRENCE, Alfred John, Major, B.Sc., (McGill '14), Patent Engr., Northern Electric Co., Montreal, Que. (*H*) 662 Davaar Ave. (*S. 1915*) (*Jr. 1916*) (*A.M. 1917*)

LAWRENCE, Edward Arthur, Irrigation Br., Dept. Nat. Res., C.P.R., Lethbridge, Alta. (*H*) 916–8th St. S. (*S. 1932*)

♂LAWRENCE, Robt. Spencer, Lieut., Watermaster, Engrg. Br., C.P.R., A.R. & I. Bldg., Lethbridge, Alta. (*H*) Box 151, Coaldale, Alta. (*A.M. 1920*)

♂LAWRENCE, W. S., Lt.-Col., R.C.E., (R.M.C., Kingston '09), 87 St. Louis St., Quebec, Que. (*Jr. 1914*) (*A.M. 1925*)

LAWSON, Geo. W., B.A.Sc., (Tor. '33), Dufferin Paving and Crushed Stone Ltd., Toronto, Ont. (*H*) 37 Fleming Cres., Leaside, Ont. (*S. 1935*) (*Jr. 1938*)

LAWSON, Horace H., Major, (R.M.C., Kingston '10), B.Sc., (Queen's '36), O.L.S., Assoc. Prof. of Surveying, R.M.C., Kingston, Ont. (*H*) 25 Wellington St. (*A.M. 1932*) (*M. 1937*)

♂LAWSON, Wilfrid S., Major, Chief Engr., Penitentiaries Br., Dept. of Justice, Confederation Bldg., Ottawa, Ont. (*H*) 104 The Driveway. (*A.M. 1907*) (*M. 1916*)

♂LAWSON, Wm. John, B.Sc., (N.B. '15), Asst. Chief Highway, D.P.W., Highway Divn., Fredericton, N.B. (*H*) 813 George St. (*Jr. 1921*) (*A.M. 1927*)

LAWTON, Fred Lewis, B.A.Sc., (Tor. '23), Chief Engr., Saguenay Power Co. Ltd., Arvida, Que. (*H*) 2 Larouche St., Chicoutimi, Que. (*S. 1920*) (*A.M. 1928*) (*M. 1936*)

♂LAYNE, Geoffrey Francis, Lieut., M.C., B.Sc., (McGill '14), Mech. Supt., Price Bros. & Co. Ltd., Box No. 77, Kenogami, Que. (*S. 1914*) (*Jr. 1919*) (*A.M. 1920*)

♂LAYNE, John Graham, Sub-Lt., R.N.V.R., B.Sc., (McGill '23), Mgr., West India Rum Refinery Ltd., Black Rock 26, Barbados, B.W.I. (*S. 1921*) (*A.M. 1928*)

LAYTON, Michael Shakespear, B.Eng., (McGill '35), Asst. Chem. Engr., Steel Co. of Canada, Montreal, Que. (*H*) Apt. 518, 1500 Stanley St. (*Jr. 1938*)

LAZENBY, Thos. Wm., Chief Dftsman., Vancouver Engineering Wks. Ltd., Vancouver, B.C. (*H*) 2836–29th Ave., W. (*Jr. 1928*) (*A.M. 1934*)

LAZIER, Francis S., B.Sc., (Queen's '07), 75 Victoria Ave., Belleville, Ont. (*S. 1905*) (*A.M. 1911*) (*M. 1920*)

LAZORKA, D., B.E., (Sask. '32), Instr., Engrg. Service, Dept. of Mines and Resources, Prince Albert, Sask. (*S. 1931*) (*Jr. 1937*)

LEA, Harry Windsor, B.Sc., (McGill '31), Phillips Electrical Works, Ltd., Montreal, Que. (*H*) 5029 Grosvenor Ave. (*Jr. 1924*) (*A.M. 1935*)

†LEA, Richard S., B.Sc., Ma.E., (McGill '90), Cons. Engr., c/o The Manager, Bank of Montreal, 950 St. Catherine St. W., Montreal, Que. (*S. 1887*) (*A.M. 1894*) (*M. 1900*)

LEA, William S., B.Sc., (McGill), Cons. Engr., 1226 University St., Montreal, Que. (*H*) 1 Richelieu Place. (*A.M. 1909*) (*M. 1913*)

LEACH, John Wm., B.Sc., (Sask. '27), Imperial Oil Ltd., Regina, Sask. (*H*) 2265 Lorne St. (*Jr. 1931*)

♂LEADLAY, Francis Robt., B.Sc., (Queen's '25), Engrg. Dept., Toronto, Hamilton & Buffalo Railway Co., Hamilton, Ont. (*H*) Watertown, Ont. (*S. 1925*) (*A.M. 1929*)

LEAHEY, Jas. C. P., B.Eng., (McGill '35), i/c Testing Oper., Schick Shaver Ltd., St. Johns, Que. (*S. 1935*)

LEAVENS, J. W., B.Sc., (Queen's '30), Picton, Ont. (*S. 1928*)

LEAVER, Charles Burfoot, B.A.Sc., (Tor. '10), 824 Highland Ave., Westfield, N.J., U.S.A. (*A.M. 1918*)

LeBARON, K. S., B.Sc., (McGill '23), Plant Engr., Can. International Paper Co., Three Rivers, Que. (*H*) 952 St. Genevieve St. (*S. 1920*) (*A.M. 1926*)

LeBEL, H. W. S., B.Eng., (McGill '37), Box 167, Fort Erie N., Ont. (*H*) Namur, Que. (*S. 1937*)

LeBEL, Raymond, 4387 Christophe Colomb, Montreal, Que. (*S. 1938*)

LeBLANC, C. Jos., B.A.Sc., (Ecole Polytech., Montreal '10), Q.L.S., Asst. Supt. of Roads, City of Montreal, Room 312, City Hall, Montreal, Que. (*H*) 169 Jarry St., Villeray Ward, Montreal, Que. (*A.M. 1920*)

LeBLANC, Jules, B.A.Sc., (Ecole Polytech., Montreal '28), Q.L.S., Engr., Provincial Electricity Bd., Montreal, Que. (*H*) 739 Dunlop Ave., Outremont, Que. (*S. 1928*) (*Jr. 1932*) (*A.M. 1938*)

LEBLANC, Raymond F., B.A.Sc., (Ecole Polytech., Montreal '37 and '38), 371 St. Joseph Blvd. W., Montreal, Que. (*S. 1936*)

LeBOURVEAU, Homer Benjamin, B.A.Sc., (Alta. '24), Asst. Engr., Calgary Power Co. Ltd., Insurance Exchange Bldg., Calgary, Alta. (*H*) 1418-4-A St. N.W. (*A.M. 1930*)

LeBOUTILLIER, W. P. C., B.Sc., (McGill '27), Asst. Groundwood Supt., Price Bros. & Co. Ltd., Kenogami, Que. (*Jr. 1929*) (*A.M. 1938*)

♂LeCAPELAIN, Chas. King, Asst. Engr., Engrg. and Constrn. Service, Dept. of Mines and Resources, Box 232, Banff, Alta. (*A.M. 1933*)

LECAVALIER, Fernand, 6280 St. Denis St., Montreal, Que. (*S. 1937*)

LECAVALIER, Jean Paul, B.A.Sc., (Ecole Polytech., Montreal '37), Demonstrator, Ecole Polytechnique, Montreal, Que. (*H*) 6280 St. Denis St. (*S. 1936*)

LECKY, Robert John, Mgr., R. J. Lecky & Associates; Secy., Building and Construction Industries Exchange, 342 W. Pender St., Vancouver, B.C. (*H*) 6450 Elm St. (*A.M. 1907*)

♂LeCLAIR, Wm. Jas., Capt., Secy. Mgr., White Pine Bureau, 38 King St. W., Toronto, Ont. (*H*) 2 Rosedale Rd. (*S. 1914*) (*Jr. 1919*) (*A.M. 1928*) (*M. 1938*)

LECLAIRE, Jos. Paul, B.A.Sc., (Ecole Polytech., Montreal '02), Chief Engr., Montreal Harbour, National Harbours Bd., Montreal, Que. (*H*) 191 Maplewood Ave., Outremont, Que. (*M. 1925*)

LECLERC, Pierre, 4398 De Lanaudiere St., Montreal, Que. (*A.M. 1920*)

LeCOINTE, P. P., C.E., (Ecole Nat. des Ponts et Chaussées '08), Cons. Engr., Room 98, 354 St. Catherine St. E., Montreal, Que. (*M. 1938*)

LEDUC, Francois J., The Hon., B.A.Sc., (Ecole Polytech., Montreal '24), D.A.Sc., (H.C.), Room 98, 354 St. Catherine St. E., Montreal, Que. (*H*) 10832 Henri Julien. (*M. 1938*)

LEE, Frank, (Yale '94), Divn. Engr., C.P.Ry., Vancouver, B.C. (*M. 1908*)

♂LEE, L. A. C., B.A.Sc., (Tor. '16), Chief Concrete Engr., Bldg. Dept., City of Toronto, City Hall, Toronto, Ont. (*H*) 209 Silverbirch Ave. (*M. 1934*)

LEE, Robert J., Private Practice, Estevan, Sask. (*1938*)

LEE, Wm. States, Jr., C.E., (Princeton '24), Pres., W. S. Lee Engineering Corpn., Power Bldg., Charlotte, N.C. (*H*) 2601 Sherwood Ave. (*A.M. 1930*)

LEEBOSH, Ilja, Engr., Can. Bridge Co. Ltd., Walkerville, Ont. (*H*) 957 Moy Ave., Windsor, Ont. (*A.M. 1938*)

LEES, Thomas, A.R.T.C., (Glasgow), Dist. Engr., C.P.R., Calgary, Alta. (*H*) 2601–7th St. W. (*A.M. 1911*) (*M. 1928*)

LEFEBVRE, Jean, B.A.Sc., (Ecole Polytech., Montreal '34), Chem. Engr., Imperial Oil Ltd., Montreal East, Que. (*H*) Apt. 10, 4880 Queen Mary Rd., Montreal, Que. (*S. 1934*)

LEFEBVRE, Joseph Alexis, Principal Engr., Dist No. 2, Highways Dept., Parliament Bldgs., Quebec, Que. (*H*) 47 Vallee Blvd., Beauport, Que. (*A.M. 1915*) (*M. 1926*)

†LEFEBVRE, Olivier Odilon, B.A.Sc., (Ecole Polytech., Montreal '02), D.Sc., Controller, Province of Quebec Provincial Electricity Board, Room 804, Transportation Bldg., 132 St. James St. W., Montreal, Que. (*H*) 26 Robert Ave., Outremont, Que. (*S. 1903*) (*A.M. 1912*) (*M. 1920*) (*Past President*)

LEFEBVRE, Paul, B.A.Sc., (Ecole Polytech., Montreal '30), c/o Fire Commrs. Office, D.P.W., Quebec, Que. (*H*) 94 Grande Allee, Quebec, Que. (*A.M. 1932*)

LEFORT, Jean, B.Eng., (McGill '36), 4033 Lacombe Ave., Montreal, Que. (*S. 1935*)

LEFRANCOIS, J. Germain, B.A.Sc., (Ecole Polytech., Montreal '36), Sales Engr., Can. Fairbanks Morse Co. Ltd., Montreal, Que. (*H*) 123 Chemin Chambly, Longueuil, Que. (*Jr. 1937*)

LEGER, J. A. K., B.Sc., (N.B. '38), 26 Ashburnham St., Toronto 10, Ont. (*S. 1937*)

♂LEGER, Oswald E., Capt., Asst. to Pres., Hamilton Bridge Co., Hamilton, Ont. (*A.M. 1924*) (*M. 1936*)

LEGG, John H., B.Sc., (McGill '29), Gen. Supt., Can. Kaolin Silica Products Ltd., St. Remi d'Amherst, Que. (*S. 1927*) (*A.M. 1935*)

LEGGET, Robt. F., B.Eng., (Liverpool '25), (M.Eng., '27), Asst. Prof. of Civil Engrg., Univ. of Toronto, Toronto, Ont. (*H*) 244 Glenrose Ave. (*Jr. 1929*) (*A.M. 1931*)

LEGRIS, Charles E., B.Sc., (McGill '14), U.S. Treas. Dept., Kewaunee, Wis., U.S.A. (*A.M. 1923*)

LEIGHTNER, D. B., B.Sc., (Man. '31), Can. Westinghouse Co. Ltd., Hamilton, Ont. (*H*) 200 Cumberland Ave. (*S. 1929*) (*Jr. 1936*)

LEIGHTON, Chester Anam, Gen. Supt., Arthur A. Johnson Corp., 29-28 Hunter Ave., Long Island City, N.Y. (*H*) 39 Churchill St., Amherst, Mass. (*A.M. 1924*)

LEITCH, Hugh Jas., B.Sc., (McGill '26), Mgr., Sault Structural Steel Co. Ltd., Box 963, Sault Ste. Marie, Ont. (*S. 1920*) (*Jr. 1927*) (*A.M. 1934*)

LEMAN, Beaudry, B.Sc., Dr.C.Sc., Pres., Banque Canadienne Nationale, Montreal, Que. (*H*) 597 St. Catherine Rd., Outremont, Que. (*S. 1901*) (*A.M. 1902*)

LeMAISTRE, E. B. A., c/o Canada House, Trafalgar Sq. London, S.W.1. (*S. 1937*)

LEMBCKE, Robert E., B.S. in C.E., Asst. Engr., T. & P. Rly., Rm. 213, T. & P. Depot, Fort Worth, Texas, U.S.A. (*H*) 2014 Market St. (*A.M. 1914*)

LEMIEUX, Gilbert, B.A.Sc., (Ecole Polytech., Montreal '36), 112 Abraham Hill, Quebec, Que. (*S. 1935*) (*Jr. 1938*)

LEMIEUX, Henri Julien, 759-B Champagneur Ave., Outremont, Que. (*S. 1938*)

LEMIEUX, Roland A., B.A.Sc., (Ecole Polytech., Montreal '37), Dept. of Roads, Room 12, Samson Bldg., Quebec, Que. (*S. 1937*)

LEMON, Marvin R., B.A.Sc., (Tor. '33), Stouffville, Ont. (*S. 1933*)

♂LEONARD, Ibbotson, Col., D.S.O., (R.M.C., Kingston '03), B.Sc., (McGill '05), Pres., E. Leonard & Sons, Ltd., 381 York St., London, Ont. (*H*) 782 Wellington St. (*S. 1903*) (*A.M. 1912*) (*M. 1922*)

♂LePAN, Arthur D'Orr, Lt.-Col., B.A.Sc., (Tor. '08), Supt., University of Toronto, Toronto, Ont. (*H*) 82 Walmer Rd. (*A.M. 1921*)

LEROUX, Jacques P., 3686 St. Hubert St., Montreal, Que. (*S. 1937*)

LEROUX, Louis Jos., B.A.Sc., (Ecole Polytech., Montreal '06), Engr. of Bridges and Tunnels, City of Montreal, Rm. 407, City Hall, Montreal, Que. (*H*) 28 Holyrood Ave., Outremont, Que. (*A.M. 1930*)

LeROY, Wm. Lindsay, Prescott, Ont. (*M. 1926*)

LESLIE, Roy Campbell, M.Sc., (Tor. '24), Asst. Engr., Can. Bridge Co. Ltd., Walkerville, Ont. (*H*) 2334 Chilver Rd. (*S. 1921*) (*Jr. 1925*) (*A.M. 1930*)

LESSARD, C. Camille, B.S.A. and C.E., (Ecole Polytech., Montreal '22), Cons. Engr., 32 Blvd. des Alliés, Quebec, Que. (*A.M. 1922*)

LESSARD, Roger, 6214 De Normanville St., Montreal, Que. (*S. 1938*)

♂LESTER, Jas. Fred., Lieut., Res. Engr., Dept. Highways, Ont., Parliament Bldgs., Toronto, Ont. (*H*) 298 Berkeley St. (*A.M. 1920*)

♂LETSON, H. F. G., Col., M.C., B.Sc., (B.C. '19), Ph.D., (London '23), Mang. Dir., Letson & Burpee, 172 Alexander St., Vancouver, B.C. (*H*) 1775-W. 40th Ave. (*M. 1936*)

LETSON, Jos. Edwin, Transit and Storage Co., Wayne, Mich., U.S.A. (*S. 1910*) (*Jr. 1914*) (*A.M. 1920*)

LEVIN, Max., B.Sc., (Man. '30), M.A.Sc., (Tor. '33), Dftsman., Dept. of Highways, Ont., Bancroft, Ont. (*S. 1928*) (*A.M. 1937*)

LEVINE, S. Dave, 292 Charles St., Winnipeg, Man. (*S. 1937*)

LEWIS, Crompton Emerson, B.A.Sc., (Tor. '36), Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*H*) 334 Reid St. (*S. 1937*)

LEWIS, David J., B.Sc., (Queen's '24), Dominion Bridge Co. Ltd., Lachine, Que. (*H*) 129–34th Ave., Lachine, Que. (*S. 1922*) (*A.M. 1929*)

LEWIS, David O., Cons. Civil Engr., 816 Vancouver Blk., Vancouver, B.C. (*H*) 1055–12th Ave. W. (*A.M. 1894*) (*M. 1907*)

LEWIS, E. Keith, B.Sc., (N.S.T.C. '30), Imperial Oil Ltd., P.O. Box 490, Dartmouth, N.S. (*H*) Imperoyal, N.S. (*S. 1929*) (*Jr. 1935*)

♂LEWIS, Hugh Miles, Lieut., M.S.M., Plant Engr., Pacific Mills Ltd., Ocean Falls, B.C. (*A.M. 1920*)

LEWIS, J. Wentworth, Gen. Mgr., American Concrete Corp., 4727 N. Lamson Ave., Chicago, Ill. (*H*) 722 Erie St., Oak Park, Ill. (*Jr. 1920*) (*A.M. 1931*)

LEWIS, Stanley T., Dist. Engr., C.P.R., Regina, Sask. (*H*) 2128 Retallack St. (*1938*)

LEY, Cecil F., Dom. Bridge Co. Ltd., P.O. Box 280, Montreal, Que. (*H*) 33-21st Ave., Lachine, Que. (*S. 1935*)

L'HEUREUX, P. E., B.A.Sc., (Ecole Polytech., Montreal '36), Asst. Engr., Associated Engineers Ltd., 10 St. James St. W., Montreal, Que. (*H*) 6316 St. Denis St. (*S. 1936*)

L'HOMME, L. P., 50 Yamaska St., Farnham, Que. (*S. 1937*)

♂LIBBY, Philip Nason, B.Sc., (Maine '17), Mech. Engr., Tennessee Eastman Corp., Kingsport, Tenn. (*H*) 1705 Orchard Lane, Kingsport, Tenn. (*Jr. 1922*) (*A.M. 1927*)

LICHTY, Lyall J., B.A.Sc., (Tor. '33), Asst. Mill Supt., Normetal Mining Corp. Ltd., Dupuy, Que. (*S 1931*)

LILLEY, L. G., B.Sc., (N.B. '35), Constrn. Dept., Bell Telephone Co. of Canada, Montreal, Que. (*H*) 57 Havelock St., West Saint John, N.B. (*S. 1935*) (*Jr. 1937*)

LIND, Walter J., B.A.Sc., (B.C. '32), M.A.Sc., (B.C. '35), Can. Gen. Elec. Co. Ltd., Toronto, Ont. (*H*) 614 Huron St., Toronto, Ont. (*S. 1930*) (*Jr. 1938*)

♂LINDSAY, Chas. C. (*q*), Major, M.C., C. de G., B.Sc., (McGill '15), Partner, M. D. Barclay, Inc., and Lindsay & Belanger, Rms. 806-8, Tramways Bldg., Montreal, Que. (*H*) 318 Kensington Ave., Westmount, Que. (*S. 1908*) (*A.M. 1919*)

♂LINDSAY, Guy Adamson, Lieut., B.Sc., (McGill '20), Engr. i/c Gen. Engrg. Br., Dept. of Transport, 313 West Block, Ottawa, Ont. (*H*) 69 Ossington Ave. (*S. 1914*) (*A.M. 1922*)

LINDSEY, Chas. R., B.Sc., (Ohio Nor. '05), Shawinigan Engineering Co. Ltd., Power Bldg., Montreal, Que. (*H*) 534 Clarke Ave., Westmount, Que. (*A.M. 1916*)

LINGLEY, Harold P., B.Sc., (N.B. '30), D.P.W., Canada, P.O. Box 1417, Saint John, N.B. (*H*) 148 Waterloo St. (*S. 1930*) (*Jr. 1936*)

♂LINK, Norman Archibald, Asst. Supt., C.P.R., Macleod, Alta. (*A.M. 1927*)

♂LINTON, Adam P., Lt.-Col., O.B.E., B.A.Sc., (Tor. '08), Chief Bridge Engr., Dept. of Highways, Sask., Regina, Sask. (*H*) 3080 Rae St. (*S. 1908*) (*A.M. 1913*) (*M. 1935*)

♂LITTLE, Edward Caruthers, Lieut., (Belgian C. de G.), B.Sc., (McGill '15), Supt., So. Divn., Welland Ship Canal, Dept. of Transport, Humberstone, Ont. (*H*) 26 Parkway Dr., Welland, Ont. (*S. 1913*) (*Jr. 1919*) (*A.M. 1921*)

LITTLE, Harold R., B.Sc., (McGill '11), Partner, Lawson & Little, 1227 University Tower, Montreal, Que. (*H*) 11 Anwoth Rd., Westmount, Que. (*S. 1909*) (*A.M. 1913*)

LITTLE, Harry, Sales Engr., R. & M. Bearings Canada, Ltd., 1006 Mountain St., Montreal, Que. (*S. 1931*)

♂LIVINGSTON, David A., Major, c/o C.P.R., Virden, Man. (*S. 1909*) (*A.M. 1909*)

LIVINGSTONE, Robert, Mgr., Lethbridge Collieries, Ltd., Lethbridge, Alta. (*H*) 518-14th St. S. (*M. 1923*) (*Life Member*)

LLEWELLYN, Leopold Wm., B.Sc., (Sask. '27), Northwestern Iron Wks. Ltd., Regina, Sask. (*H*) 2848 Retallack St. (*Jr. 1929*) (*A.M. 1937*)

LLOYD, David S., B.A.Sc., (Tor. '25), Sales Mgr., Dom. Oxygen Co., Ltd., Rm. 712, 159 Bay St., Toronto 2, Ont. (*H*) 82 Woodlawn Ave. E. (*S. 1923*) (*Jr. 1928*) (*A.M. 1933*)

LLOYD, M. F. R., Canal Supt., Dept. of Nat. Res., C.P.R., Box 84, Magrath, Alta. (*A.M. 1922*)

LOCHHEAD, John S., B.Eng., (McGill '37), 345 Ballantyne Ave. N., Montreal West, Que. (*S. 1934*)

LOCHHEAD, K. Y., B.Eng., (McGill '32), Hudson's Bay Co., Retail Store, Vancouver, B.C. (*S. 1931*) (*Jr. 1935*)

LOCHHEAD, Stuart G., B.Eng., (McGill '38), Dom. Bridge Co. Ltd., Montreal, Que. (*H*) 66 Strathearn Ave., Montreal West, Que. (*S. 1928*) (*Jr. 1931*)

LOCKEBERG, Rolf S., 542 Wellington St., Ottawa, Ont. (*S. 1938*)

LOCKE, C. W. E., B.A.Sc., (B.C. '30), Engr., Pacific Mills Ltd., P.O. Box 376, Ocean Falls, B.C. (*S. 1930*) (*A.M. 1937*)

LOCKWOOD, Clarence Kingsley, B.Eng., (McGill '35), 602 Cote St. Antoine Rd., Westmount, Que. (*S. 1935*)

♂LOGAN, Robert Archibald, Major, D.L.S., N.S.L.S., Upper Lakeville, Halifax Co., N.S. (*A.M. 1924*)

LOGAN, R. S., Jr., B.Sc., (McGill '25), 45 Aberdeen Ave., Westmount, Que. (*S. 1922*) (*A.M. 1933*)

LOGAN, William A., 14 Murray St., Peterborough, Ont. (*A.M. 1903*) (*Life Member*)

LOGGIE, Gerald Purves, Lt.-Col., (R.M.C., Kingston '05), R.C.O.C., Ord. Repres., Dept. of Nat. Defence. Address: c/o High Commr. for Canada, Canada House, London, S.W.1. (*Affil. 1937*)

LOGIE, Ernest Roy, Divn. Engr., C.N.R., Belleville, Ont. (*H*) 15 Queen St. (*A.M. 1921*)

LOGIE, W. A., B.Sc., (N.B. '38), Montreal L., H. and P. Cons., Montreal, Que. (*H*) 3537 Shuter St. (*S. 1938*)

LOISELLE, H. J., B.Eng., (McGill '37), Apt. 5, 65 Duverger Ave., Outremont, Que. (*S. 1937*)

LOISELLE, J. C., 5586 Queen Mary Rd., Montreal, Que. (*S. 1936*)

LOMBARD, Robert A., B.Sc., (N.S.T.C. '32), R.R. 1, Malagash, N.S. (*S. 1932*)

LOMER, Gerald B., B.Sc., (McGill '10), Power Corp. of Canada, 355 St. James St., Montreal, Que. (*H*) 1819 Dorchester St. W. (*A.M. 1927*)

LONDON, Woodrow P., B.Sc., (N.B. '34), N.B. Power Comm., Bathurst, N.B. (*S. 1934*)

♂†LONGLEY, Francis Fielding, Col., C.B.E., D.S.M., (West Point '02), Vice-Pres., Lock Joint Pipe Co., 150 Rutledge Ave., East Orange, N.J. (*H*) 11 Courter Ave., Maplewood, N.J. (*A.M. 1911*) (*M. 1920*)

LONGSTAFF, John Calvin, (Tor. '10), Field Engr., James Ruddick, C.E., Rm. 414, Quebec Power Co., Quebec, Que. (*A.M. 1931*)

LONGWORTHY, Ward Odell, B.A.Sc., Asst. to Chief Engr., Imperial Oil Ltd., Regina, Sask. (*H*) 645 Winnipeg St. (*A.M. 1936*)

LOOMIS, J. G. M., B.Eng., (McGill '36), Engr., Bitumen Products Corp., 3590 St. Patrick St., Montreal, Que. (*H*) 1694 Lincoln Ave., Montreal, Que. (*S. 1936*)

♂LORD, Ernest Ellis, Lieut., Smith Bros. & Wilson, Ltd., 104 Dominion Bank Bldg., Regina, Sask. (*H*) 3067 Angus St. (*A.M. 1923*)

LORD, G. Ross, B.A.Sc., (Tor. '29), S.M., Lecturer, Mech. Engrg., University of Toronto, Toronto, Ont. (*H*) 40 Maxwell Ave. (*S. 1927*) (*A.M. 1934*)

♂LOTT, Harry C., (A.C.G.I.), Lieut.-Col., M.C., Balfour Beatty & Co., Ltd., 66 Queen St., E.C.4, London, England. Res.: Constitutional Club, Northumberland Ave., London, W.C.2. (*S. 1907*) (*A.M. 1913*)

♂LOUDON, Thomas R., Major, B.A.Sc., (Tor. '06), Prof. of Applied Mechanics, University of Toronto, Toronto, Ont.; Cons. Engr. (*H*) 189 Sheldrake Blvd. (*A.M. 1910*) (*M. 1919*)

LOUTIT, J. A., B.A.Sc., (Tor. '38), 542 Church St., Toronto, Ont. (*S. 1937*)

♂LOVE, Alexander, Lieut., B.Sc., (Glasgow '12), Plant Engr., Hamilton Bridge Co., Ltd., Hamilton, Ont. (*H*) 40 Paisley Ave. S. (*A.M. 1920*) (*M. 1934*)

LOVE, Edwin Reginald, B.Sc., (Man. '34), Can. Westinghouse Co., Hamilton, Ont. (*H*) 784 King St. E. (*S. 1931*)

LOVE, H. W., B.Sc., (Queen's '36), Lieut., R.C.E., M.D. No. 5, Quebec, Que., Engr. i/c Dom. Arsenal, Valcartier, Que. (*Jr. 1937*)

†LOVELACE, Edgar S. M., B.A.Sc., (McGill '88), 457 Elm Ave., Westmount, Que. (*S. 1887*) (*A.M. 1893*) (*M. 1906*) (*Life Member*)

♂LOVELL, William Edward, B.Sc., (Man. '21), Prof. of Elec. Engrg., University of Saskatchewan, Saskatoon, Sask. (*H*) 1224 Elliott St. (*S. 1911*) (*A.M. 1925*) (*M. 1936*)

LOVETT, Percy Arthur, B.Sc., (N.S.T.C. '28), Sec.-Treas., Engineering Service Co. Ltd., Halifax, N.S. (*H*) 10 Shirley St. (*S. 1928*) (*Jr. 1931*) (*A.M. 1935*)

LOW, Charles D., 376 Lewis St., Ottawa, Ont. (*S. 1929*)

♂LOW, Charles M., Lieut., B.Sc., (Edinburgh '11), Mgr., Lake St. Joseph Transportation Co. Ltd., Root Portage, Hudson, Ont. (*A.M. 1921*)

LOW, David Duncan, B.Sc., (Sask. '23), C.N.R., Regina, Sask. (*H*) 2269 Princess St. (*1938*)

LOW, Richard Alex., B.Sc., (Queen's '28), Asst. Prof., C.E. Dept., Queen's University, Kingston, Ont. (*H*) 86 Sydenham St. (*A.M. 1929*)

LOWLES, G. A., B.Eng., (McGill '37), Chemist, Can. Industries Ltd., Windsor, Ont. (*H*) 4206 Hingston Ave., Montreal, Que. (*S. 1937*)

LOWRIE, Andrew W. P., B.A.Sc., (Tor. '11), 510-11th St. W., Calgary, Alta. (*A.M. 1916*)

LOWRY, Geo. H., Divn. Engr., Dept. of Highways, Ont., Fort Frances, Ont. (*A.M. 1919*)

♂LOY, J. Austin, Capt., M.C., B.Sc., (McGill '21), The Bell Telephone Co. of Canada, Montreal, Que. (*H*) 4832 Western Ave., Westmount, Que. (*S. 1919*) (*Jr. 1922*) (*A.M. 1927*)

LUCAS, John Wm., B.Sc., (Alta. '30), Tester of Bldg. Materials, Testing Labs., D.P.W., Ottawa, Ont. (*S. 1928*) (*Jr. 1932*) (*A.M. 1936*)

♂LUCK, Cecil George John, Capt., M.C. and Bar, 102 Banning St., Port Arthur, Ont. (*A.M. 1920*)

LUDGATE, Jas. Vernon, B.Sc., (Queen's '23), 91 Harvey St., North Bay, Ont. (*A.M. 1931*)

LUKE, E. C., (R.M.C., Kingston '24), Flt.-Lt., Chief Wks. Officer, Western Air Command, R.C.A.F., Vancouver, B.C. (*H*) Sta. 9, 2310 Cornwall St. (*A.M. 1936*)

LUMB, Wm. Ewart, B.Sc., (Queen's '13), O.L.S., D.L.S., Sales and Promotion Engr., Canada Cement Co., Montreal, Que. (*H*) 309 Frontenac St., Kingston, Ont. (*A.M. 1936*)

LUMBERS, Wm. Cooper, (Tor. '01), Asst. Engr., H.E.P.C. of Ont., 620 University Ave., Toronto, Ont. (*H*) 67 Metcalfe St. (*A.M. 1921*)

♂LUMSDEN, Hugh Allan, Major, B.Sc., (McGill '12), County Engr., County of Wentworth, Court House, Hamilton, Ont. (*H*) 250 Duke St. (*S. 1905*) (*Jr. 1911*) (*A.M. 1913*) (*M. 1923*)

LUNDIE, Jas., B.Sc., (Sask. '30), C.P.R., Municipal Airport, Moose Jaw, Sask. (*Jr. 1936*)

LUNN, Fred Richard, B.Sc., (McGill '29), Mgr., G. J. Lunn & Co., 618 Chatham St., Montreal, Que. (*H*) 458 Argyle Ave., Westmount, Que. (*S. 1927*) (*A.M. 1938*)

LUPTON, Mac Joseph, B.Sc., (Man. '34), M.Eng., (McGill '36), 610 St. Joseph St., Lachine, Que. (*S. 1934*)

LUSBY, G. W., B.Sc., (N.S.T.C. '25), Ford Motor Co. of Canada, Windsor, Ont. (*H*) 1268 Hall Ave. (*S. 1925*) (*Jr. 1931*) (*A.M. 1937*)

LUSCOMBE, Charles, Supt. of Constrn., The Shawinigan Engineering Co., Power Bldg., Montreal, Que. Address: P.O. Box 264, La Tuque, Que. (*A.M. 1908*)

LYNCH, F. C. C., Chief, Bureau of Geology and Topography, Dept. of Mines and Resources, Victoria Memorial Museum, Ottawa, Ont. (*H*) 283 Wilbrod St. (*Affil. 1916*) (*A.M. 1924*)

LYNCH, John Franklin, B.Sc., (N.B.), (El. '29, Ci. '33), Dept. of Highways, N.B., Moncton, N.B. (*H*) 149 Northumberland St., Fredericton, N.B. (*Jr. 1932*)

♂LYNN, Harold Riviere, Major, Pres., Lynn, MacLeod Engineering Supplies Ltd., Box 278, Thetford Mines, Que. (*A.M. 1920*)

LYON, G. M., B.Sc., (Man. '31), Engr., Red Lake Gold Shore Mines, Red Lake, Ont. (*H*) 1278 Wellington Cres., Winnipeg, Man. (*S. 1929*) (*A.M. 1938*)

LYONS, Gerald Stanley, B.Sc., (Queen's '24), Toll Cable Engr., The Bell Telephone Co. of Canada, Ltd., Beaver Hall Bldg., Montreal, Que. (*H*) 4552 Draper Ave. (*S. 1922*) (*Jr. 1930*)

LYONS, J. H. K., B.Sc., (Man. '36), B.Eng., (McGill '37), 2063 Stanley St., Montreal, Que. (*S. 1936*)

♂LYSTER, Horace M., Lieut., M.C., B.Sc., (McGill '13), Gen. Mgr., Dom. Welding Engineering Co. Ltd., P.O. Box 594, Montreal, Que. (*H*) 485 Strathcona Ave., Westmount, Que. (*A.M. 1920*)

♂MACAFEE, Ralph Evans, Major, M.C., B.Sc., (McGill '10), Mgr., Eastern Br., Babcock-Wilcox & Goldie-McCulloch, Ltd., 312 Canada Cement Bldg., P.O. Box 3040, Montreal, Que. (*H*) 4156 Dorchester St. W. (*A.M. 1920*) (*M. 1931*)

MACALLUM, Andrew Fullerton, B.A.Sc., C.E., (Tor. '96), 108 Avenue Rd., Toronto, Ont. (*A.M. 1907*) (*M. 1908*)

McALPINE, Robert F., B.Sc., (N.S.T.C. '28), 93 Cromarty St., Sydney, N.S. (*Jr. 1929*)

McANDREW, Jos. B., B.A.Sc., (Tor. '12), Asst. Designing Engr., Welland Ship Canal, Dept. of Transport, 70 Church St., St. Catharines, Ont. (*A.M. 1919*)

McARA, Peter Graham, B.Sc., (Sask. '29), Asst. Supt., W.W. Dept., City of Regina, Sask. (*H*) 179 Angus Cres. (*A.M. 1934*)

McARTHUR, Donald S., 613 Clarence Ave., Saskatoon, Sask. (*S. 1938*)

McARTHUR, Duncan, Principal Surveyor for Canada, British Corp'n. Registry of Shipping and Aircraft, 360 Place Royale, Montreal, Que. (*H*) 1374 Sherbrooke St. W. (*M. 1921*)

McARTHUR, Franklin, B.Sc., (Queen's '07), Pres., The McArthur Engineering and Construction Co. Ltd., 15 Douglas St., Guelph, Ont. (*A.M. 1909*) (*M. 1919*)

♂MACAULAY, Robt. Vernon, Lieut., M.C., B.A.Sc., (Tor. '12), Asst. Vice-Pres., Bell Telephone Co. of Canada, Montreal, Que. (*H*) 727 Roslyn Ave., Westmount, Que. (*M. 1927*)

McAULAY, G. F., 12007-103 Ave., Edmonton, Alta. (*S. 1937*)

McAVITY, G. Clifford, T. McAvity Sons, Ltd., Saint John, N.B. (*H*) Rothesay, N.B. (*Affil. 1919*)

MacBRIDE, Duncan, Director and Gen. Mgr., Island Freezing and Packing Co. Ltd., Cold Storage, Victoria, B.C. (*A.M. 1929*)

McBRIDE, Ernest Willard, B.A.Sc., (Tor. '23), Engr., Abitibi Power and Paper Co., Ltd., Toronto, Ont. (*H*) 86 High Park Ave. (*S. 1920*) (*Jr. 1928*) (*A.M. 1935*)

McBRIDE, J. Wallace, B.Sc., (Man. '38), Graduate House, M.I.T., Cambridge, Mass. (*H*) 402 The Ambassador, Winnipeg, Man. (*S. 1938*)

McBRIDE, Wilbert Geo., B.Sc., (McGill '02), Prof. of Mining Engrg., McGill University, Montreal, Que. (*M. 1936*)

McCABE, R. L., B.Sc., (McGill '30), 4914 Grosvenor Ave., Westmount, Que. (*S. 1928*)

♂McCAGHEY, Norman F., Major, D.S.O., M.C., Price Bros. & Co., Ltd., Box 8, Riverbend, Que. (*S. 1913*) (*Jr. 1920*) (*A.M. 1923*)

*L.*McCALL, Thos. Lockhart, Chief Mining Engr., Dominion Steel and Coal Corp., Ltd., Sydney, N.S. (*H*) 186 Kings Rd. (*M. 1930*)

McCALLUM, Francis, B.Sc., (Sask. '38), Assiniboia Hotel, Medicine Hat, Alta. (*S. 1938*)

♂McCAMMON, John Whyte, Lieut., B.Sc., (McGill '13), Controller, Province of Quebec Provincial Electricity Bd., 132 St. James St., Montreal, Que. (*H*) 11 Belfrage Rd., Westmount, Que. (*Jr. 1913*) (*A.M. 1924*)

McCANN, Edward Howard, B.Eng., (McGill '34), Y.M.C.A., Fort William, Ont. (*S. 1934*) (*Jr. 1936*)

McCANN, Wm. Neil, B.Sc., (Man. '34), Jr. Engr., P.F.R.A., Federal Govt., Eastend, Sask. (*S. 1934*)

McCANNEL, D. A. Roy, B.Sc., (Queen's), City Engr., City of Regina, Regina, Sask. (*H*) 2258 Osler St. (*S. 1914*) (*A.M. 1917*) (*M. 1930*)

McCAREY, Jos. Newell, B.Sc., (Queen's '35), The Wabi Iron Wks. Ltd., New Liskeard, Ont. (*Jr. 1937*)

MacCARTHY, Henry Blair, B.Sc., (McGill '28), Sr. Asst. Engr., Dept. Nat. Defence, 507 Canadian Bldg., Ottawa, Ont. (*H*) 110 Lisgar St. (*Jr. 1930*)

♂McCARTHY, Thos. V., B.A.Sc., (Tor. '13), Dept. of Highways, Bancroft, Ont (*H*) 11 Lowther Ave., Toronto, Ont. (*A.M. 1919*)

♂McCLELLAND, Harold Langdon, B.A.Sc., (Tor. '17), M.A.Sc., Cons. Engr., 505, 330 Bay St., Toronto, Ont. (*H*) 1044 College St. (*A.M. 1928*)

McCLELLAND, Richard James, 378 Brock St., Kingston, Ont. (*H*) 185 Clergy St. (*S. 1903*) (*A.M. 1915*)

McCLELLAND, W. Raymond, B.Sc., M.Sc., (McGill '23), Mines Engr., Bureau of Mines, Dept. of Mines and Resources, Ottawa, Ont. (*H*) 225 Carling Ave. (*S. 1920*) (*Jr. 1923*) (*A.M. 1929*)

♂McCLINTOCK, G. A., Major, B.A.Sc., (Tor. '24), Engr., Keasbey & Mattison Co., Bell Asbestos Mines Dept., Thetford Mines, Que. (*S. 1914*) (*A.M. 1925*)

McCLUNG, Jos. Eldon, B.Sc., (McGill '26), 50 Wexford Ave. S., Hamilton, Ont. (*S. 1924*)

McCLYMONT, Herbert Ross, Member of Firm, McMaster-Jacob Engineering Co. Ltd., 107 Front E., Toronto 5, Ont. (*H*) 157 Pinewood Ave. (*A.M. 1919*)

McCOLEMAN, Hugh Alexander, Redcliff, Alta. (*S. 1936*)

♂McCOLL, Samuel E., Lieut., B.A., (Man. '07), M.L.S., D.L.S., S.L.S., Director of Surveys, Man., Dept. of Mines and Nat. Res., Winnipeg, Man. (*H*) 178 Langside St. (*Jr. 1916*) (*A.M. 1919*)

McCOLL, Wm. Ross, B.A.Sc., (Tor. '33), Steel Co. of Canada, Hamilton, Ont. (*H*) 12 Caroline St. S. (*S. 1933*) (*Jr. 1938*)

♂McCOLOUGH, Reginald Walker, Capt., S.B., (N.S.T.S. '11), Chief Engr., Dept. of Highways, N.S., Halifax, N.S. (*H*) 73 Oakland Rd. (*A.M. 1918*) (*M. 1938*)

♂McCONKEY, Thomas C., Lieut., B.Sc., (McGill '06), Vice-Pres., B. J. Coghlin Co., Ltd., 3320 Ontario St. E., Montreal, Que. (*H*) 4070 Highland Ave. (*S. 1904*) (*A.M. 1913*)

McCONNELL, S. Bruce, Dist. Engr., C.P.R., North Bay, Ont. (*H*) 7 Brennan Court. (*S. 1899*) (*A.M. 1905*) (*M. 1916*)

McCORMACK, D. N., B.Sc., (N.B. '28), B.Sc., (Man. '33), Chief Dftsman., Spruce Falls Power and Paper Co., Kapuskasing, Ont., P.O. Box 431. (*H*) 9 Dominion Ave. (*S. 1927*) (*Jr. 1928*) (*A.M. 1937*)

McCORMICK, A. T., B.Sc., (Man. '30), Territory Engr., Dom. Sound Equipments Ltd., Calgary, Alta. (*H*) 1614-16th Ave. W. (*S. 1928*) (*A.M. 1934*)

McCORMICK, R. S., Gen. Supt. and Chief Engr., Algoma Central and Hudson Bay Rly. Co., Sault Ste. Marie, Ont. (*H*) 321 E. Spruce St., Sault Ste. Marie, Mich. (*M. 1913*)

♂McCORT, C. Roy, Capt., B.A.Sc., (Tor. '15), 1 de Casson Rd., Westmount, Que. (*Jr. 1919*) (*A.M. 1920*)

McCOUBREY, Jas. Addison, 99 Broadway Ave., Toronto, Ont. (*A.M. 1924*)

McCOY, Lyle, Can. Car and Foundry Ltd., 621 Craig St. W., Montreal, Que. (*H*) 97 Brock Ave. N., Montreal West, Que. (*A.M. 1919*)

McCRADY, Donald C., B.Eng., (McGill '36), 116 Concord Ave., Toronto 4, Ont. (*S. 1935*)

McCRADY, Louis de Bernier, B.S., C.E., (Clemson), Chief Engr., Canadian Industries Ltd., Beaver Hall Bldg., Montreal, Que. (*H*) 24 Richelieu Place. (*M. 1921*)

McCRADY, MacH., B.Sc., Chief of Labs., Prov. Ministry of Health, 89 Notre Dame St. E., Montreal, Que. (*H*) 3469 Northcliffe Ave. (*A.M. 1914*)

McCRAE, Donald Gordon, Project Mgr., Southern Okanagan Lands Project, Box A, Oliver, B.C. (*A.M. 1925*)

♂MacCRIMMON, Duncan Daniel, Capt., M.C., Box 45, Williamstown, Ont. (*A.M. 1926*)

McCRONE, Donald G., B.A.Sc., (Tor. '27), Asst. Sulphite Supt., E. B. Eddy & Co., Hull, Que. (*H*) 378 Huron Ave., Ottawa, Ont. (*Jr. 1929*) (*A.M. 1934*)

McCRORY, James Alexander, B.S., (Penn. State '07), Vice-Pres. and Chief Engr., Shawinigan Engineering Co., Power Bldg., Montreal, Que. (*H*) Apt. C-32, 3940 Cote des Neiges Rd. (*A.M. 1921*) (*M. 1926*)

♂McCRUDDEN, Harry E., Lieut., Staff Engr., The Bell Telephone Co. of Canada, Ltd., Montreal, Que. (*H*) 734 Upper Belmont Ave., Westmount, Que. (*S. 1913*) (*Jr. 1919*) (*A.M. 1927*)

McCUBBIN, George A., O.L.S., Private Practice, Box 327, Chatham, Ont. (*H*) 40 Lacroix St. (*A.M. 1899*) (*M. 1919*)

McCULLOCH, Andrew, Consulting, Penticton, B.C. (*M. 1907*)

McCULLOCH, Andrew L., (Tor. '87), P.O. Box 41, Nelson, B.C. (*A.M. 1891*) (*M. 1909*) (*Life Member*)

McCULLOCH, Orval James, B.Sc., (McGill '17), Angus Robertson, Ltd., 1406 University Tower Bldg., Montreal, Que. (*S. 1916*) (*A.M. 1927*)

McCUNE, Samuel, B.Sc., (Illinois '30), Address unknown. (*Jr. 1936*)

♂McCURDY, L. B., Capt., (N.S.T.C. '13), Chief Engr., Dom. Reinforcing Steel Co. Ltd., Clanranald Ave., Montreal, Que. (*H*) 1576 Summerhill Ave. (*A.M. 1920*)

McCURDY, Lyall R., B.Sc., M.Sc., (McGill '27), Asst. Prof., Mech. Engrg., McGill University, Montreal, Que. (*H*) 2254 Hingston Ave. (*S. 1919*) (*Jr. 1926*) (*A.M. 1929*)

McDERMID, George, B.Sc., (Man. '27), Engr., Way and Structures, Winnipeg Electric Co., Winnipeg, Man. (*H*) 493 Dominion St. (*A.M. 1934*)

MacDERMOT, Sidney Guy, B.Sc., (McGill '05), Can. Johns-Manville Co. Ltd., 910 St. James St., Montreal, Que. (*H*) 18 Dufferin Rd., Ste. Rose, Que. (*A.M. 1919*)

MacDIARMID, Archibald A., B.Sc., (McGill '10), Chief Engr., Price Bros. & Co., Quebec, Que. (*H*) 90 de Salaberry Ave. (*S. 1909*) (*A.M. 1914*) (*M. 1926*)

MACDONALD, Albert E., M.Sc., (McGill '22), Prof. and Head of Dept. of C.E., University of Manitoba, Winnipeg, Man. (*H*) 331 Cambridge St. (*S. 1919*) (*Jr. 1922*) (*A.M. 1932*) (*M. 1936*)

McDONALD, Alexander J., B.Sc., (Queen's '36), Queen's University, Kingston, Ont. (*H*) 537 Albert St. (*S. 1935*)

MACDONALD, Archibald J., B.A., B.Sc., P.O. Box 792, Halifax, N.S. (*A.M. 1907*)

MacDONALD, Arden M., B.Sc., (N.S.T.C. '33), Can. Carborundum Co. Ltd., 2133 Main St., Niagara Falls, Ont. (*S. 1931*) (*Jr. 1935*)

♂MACDONALD, Arthur C., Lt.-Col., D.S.O., (R.M.C., Kingston), Chairman, Macdonald, Gibbs & Co. (Engineers), Ltd., 28 Finsbury Sq., London, E.C.2, England. (*H*) 69 Courtfield Gardens. (*M. 1898*)

MacDONALD, Arthur Lamond, B.Sc., (Acadia '35), B.E., (N.S.T.C. '38), 8 Fletcher St., Glace Bay, N.S. (*S. 1938*)

♂MACDONALD, C. Beverley R., Capt., (R.M.C., Kingston '14), Dir. and Res. Agent, Humphreys Ltd., Dhibban, Iraq. Address: Humphreys Ltd., Knightsbridge, London, England. (*S. 1914*) (*A.M. 1919*) (*M. 1931*)

♂McDONALD, Claude K., Lieut., The Shawinigan Water and Power Co., Power Bldg., Montreal, Que. (*H*) Apt. 10, 5967 Cote St. Antoine Rd. (*A.M. 1924*)

MACDONALD, Colin, M.A.Sc., (Tor. '36), Asst. Engr., Cons. Mines, Ltd., South Porcupine, Ont. (*S. 1934*)

McDONALD, D. Harold, Sr., Asst. Engr., D.P.W., Canada, London, Ont. (*Jr. 1916*) (*A.M. 1917*)

McDONALD, Donald John, B.Sc., (Queen's '26), Bell Telephone Co. of Canada, Beaver Hall Bldg., Montreal, Que. (*H*) 5149 Earnscliffe Ave. (*Jr. 1930*) (*A.M. 1938*)

MacDONALD, Donald Stewart, B.Sc., (Queen's '24), Bird Construction Co. Ltd., Moose Jaw, Sask. (*A.M. 1932*)

MacDONALD, Geo. E., B.Sc., (N.S.T.C. '34), Upper Musquodoboit, N.S. (*S. 1937*)

♂MacDONALD, Jas. Campbell, Major, M.C., B.E., (Dalhousie '06), Comptroller of Water Rights, Dept. of Lands, Prov. of B.C., Parliament Bldgs., Victoria, B.C. (*H*) 29 Cambridge St. (*S. 1908*) (*A.M. 1912*) (*M. 1923*)

MacDONALD, James Wm., Asst. Supt., Imperial Oil Ltd., Sarnia, Ont. (*H*) R.R. 3, Beach Rd., Sarnia, Ont. (*Jr. 1920*) (*A.M. 1927*)

MACDONALD, Jeremiah James, B.Sc., (McGill '11), Sir Alexander Gibb & Partners, Queen Anne's Lodge, Westminster, London, S.W.1. (*S. 1911*) (*A.M. 1913*) (*M. 1920*)

♂MACDONALD, John A., Lieut., B.Sc., (N.S.T.C. '20), Bureau of Geology and Topography, Dept. of Mines and Resources, Victoria Memorial Museum, Ottawa, Ont. (*H*) 34 Glen Ave. (*S. 1920*) (*A.M. 1924*)

MACDONALD, John E., B.A.Sc., (B.C. '31), West Kootenay Power and Light Co., Box 415, Trail, B.C. (*S. 1929*) (*A.M. 1938*)

McDONALD, Kenneth Duncan, B.A.Sc., (Tor. '15), Technical Sales, Imperial Oil, Ltd., 56 Church St., Toronto, Ont. (*H*) 104 Hillsdale Ave. W. (*A.M. 1920*)

♂MacDONALD, Leslie Stewart, Lieut., B.Sc., (Alta. '15), D.L.S., Hamilton Bridge Co., Hamilton, Ont. (*H*) 102 Arkell St. (*S. 1915*) (*A.M. 1921*)

MacDONALD, Murray Vickers, B.Sc., (Sask.), M.Sc., (McGill '38), D.L.S., S.L.S., Can. Industries Ltd., McMasterville, Que. (*H*) Purvis Club (*S. 1931*) (*Jr. 1932*)

McDONALD, Norman Geddes, B.A.Sc., (Tor. '18), Cons. Engr., Gore, Nasmith & Storrie, 1130 Bay St., Toronto, Ont. (*H*) 38 Old Bridle Path. (*Jr. 1919*) (*A.M. 1922*)

MacDONALD, Peter Jas., Apt. 33, 10 Tichister Rd., Toronto, Ont. (*A.M. 1919*)

MacDONALD, Walter Elwood, City W.W. Engr., Transportation Bldg., Ottawa, Ont. (*H*) 330 Driveway, Ottawa, Ont. (*A.M. 1932*)

MacDONALD, Wm. Cole, Highway Engr., D.P.W., N.B., Ferry Rd. P.O., N.B. (*A.M. 1919*)

MACDONALD, Wm. G., Chief Engr., N.S. Light and Power Co. Ltd., P.O. Box 770, Halifax, N.S. (*A.M. 1929*)

♂MacDONALD, William M. Bell, Lieut., B.Sc., (McGill '07), Elec. Engr., Rammerscales, Lockerbie, Scotland. (*S. 1908*) (*A.M. 1914*)

♂McDONALD, Wm. Sutherland, B.Sc., (Alta. '15), D.L.S., Asst. Engr., Canals Admin., Dept. of Transport, Ottawa, Ont. (*H*) 110 Brighton Ave. (*Jr. 1919*) (*A.M. 1923*)

♂MACDONELL, C. K. S., Lt.-Col., Res. Engr., Dept. of Highways, Ont., 48½ Market Sq., Chatham, Ont. (*H*) 508 King St. W. (*A.M. 1920*)

McDONNELL, Frank, Chairman, Steamship Inspection Br., Dept. of Transport, Hunter Bldg., Ottawa, Ont. (*H*) 404 Laurier Ave. E. (*M. 1921*)

McDOUGALL, D. H., Col., LL.D., Box 200, Stellarton, N.S. (*M. 1913*)

MacDOUGALL, Duncan Alexander, 7-B Fort Garry Court, Winnipeg, Man. (*M. 1920*)

MACDOUGALL, Geo. D., B.Sc., (McGill '95), Cons. Engr., P.O. Box 1565, New Glasgow, N.S. (*A.M. 1901*) (*M. 1909*) (*Life Member*)

McDOUGALL, Geo. K., B.Sc., (McGill '04), McDougall & Friedman, Cons. Engrs., 1221 Osborne St., Montreal, Que. (*H*) 1528 Pine Ave. W. (*S. 1904*) (*A.M. 1912*) (*M. 1919*)

McDOUGALL, J. Cecil, B.Sc., B.Arch., (McGill '10), Architect, 1221 Osborne St., Montreal, Que. (*H*) 68 Rosemount Crescent, Westmount, Que. (*A.M. 1919*)

McDOUGALL, John Frederick, B.Sc., (Alta. '30), M.Sc., (McGill '31), Supt. of Bldgs., McDougall & Secord, Ltd., 211 Empire Block, Edmonton, Alta. (*H*) 9910-103rd St. (*S. 1928*) (*A.M. 1936*)

McDOUGALL, J. Lyle, Mech. Engr., Ontario Paper Co., Thorold, Ont. (*H*) 37 Yates St., St. Catharines, Ont. (*Jr. 1930*)

McDOWALL, Robert, C.E., (Tor. '01), O.L.S., Private Practice, 235 W. 7th St., Owen Sound, Ont. (*S. 1887*) (*A.M. 1892*) (*Life Member*)

McDUNNOUGH, Ralph B., B.A.Sc., (McGill '95), Chief Engr., Quebec Power Co., 229 St. Joseph St., Quebec, Que. (*H*) 86 St. Louis Rd. (*A.M. 1927*)

McELHANNEY, Thomas Andrew, B.A.Sc., (Tor. '12), D.L.S., B.C.L.S., Supt., Forest Products Laboratories of Canada, Dom. Forest Service, Dept. Mines and Resources, Ottawa, Ont. (*H*) 132 Broadway Ave. (*A.M. 1922*)

♂McEWEN, Alan B., Major, D.S.O., B.Sc., (McGill '12), (R.M.C., Kingston), Engr., Can. Industries Ltd., P.O. Box 10, Montreal, Que. (*H*) 4870 Cote des Neiges Rd. (*S. 1910*) (*Jr. 1914*) (*A.M. 1918*)

McEWEN, George G., B.A.Sc., (Tor. '05), Dom. Water and Power Bureau, Dept. of Mines and Resources, Norlite Bldg., Ottawa, Ont. (*A.M. 1916*)

McEWEN, Harold James, B.A.Sc., (Tor. '12), Dist. Mgr., Can. Westinghouse Co., Ltd., 320–8th Ave. W., Calgary, Alta. (*H*) 1918–12th St. W. (*A.M. 1921*)

McEWEN, M. N., B.Sc., (Man. '32), Dept. of Highways, Ont., Lake of the Woods Hotel, Kenora, Ont. (*Jr. 1937*)

McFARLAND, W. I., B.Sc., (Alta. '29), Elec. Engr., City Power Plant, City of Edmonton, Alta. (*H*) 10163–116th St. (*Jr. 1931*) (*A.M. 1936*)

♂MACFARLANE, Athol Herridge, Major, M.C., 1494 W. 40th Ave., Vancouver, B.C. (*A.M. 1923*)

McFARLANE, John A., B.A.Sc., (Tor. '04), 258 Aberdeen Ave., Hamilton, Ont. (*A.M. 1910*) (*M. 1919*)

MACFARLANE, M. C., B.Sc., Almonte, Ont. (*S. 1887*) (*A.M. 1889*) (*M. 1912*) (*Life Member*)

♂McFARLANE, M. L. D., Capt., Gen. Mgr., Record-O-Tone Inc., 6059 Santa Monica Blvd., Hollywood, Calif. (*S. 1913*) (*A.M. 1924*)

♂MacFARLANE, Peter Wm., Supt'g. Engr., Bldgs. and Grounds, McGill University, Montreal, Que. (*H*) 3535 Carleton Rd. (*Affil. 1935*)

MACFARLANE, Robt. Murray, B.Eng., (McGill '36), 1610 Pine Ave. W., Montreal, Que. (*S. 1936*)

♂McFARLANE, William Thompson, Major, (R.M.C., Kingston '08), Asst. Hydr. Engr., Dom. Water and Power Bureau, Dept. Mines and Resources, Rm. 427, Calgary Public Bldg., Calgary, Alta. (*H*) 602 Rideau Rd. (*S. 1908*) (*Jr. 1913*) (*A.M. 1921*)

♂McFAUL, Wm. Lawrence, Lieut., B.A.Sc., (Tor. '13), City Engr. and Mgr. of Water Works, City of Hamilton, City Hall, Hamilton, Ont. (*H*) 165 Chedoke Ave. (*A.M. 1919*) (*M. 1925*)

McGAAN, Wm. H., Gen. Mtce. Inspr., C.N.R., Rm. 603, 360 McGill St., Montreal, Que. Address: Box 32, Station B. (*S. 1906*) (*A.M. 1912*)

McGAVIN, Charles James, Chief Engr., Water Rights, Sask., 501 Leader Post Bldg., Regina, Sask. (*H*) 18 Braemar Apts. (*A.M. 1921*) (*M. 1936*)

McGEACHY, Donald D. C., 323 University Ave., Kingston, Ont. (*S. 1938*)

McGEE, Leonard D., B.Eng., (McGill '33), Dom. Tire Factory, Dom. Rubber Co., Kitchener, Ont. (*H*) 128 Earl St. (*S. 1933*)

MacGIBBON, J. Alex., B.Eng., (McGill '37), 3671 Jeanne Mance St., Montreal, Que. (*S. 1937*)

McGILLIS, Lester, B.Sc., (McGill '24), Mgr., Beauharnois Divn., Shawinigan Water and Power Co., P.O. Box Y, Valleyfield, Que. (*S. 1922*) (*Jr. 1928*) (*A.M. 1935*)

MacGILL, Elizabeth M. G., B.A.Sc., (Tor. '27), M.S.E., (Mich. '29), Brunelli Engr., Aircraft Divn., Can. Car and Foundry Co., Fort William, Ont. (*H*) 1437 Hamilton St. (*A.M. 1938*)

MACGILLIVRAY, Alexander M., B.Sc., Dist. Engr., C.N.R., Saskatoon, Sask. (*H*) 615–6th Ave. (*A.M. 1904*)

MACGILLIVRAY, Andrew, B.A., B.Sc., (St. Fr. Xav.), N.S.L.S., Asst. Engr., D.P.W., Bellevue Bldg., Halifax, N.S. (*H*) 25 Brenton St. (*A.M. 1916*) (*M. 1921*)

MacGILLIVRAY, John Alex., Underground Engr., Greater Winnipeg Sanitary Dist. (*H*) 240 Niagara St., River Heights, Winnipeg, Man. (*Jr. 1917*) (*A.M. 1919*)

MACGILLIVRAY, Malcolm Stuart, B.Sc., (Queen's '23), Can. Industries, Ltd., Montreal, Que. (*H*) Apt. 15, 4100 Cote des Neiges Rd. (*A.M. 1935*)

McGINNIS, A. D., B.Sc., (Queen's '38), King St. W., Kingston, Ont. (*S. 1938*)

McGINNIS, Thos. A., B.Sc., (Queen's '09), Owner, McGinnis & O'Connor, 412 King St. E., Kingston, Ont. (*H*) King St. W. (*S. 1908*) (*A.M. 1912*) (*M. 1923*)

McGORMAN, Samuel Ernest, (Tor. '05), Contracting Engr., Can. Bridge Co., Walkerville, Ont. (*H*) 511 Devonshire Rd. (*M. 1921*)

MacGOWAN, Andrew R., Hoboken Manufacturers Railroad Co., Foot of 5th St., Hoboken, N.J. (*S. 1903*) (*A.M. 1909*)

MacGOWAN, Wm. Hartley, 6515 Cote St. Luc Rd., Montreal, Que. (*S. 1938*)

♂McGRAIL, Thomas Ernest, Sales Repres., Can. Sirocco Co., Windsor, Ont. (*H*) P.O. Box 555, Station B, Ottawa, Ont. (*A.M. 1922*)

McGREGOR, Douglas Robt., B.Eng., (McGill '35), Can. Gen. Elec. Co. Ltd., Peterborough, Ont., P.O. Box 807. (*S. 1933*)

♂McGREGOR, James, Major, D.S.O., C.E., (Glasgow '00), "Gleniffer," Thorn Road, Bearsden, Glasgow, Scotland. (*A.M. 1909*) (*M. 1920*)

MacGREGOR, Jas. G., B.A., B.Sc., Dist. Supt., Can. Utilities Ltd., Vegreville, Alta. (*S. 1929*) (*A.M. 1935*)

MacGREGOR, Kenneth Roy, B.Sc., (Queen's '25), Eganville, Ont. (*A.M. 1934*)

McGREGOR, Leslie S., B.Eng., (McGill '36), C.N.R., Turcot Roundhouse, C.N.R., Montreal, Que. (*H*) 5942 Clanranald Ave. (*S. 1935*)

McGUGAN, Angus, R.T.C., (Glas.), Designing Engr., Williams & Wilson, Ltd., 544 Inspector St., Montreal, Que. (*H*) 6881 Monkland Ave. (*A.M. 1938*)

♂McGUINNESS, Thos., Asst. Supt., Street Rly. Dept., Regina Municipal Rly., Regina, Sask. (*H*) 1925 Athol St. (*M. 1936*)

♂McGUINNESS, Wm. Norman, Engrg. Dept., Northern Electric Co. Ltd., Montreal, Que. (*H*) 69 Kings Rd., Valois, Que. (*A.M. 1929*)

McGUIRE, Jas. F., B.Eng., (McGill '34), Sales Engr., Lincoln Electric Co. of Canada, Montreal, Que. (*H*) 3710 Jeanne Mance St. (*Jr. 1936*)

McHENRY, Morris James, B.A.Sc., (McGill '10), Director, Sales Promotion, H.E.P.C. of Ont., Toronto, Ont. (*H*) 64 Grenview Blvd. (*M. 1938*)

McHUGH, Fred. Jos., Chief Dftsman., Bridge and Mech. Divn., Dominion Bridge Co., Ltd., Box 280, Montreal, Que. (*A.M. 1925*)

McHUGH, John, Res. Engr., Dept. of Fisheries, 427 Winch Bldg., Vancouver, B.C. (*H*) 5837 Elm St. (*A.M. 1918*)

McILQUHAM, W. S., Jr., B.Sc., (Queen's '23), Engr., Hydr. Dept., Dom. Engineering Wks., Ltd., Lachine, Que. (*H*) 2301 Beaconsfield Ave. (*Jr. 1926*) (*A.M. 1937*)

McILWAIN, Samuel, Div. Engr., C.N.R., Central Station, Ottawa, Ont. (*H*) 391 Sunnyside Ave. (*A.M. 1920*)

♂McINTEE, Arthur, Res. Engr., Toronto Terminals Rly. Co., Rm. 402, New Union Sta., Toronto, Ont. (*H*) Apt. 69, 21 Sherwood Ave. (*A.M. 1921*)

McINTIRE, Earl John, Vice-Pres., S. E. Dinsmore Co. Ltd., 903 Security Bldg., Windsor, Ont. (*A.M. 1920*)

♂McINTOSH, Ernest Donald, Lieut., B.Sc., (McGill '19), Asst. to Chief Engr., Canada Starch Co. Ltd., Montreal, Que. (*H*) 29 Burton Ave., Westmount, Que. (*S. 1914*) (*A.M. 1920*)

McINTOSH, John Cameron, B.S.c, (Queen's '25), Jas. MacLaren Co., Mont Laurier, Que. (*S. 1924*) (*A.M. 1930*)

McINTOSH, J. Harrington, B.A.Sc., (Tor. '23), Wks. Mgr., B.C. Cement Co., Ltd., Bamberton, Tod Inlet P.O., B.C. (*S. 1920*) (*A.M. 1930*)

McINTOSH, Wm. Gardner, B.Sc., (Man. '37), Boeing Aircraft of Canada Ltd., Vancouver, B.C. (*H*) 1955 Haro St. (*S. 1935*)

McINTYRE, D. V., B.Sc., 15 Randolph St., Welland, Ont. (*S. 1930*) *Jr. 1936*)

MacISAAC, Vernon W., B.Sc., (Queen's '21), Mech. Engr., Ford Motor Co. of Canada, E. Windsor, Ont. (*H*) 301 Parkview Apts., 410 Giles Blvd., Windsor, Ont. (*S. 1920*) (*A.M. 1927*)

MACK, John, Box E, Woodbridge, Ont. (*A.M. 1917*)

♂MacKAY, Ernest George, Lt.-Col., B.A.Sc., (Tor. '12), O.L.S., D.L.S., Mackay & Mackay, Rm. 504, Imperial Bldg., Hamilton, Ont. (*H*) 96 Herkimer St. (*A.M. 1921*)

♂McKAY, Hugh Alex. B.A.Sc., (Tor. '23), Vice-Pres. and Mgr., London Structural Steel Co., Ltd., London, Ont. (*H*) 1500 Dundas St. (*S. 1921*) (*Jr. 1925*) (*A.M. 1928*)

MacKAY, Ian Norton, B.Eng., (McGill '35), Dom. Engineering Wks. Ltd., Lachine, Que. (*H*) 4375 Montrose Ave., Westmount, Que. (*S. 1935*)

MacKAY, Jas. Arthur, B.Sc., (N.S.T.C. '11), Asst. Engr., C.N.R., Halifax, N.S. (*H*) Bedford, N.S. (*A.M. 1927*)

MacKAY, James J., O.L.S., Pres., MacKay & MacKay, 504 Imperial Bldg., Hamilton, Ont. (*H*) R.R. 2, Freeman, Ont. (*M. 1921*)

♂McKAY, Jas. Kenneth, Lieut., Divn. Engr., Dept. of Highways, N.S., Clyde River, N.S. (*S. 1907*) (*Jr. 1912*) (*A.M. 1920*)

MacKAY, Leon F., B.Sc. and C.E., (Ecole Polytech., Montreal '15), Sales Engr., Can. Bitumuls Co. Ltd., 60 St. James St. W., Montreal, Que. (*H*) 401 Sherbrooke St. E. (*S. 1911*) (*A.M. 1922*)

MACKAY, Leslie, B.Sc., (Man. '27), 841 Somerset Ave., Fort Garry, Man. (*S. 1924*) (*Jr. 1930*)

MacKAY, Norman A., 452 Secord St., Viauville, Montreal, Que. (*S. 1937*)

MACKAY, Robert, Supt., City of Calgary, City Hall, Calgary, Alta. (*H*) 718 Boulevard N.W. (*A.M. 1918*)

McKAY, R. Donald, B.Sc., (N.S.T.C. '33), Sanitary Engr., Dept. Public Health, N.S. (*H*) 72 Duncan St., Halifax, N.S. (*S. 1932*) (*Jr. 1935*) (*A.M. 1938*)

MACKAY, W. B. F., (R.M.C., Kingston), B.Sc., (Man. '38), 820 Wellington Crescent, Winnipeg, Man. (*S. 1936*)

McKECHNIE, Thos. Robt., B.E., (Sask. '23), Asst. Engr., Imperial Oil Ltd., Regina, Sask. (*H*) 2348 Wallace St., Regina, Sask. (*A.M. 1936*)

McKEE, Gordon H. W., B.Eng., (McGill '36), M.B.A., '38, Instructor, Dept. of Business Administration, Univ. of Western Ontario, London, Ont. (*S. 1936*)

McKEEVER, J. L., B.Sc., (B.C. '30), Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*H*) 550 Homewood Ave. (*S. 1930*) (*Jr. 1936*)

♂MACKENZIE, Alexander Macdonald, B.A.Sc., (Tor.), Gen. Plant Superv., Bell Telephone Co. of Canada, Ltd., Montreal, Que. (*H*) 3042 Trafalgar Ave. (*A.M. 1921*)

†McKENZIE, B. Stuart, B.A., B.Sc., (McGill '01), Consultant, Can. Engineering Standards Assoc., Room 3010, National Research Bldg., Ottawa, Ont. (*H*) 16 Glen Ave. (*S. 1902*) (*A.M. 1911*) (*M. 1919*)

P. ♂MACKENZIE, Chalmers Jack, Lieut., M.C., B.E., (Dalhousie), M.C.E., (Harvard), Dean of Engineering, University of Saskatchewan, Saskatoon, Sask. (*H*) 227–5th Ave. N. (*Jr. 1911*) (*A.M. 1914*) (*M. 1920*)

♂MACKENZIE, D. Campbell, Consulting Mining Engr., 815 W. Hastings St., Vancouver, B.C. (*H*) 1829-W 35th Ave. (*M. 1936*)

MacKENZIE, D. G., B.Sc., (McGill '22), Vice-Pres. and Gen. Mgr., Rogers-Majestic Corp. Ltd., 622 Fleet St., Toronto, Ont. (*H*) 214 Russell Hill Rd. (*S. 1920*) (*A.M. 1928*)

MacKENZIE, Gordon Leslie, B.Sc., (Queen's '19), D.L.S., S.L.S., Designing and Office Engr., P.F.R.A., Dept. of Agriculture, 910 McCallum Hill Bldg., Regina, Sask. (*H*) 2230 Elphinstone St. (*S. 1919*) (*Jr. 1922*) (*A.M. 1922*)

MacKENZIE, Howard A., (Kaiser-i-Hind), Supt., Can. Lift Truck Co. Ltd., 754 St. Paul St., Montreal, Que. (*H*) 2430 Rushbrooke St. (*A.M. 1909*) (*M. 1914*)

MacKENZIE, Hugh Ross, B.A.Sc., (Tor. '13), Chief Engr., Dept. of Highways and Transportation, Sask., Regina, Sask. (*H*) 3220 Victoria Ave. (*A.M. 1916*) (*M. 1936*)

McKENZIE, Jas. Edgar, B.Sc., (Queen's '12), Consultant, 802–135th Ave., Calgary, Alta. (*H*) 239–12th Ave. W. (*S. 1912*) (*A.M. 1918*) (*M. 1936*)

MACKENZIE, John Alex., (Tor. '06), Mgr., Minto Gold Mines, Minto, B.C. (*M. 1936*)

♂MACKENZIE, John Allen, Major, D.S.O., (R.M.C., Kingston '09), Div. Engr., C.P.R., Rm. 335, Union Station, Toronto, Ont. Res.: Metropole Hotel. (*Jr. 1912*) (*A.M. 1925*)

MacKENZIE, John Fenwick Fraser, Mgr., Str'l. Dept., Robb Engineering Wks. Ltd., and Local Mgr., Dom. Bridge Co. Ltd., Amherst, N.S. (*H*) 11 Rupert St. (*Jr. 1920*) (*A.M. 1928*)

♂MacKENZIE, John Fraser, Capt., Roadmaster, C.N.R., Fredericton, N.B. (*H*) 426 George St. (*S. 1914*) (*A.M. 1921*)

MacKENZIE, John James, B.Sc., (Man. '38), 17 Greenway Ave., Hamilton, Ont. (*S. 1938*)

♂MACKENZIE, John Percival, Lt.-Col., D.S.O., 2 Bars, C. de G., Gen. Mgr., Western Bridge Co. Ltd., 1st Ave. and Columbia St., Vancouver, B.C. (*H*) 2947 Marine Dr. (*A.M. 1920*) (*M. 1936*)

McKENZIE, Ralph B., B.Sc., (Alta. '32), McKenzie Electric Co., Lethbridge, Alta. (*H*) 1230–5th Ave. S. (*S. 1932*) (*Jr. 1937*)

MACKENZIE, Robert K., (R.M.C., Kingston '38), Royal Military College, Kingston, Ont. (*S. 1938*)

MacKENZIE, Russell George, Asst. Engr., City of Vancouver, City Hall, Vancouver, B.C. (*H*) 981-W 21st Ave. (*Jr. 1920*) (*A.M. 1930*)

♂MacKENZIE, Wm. Jas., Lieut., Dftsman., C.N.R., Rm. 460, Union Sta., Winnipeg, Man. (*H*) 802 North Drive, Fort Garry, Man. (*A.M. 1919*)

♂MACKENZIE, Wm. Langlands, Lieut., B.Sc., (McGill '17), Designing Engr., Dept. of Transport, Ottawa, Ont. (*H*) 265 Harmer Ave. (*S. 1916*) (*A.M. 1924*)

McKENZIE, William L., Mgr., McKenzie Electric Ltd., 706-3rd Ave. S., Lethbridge, Alta. (*H*) 1230-5th Ave. S. (*A.M. 1922*)

McKERGOW, Charles Millar, Major, B.Sc., M.Sc., (McGill '04), Prof., Mech. Engrg., McGill University, Montreal, Que. (*H*) 343 Kensington Ave., Westmount, Que. (*S. 1903*) (*A.M. 1911*) (*M. 1921*)

MACKERRAS, John D., Vice-Pres., First Trust & Savings Bank of Pasadena, Calif. (*S. 1899*) (*A.M. 1900*)

McKIBBIN, K. H., (R.M.C., Kingston '36), B.Sc., (Queen's '38), R.C.O.C., M.D. No. 3, Kingston, Ont. (*H*) 468 Princess St. (*S. 1935*)

MACKIE, Geo. A., B.Sc., (N.B. '35), 223 King St. E., Saint John, N.B. (*S. 1935*)

MACKIE, Geo. M., Box 1601, Lorne St., New Glasgow, N.S. (*S. 1930*)

McKIEL, Harold Wilson, B.A., B.Sc., (Queen's '08 and '12), Dean of the Faculty of Applied Science, Mount Allison University, Sackville, N.B. Box 473. (*A.M. 1919*) (*M. 1923*)

McKILLOP, Vernon Archibald, B.A.Sc., (Tor. '24), Engr., Public Utilities Comm., London, Ont. (*H*) 497 Baker St. (*Jr. 1926*) (*A.M. 1927*)

McKINNEY, J. Harold, Asst. Engr., National Harbours Board, Saint John, N.B. (*H*) 161 Germain St. (*Jr. 1920*) (*A.M. 1926*)

♂McKINNEY, John E., Divn. Plant Engr., Bell Telephone Co. of Canada, 76 Adelaide St. W., Toronto, Ont. (*H*) 124 Burgess Ave. (*A.M. 1938*)

McKINNON, Alex. Huntley, B.Sc., (N.S.T.C. '34), Maritime Tel. and Tel. Co. Ltd., New Glasgow, N.S. (*H*) 376 E. River Rd. (*S. 1934*)

MacKINNON, Chas. Eric, B.A.Sc., (Tor. '28), Cranbrook Foundry Co. Ltd., Cranbrook, B.C. (*A.M. 1936*)

MACKINNON, Donald Laughland, 550 Charlotte St., Fredericton, N.B. (*S. 1938*)

♂MACKINNON, John Geo., Lieut., (Tor. '09), Cons. Engr., Wyse Block, Moncton, N.B. (*H*) 411 Highfield St. (*A.M. 1925*)

♂MacKINNON, Murdoch Ashley, Lieut., B.Sc., (N.B. '13), Hydro. Engr., Hydrographic Service, Dept. of Mines and Resources, Ottawa, Ont. (*H*) 66 Brighton Ave. (*S. 1913*) (*A.M. 1921*)

McKINNON, Ronald Morrison, B.Sc., (N.S.T.C. '12), Asst. Engr., City of Halifax, City Hall, Halifax, N.S. (*A.M. 1921*)

MacKINNON, W. D., B.Sc., (Queen's '25), Supt., Bd. Mill and Steam Plant, Donnacona Paper Co., Donnacona, Que. (*S. 1924*) (*Jr. 1929*) (*A.M. 1934*)

MacKINTOSH, Colin Dugald, Div. Engr., C.P.R., Kenora, Ont. (*H*) 127-4th St. N. (*A.M. 1911*) (*M. 1922*)

MACKINTOSH, Jas., Asst. Engr., H.E.P.C. of Ont., 620 University Ave., Toronto, Ont. (*H*) 83 Deloraine Ave. (*A.M. 1911*)

♂MACKLEM, Oliver T., B.Sc., (McGill), Prof. of Engrg., Royal Military College, Kingston, Ont. (*H*) 27 Clergy St. W. (*S. 1907*) (*A.M. 1913*)

McKNIGHT, Chas. E. V., B.Sc., (Queen's '33), Safety Director, Lakeshore Gold Mines Ltd., Kirkland Lake, Ont. (*S. 1933*) (*Jr. 1938*)

♂McKNIGHT, Robert Cleland, Major, (R.M.C., Kingston '06), County Engr., Grey County, Court House, Owen Sound, Ont. (*H*) 685-2nd Ave. W. (*S. 1906*) (*Jr. 1913*) (*A.M. 1922*)

G.McLACHLAN, Duncan W., B.Sc., (McGill '06), Engr., Design and Capital Constrn., Gen. Engrg., Dept. of Transport, Ottawa, Ont. (*S. 1902*) (*A.M. 1908*) (*M. 1920*)

McLACHLAN, Hugh F., (R.M.C., Kingston '30), Can. Westinghouse Co. Ltd., Hamilton, Ont. (*H*) 50 Carrick Ave. (*S. 1931*) (*Jr. 1936*)

♂MacLACHLAN, John Gordon, Major, Dist. Engr., i/c Hudson Bay Rly., C.N.R., Drawer 180, The Pas, Man. (*A.M. 1919*)

MACLACHLAN, Wills, B.A.Sc., (Toronto '07), Cons. Engr., 50 Oakwood Ave., Toronto, Ont. (*M. 1920*)

♂McLAGAN, Thomas Rodgie, B.Sc., (McGill '23), Industrial Consultant, P. E. Dufresne, T. R. McLagan & Associates, 204 Bank of N.S. Bldg., Montreal, Que. (*H*) 1610 Sherbrooke St. W. (*S. 1921*) (*A.M. 1926*)

McLAREN, Arthur A., B.Sc., (Queen's '11), D.L.S., Chief Engr., Seaboard Construction Corp., Katonaho, N.Y. (*H*) Bedford Rd. (*A.M. 1920*)

McLAREN, D. L., B.A.Sc., (Tor. '14), Sales Engr., Can. Gen. Elec. Co., Ltd., 212 King St. W., Toronto, Ont. (*H*) 33 Prince Arthur Ave. (*A.M. 1919*)

MacLAREN, Fred. Wm., B.Sc., (N.B. '36), Can. Gen. Elec. Co. Ltd., 212 King St. W., Toronto, Ont. (*H*) 84 Albany Ave. (*S. 1936*)

♂MacLAREN, Jas. Ferris, Major, M.C., Partner, Gore, Nasmith & Storrie, Bay-Charles Bldg., Toronto, Ont. (*H*) 126 Golfdale Rd. (*A.M. 1921*)

McLAREN, John H., B.Sc., (McGill '01), Designing Engr., Montreal Engineering Co. Ltd., 244 St. James St., Montreal, Que. (*H*) 3465 Cote des Neiges Rd. (*A.M. 1912*)

McLAUGHLIN, Wm. Gordon, B.Sc., (Queen's '34), M.Sc., (M.I.T. '36), E. B. Eddy Co., Hull, Que. (*H*) Cumberland, Ont. (*Jr. 1937*)

MacLAURIN, Jas. G., B.A.Sc., (Tor. '12), Temiskaming, Que. (*A.M. 1919*)

McLEAN, Douglas L., B.Sc., (McGill '09), Asst. Chief Engr., Greater Winnipeg Sanitary Dist., City Hall Annex, Winnipeg, Man. (*H*) 701 McMillan Ave. (*S. 1904*) (*A.M. 1912*)

McLEAN, Gordon M., B.Sc., (N.S.T.C. '32), Sullivan Hotel, Sullivan, Que. (*H*) Souris, P.E.I. (*S. 1931*) (*Jr. 1936*)

McLEAN, Howard J., Production Supt., Calgary Power Co., Ltd., Insurance Exchange Bldg., Calgary, Alta. (*H*) 629-44th Ave. W. (*Jr. 1920*) (*A.M. 1924*)

♂McLEAN, H. J. G., Major, M.C., Engr. and Mfrs. Agent, Box 1, Station H (*H*) Apt. 46, 4324 Sherbrooke St. W., Montreal, Que. (*A.M. 1922*)

McLEAN, Murray D., B.Eng., (McGill '37), 2325 St. Luke St., Montreal, Que. (*S. 1937*)

♂McLEAN, Norman B., Major, (R.M.C., Kingston '92), 4988 Victoria Ave., Montreal, Que. (*A.M. 1899*) (*M. 1919*) (*Life Member*)

McLEAN, William A., Cons. Engr., Wynne-Roberts, Son & McLean, Rm. 528, Bank of Hamilton Bldg., 67 Yonge St., Toronto, Ont. (*H*) "Glen Ian," Pickering, Ont. (*A.M. 1899*) (*M. 1912*)

McLEAN, Wm. Brown, B.Sc., (McGill '99), Owner, W. B. McLean & Co., 955 St. James St., Montreal, Que. (*H*) 154-44th Ave., Lachine, Que. (*A.M. 1906*) (*M. 1922*)

McLEISH, John, B.A., (Tor. '96), Director, Mines and Geol. Br., Dept. of Mines and Resources, Ottawa, Ont. (*H*) 299 First Ave. (*M. 1923*)

McLELLAN, Roy Alex., B.Sc., (Tor. '12), Partner, McLellan & Underwood, Saskatoon, Sask. (*1938*)

McLENNAN, Duncan O., B.Sc., (N.B. '30), Personnel Mgr., The E. B. Eddy Co. Ltd., Hull, Que. (*H*) 346 Bronson Ave., Ottawa, Ont. (*A.M. 1935*)

McLENNAN, Gordon Roderick, B.Sc., (McGill '23), Can. Industries Ltd., Montreal, Que. (*H*) 4193 Hampton Ave., N.D.G. (*S. 1921*) (*Jr. 1925*) (*A.M. 1931*)

McLENNAN, Kenneth R., B.Sc., (Queen's '06), Asst. Engr., C.N.R., Rm. 433, New Union Station, Toronto, Ont. (*H*) 133 Madison Ave. (*S. 1907*) (*A.M. 1912*)

MACLENNAN, Wm. Ewen, 49 Murray Block, Fort William, Ont. (*A.M. 1938*)

McLEOD, Arthur Malcolm, B.Sc., (Alta. '35), Can. Westinghouse Co. Ltd., Hamilton, Ont. (*H*) 61 Victoria Ave. S. (*S. 1937*)

McLEOD, C. Kirkland, B.Sc., (McGill '13), Keefer Bldg., 1440 St. Catherine St. W., Montreal, Que. (*H*) 656 Belmont Ave., Westmount, Que. (*Jr. 1914*) (*A.M. 1921*)

MACLEOD, Douglas Norman, B.Eng., (McGill '35), Engr., C.P.R. Communications, Montreal, Que. (*H*) 4548 St. Catherine St. W. (*S. 1936*)

MACLEOD, Ernest M., B.Sc., (N.S.T.C. '26), J. R. Booth Ltd., Ottawa, Ont. (*H*) 465 Parkdale Ave. (*Jr. 1930*)

♂MACLEOD, Geo., Asst. Res. Engr., D.P.W., Court House, Salmon Arm, B.C. (*H*) Valley Rd. (*Jr. 1912*) (*A.M. 1920*)

♂MacLEOD, Geo. G. W., B.Sc., (Queen's '13), Mgr., Mines Dept., Algoma Central Rly. (*H*) 121 McGregor Ave., Sault Ste. Marie, Ont. (*M. 1936*)

†MacLEOD, Geo. Roderick, B.Sc., (McGill '97), Consulting Engr., 4056 Trafalgar Rd., Montreal, Que. (*S. 1897*) (*A.M. 1908*) (*M. 1914*)

MACLEOD, Gordon, B.Eng., (McGill '35), C.P.R. Communications, Rm. 35, 304 Hospital St., Montreal, Que. (*S. 1936*)

MacLEOD, Gordon R., B.Eng., (McGill '37), 4585 Harvard Ave., N.D.G., Montreal, Que. (*S. 1937*)

♂MacLEOD, Hector John, Major, B.Sc., (McGill '14), M.Sc., (Alta. '16), M.A., Ph.D., (Harvard '21), Head of Dept., Elec. and Mech. Engrg., University of British Columbia, Vancouver, B.C. (*H*) 1529 Western Crescent, University Hill. (*M. 1930*)

McLEOD, Henry Waldron, B.A.I., (N.B.), Principal Asst. Engr., Western Lines, C.P.R., Winnipeg, Man. (*A.M. 1913*)

MacLEOD, John Angus, Chief Engr., Steel Divn., Dom. Iron and Steel Co., Sydney, N.S. (*H*) 33 Trinity Ave. (*A.M. 1931*)

MACLEOD, John Stewart, Supt'g. Engr., Sault Ste. Marie Canal, Dept. of Transport, Sault Ste. Marie, Ont. (*A.M. 1915*)

MacLEOD, John W., B.A., B.Sc., (McGill '14), M.A., (St. Fr. Xav. '11), President, Greenwood Coal Co., Ltd., P.O. Box 196, New Glasgow, N.S. (*A.M. 1919*)

MACLEOD, Keith, B.Sc., (McGill '12), Truscon Steel Co., Youngstown, Ohio. Address: 18324 Newell Rd., Shaker Heights, Ohio. (*S. 1912*) (*A.M. 1922*)

McLEOD, Simon Fraser, Inspr. of Boilers, Alta., D.P.W., Calgary, Alta. (*H*) 1531-14th Ave. (*A.M. 1934*)

McLEOD, Wilson Churchill, B.Sc., (N.S.T.C. '30 and '34), Can. Westinghouse Co., Hamilton, Ont. (*H*) 51 Eastbourne Ave. (*S. 1930*) (*Jr. 1936*)

MacMAHON, James W., 614 Grosvenor Ave., Westmount, Que. (*S. 1909*) (*A.M. 1913*)

McMAHON, John Leonard, B.Sc., (Man. '28), Dftsman., C.N.R., Rm. 460, Union Sta., Winnipeg, Man. (*H*) 557 Mountain Ave. (*Jr. 1928*)

McMANAMNA, Theodore Louis, B.S., (Kansas '32), Mgr., International Water Supply Ltd., New Bank of Toronto Bldg., London, Ont. (*A.M. 1938*)

McMANUS, Leslie H., B.Sc., (Alta. '34), D.P.W., Old Court House, Calgary, Alta. (*H*) 11008-84th Ave., Edmonton, Alta. (*S. 1936*) (*Jr. 1938*)

♂McMANUS, M. H., Lieut., General Contractor, 290 Tower Rd., Halifax, N.S. (*Affil. 1926*)

McMASTER, Alexander T. C., B.A.Sc., (Tor. '03), Pres., McMaster-Jacob Engineering Co. Ltd., 107 Front St. E., Toronto, Ont. (*H*) 17 Lyall Ave. (*M. 1917*)

McMASTER, Arthur W., B.Sc., (McGill '00), 629 Clarke Place, Westmount, Que. (*S. 1899*) (*A.M. 1909*) (*M. 1929*)

McMATH, A. A. B., B.Eng., (McGill '34), Can. Ingersoll-Rand Co. Ltd., Sherbrooke, Que. (*H*) 218 Ontario St. (*S. 1934*) (*Jr. 1938*)

McMATH, Jack P. C., B.Sc., (Alta. '36), Northern Electric Co. Ltd., Montreal, Que. (*H*) 5356 Bannatyne Ave., Verdun, Que. (*S. 1936*)

McMILLAN, Colin Brock, B.Sc., (Queen's '36), 415 Besserer St., Ottawa, Ont. (*S. 1936*)

McMILLAN, David, Surveys Engr., Geodetic Service, Dept. of Mines and Resources, Ottawa, Ont. (*H*) 124 Ossington Ave. (*A.M. 1921*)

McMILLAN, Herbert William, Works Mgr., Dom. Bridge Co., Ltd., Lachine, Que. (*H*) 25-41st Ave. (*A.M. 1921*)

McMILLAN, Hugh, B.Sc., (Man. '27), Dept. of Highways, Ont., 48½ Market Sq., Chatham, Ont. (*A.M. 1936*)

McMILLAN, Jas., B.Sc., (Alta. '24), Calgary Power Co., 506 Insurance Exchange Bldg., Calgary, Alta. (*H*) 3046-5th St. S.W., Calgary, Alta. (*A.M. 1934*)

MacMILLAN, Kenneth L., Chief Dftsman., Canada Cement Co. Ltd., Montreal, Que. (*H*) 235 Lazard Ave., Town of Mount Royal, Que. (*A.M. 1930*)

McMILLAN, Ralph E., B.Sc., (McGill '26), Apt. 21, 3410 Atwater Ave., Montreal, Que. (*S. 1922*) (*Jr. 1930*) (*A.M. 1936*)

McMILLAN, Thos. Stewart, B.Sc., (N.B. '37), Highway Divn., D.P.W., N.B., Chatham, N.B. (*H*) Jacquet River, N.B. (*S. 1937*)

♂McMORDIE, H. Campbell, Major, B.A.Sc., (Tor.), Cons. Strl. Engr., 1523 Pelissier St., Windsor, Ont. (*S. 1909*) (*A.M. 1920*)

McMORDIE, R. C., B.Sc., (Tor. '30), Strl. Asst. Engr., H. G. Acres & Co. Ltd., Niagara Falls, Ont. (*H*) 2201 Orchard Ave. (*S. 1930*) (*A.M. 1936*)

McMULKIN, F. J., B.S., (Mich. C.M.T. '37), Algoma Steel Corp., Sault Ste. Marie, Ont. (*H*) 123 Upton Rd. (*Jr. 1938*)

McMULLEN, Wm. F., B.A.Sc., (Tor. '35), Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*S. 1933*)

♂McMURTRY, Lawrence Carleton, Lieut., B.A.Sc., (Tor. '22), Mgr. of Erection, Horton Steel Wks., Ltd., Box 153, Fort Erie North, Ont. (*A.M. 1927*)

MacNAB, Ira P., S.B., (N.S.T.C.), Commr., Bd. of Commrs. of Public Utilities, Provincial Administration Bldg., 195 Hollis St., Halifax, N.S. (*M. 1919*)

McNAB, Jas. Veitch, (Tor. '06), Dist. Engr., C.P.R., Moose Jaw, Sask. (*1938*)

MACNAB, John J., B.Sc., (McGill '06), Private Practice, Engrg. and Contracting, Trenton, Ont. (*S. 1904*) (*A.M. 1907*)

MacNAB, S. D., i/c C.E. Testing Lab., McGill University, Montreal, Que. (*H*) 900 Sherbrooke St. W. (*A.M. 1918*)

MACNABB, Thomas Creighton, B.A., (Man. '02), Gen. Supt., C.P.R., Saint John, N.B. (*H*) Rothesay, N.B. (*A.M. 1908*) (*M. 1926*)

McNALLY, Patrick J., Bartonville, Ont (*S. 1936*)

♂†McNAUGHTON, A. G. L., Major-Gen., C.B., C.M.G., D.S.O., LL.D., D.C.L., M.Sc., (McGill '12), Pres., National Research Council, Sussex St., Ottawa, Ont. (*H*) 333 Chapel St. (*A.M. 1914*) (*M. 1927*)

McNAUGHTON, A. R. L., (R.M.C., Kingston '38), 333 Chapel St., Ottawa, Ont. (*S. 1937*)

♂MACNAUGHTON, Moray F., B.Sc., (McGill '22), M.Sc., (Mich. '24), Cons. Engr., Milton Hersey Co. Ltd., 980 St. Antoine St., Montreal, Que. (*H*) 360 Grosvenor Ave., Westmount, Que. (*S. 1920*) (*Jr. 1926*) (*A.M. 1932*)

McNEICE, L. G., B.Sc., (Queen's '13), Engr. and Mgr., Orillia Water, Light and Power Comm., Orillia, Ont. (*H*) 132 Matchedash St. N. (*S. 1913*) (*A.M. 1919*) (*M. 1936*)

MACNEIL, Duncan Paul, B.Sc., (N.S.T.C. '36), Dftsman., Dom. Coal Co., Glace Bay, N.S. (*H*) 29½ Commercial St. (*Jr. 1938*)

♂McNICOL, James Arthur, Capt., Estimating Engr., Toronto Transportation Comm., 35 Yonge St., Toronto, Ont. (*H*) 72 Gormley Ave. (*M. 1920*)

MacNICOL, Nicol, B.A.Sc., (Tor. '19), Commr. of Works, Forest Hill Village, 333 Lonsdale Rd., Forest Hill Village, Ont. (*H*) 18 Elderwood Dr. (*S. 1919*) (*Jr. 1923*) (*M. 1935*)

♂McNICOLL, Arthur Edward, 250 Stewart St., Ottawa, Ont. (*S. 1921*) (*A.M. 1925*)

McNIVEN, John J., B.Sc., (McGill '12), Lytle Engineering Specialties Ltd., 842 St. James St., Montreal, Que. (*H*) 4430 St. Catherine St. W., Westmount, Que. (*A.M. 1921*)

MACNUTT, E. G., B.Eng., (McGill '37), 516 Main St. E., Hamilton, Ont. (*S. 1937*)

♂MACPHAIL, Alexander, Col., C.M.G., D.S.O., LL.D., B.Sc., (McGill '93), Prof., Gen. Engrg., Queen's University, Kingston, Ont. (*H*) 50 Clergy St. (*M. 1906*)

McPHAIL, Alex. Lyall, B.A.Sc., (Tor. '14), Supt., Waterworks Comm., City of St. Catharines, Ont. (*H*) 52 York St. (*A.M. 1928*)

MacPHAIL, Gordon M., B.Sc., (N.B. '26), Dept. of Highways, N.B., Woodstock, N.B. (*S. 1926*) (*A.M. 1930*)

♂MACPHAIL, Jeffrey Burland, Capt., B.A., B.Sc., (McGill '21), Shawinigan Engineering Co., Power Bldg., Montreal, Que. (*H*) 3117 Daulac Rd. (*A.M. 1920*)

MACPHAIL, John Goodwill, B.A., B.Sc., (Queen's '05), Chief of Aids to Navigation, Dept. of Transport, Hunter Bldg., Ottawa, Ont. (*H*) 445 Albert St. (*S. 1904*) (*A.M. 1910*) (*M. 1922*)

†MACPHAIL, Wm. Matheson, B.A.Sc., (McGill '98), 15 Edmonton St., Winnipeg, Man. (*S. 1897*) (*A.M. 1901*) (*M. 1916*)

McPHERSON, Alex. Ferrier, B.Sc., (Alta. '27), Can. Westinghouse Co. Ltd., Hamilton, Ont. (*H*) 103 Gladstone Ave. (*Jr. 1931*)

MacPHERSON, Duncan, Lieut.-Col., (R.M.C., Kingston), Apt. 4, 256 Heath St. W., Toronto, Ont. (*M. 1887*) (*Life Member*)

MACPHERSON, D. C., B.Sc., (Queen's '24), Factory Supt., Can. Marconi Co., Town of Mt. Royal, Que. (*H*) 160 Trenton Ave. (*S. 1922*) (*A.M. 1938*)

McPHERSON, E. L., Box 67, Vulcan, Alta. (*S. 1938*)

McPHERSON, Fred. G., Alexandra Ave., Bridgewater, N.S. (*A.M. 1907*)

MACPHERSON, Fred Liddell, Office Engr., D.P.W., B.C., Court House, New Westminster, B.C. (*H*) 1885 W. 14th Ave., Vancouver, B.C. (*A.M. 1909*) (*M. 1913*)

MACPHERSON, H. Nolan, B.A.Sc., (Tor. '14), Mgr., Permanent Timber Products, Ltd., Pacific Bldg., Vancouver, B.C. (*H*) 1525-W. 28th Ave. (*A.M. 1917*) (*M. 1936*)

MacPHERSON, John Miles, B.Sc., (N.B. '33), Res. Engr., D.P.W., Highway Divn., Edmundston, N.B. (*H*) North Devon, N.B. (*S. 1934*) (*Jr. 1937*)

♂MacQUARRIE, Edison Malcolm, B.A.Sc., (Tor. '24), O.L.S., Cons. Engr., 620 Queen St. E., Sault Ste. Marie, Ont. (*H*) 117 McGregor Ave. (*S. 1920*) (*A.M. 1927*) (*M. 1936*)

♂McQUEEN, Andrew W. F., B.A.Sc., (Tor. '23), C.E. '32, Hydra. Engr., H. G. Acres & Co., Ltd., Cons. Engrs., Niagara Falls, Ont. (*H*) 2250 Dawlish Ave. (*S. 1920*) (*Jr. 1927*) (*A.M. 1929*)

McQUEEN, Duncan Roderick, B.A.Sc., (Tor. '32), Can. Gypsum Co. Ltd., Guelph, Ont. (*H*) 229 Woolwich St. (*S. 1930*) (*A.M. 1938*)

♂McQUEEN, Howard Renton, Capt., (R.M.C., Kingston '07), Mgr., Iron Fireman Ltd., 850 Notre Dame St. W., Montreal, Que. (*H*) 6878 Sherbrooke St. W. (*A.M. 1931*)

MacRAE, Alexander Ernest, B.Sc., (Queen's '14), Cons. Engr. and Patent Solicitor, 56 Sparks St., Ottawa, Ont. (*H*) 172 Fourth Ave. (*A.M. 1921*)

McRAE, Ian F., Asst. to Wks. Mgr., Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*H*) 156 Douro St. (*A.M. 1937*)

McRAE, John Bell, B.A.Sc., (McGill '98), Cons. Engr., 321 Ottawa Electric Bldg., Ottawa, Ont. (*H*) 172 Clemow Ave. (*A.M. 1904*) (*M. 1916*)

McRAE, Robert Bruce, B.Sc., (Alta.), M.A.Sc., (Tor. '37), Indust. Engr., Julius Kayser & Co., Sherbrooke, Que. P.O. Box 482. (*S. 1937*)

MACREDIE, J. R. C., B.Sc., (N.B. '31), 752 King St., Fredericton, N.B. (*S. 1931*) (*Jr. 1937*)

♂MacROSTIE, Norman Barry, Lieut., B.A., B.Sc., (Queen's '11), O.L.S., Cons. Engr., 193 Sparks St., Ottawa, Ont. (*H*) 46 Bellwood Ave. (*A.M. 1921*)

♂McVEAN, Harold Gordon, Lt.-Col., B.A.Sc., (Tor. '02), Consultant, 66 King St. W., Toronto, Ont. (*H*) 150 Balmoral Ave. (*A.M. 1912*) (*M. 1928*)

♂McWILLIAM, Archibald, Str'l. Dftsman., Whitehead & Kales, River Rouge, Mich. (*H*) 12393 Wark Ave., Detroit, Mich. (*A.M. 1931*)

MADDEN, Maurice Stuart, B.Sc., (Queen's '13), Hydro. Service, Dept. of Mines and Resources, Confederation Bldg., Ottawa, Ont. (*A.M. 1920*)

MADDOCK, Chas. Orvill, B.A.Sc., (Tor. '18), Designing Dftsman, International Nickel Co., Box 250, Copper Cliff, Ont. (*A.M. 1926*)

MADELEY, W. A., B.A.Sc., (B.C. '32), Pacific Great Eastern Rly., Squamish, B.C. (*S. 1928*) (*Jr. 1934*)

MAGEE, E. D. B., (R.M.C., Kingston '38), 131 Imperial St., Toronto, Ont. (*S. 1938*)

MAGIE, Louis DeWitt, 371 Reid St., Peterborough, Ont. (*M. 1920*)

MAGUIRE, Jas. C., B.Eng., (McGill '37), Chem. Engr., Imperial Oil Ltd., Sarnia, Ont. (*H*) 329 N. Vidal St. (*S. 1937*)

♂MAGWOOD, Wm. Herbert, Col., Town Engr., 168 Pitt St., P.O. Drawer 1089, Cornwall, Ont. (*H*) 128 Second St. E. (*A.M. 1905*) (*M. 1919*)

♂MAHAFFY, Herbert Laurence, Lieut., B.Sc., (McGill '20) Const'n. Engr., Power Corp. of Canada, 355 St. James St., Montreal, Que. (*H*) 8020 Western Ave., Montreal West, Que. (*S. 1914*) (*A.M. 1925*)

MAHON, A. G., B.Sc., (N.S.T.C. '29), Asst. Engr., N.S. Power Comm., Halifax, N.S (*H*) 21 Bloomingdale Terrace. (*S. 1929*) (*A.M. 1937*)

♂MAHON, Harry Wendell, B.Sc., (N.S.T.C. '14), Engr., N.S. Power Comm., P.O. Box 1192, Halifax, N.S. (*Jr. 1916*) (*A.M. 1918*)

MAHOUX, R. J., B.Eng., (McGill '37), Cons. Paper Corp. Ltd., Grand'Mere, Que. (*S. 1937*)

MAILHOT, Gaston A., B.A.Sc., (Ecole Polytech., Montreal '37), Supt'g Engr. and Constr'n., Armand Sicotte, 10 St. James St., Montreal, Que. (*H*) 3542 Ontario St. E. (*S. 1936*)

MAIN, Daniel Todd, Vice-Pres. and Sec.-Treas., Adanac Supplies Ltd.; Vice-Pres., Can. Waugh Equipment, 974 St. Antoine St., Montreal, Que. (*H*) 35 Aberdeen Ave., Westmount, Que. (*M. 1917*)

♂MAIN, Thos. C., Lieut., C. de G., Asst. Engr., Water Supply, C.N.R., Rm. 460, Union Sta., Winnipeg, Man. (*H*) 136 Lawndale Ave., Norwood, Man. (*A.M. 1917*)

MALBY, A. L., B.Sc., (Man. '34), Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*H*) 303 Rubidge St. (*Jr. 1936*)

MALBY, Geo. Thos., B.Sc., (Man. '35), Saguenay Power Co., Box 58, Arvida, Que. (*Jr. 1938*)

MALCOLM, Alvin Lawrence, B.A.Sc., (Tor. '11), H.E.P.C. of Ont., Bala, Ont. (*A.M. 1921*)

♂MALCOLM, Wm. Lindsay, Lt.-Col., M.A., B.Sc., (Queen's '07), M.C.E., Ph.D., (Cornell), O.L.S., D.L.S., Dean, School of Civil Engrg., Cornell University, Ithaca, N.Y. (*S. 1907*) (*A.M. 1909*) (*M. 1920*)

MALLOCH, Norman, B.Sc., (Queen's '12), H.E.P.C. Ont., Arnprior, Ont. (*A.M. 1919*)

MALONE, W. Harcourt, B.Sc., (McGill '23), Kenogami, Que. (*A.M. 1936*)

MALONE, Willis P., B.Sc., (McGill '25), Northern Electric Co. Ltd., Montreal, Que. (*H*) Apt. 1, 5540 Queen Mary Rd. (*S. 1925*) (*Jr. 1929*)

MANLEY, Edward Hugh, B.Sc., (Syracuse '31), 398 Elm Ave., Westmount, Que. (*A.M. 1937*)

MANN, O. Nelson, B.E., (N.S.T.C. '35), Eagle Pencil Co. of Canada, Ltd., Drummondville, Que. (*H*) 978 Mercure Blvd. (*S. 1936*) (*Jr. 1937*)

MANNING, Ralph Clark, B.A.Sc., (Tor. '17), Dist. Engr., Can. Institute of Steel Construction, 505 Bloor Bldg., Toronto, Ont. (*H*) 37 Willowbank Blvd. (*A.M. 1930*) (*M. 1938*)

MANNING, Walter J., B.A.Sc., (Ecole Polytech., Montreal '27), Apt. 4, 3203 Maplewood Ave., Montreal, Que. (*S. 1929*) (*A.M. 1938*)

MANOCK, Wilbur R., B.Sc. in C.E., (Illinois '10), Mgr., Horton Steel Wks. Ltd., Fort Erie N., Ont. (*A.M. 1927*)

♂MANSBRIDGE, Alf. S., Lieut., Engrg. Dept., West Kootenay Power and Light Co., South Slocan, B.C. (*Jr. 1920*) (*A.M. 1922*)

♂MANSON, Alex. B., Lieut., B.A.Sc., (Tor. '10), Gen. Mgr., Public Utilities Comm., 7-9 Ontario St., Stratford, Ont. (*H*) 107 Caledonia St. (*S. 1910*) (*A.M. 1914*) (*M. 1925*)

MANSON, George J., M.E., (Tor. '13), Hawley Products Canada Ltd., P.O. Box 760, Brantford, Ont. (*A.M. 1928*)

♂MAPLE, H. E., Major, V.D., Engr., Engrg. Services Br., Dept. National Defence, Canadian Bldg., Ottawa, Ont. (*H*) 350 Driveway. (*A.M. 1917*)

MARBLE, Wm. O., Partner, Hodgson, King & Marble, 1401 Main St., Vancouver, B.C. (*M. 1919*)

MARCH, Jos. Wade, B.Sc., (N.S.T.C. '23), 59 Henry St., Halifax, N.S. (*Jr. 1924*) (*A.M. 1930*)

MARCHAND, Fernand, 8202 St. Denis St., Montreal, Que. (*S. 1937*)

MARCHAND, Raymond, B.A.Sc., (Ecole Polytech., Montreal '31), 527 St. Clement St., Montreal, Que. (*A.M. 1937*)

MARCOTTE, Roland, B.Sc., (Milwaukee '33), Asst. Power Engr., Saguenay Power Co., Arvida, Que. (*Jr. 1938*)

♂MARLATT, Chas. E., B.Sc., (Queen's '23), Supt. Safety and Fire Insurance, Cons. Mining and Smelting Co., Trail, B.C. (*S. 1922*) (*Jr. 1925*) (*A.M. 1931*)

MARR, Norman, B.A.Sc., C.E., (Tor. '12), Chief Hydr. Engr., Dom. Water and Power Bureau, Survey and Engrg. Br., Dept. of Mines and Resources, Ottawa, Ont. (*H*) 347 Stewart St. (*S. 1909*) (*Jr. 1911*) (*A.M. 1916*) (*M. 1928*)

MARROTTE, Louis Henry, B.Sc., (McGill '04), Asst. Supt. of Stations, Montreal L., H. and P. Cons., Power Bldg., Montreal, Que. (*H*) 3872 Melrose Ave. (*A.M. 1920*) (*M. 1922*)

♂MARSHALL, Irvine Meredith, Capt., M.C., B.Sc., (Queen's '21), Gen. Mgr., Sullivan Cons. Mines, Ltd., Sullivan, Que. (*A.M. 1921*)

♂MARSHALL, J. A. P., B.Sc., C.E., (Tor.), Chief Municipal Engr., Dept. of Highways, Parliament Bldgs., Toronto, Ont. (*Jr. 1912*) (*A.M. 1916*)

MARSHALL, M. Hill, Engr., Dept. of Agriculture, P.F.R.A., 501 Leader-Post Bldg., Regina, Sask. (*H*) 14 Bartleman Apts. (*A.M. 1911*) (*M. 1916*)

MARSHALL, W. A., B.Sc., (Queen's '37), Dom. Reinforcing Steel Co. Ltd., Ottawa, Ont. (*H*) 567 Island Park Drive, Ottawa, Ont. (*S. 1937*)

MARSTON, Guy Reeves, County Engr. of Norfolk, Court House, Simcoe, Ont. (*H*) 57 Norfolk St. N. (*A.M. 1921*)

MARTEL, Pierre, 3471 Laval Ave., Montreal, Que. (*S. 1937*)

MARTIN, Clifford Davison, B.E., (N.S.T.C. '38), Box 262, Amherst, N.S (*S. 1938*)

MARTIN, Colin H., B.Sc., (Man. '34), P.O. Box 355, Selkirk, Man. (*S. 1935*) (*Jr. 1936*)

♂MARTIN, Edward Byron, Lieut., B.Sc., (N.B. '12), City Engr., City of Moncton. (*H*) 35 Cameron St., Moncton, N.B. (*A.M. 1920*)

MARTIN, Edward Newcome, B.Sc., (McGill '05), Wood Cadillac Mines Ltd., P.O. Drawer 2, Kewagama, Que. (*M. 1932*)

MARTIN, Frank J., B.Sc., (Sask. '28), Arch't. and Str'l. Engr., 302 Avenue Bldg., Saskatoon, Sask. (*H*) 121 Albert St. (*Jr. 1931*) (*A.M. 1936*)

MARTIN, Gerald N., B.A.Sc., (Ecole Polytech., Montreal '34), 26 Harrington St., Derby, England. (*Jr. 1937*)

MARTIN, H. Milton, Jr., B.Eng., (McGill '37), 59 Fauquier Ave., Sault Ste. Marie, Ont. (*S. 1937*)

MARTIN, J. Adolphe, 3492 Berri St., Montreal, Que. (*S. 1938*)

♂MARTIN, Lawrence Thos., Lt.-Col., D.S.O., Vice-Pres. and Mang. Dir., Gleeson Martin Ltd., 519 Ottawa Electric Bldg., Ottawa, Ont. (*H*) 267 Somerset St. W. (*M. 1921*)

MARTIN, Lucien, B.A.Sc., (Ecole Polytech., Montreal '31), Bridge Constrn. Engr., D.P.W., Parliament Bldgs., Quebec, Que. (*H*) Apt. 4, 382 St. Foye Rd. (*Jr. 1932*) (*A.M. 1934*)

MARTIN, Percival Ralph, 80 Ottawa St., Granby, Que. (*S. 1938*)

♂MARTIN, Robt. McCradie, B.Sc., (Alta '15), 1674 Davie St., Vancouver, B.C. (*A.M. 1923*)

MARTIN, Tom E., B.Sc., (Alta. '37), National Aniline and Chemical Co. Inc., 351 Abbott Rd., Buffalo, N.Y. (*H*) 405 Northampton St., Buffalo, N.Y. (*S. 1937*)

MARTINDALE, E. S., B.A.Sc., (Tor. '11), D.L.S., Bureau of Mines, Dept. of Mines and Resources, Victoria Memorial Museum, Ottawa, Ont. (*H*) 308 Manor Rd., Rockcliffe Park. (*A.M. 1919*)

MARTINEAU, Jos. Omer, B.Sc., (Queen's '15), Asst. Chief Engr., Roads Dept., Que., Quebec, Que. (*H*) Apt. 104, Chateau St. Louis, Grande Allée. (*M. 1935*)

MARTYN, Oscar Wm., B.Sc., (Tor. '10), Private Practice, 257 Angus Crescent, Regina, Sask. (*1938*)

MASON, G. A. R., B.Sc., (Alta. '34), Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*H*) 1181 Seymour Ave. (*S. 1934*)

MASON, H. L. K., 78 Wellington St., Kingston, Ont. (*S. 1938*)

MASON, Orley B., B.Eng., (McGill '33), P.O. Box 169, Chillicothe, Ohio. (*S. 1933*) (*A.M. 1937*)

MASSE, Fernand Andre, B.A.Sc., (Tor. '31), Asst. to Chief Chem., Abitibi Power and Paper Co., Sault Ste. Marie, Ont. (*H*) 301 Beverley St. (*Jr. 1932*)

MASSEY, Denton, B.Sc., (M.I.T. '24), 372 Bay St., Toronto, Ont. (*H*) 34 Alexandra Wood. (*S. 1920*) (*A.M. 1930*)

MASSUE, Huet, B.A.Sc., (Ecole Polytech., Montreal '13), Asst. Engr., The Shawinigan Water and Power Co., Power Bldg., Montreal, Que. (*H*) 3815 St. Hubert St. (*S. 1912*) (*A.M. 1918*) (*M. 1938*)

♂MATHER, Richard H., Lieut., B.Sc., (McGill '13), Asst. Mgr., Comm. and Distri. Dept., Shawinigan Water and Power Co., Montreal, Que. (*H*) 5583 Queen Mary Rd. (*A.M. 1919*)

MATHER, William Allan, B.Sc., (McGill '08), Gen. Mgr. of Western Lines, C.P.R., Winnipeg, Man. (*H*) 103 Handsart Blvd., Tuxedo, Man. (*A.M. 1911*) (*M. 1920*)

MATHESON, Arthur J., (R.M.C., Kingston), 114 Hillsdale Ave. W., Toronto, Ont. (*S. 1895*) (*A.M. 1899*) (*M. 1910*) (*Life Member*)

MATHESON, J. H. Parks, B.Sc., (McGill '30), 92-A 4th St., Shawinigan Falls, Que. (*S. 1928*)

MATHESON, J. S., B.Sc., (N.S.T.C. '34), 327 South St., Halifax, N.S. (*S. 1930*)

MATHESON, Murray Alex., B.Sc., (Sask. '33), Tropical Oil Co., Barranca Bermeja, Colombia, S.A. (*Jr. 1936*)

MATHEWS, Henry Mends, Merz & McLellan, 32 Victoria St., London, S.W.1, England. (*A.M. 1930*)

MATHIESON, John Richard, B.Sc., (Man. '36), 1429 Hamilton Ave., Fort William, Ont. (*S. 1935*) (*Jr. 1937*)

MATHIESON, T. S., B.Sc., (Queen's '26), Designing Mech. Engr., Falconbridge Nickel Mines, Ltd., Box 193, Falconbridge, Ont. (*Jr. 1928*) (*A.M. 1937*)

MATTHEWS, Samuel, B.Sc., (Sask. '28), Ceramic Engr., Dom. Fire Brick and Clay Products Ltd., Claybank, Sask. (*A.M. 1935*)

MATTICE, E. S., B.A.Sc., (McGill '90), Boucherville, Que. (*S. 1887*) (*A.M. 1895*) (*M. 1902*) (*Life Member*)

MATTSON, Ragnar John, B.Sc., (R.T.C., Stockholm '20), Engr., Foundation Co. of Canada, Ltd., Montreal, Que. (*H*) 4692 Victoria Ave. (*A.M. 1934*)

MAUDE, John Henry, Chief Designer, M.M. and P.M. Dept., Dom. Engineering Co. Ltd., Lachine, Que. (*H*) 657 Allard St., Verdun, Que. (*A.M. 1934*)

♂MAXWELL, Marvin W., Major, M.C., B.Sc., (N.B. '12), Indust. Commr., C.N.R., 1400 Woolworth Bldg., New York, N.Y. (*H*) 3900 Greystone Ave. (*A.M. 1919*)

MAYHEW, Earle Chandler, (R.M.C., Kingston '34), B.Sc., (Queen's '35), Lieut., O.M.E., R.C.O.C., M.D., No. 3, Kingston, Ont. (*H*) 535 Fairford St. E., Moose Jaw, Sask. (*S. 1935*)

Mc—see under Mac

♂MEADD, Howard E., B.Sc., (Queen's '21), Plant Engr., Howard Smith Paper Mills, Ltd., Cornwall, Ont. (*H*) 214 Bedford St. (*S. 1920*) (*A.M. 1923*)

♂MEADE, John Campbell, Lieut., Ste. D, 1818 Scarth St., Regina, Sask. (*A.M. 1918*)

MEADOWS, Jas. O., B.Sc., (Wisc.), Sanitary Engr., J. T. Donald & Co. Ltd., 1181 Guy St., Montreal, Que. (*H*) 3495 Marlowe Ave. (*A.M. 1911*)

MEAGHER, Robt. Douglas, B.Eng., (McGill '38), 571 Island Park Drive, Ottawa, Ont. (*S. 1938*)

MEALS, Casper D., Chief Engr., Wire Rope Divn., Bethlehem Steel Corp., Williamsport, Pa. (*H*) 801 Lafayette Parkway, Faxon. (*M. 1935*)

♂MECHIN, Frederick Charles, Capt., B.A.Sc., (Tor. '14), Mgr., Montreal Refinery, Imperial Oil Ltd., Box 1510, Montreal, Que. (*H*) 11844 Notre Dame St., Pointe aux Trembles, Que. (*A.M. 1917*)

♂MEDFORTH, Geo. T., Lieut., Mang. Engr., Canada Electric Co., Ltd., Amherst, N.S. (*A.M. 1923*)

♂MEDLAR, George Elmer, Office Engr., Windsor Utilities Comm., 607 Canada Bldg., Windsor, Ont. (*H*) 1548 Dougall Ave. (*Jr. 1922*) (*A.M. 1930*)

MEEHAN, Owen Michael, B.Sc., (N.S.T.C. '29), Hydrographic Service, Dept. of Mines and Resources, Hunter Bldg., Ottawa, Ont. (*A.M. 1932*)

♂MEEK, Victor M., Lieut., B.Sc., (McGill '10), Asst. Controller, Dom. Water and Power Bureau, Dept. of Mines and Resources, Ottawa, Ont. (*H*) 181 Gilmour St. (*A.M. 1914*) (*M. 1925*)

MELDRUM, Alan H., B.Sc., (Alta. '38), Algoma Steel Corp., Sault Ste. Marie, Ont. (*H*) 174 McDougall St. (*Jr. 1938*)

MELDRUM, Wm., Mining Engr., Lethbridge Collieries Ltd., Lethbridge, Alta. (*H*) 521-15th St. So. (*A.M. 1925*)

MELLOR, Alfred A., M.Sc., Vice-Pres., The Nichols Chemical Co., Ltd., 1111 Beaver Hall Hill, Montreal, Que. (*H*) 619 Belmont Ave., Westmount, Que. (*A.M. 1909*)

MELLOR, Alfred Geoffrey, B.Eng., (McGill '34), Buffalo Niagara Electric Corp., Buffalo, N.Y. (*H*) 45 W. Mohawk St. (*S. 1932*)

MELLOR, John Harold, B.Sc., (McGill '30), Can. Copper Refiners, Ltd., P.O. Box 489, Montreal, Que. (*H*) Apt. 43, 331 Clarke Ave., Westmount, Que. (*S. 1930*) (*Jr. 1934*)

MELSTED, Valdimar J., Mgr., Jolly Creek Placers, Rock Creek, B.C. (*S. 1910*) (*A.M. 1913*)

MENARD, Raymond, 7995 Casgrain St., Montreal, Que. (*S. 1937*)

MENDELSOHN, Albert, P.O. Box 177, St. Agathe des Monts, Que. (*S. 1937*)

MENGES, Edwin A. H., Chief Engr., Disher Steel Construction Co. Ltd., 80 Commissioners St., Toronto 2, Ont. (*H*) 40 Strathearne Blvd., Forest Hill. (*A.M. 1930*) (*M. 1936*)

MENZIES, John Ross, B.A.Sc., (Tor. '26), O.L.S., Dist. Engr., Dept. of Pensions and National Health, 170 Youville Sq., Montreal, Que. (*H*) 4989 Connaught Ave. (*S. 1926*) (*Jr. 1927*)

MERCIER, Jules M., 6177 Durocher Ave., Outremont, Que. (*S. 1938*)

MERSHON, Ralph D., M.E., D.Sc., Pickwick Arms Hotel, Greenwich, Conn. (*M. 1904*)

MESSEL, M. J., B.Eng., (McGill '38), Rivers, Man. (*S. 1935*)

MESSENGER, W. A., B.Sc., (McGill '22), Mill Mgr., Back River Power Co., Sault-au-Recollet, Montreal, Que. (*H*) 494 Victoria Ave., Westmount, Que. (*S. 1920*) (*A.M. 1928*)

MÉTHÉ, Philippe, B.A., C.E., (Ecole Polytech., Montreal '15), Director, L'Ecole Technique de Québec, 185 Blvd. Langelier, Quebec, Que. (*S. 1913*) (*A.M. 1928*)

♂MEWS, John Courtenay, Supt., Surface, Trans. and Constrn., Buchans Mining Co., Ltd., Buchans, Nfld. (*Jr. 1921*)

MIALL, Edward, Jr., Engr. i/c Airport, Civil Aviation Divn., Dept. of Transport, North Bay, Ont. (*Jr. 1934*)

MICHAUD, J. Arthur, D.P.W., Parliament Bldgs., Toronto, Ont. (*A.M. 1923*) (*M. 1938*)

♂MICHIE, Victor, Capt., Cons. Engr. and Contr., 408 McArthur Bldg., Winnipeg, Man. (*H*) Ste. 14-B, Locarno Apt., Roslyn Rd. (*A.M. 1909*) (*M. 1921*)

MICKELSON, Andrew Julius, B.Sc., (Tri.-State '26), C.E. '32, 39 Ray Blvd., Port Arthur, Ont. (*A.M. 1936*)

MIDGLEY, Frank H., A.R.T.C., (Glasgow), Engr., L.E., N. & G.R. Rlys., Preston, Ont. (*H*) 78 Water St., Galt, Ont. (*S. 1907*) (*Jr. 1912*) (*A.M. 1921*) (*M. 1926*)

MIDGLEY, Geo. Henry, B.Sc., (Mt. Allison '22), B.Sc., (N.S.T.C. '24), Sales Engr., Dom. Bridge Co. Ltd., P.O. Box 280, Montreal, Que. (*Jr. 1928*) (*A.M. 1935*)

MIESCHER, W. A., C.E., (Fed. Polytech., Zurich), i/c Constrn. Rhine Regulation, Rheinbauamt, Freiburg, Germany. (*H*) 22 Silberbachstrasse, Freiburg. (*A.M. 1928*)

♂MIÉVILLE, A. L., Lt.-Col., D.S.O., M.C., Switchgear & Cowans Ltd., Elsmere Rd., Manchester 16, England. (*A.M. 1911*) (*M. 1924*)

MIFFLEN, Sydney C., B.Sc., (McGill '14), Office Engr. and Chief Mine Surveyor, Dom. Steel and Coal Corp. Ltd., Glace Bay, N.S. (*H*) 60 Whitney Ave., Sydney, N.S. (*Jr. 1918*) (*A.M. 1920*) (*M. 1930*)

MILES, Edgar S., B.A.I., (N.B. '04), Engr., A. W. Robertson Ltd., Ft. of Spadina Ave , Toronto, Ont. (*H*) 200 Riverside Dr. (*A.M. 1911*) (*M. 1936*)

MILES, Edmund Lancelot, Mgr., Eastern Divn., Standard Paving Ltd., Charlottetown, P.E.I. (*H*) 80 Brighton Rd. (*A.M. 1907*) (*M. 1918*)

MILES, Harold Roy, Div. Engr., C.P.R., Moose Jaw, Sask. (*A.M. 1902*) (*M. 1919*)

MILLAR, Peter, Asst. Engr., Dom. Bridge Co. Ltd., Box 280, Montreal, Que. (*H*) 57-24th Ave., Lachine, Que. (*A.M. 1931*)

MILLER, Alex. M., B.Sc., (N.S.T.C. '34 and '35), New Waterford, N.S. (*S. 1935*)

MILLER, Charles, B.Sc., (Queen's '30), Hydra. Engr., Saguenay Power Co. Ltd., Arvida, Que. (*H*) 902 Moissan St. (*S. 1928*) (*A.M. 1935*)

MILLER, Chas. Arthur, B.A.Sc., (Tor. '36), Engrg. Dept., Can. Industries Ltd., P.O. Box 10, Montreal, Que. (*Jr. 1938*)

MILLER, D. C. R., B.A.Sc., (Tor. '35), Duplak (Windsor) Ltd., 1850 Walker Rd., Walkerville, Ont. (*H*) 1207 Chilver Rd. (*S. 1932*)

MILLER, Donald Waters, B.Sc., (Man. '35), Island Mountains Mines Co. Ltd., Wells, B.C. (*H*) 616 Ashburn St., Winnipeg, Man. (*S. 1935*) (*Jr. 1938*)

MILLER, E. Carlyle, Dir., T. Pringle & Son Ltd., Rm. 706, 485 McGill St., Montreal, Que. (*A.M. 1921*)

MILLER, Errol Leslie, B.Eng., (McGill '36), 5849 Jeanne Mance St., Montreal, Que. (*S. 1936*)

MILLER, G. Grant, B.Sc., (N.B. '32), E. S. Stephenson & Co. Ltd., Saint John, N.B. (*H*) 1 R.R., Saint John, N.B. (*S. 1932*)

MILLER, Harry, B.A.Sc., (Tor. '25), Factory Planning Engr., Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*H*) 4735 Upper Grosvenor Ave. (*A.M. 1930*)

MILLER, Harry Edward, Dist. Engr., D.P.W., Canada, Charlottetown, P.E.I. Address: Box 307, Charlottetown, P.E.I. (*Jr. 1920*) (*A.M. 1925*)

♂MILLER, Henry B., Capt., M.C., B.Sc., (McGill '07), Patricia, Alta. (*S. 1904*) (*Jr. 1912*) (*A.M. 1917*)

MILLER, John Jackson, B.Sc., (Man. '37), Inspr., C.N.R., Montreal, Que. (*H*) Apt. 26, 3015 Sherbrooke St. W. (*S. 1937*)

MILLER, J. J. H., B.Sc., (McGill '25), Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*H*) 1600 Athlone Rd., Town of Mt. Royal, Que. (*S. 1923*) (*A.M. 1931*)

♂MILLER, John Leonard, Major, M.C., Pres. and Gen. Mgr., Herbert Morris Crane and Hoist Co. Ltd., Niagara Falls, Ont. (*H*) 901 Simcoe St. (*A.M. 1933*)

MILLER, Lindsay, B.Eng., (McGill '33), J. R. Booth Ltd., Ottawa, Ont. (*H*) 158 James St. (*S. 1932*)

♂MILLER, Walter St. John, Lieut., Private Practice, 703 Second St. W., Calgary, Alta. (*H*) 3003-17th St. W. (*A.M. 1921*)

♂MILLER, Warren Cron, Major, B.Sc., (Queen's '17), City Engr. and Treas., St. Thomas, Ont. (*H*) 24 Curtis St. (*S. 1916*) (*Jr. 1920*) (*A.M. 1921*) (*M. 1929*)

♂MILLER, Wilfrid Laverne, B.A.Sc., (Tor. '23), Elec. Engr., Can. Westinghouse Co., Ltd., Hamilton, Ont. (*H*) 49 Holton Ave. N. (*S. 1921*) (*Jr. 1926*) (*A.M. 1931*)

MILLER, Wm. Frederick, B.Sc., (Queen's '32), Inspr., Elec. and Gas, Dept. of Trade and Commerce, Sudbury, Ont. (*H*) 183 College St. (*S. 1930*) (*A.M. 1937*)

♂MILLER, Wm. Miles, Lt.-Col., M.C., (R.M.C., Kingston '12), O.C., Signal Training Br., Signal Training Centre, Jubbulpore, C.P., India. Address: Bank of Montreal, 9 Waterloo Place, London, S.W.1. (*S. 1910*) (*A.M. 1922*)

MILLETT, Ralph Strathie, B.Sc., (N.S.T.C. '23), Forest Product Engr., Forest Products Laboratories of Canada, Ottawa, Ont. (*H*) 146 Aylmer Ave. (*A.M. 1937*)

MILLIDGE, Edwin R., Div'n. Engr., Mtce., C.N.R., Winnipeg, Man. (*H*) 30 Purcell Ave. (*S. 1902*) (*A.M. 1909*) (*M. 1915*)

MILLIGAN, Frank S., B.A.Sc., (Tor. '11), Prop., F. S. Milligan & Co., 388 Yonge St., Toronto 2, Ont. (*H*) Second St., Oakville, Ont. (*S. 1911*) (*Jr. 1913*) (*A.M. 1917*)

MILLIKEN, Humphreys, B.S., (M.I.T. '02), Chief Engr., Elec. Dept., Montreal L., H. and P. Cons., Power Bldg., Montreal, Que. (*H*) 280 Markham Rd., Town of Mt. Royal, Que. (*M. 1925*)

MILLS, Arthur McTavish, B.Sc., (Queen's '19), Divn. Engr., Dept. of Highways, Ont., Bancroft, Ont. (*S. 1919*) (*A.M. 1926*)

♂MILLS, Frederick Oldham, Asst. Engr., D.P.W., Canada, Post Office Bldg., New Westminster, B.C. (*H*) 108-6th Ave. (*S. 1906*) (*A.M. 1912*)

MILLS, Thos. S., B.A., B.Sc., (Queen's '11), D.L.S., Chief Engr., Engrg. and Constrn. Service, Dept. of Mines and Resources, Jackson Bldg., Ottawa, Ont. (*H*) 72 Craig St. (*A.M. 1919*) (*M. 1926*)

MILLS, W. Stuart, B.Sc., (Queen's '21), Wallace & Tiernan Ltd., 350 Sorauren Ave., Toronto, Ont. (*Jr. 1921*)

♂MILNE, Arthur Hartley, Lieut., B.Sc., (McGill '17), Dir., Dept. of Bldgs., Protestant Bd. of School Commrs., 3460 McTavish St., Montreal, Que. (*H*) 4786 Grosvenor Ave. (*S. 1914*) (*Jr. 1918*) (*A.M. 1920*) (*M. 1928*)

MILNE, Jas. R. B., Spruce Falls Power and Paper Co., Kapuskasing, Ont. (*Jr. 1932*)

MILNE, Winford Gladstone, Gen. Mgr., N. Slater Co., Ltd., Hamilton, Ont. (*H*) 151 Delaware Ave. (*A.M. 1919*) (*M. 1935*)

MILOT, Camille, B.A.Sc., C.E., (Ecole Polytech., Montreal '19), Asst. Chief Engr., D.P.W. and L., Quebec, Que. (*H*) 70 Moncton St. (*S. 1919*) (*Jr. 1920*) (*A.M. 1922*)

MINARD, Guy M., B.Sc., (Queen's '28), Supt. of Tech. Dept., Spruce Falls Power and Paper Co., Kapuskasing, Ont. (*H*) 33 Drury Ave. (*Jr. 1929*)

MINSHALL, Harry Hugh, Engr., Dom. Bridge Co. Ltd., 275 W. First Ave., Vancouver, B.C. (*H*) 3895 W. 22nd Ave. (*A.M. 1938*)

MISENER, John S., Refinery Mgr., Acadia Sugar Refining Co., Box 400, Woodside, Dartmouth, N.S. (*M. 1919*)

♂MITCHELL, Chas Hamilton, Brig.-Gen., C.B., C.M.G., D.S.O., B.A.Sc., C.E., (Tor. '98), LL.D., D.Eng., Dean of the Faculty of Applied Science, University of Toronto, and Cons. Engr., Toronto, Ont. (*H*) 35 N. Sherbourne St., Rosedale, Toronto, Ont. (*S. 1894*) (*A.M. 1898*) (*M. 1902*) (*Past-President*)

♂MITCHELL, Coulson N., Capt., V.C., M.C., B.C.E., (Man. '12), Gen. Supt. of Constrn., Power Corp. of Canada, Ltd., 355 St. James St., Montreal, Que. (*H*) 123 Vivian Ave., Town of Mt. Royal, Que. (*S. 1911*) (*A.M. 1917*)

MITCHELL, David Alex., B.A.Sc., (Tor. '37), H.E.P.C. of Ont., Leaside, Ont. (*H*) 8 Randolph Rd., Leaside, Ont. (*Jr. 1938*)

♂MITCHELL, Frank Leslie, Lieut., B.Sc., (McGill '21), Gen. Mgr., Woods Mfg. Co., 2660 Mullins St., Montreal, Que. (*H*) 614 Victoria Ave., Westmount, Que. (*Jr. 1922*) (*A.M. 1930*)

♂MITCHELL, Gordon, Capt., B.A.Sc., (Tor. '15), 796 Crawford St., Toronto, Ont. (*S. 1914*) (*A.M. 1926*)

MITCHELL, G. B., C.E., (Colorado), 1 Rosemount Ave., Westmount, Que. (*M. 1913*)

MITCHELL, J. Murray, B.Sc., (McGill '23), Dist. Traffic Supt., The Bell Telephone Co. of Canada, Three Rivers, Que. (*H*) 2427–5th Ave. (*S. 1922*) (*Jr. 1930*) (*A.M. 1935*)

MITCHELL, Jas. Thomson, B.Sc., (Glasgow '14), Commr. of Patents, Patent Office, Ottawa, Ont. (*H*) 43 Delaware Ave. (*A.M. 1916*)

MITCHELL, Lawrence E., B.Sc., (N.S.T.C. '32), Refinery Inspr., Intern. Petroleum Co. Ltd., Talara, Peru, S.A. (*H*) Welchpool, Campobello, N.B. (*S. 1930*)

MITCHELL, Robt. Walter, B.Eng., (McGill '33), Merck & Co. Ltd., Montreal, Que. (*H*) 135 Balfour Ave., Town of Mt. Royal, Que. (*S. 1933*)

♂MITCHELL, R. W., Major, M.C., Chief Engr., Pressure Pipe Co. of Canada, Ltd., 760 Victoria Sq., Montreal, Que. (*H*) 3284 Cedar Ave. (*Jr. 1912*) (*A.M. 1920*)

MITCHELL, Samuel Phillips, Cons. Engr. and Pres., Seaboard Construction Co., 1450 Real Estate Trust Bldg., Philadelphia, Pa. (*H*) 127 Maplewood Ave. (*M. 1912*)

MITCHELL, Wallace M., B.Sc., (McGill '24), Res. Engr., Brunner, Mond Canada, Ltd., Amherstburg, Ont. (*H*) Laird Ave. (*S. 1923*) (*A.M. 1930*)

MITCHELL, Wm. Gordon, B.Sc., M.Sc., (McGill '14), Cons. Engr., 680 Sherbrooke St. W., Montreal, Que. (*H*) 12 Redpath Place. (*M. 1920*)

MITCHELL, Wm. Reg., B.Sc., (Man. '34), 507 Queens Ave., London, Ont. (*S. 1934*)

♂MITCHESON, Septimus, Chief Dftsman., Shell Oil Co. of Canada, Montreal East, Que. (*H*) 2226 Hingston Ave., N.D.G. (*A.M. 1931*)

MODJESKI, Ralph, C.E., Dr. Engrg., 30 Beekman Place, New York, N.Y. (*M. 1909*)

MOES, G., Gen. Mgr., Hamilton Sterling Electrical Co. Ltd., 428 Cannon St. E., Hamilton, Ont. (*H*) Aldershot, Ont. (*A.M. 1930*)

MOFFAT, Alex. Robertson, Box 32, Bourlamaque, Que. (*Jr. 1925*) (*A.M. 1938*)

MOFFAT, Thomas Stuart, B.Sc., (McGill '27), Supt., Provincial Wood Products Co., Kanes Corner, Saint John, N.B. (*H*) 67 Seely St. (*S. 1925*) (*A.M. 1935*)

MOFFATT, Robert W., B.A.Sc., (Tor. '10), Asst. Prof., Dept. of C.E., University of Manitoba, Winnipeg, Man. (*H*) 900 Jessie Ave. (*S. 1910*) (*A.M. 1913*)

MOLD, Robt. Chas., Res. Inspr., Associated Factory Mutual Fire Insurance Cos., 801 Sterling Tower Bldg., Toronto, Ont. (*H*) 18 Bridgeview Rd. (*Affil. 1936*)

MOLKE, Eric C., C.E., (Vienna '23), Strl. Engr., Roberts & Schaefer Co., 1100 Wrigley Bldg., Chicago, Ill. (*H*) 829 Belle Plaine Ave. (*Jr. 1927*) (*A.M. 1930*)

MOLLAND, Fred. W., B.Sc., (Queen's '37), Paranite Wire and Cable Corp., Jonesboro, Ind. (*H*) 512 S. Western Ave., Marion, Ind., U.S.A. (*S. 1937*)

MOLLARD, J. E., B.Sc., (Sask. '31), Dist. Supt., Sask. Power Comm., Tisdale, Sask. (*S. 1931*) (*A.M. 1935*)

MOLLER, Holger Peter, E.E., (R.T.C., Copenhagen '23), Elec. Supt., Lake St. John Power and Paper Co., Dolbeau, Que. P.O. Box 99. (*A.M. 1937*)

MOLLEUR, Gerald, B.A.Sc., (Ecole Polytech., Montreal '24), Quebec Electricity Bd., 67 Grande Allée, Quebec, Que. (*H*) 97 Lockwell St. (*S. 1924*) (*A.M. 1932*)

MOLONEY, J. Grant, B.Sc., (Tri.-State '35), Editor, "Canadian Engineer," 341 Church St., Toronto, Ont. (*Jr. 1936*)

♂MONKMAN, George H. N., Capt., 10304–133rd St., Edmonton, Alta. (*S. 1910*) (*Jr. 1914*) (*A.M. 1921*) (*M. 1927*)

G.†MONSARRAT, Chas. N., Lt.-Col., Cons. Engr., Monsarrat & Pratley, 909 Drummond Bldg., Montreal, Que. (*H*) E-70, The Chateau Apts. (*A.M. 1898*) (*M. 1905*)

MONTAGUE, John Russell, C.E. and B.A.Sc., (Tor. '14), Designing Engr., Hydr. Dept., H.E.P.C. of Ont., 620 University Ave., Toronto, Ont. (*H*) 51 Chudleigh Ave. (*A.M. 1918*)

MONTGOMERY, Hugh R., B.Sc., (McGill '29), Engr., The Atlas Construction Co. Ltd., 200 Roxborough St. E., Toronto, Ont. (*S. 1928*) (*A.M. 1932*)

♂MONTGOMERY, Samuel Clifford, Lieut., M.C., B.Sc., (McGill '15), Constrn. Office, Cons. Mining and Smelting Co., Trail, B.C. (*S. 1911*) (*Jr. 1920*) (*A.M. 1929*)

MONTGOMERY, Thos., Chief Engr., Imperial Oil Ltd., Sarnia, Ont. (*H*) 276 North Brock St. (*M. 1922*)

MONTI, A., 60 Jean Talon St. E., Montreal, Que. (*S. 1938*)

♂MONTIZAMBERT, Harry Bell, Capt., Apt. 7, 1445 Bishop St., Montreal, Que. (*A.M. 1926*)

♂MONTIZAMBERT, H. St. J., Lt.-Col., Pres., Montizambert & Co., 601, 510 Hastings St. W., Vancouver, B.C. (*M. 1913*)

MONTREUIL, Joseph O., M.A., Chief of Dist. No. 5, Prov. Que. Dept. of Rds., Quebec, Que. (*H*) Everell, Que. (*A.M. 1904*) (*M. 1913*)

†MOODIE, Kenneth, B.Sc., (McGill '95), Combustion Engr., D.P.W. of B.C., Victoria, B.C. (*H*) 4261–12th Ave. W., Vancouver, B.C. (*S. 1895*) (*A.M. 1911*) (*M. 1926*)

MOODIE, Walter Taylor, Gen. Supt., C.N.R., Vancouver, B.C. (*M. 1918*)

MOON, Clyfforde G., 66½ Yates St., St. Catharines, Ont. (*S. 1907*) (*A.M. 1911*)

MOON, George Douglas, B.A.Sc., (Tor. '23), Gen. Plant Constrn. Supervisor, E.A., The Bell Telephone Co. of Canada, Ltd., Montreal, Que. (*H*) Apt. 11, 3485 Van Horne Ave. (*S. 1921*) (*Jr. 1928*) (*A.M. 1934*)

♂MOONEY, Frank M., Jr., B.Sc., (McGill '20), Apt. 1, 376 Redfern Ave., Westmount, Que. (*S. 1914*) (*Jr. 1921*) (*A.M. 1926*)

MOONEY, John P., B.Sc., (N.B. '16), Mgr., Mooney Construction Co., 49 Canterbury St., Saint John, N.B. (*H*) 16 Queen Sq. (*Jr. 1918*) (*A.M. 1920*)

MOORE, Alex. Glydon, B.Sc., (N.S.T.C. '25), Res. Engr., Cie Immobilière de Ste. Marguerite, Que., Domaine D'Esterel, Lake Masson, Que. (*S. 1923*) (*Jr. 1930*) (*A.M. 1935*)

♂MOORE, Chas. M., B.Sc., (Queen's '19), Medicine Hat, Alta. (*S. 1919*) (*Jr. 1920*) (*A.M. 1924*)

G.MOORE, Ernest Vivian, B.Sc., (McGill '00), Tor. Sales Repres., Dom. Coal Co. Ltd., 217 Bay St., Toronto, Ont. (*H*) 121 Chaplin Cres. (*A.M. 1903*) (*M. 1919*)

MOORE, Henry Alex., B.A., (Tor. '93), Engrg. Dept., Cons. Mining and Smelting Co. of Canada, Trail, B.C. (*M. 1907*) (*Life Member*)

MOORE, Herbert H., (Tor. '02), A.L.S., D.L.S., Private Practice, 427 Riverdale Ave., Calgary, Alta. (*S. 1904*) (*A.M. 1909*)

MOORE, Lewis N., B.Sc., (McGill '27), Asst. Div. Equipment Engr., E.O.D., The Bell Telephone Co. of Canada, Ottawa, Ont. (*H*) 312 Fifth Ave. (*S. 1927*) (*A.M. 1932*)

MOORE, Reginald Arthur, B.Sc., (McGill '23), English Electric Co., St. Catharines, Ont. (*H*) 54 Glenridge Ave. (*S. 1921*) (*Jr. 1926*)

MOORE, Robt. H., B.Sc., (Man. '34), Hudson's Bay M. & S. Co. Ltd., Flin Flon, Man. (*H*) 240 Balfour Ave., Winnipeg, Man. (*S. 1930*)

♂MOORE, Thomas John McLuckie, Dom. Water and Power Bureau, Dept. of Mines and Resources, Box 235, North Bay, Ont. (*A.M. 1922*)

MOORE, Wm. Herbert, B.Sc., (McGill '27), (M.Eng., '32), Elec. Engr., Can. Marconi Co. Ltd., Montreal, Que. (*H*) 460 Grosvenor Ave., Westmount, Que. (*S. 1925*) (*A.M. 1934*)

MOORE, Wm. J., (Tor. '06), O.L.S., County Engr., and Rd. Supt., Renfrew County, Box 1048, Pembroke, Ont. (*S. 1907*) (*A.M. 1910*)

MORAN, Taylor Matthew, B.Sc., (McGill '23), Factory Mgr., Dom. Rubber Co. Ltd., Montreal, Que. (*H*) 4571 Hingston Ave., N.D.G. (*A.M. 1929*)

MORAZAIN, Jules F., B.Sc., (Queen's '38), 185 Brock St., Kingston, Ont. (*S. 1938*)

MORENCY, John, B.A.Sc., (Ecole Polytech., Montreal '32), Inspr., Quebec Bureau of Mines, Quebec, Que. (*Jr. 1937*)

MOREY, Harold Arthur, B.Sc., (Dartmouth '08), Mgr., N.S. Wood Pulp and Paper Co. Ltd., Charleston, Queen's Co., N.S. (*A.M. 1922*)

MORGAN, A. Hedley, Vice-Pres. and Wks. Mgr., E. Leonard & Sons, Ltd., London, Ont. (*H*) 294 Hyman St. (*M. 1922*)

MORGAN, N. L., B.Sc., (McGill '14), Cable Research Engr., Northern Electric Co. Ltd., Montreal, Que. (*H*) 107 Kindersley Rd. So., Town of Mount Royal, Que. (*A.M. 1919*)

♂MORGAN, Philip Harold, Capt., Box 491, Beauharnois, Que. (*A.M. 1934*)

MORGAN, Ralph T., B.Eng., (McGill '35), Mech. Engr., Can. International Paper Co., P.O. Box 510, Three Rivers, Que. (*Jr. 1937*)

MORIN, Alphonse, 825 Sherbrooke St. E., Montreal, Que. (*S. 1938*)

♂MORISSET, Jos. Eudore, Asst. Chief Engr., Donnacona Paper Co., Donnacona, Que. (*H*) 6 Senall Place. (*A.M. 1938*)

MORITZ, Chas. J. H., B.Sc., (Mich. '97), Vice-Pres., Aluminium Ltd. Address: Aluminum Co. of America, Niagara Falls, N.Y. (*A.M. 1901*) (*M. 1909*)

MORLEY, Edward H., R.R. 2, Rose Cottage, Yarmouth, N.S. (*M. 1910*) (*Life Member*)

MORRIS, Harold K., B.Eng., (McGill '35), 20 Thornhill Ave., Westmount, Que. (*S. 1935*)

†MORRIS, James L., C.E., (Tor. '85), D.Eng., '27, O.L.S., Inspr. of Surveys and Engr., Ont., Parliament Bldgs., Toronto, Ont. (*H*) Apt. 303, 200 St. Clair Ave. W. (*A.M. 1887*) (*M. 1904*) (*Life Member*)

MORRIS, John William, B.A.Sc., (McGill '94), Gen. Mgr., Newfoundland Light and Power Co., P.O. Box 823, St. John's, Nfld. (*H*) 22 Atlantic Ave. (*M. 1920*)

♂MORRISEY, Henry Fairweather, Lt.-Col., M.Sc., (N.B. '15), Dist. Engr., Dept. of Transport, Saint John, N.B. (*H*) 65 Hazen St. (*Jr. 1913*) (*A.M. 1922*)

♂MORRISEY, T. Sydney, Lt.-Col., D.S.O., (R.M.C. '10), Secy.-Treas., Associated Screen News, Montreal, Que. (*H*) 3275 Cedar Ave. (*S. 1910*) (*Jr. 1913*) (*A.M. 1924*) (*M. 1931*)

MORRISON, C. F., B.E., (Sask. '25), M.Sc., (McGill '27), Asst. Prof., C.E., Univ. of Toronto, Toronto, Ont. (*H*) 29 Claxton Blvd. (*Jr. 1929*) (*A.M. 1936*)

MORRISON, George, (C.G.I. '97), Commonwealth Electric Corp. Ltd., P.O. Box 308, Welland, Ont. (*A.M. 1924*) (*M. 1926*)

MORRISON, G. H., B.Sc., (N.S.T.C. '25), Cons. Mining and Smelting Co., Mackay Bldg., Sudbury, Ont. (*Jr. 1930*)

MORRISON, J. Alex., B.A.Sc., (Tor. '28), Director, Util. Lab., Consumers Gas Co., 134 Richmond St. W., Toronto, Ont. (*H*) 931 College St. (*S. 1928*) (*A.M. 1937*)

♂MORRISON, James R., Lieut., Field Engr., Dom. Coal Co., Glace Bay, N.S. (*H*) 28 Lorway Ave., Sydney, N.S. (*S. 1905*) (*A.M. 1914*)

MORRISON, John D., 68 Bruce Ave., Westmount, Que. (*S. 1937*)

MORRISON, J. W., B.Sc., (Dalhousie and N.S.T.C.), Cons. Mining Engr., 111 Main St., Haileybury, Ont.; also Mang. Dir., Albany River Mines. (*M. 1919*)

MORRISON, Thos. Jack, B.Sc., (McGill '30), 292 Chatham St. W., Windsor, Ont. (*S. 1930*)

MORRISON, William P., Sr. Asst. Engr., P.W.D., Canada, P.O. Box 225, Halifax, N.S. (*A.M. 1898*) (*M. 1907*) (*Life Member*)

♂MORRISON, Wm. Stuart Estleigh, Lieut.-Cmdr., (E.), (Rtd.), Chief Engr., Provincial Secretary's Dept., P.O. Box 27, Burwash, Ont. (*A.M. 1927*)

MORROW, Harold A., (R.M.C., Kingston), Pres., Morrow & Beatty, Ltd., Box 782, Peterborough, Ont. (*H*) "Clonsilla," Peterborough, Ont. (*S. 1888*) (*A.M. 1894*) (*M. 1902*)

MORROW, Thos. Maclellan, B.Sc., (McGill '13), 21 Melbourne Ave., Westmount, Que. (*A.M. 1923*)

MORSE, John, B.Sc., (Chalmers '06), Gen. Supt., Shawinigan Water and Power Co., 611 Power Bldg., Montreal, Que. (*H*) 3437 Harvard Ave. (*A.M. 1916*) (*M. 1926*)

G.†MORSSEN, Chas. M., C.E., (Ecole Nat. des Ponts et Chaussées), Cons. Engr., Rm. 24, 758 Victoria Sq., Montreal, Que. (*A.M. 1909*) (*M. 1914*)

MORTON, Archibald Marshall, Res. Engr., Rhokana Corp. Ltd., Nkana, Nor. Rhodesia, P.O. Box 9. (*M. 1936*)

MORTON, Philip S. A., B.A.Sc., (Tor. '28), Can. Gen. Elec. Co. Ltd., Montreal, Que. (*H*) 3570 Lorne Cres. (*Jr. 1931*)

MORTON, Ralph MacKenzie, B.A.Sc., (B.C. '25), Asst. Engr., Bepco Canada Ltd., 1050 Mouutain St., Montreal, Que. (*H*) 4354 Walkley Ave. (*S. 1923*) (*Jr. 1929*) (*A.M. 1937*)

MOSELEY, S. Charles, B.Eng., (McGill '37), Can. Car and Foundry Co., Longue Pointe, Montreal, Que. (*S. 1937*)

MOSLEY, Harold Gordon, Chief Surveyor, Cumberland Rly. and Coal Co., Springhill, N.S. (*Jr. 1935*)

MOSS, Charles S., Deer Park, B.C. (*A.M. 1902*) (*Life Member*)

MOSS, Brian V., Fraser River High Bar Placers Survey Inc., Clinton, B.C. (*S. 1936*)

MOTHERWELL, Chas. G., B.Eng., (McGill '38), 574 Cote St. Antoine Rd., Westmount, Que. (*S. 1937*)

G.†MOTLEY, Phillips B., 2 Sunnyside Ave., Westmount, Que. (*A.M. 1898*) (*M. 1905*)

♂MOTT, Harold Edgar, Capt., B.Sc., (McGill '22), Pres. and Gen. Mgr., H. E. Mott & Co. Ltd., Brantford, Ont. (*H*) 63 Chestnut Ave. (*S. 1919*) (*A.M. 1926*) (*M. 1935*)

MOULD, John. M.Sc., (Sask. '32), Field Engr., Govt. Alta., Water Rights Br., Edmonton, Alta. (*1938*)

MOULE, G. W., B.Sc., (Man. '37), Can. Industries Ltd., Montreal, Que. (*H*) 560 Lansdowne Ave., Westmount, Que. (*S. 1935*)

MOULTON, Arthur Garland, Vice-Pres., Thompson-Starrett Co. Inc., 444 Madison Ave., New York, N.Y. (*H*) 5432 E. View Park, Chicago, Ill. (*M. 1923*)

♂MOUNT, Wilfred Rowland, Major, M.C., Engr. and Supt. W.W., City of Edmonton, Civic Block, Edmonton, Alta. (*H*) 9801-110th St. (*A.M. 1921*) (*M. 1934*)

♂MOUNTFORD, Geo. Colledge, Mech. Supervisor, Ont. Plant, H.E.P.C. of Ont., Niagara Falls, Ont. Address: Chippawa, Ont. (*A.M. 1926*)

♂MOXON, Geo. Burnham, Aluminum Co. of Canada, P.O. Box 141, Arvida, Que. (*H*) 463 Grosvenor Ave., Westmount, Que. (*A.M. 1934*)

♂†MUCKLESTON, Hugh B., Major, (R.M.C., Kingston '94), Cons. Engr., 470 Granville St., Vancouver, B.C. (*H*) 1154 Gilford St. (*M. 1907*)

♂MUDGE, Reginald, Capt., B.Sc., (McGill '06), Asst. Engr., C.P.R., Rm. 401, Windsor Station, Montreal, Que. (*H*) 3610 Durocher St. (*S. 1906*) (*A.M. 1913*)

MUELLER, E. K., B.A.Sc., (Tor. '24), Dist. Engr., C.N.D., The Bell Telephone Co. of Canada, Toronto, Ont. (*H*) 74 Robina Ave. (*S. 1921*) (*A.M. 1930*)

MUELLER, Victor Leo, Engr., Can. and General Finance Co., Ltd., 25 King St. W., Toronto, Ont. (*H*) 49 Radford Ave. (*Jr. 1921*)

MUGAAS, Henrik, Lamaque Gold Mines, Ltd., Val d'Or, Via Amos, Que. (*A.M. 1932*)

MUIR, Clarke Bower, B.Sc., (N.S.T.C. '31), Supt., Wire Dept., Can. Gen. Elec. Co., Peterborough, Ont. (*H*) 323 Dalhousie St. (*S. 1931*)

MUIR, Harvey Jos., B.A.Sc., (Tor. '30), Sales Service Engr., Bailey Meter Co. Ltd., 906 McArthur Bldg., Winnipeg, Man. (*H*) 33 Wakefield Apts. (*A.M. 1936*)

MUIR, Wm. Gordon, B.Sc., (N.S.T.C. '31), Sales Engr., Alexander Murray Co. Ltd., Halifax, N.S. (*H*) 28 Victoria Rd. (*Jr. 1933*)

♂MUIRHEAD, Stuart R., B.A.Sc., (Tor. '24), Engr., Dept. of Telephones, Sask., Regina, Sask. (*H*) 371 Leopold Crescent. (*S. 1920*) (*Jr. 1924*) (*A.M. 1930*) (*M. 1936*)

MULLEN, Thos. J., Jr., B.Eng., (McGill '34), Indust. Engr., B. F. Sturtevant Co., Hyde Park, Boston, Mass., U.S.A. (*S. 1933*)

MULLIGAN, H. I., B.Sc., (McGill '26), Fort Coulonge, Que. (*S. 1926*) (*A.M. 1935*)

MULLINS, Harrison Alex., B.Sc., (Man. '37), Elec. Engr., Taylor Electric Mfg. Co., London, Ont. (*H*) 364 King St. (*S. 1937*)

♂†MULOCK, Redford H., C.B.E., D.S.O., B.Sc., Air Commodore, 3484 Marlowe Ave., Montreal, Que. (*S. 1905*) (*A.M. 1912*)

MUMFORD, Wm. Vaus, Engr., City Arch't.'s Dept., City of Toronto, City Hall, Toronto, Ont. (*H*) 83 Glenmore Rd. (*A.M. 1929*)

♂MUNFORD, Thomas Albert Sprake, Asst. Engr., Bruce Divn., C.P.R., Rm. 333, Union Station, Toronto, Ont. (*H*) 94 Glenholme Ave. (*A.M. 1921*)

♂MUNRO, Alan H., Lieut., B.A.Sc., (Tor. '11), 352 Brock St., Peterborough, Ont. (*S. 1911*) (*A.M. 1920*)

MUNRO, David J., B.Sc., (McGill '23), Equipment Engr., Montreal Tramways Co., Youville Shops, Montreal, Que. (*H*) 36 Dobie Ave., Town of Mt. Royal, Que. (*S. 1921*) (*Jr. 1927*)

MUNRO, Geo. Neil, B.Sc., (Sask. '26), 719 Clifton St., Winnipeg, Man. (*A.M. 1937*)

♂MUNRO. W. Hamilton, Major, (Tor. '04), Gen. Mgr., Ottawa Electric Co. and Ottawa Gas Co., 300 Cooper St., Ottawa, Ont. (*A.M. 1908*) (*M. 1920*)

MUNSON, A. H., (Tor. '09), Asst. Wks. Mgr., Dom. Bridge Co. Ltd., Montreal, Que. (*H*) 8031 Western Ave. (*S. 1911*) (*A.M. 1916*)

♂MUNTZ, E. P., Capt., B.A.Sc., (Tor. '14), Pres., E. P. Muntz, Ltd., Box 357, Dundas, Ont. (*H*) 292 Bay St. S., Hamilton, Ont. (*S. 1913*) (*A.M. 1919*) (*M. 1927*)

♂MURDIE, Wm. Campbell, Capt., M.C., B.A.Sc., M.A.Sc., (Tor.), Survey and Engrg. Br., Dept. of Mines and Resources, Ottawa, Ont. (*A.M. 1921*)

MURDOCH, Gilbert Gray, Private Practice, 74 Carmarthen St., Saint John, N.B. (*H*) 272 Douglas Ave. (*S. 1905*) (*A.M. 1911*) (*M. 1919*)

MURDOCK, Charles Russell, B.A.Sc., (Tor. '11), Town Engr. and Townsite Mgr., Spruce Falls Power and Paper Co., Box 319, Kapuskasing, Ont. (*A.M. 1912*)

MURPHY, Adelbert Arthur, B.Sc., (McGill '09), Mgr., Murphy Electric Co., Saskatoon, Sask. (*H*) 216-1st Ave. N. (*1938*)

MURPHY, Alexander Gordon S., B.Sc., (McGill '22), Engr., Montreal Harbour, National Harbours Bd., Montreal, Que. (*H*) 4828 Wilson Ave., N.D.G. (*Jr. 1922*) (*A.M. 1931*)

MURPHY, Daniel Francis, B.Eng., (McGill '36), Foundation Co. of Canada, Montreal, Que. (*H*) 6805 Chabot St. (*S. 1936*)

MURPHY, Emmett Patrick, Dept. of Transport, Port Colborne, Ont. Address: Laurentian Club, Ottawa, Ont. (*S. 1909*) (*A.M. 1915*)

MURPHY, John J., 70 Gloucester St., Ottawa, Ont. (*A.M. 1890*)

†MURPHY, John, 23 Java St., Ottawa, Ont. (*A.M. 1904*) (*M. 1913*)

MURPHY, Stephen John, B.Sc., (McGill '13), National Research Council, Ottawa, Ont. (*H*) 163 Holmwood Ave., Ottawa, Ont. (*A.M. 1922*)

MURPHY, Thos. R. H., Cons. Engr., Mead Investment Co., N.W. Monument St., Dayton, Ohio. (*H*) R.F.D. No. 1, Ridgefield, Conn. (*A.M. 1917*)

MURRAY, Archibald (*q*), B.A., (Acadia '94), Asst. Engr., Dept. of Transport, 317 West Block, Ottawa, Ont. (*H*) 210 Aylmer Apts. (*S. 1904*) (*A.M. 1914*)

MURRAY, Robt. Leslie, Vernon, P.E.I. (*S. 1931*)

♂MURRAY, Robt. Roy, Lt.-Col., M.C. and Bar, B.Sc., (N.S.T.C. '14), Mgr., Machy. Dept., Wm. Stairs Son & Morrow, Water St., Halifax, N.S. (*A.M. 1920*)

MURRAY, William Alexander, 36 The Linton, 1509 Sherbrooke St. W., Montreal, Que. (*H*) Georgeville, Que. (*A.M. 1898*)

MURRAY, Wm. MacG., B.Eng., (McGill '32), S.M., (M.I.T. '33), Sc.D., (M.I.T. '36), Rm. 1-321, Mass. Institute of Technology, Cambridge, Mass. (*H*) Georgeville, Que. (*S. 1932*) (*A.M. 1938*)

♂MURRAY, Wm. Paul, Lieut., M.C., B.A.Sc., (Tor. '09), Erection Engr., Dom. Bridge Co. Ltd., P.O. Box 280, Montreal, Que. (*H*) 725 Upper Belmont Ave., Westmount, Que. (*Jr. 1911*) (*A.M. 1919*)

MURRIN, Wm. Geo., Pres., B.C. Electric Railway Co., Ltd., Vancouver, B.C. (*H*) 2106 W. Marine Dr. (*M. 1924*)

♂MUSGRAVE, A. S. G., Capt., B.C.E., (T.C.D. '12), B.C.L.S., Municipal Engr., Corp. of the Dist. of Oak Bay, B.C. (*H*) 2376 Central Ave. (*A.M. 1938*)

♂MUSGRAVE, Wm. Burnthorne, B.Sc., (Queen's '20), Apt. 8, 1631 Lincoln Ave., Montreal, Que. (*A.M. 1922*)

MUSSEN, Guy A., B.Eng., (McGill '35), Dom. Bridge Co. Ltd., Montreal, Que (*H*) 74 Strathearn Ave., Montreal West, Que. (*S. 1935*)

MUSSEN, William H. C., Pres., Mussen's Ltd., 40 Phillips Place Bldg., Montreal, Que. (*H*) Flagpole Point, Dorval, Que. (*Affil. 1903*)

MYERS, Gordon Alex., B.E., (N.S.T.C. '36), Elec., Newfoundland Airport. (*H*) Bay Roberts, Nfld. (*S. 1937*)

NADEAU, Leopold Maurice, B.A.Sc., (Ecole Polytech., Montreal '36), Can. Underwriters Assoc., Coristine Bldg., Montreal, Que. (*H*) 5257 Durocher Ave., Outremont, Que. (*S. 1936*)

NAISH, S. Gordon, B.Sc., (Durham '23), Eastern Dist. Mgr., Peacock Bros. Ltd., Post Bldg., Sydney, N.S. (*H*) 100 Whitney Ave. (*Jr. 1927*) (*A.M. 1934*)

♂†NAISH, T. E., Major, P.O. Box 1167, Penticton, B.C. (*M. 1904*) (*Life Member*)

NANCARROW, Gilbert Owen, Penmorvah, Sunnyside, Carbis Bay, Cornwall, England. (*A.M. 1933*)

NANTEL, Maurice, B.A.Sc., (Ecole Polytech., Montreal '33), Montreal Water Board, 3161 Joseph St., Verdun, Que. (*H*) Apt. 5, 1482 Fort St., Montreal, Que. (*S. 1932*)

NARIMAN, R. K., (R.I.E.C., Cooper's Hill '99), Cons. Engr., c/o The Union Bank of India, Fort, Bombay, India. (*M. 1937*)

♂NASH, Jas. Cundiff, B.A.Sc., (Tor. '12), Dftsman., Can. Westinghouse Co., Ltd., Hamilton, Ont. (*H*) 147 Mountain Park Ave. (*A.M. 1922*)

NASON, Edward McKinney, B.Sc., (N.B. '36), D.P.W., N.B., Moncton, N.B. (*H*) Welsford, N.B. (*S. 1936*)

NATHANSON, Max, B.Sc., (McGill '26), Can. Armature Wks., 408 Lagauchetiere St., Montreal, Que. (*H*) 5344 Jeanne Mance St. (*S. 1925*) (*Jr. 1929*)

NATHANSON, Sol, 810 Hartland Ave., Outremont, Que. (*S. 1938*)

NATION, Frederick Spencer, B.Sc., (McGill '30), 222 Rosemary Rd., Toronto, Ont. (*S. 1930*)

NATTRESS, David Irving, B.A.Sc., (Tor. '23), Asst. Engr., H.E.P.C. of Ont., 620 University Ave., Toronto, Ont. (*H*) 44 Chicora Ave. (*S. 1920*) (*Jr. 1925*)

NEAL, Eug. L., B.Sc., (Queen's '38), 159 Bergemont Ave., Quebec, Que. (*S. 1938*)

NEAR, W. Percival, B.A., B.A.Sc., (Tor.), Commr., Ontario Municipal Board, Parliament Bldgs., Toronto, Ont. (*H*) 39 Alexandra Blvd. (*A.M. 1909*) (*M. 1920*)

NEELANDS, Ernest Wesley, B.A.Sc., (Tor. '07), O.L.S., Falconbridge Nickel Mines Ltd., Falconbridge, Ont. (*A.M. 1912*)

NEIL, J. Stuart, B.Sc., (Alta. '30), Test Engr., Can. Western Natural Gas, L., H. and P. Co. Ltd., Calgary, Alta. (*H*) 215-6th Ave. W. (*Jr. 1932*) (*A.M. 1937*)

NEILSON, Chas. Sibley, B.Sc., (Queen's '26), Hamilton Bridge Co. Ltd (*H*) 117 Hyde Park Ave., Hamilton, Ont. (*S 1925*) (*Jr. 1931*)

♂†NELLES, Douglas H., Major, D.L.S., Engr., Engrg. and Constrn. Service, Surveying and Engrg. Br., Dept. of Mines and Forests, Jackson Bldg., Ottawa, Ont. (*H*) 223 McLeod St. (*S. 1904*) (*A.M. 1906*) (*M. 1915*)

NELSON, Edward, Chief Engr., Northwestern Utilities Ltd., 10124-104th St., Edmonton, Alta. (*H*) 11003-84th Ave. (*A.M. 1935*)

NELSON, M. Stuart, B.Sc., (McGill '15), Sec.-Treas. and Mgr., Montreal Metalworked Products, Ltd., 5290 St. Patrick St., Montreal, Que. (*H*) 20 Kings Rd., Valois, Que. (*Affil. 1926*) (*A.M. 1928*)

NELSON, Wm. Andrew, B.Sc., (Queen's '37), Bailey Meter Co. Ltd., 980 St. Antoine St., Montreal, Que. (*S. 1938*)

NENNIGER, Emile, Partner, Arthur Surveyer & Co., 1003 Dom. Square Bldg., Montreal, Que. (*H*) 6154 Notre Dame de Grace Ave. (*Jr. 1926*) (*A.M. 1928*)

NESBITT, A. Deane, B.Eng., (McGill '33), Nesbitt Thomson & Co. Ltd., 355 St. James St., Montreal, Que. (*H*) 41 Forden Ave., Westmount, Que. (*S. 1933*)

NESBITT, Michael Cullum, B.A.Sc., (B.C. '31), Cons. Gold Alluvials of B.C., Wingdam, B.C. (*H*) 3701 Quadra St., Victoria, B.C. (*S. 1928*) (*Jr. 1936*)

NESBITT, William P., B.Sc., (Queen's '35), Hawkesbury, Ont. (*Jr. 1937*)

NESHAM, Lionel Charles, B.Sc., (McGill '16), Rm. 413, C.P.R., Windsor Sta., Montreal, Que. (*H*) 2134 Prudhomme Ave. (*Jr. 1919*) (*A.M. 1924*)

NEUFELD, Cornelius, B.Sc., (Sask. '35), c/o Sault Structural Steel Co. Ltd., Sault Ste Marie, Ont. (*S. 1936*)

NEVITT, Irving H., B.A.Sc., (Tor. '04), 1st. Asst. Engr., i/c Sewage Treatment and Sewage Pumping, City of Toronto, 1091 Eastern Ave., Toronto, Ont. (*H*) 8 Glen Edythe Dr. (*A.M. 1910*) (*M. 1919*)

†NEWELL, Fred, Chief Engr., Dom. Bridge Co. Ltd., Box 280, Montreal, Que. (*H*) 4052 Wilson Ave. (*A.M. 1916*) (*M. 1923*)

NEWELL, Joseph Pettus, C.E., (M.I.T.), Cons. Civil Engr., Pres., Newell, Carter & Walsh, 319 S.W. Washington St., Portland, Ore., U.S.A. (*H*) 3290 S.E. Harrison St. (*M. 1921*)

NEWHALL, Vivian A., B.A.Sc., (Tor.), Sales Engr., Bell & Morris, 527-8th Ave. W., Calgary, Alta. (*H*) 2918 Champlain St. (*A.M. 1918*)

NEWILL, Geo. Ernest, Cons. Engr., 1178 Phillips Place, Montreal, Que. (*M. 1920*)

NEWMAN, John James, O.L.S., Newman & Armstrong, Cons. Engrs., 605 Bartlett Bldg., Windsor, Ont. (*H*) 423 Campbell Ave. (*A.M. 1919*) (*M. 1920*)

NEWMAN, William, (Tor. '91), Mgr., Wm. Newman Co. Ltd., 839 Tache Ave., Winnipeg, Man. (*H*) Royal Albert Hotel. (*M. 1929*)

NEWMAN, Wm. Arthur, B.Sc., (Queen's '11), Chief Mech. Engr., C.P.R. Co. Rm. 1000, Windsor Sta., Montreal, Que. (*H*) 488 Mount Pleasant Ave., Westmount, Que. (*M. 1935*)

♂NEWTON, James Boustead, Capt., Fairmount, Annan, Dumfriesshire, Scotland. (*A.M. 1921*)

NEWTON, Samuel R., Chief Engr., Can. Ingersoll-Rand Co., Ltd., Sherbrooke, Que. (*H*) 155 Victoria St. (*S. 1902*) (*A.M. 1913*)

NICHOLL, Henry I., B.Sc., (Man. '28), Elec. Engr., P.F.R.A., Grant Hall Hotel, Moose Jaw, Sask. (*1938*)

NICHOLS, David Andrew, B.Sc., (Queen's 11), M.A., (Columbia '23), Surveys Engr., Mines and Geology Br., Dept. of Mines and Resources, Ottawa, Ont. (*H*) 29 Argyle Ave. (*M. 1926*)

NICHOLS, Judson Timmis, B.Eng., (McGill '34), Mech. Engr., Hudson Bay Mining and Smelting Co., Flin Flon, Man. (*H*) 81 Chesterfield Ave., Westmount, Que. (*S. 1931*) (*Jr. 1936*)

NICHOLSON, Edward, Asst. Engr., Dist. Engr.'s Office, C.N.R., Toronto, Ont. (*H*) 49 Garden Ave. (*A.M. 1920*)

NICHOLSON, G. W. E., (Chalmers '16), Prod. Mgr., Southern Kraft Corp., Panama City, Fla. U.S.A. (*A.M. 1926*)

NICHOLSON, J. B., B.A.Sc., (Tor. '14), Pres., The Nicholson Co., Engrs. and Contrs., Chrysler Bldg., New York, N.Y., U.S.A. (*H*) 30 Ogden Rd., Scarsdale, N.Y. (*Jr. 1914*) (*A.M. 1917*) (*M. 1937*)

NICHOLSON, John H., B.Eng., (McGill '37), Cons. Mining and Smelting Co. of Can. Ltd., Trail, B.C. (*S. 1937*)

NICHOLSON, Thos. Herbert, Pres., T. H. Nicholson Ltd., 1440 St. Catherine St. W., Montreal, Que. (*H*) 1475 Mansfield St. (*A.M. 1922*)

NICKERSON, Allan Douglas, B.Sc., (N.S.T.C. '29), Transm. Engr., Maritime Telegraph & Telephone Co., Halifax, N.S. (*H*) 324 South St. (*S. 1929*) (*A.M. 1934*)

♂NICKLIN, Harold Storey, B.A.Sc., (Tor. '15), City Engr., City Hall, Guelph, Ont. (*H*) 114 Suffolk St. (*A.M. 1920*)

NICOLAISEN, J. Z., B.Sc., (Durham '29), Private Practice, Copenhagen, Denmark. (*H*) Villa Egemaes, Espergaerde, Denmark. (*S. 1930*) (*A.M. 1935*)

NICOLLS, Jasper H. H., B.Sc., (McGill '08), M.Sc., Chemist, Supervising Solid Fuel Lab., Fuel Research Labs., Dept. of Mines and Resources, 562 Booth St., Ottawa, Ont. (*H*) 2 Sweetland Ave. (*A.M. 1927*)

NIX, Chas. E., B.Sc., (Alta. '31), Shawinigan Water and Power Co., Montreal, Que. Address: P.O. Box 203, La Tuque, Que. (*S. 1929*) (*Jr. 1937*)

NIXON, Richard Lewis, B.Sc., (N.S.T.C.), M.Sc., (King's, Halifax '23), Bursar, King's College, Halifax, N.S. (*H*) 64 Wentworth St., Dartmouth, N.S. (*A.M. 1919*)

NOONAN, Wm. Hysanth, B.Sc., (N.S.T.C. '13), C.E., 126 Roy Bldg., Halifax, N.S. (*H*) 30 Young Ave. (*S. 1913*) (*A.M. 1923*)

NORMAN, Douglas, B.Sc., (Man. '26), Distribution Transformer Engr., Can. Gen. Elec. Co. Ltd., 940 Lansdowne Ave., Toronto, Ont. (*H*) 300 The Kingsway. (*S. 1926*) (*Jr. 1931*) (*A.M. 1937*)

NORMAN, R. L., B.Eng., Dom. Sound Equipments, Ltd., Halifax, N.S. (*H*) 30 Hollis St. (*S. 1932*)

NORMANDEAU, Paul D., B.A.Sc., (Ecole Polytech., Montreal '38), 1253 Notre Dame St. E., Montreal, Que. (*S. 1936*)

NORMANDIN, A. B., B.A.Sc., (Ecole Polytech., Montreal), Q.L.S., Asst. Chief Engr., Hydraulic Service, Dept. of Lands and Forests, Rm. 173, Parliament Bldgs., Quebec, Que. (*H*) 175 Ave. des Erables. (*S. 1907*) (*A.M. 1912*) (*M. 1933*)

♂NORRIS, Chas. A., B.A.Sc., (Tor. '23), Engr., Bremner, Norris & Co. Ltd., 2049 McGill College Ave., Montreal, Que. (*H*) 4137 Beaconsfield Ave., N.D.G. (*S. 1919*) (*J. 1925*) (*A.M. 1926*)

NORRIS, Jas. H., B.Sc., (McGill '12), Man'g. Dir., Wilder-Norris Ltd., 1465 Bleury St., Montreal, Que. (*H*) 612 Dunlop Ave., Outremont, Que. (*S. 1909*) (*Jr. 1915*) (*A.M. 1919*)

NORRISH, Bernard Esterbrook, M.Sc., (Queen's '10), Man'g. Dir., Associated Screen News Ltd., 5271 Western Ave., Montreal, Que. (*H*) 750 Lexington Ave., Westmount, Que. (*A.M. 1912*)

NORRISH, Wilbert Henry, B.Sc., (Queen's '12), D.L.S., O.L.S., A.L.S., Mines and Geology Br., Dept. of Mines and Resources, Ottawa, Ont. (*H*) 326 Clemow Ave. (*S. 1912*) (*Jr. 1917*) (*A.M. 1920*)

♂NORTHEY, Robt. Kirkpatrick, Capt., B.A.Sc., (Tor. '12), Vice-Pres., The Telfer Paper Box Co., Ltd., 14 Duncan St., Toronto, Ont. (*H*) 179 Lyndhurst Ave. (*A.M. 1920*)

NORTHOVER, Arthur B. C., B.A.Sc., (Tor. '37), 16 Willcocks St., Toronto, Ont. (*S. 1937*)

NORTON, Chas. Douglas, 40 Lorne Ave., St. Lambert, Que. (*S. 1907*) (*A.M. 1915*)

♂NORWICH, Harry Ben., B.A.Sc., (Tor. '19), Div. Engr., Ontario Divn., McColl-Frontenac Oil Co., Ltd., Toronto, Ont. (*H*) 36 Humber Trail. (*S. 1919*) (*A.M. 1925*)

NOTMAN, Jas. Geoffrey, B.Sc., (McGill '22), Mgr. of Mfg., Dom. Engineering Co., Ltd., Lachine, Que. (*H*) 4655 Roslyn Ave., Westmount, Que. (*S. 1920*) (*A.M. 1930*)

NOURSE, Arthur E., B.A.Sc., (Tor. '08), Asst. Engr., H.E.P.C. of Ont., Toronto, Ont. (*H*) 33 Gormley Ave. (*S. 1907*) (*A.M. 1914*)

NOURSE, H. C., B.Sc., (Queen's '14), Engr. of Motor Vehicles, The Bell Telephone Co. of Canada, Ltd., Montreal, Que. (*H*) 2096 Vendome Ave. (*A.M. 1919*)

NOWLAN, Brete Cassius, B.Sc., (Iowa '00), Telephone Sales Mgr, Northern Electric Co. Ltd., Montreal, Que. (*H*) 5510 Queen Mary Rd. (*A.M. 1921*)

NOWLAN, B. C., Jr., B.Eng., (McGill '37), Bell Telephone Co. of Canada, Ltd., Montreal, Que. (*H*) 5510 Queen Mary Rd. (*S. 1937*)

NOYES, Donald F., B.S., (Clarkson), 824 Henley Place, Charlotte, N.C., U.S.A. (*M. 1927*)

♂NUTTER, Jack Caswell, Lieut., B.Sc., (McGill '21), Mill Mgr., Gair Co. of Can. Ltd., Carton St., Toronto 2, Ont. (*H*) 155 Rosedale Heights Dr. (*S. 1921*) (*Jr. 1926*) (*A.M. 1929*)

♂OAKES, Cecil Hewitt, Designer, Royal Arsenal, Woolwich, London, England (*H*) 145 Victoria Rd., Charlton, London, S.E.7. (*A.M. 1936*)

♂OAKS, Harold Anthony, Flt.-Cmdr., B.A.Sc., (Tor. '22), Gen. Mgr., Oaks Airways, Ltd., 312 Utilities Bldg., Port Arthur, Ont. (*H*) 43 Summit Ave. (*S. 1920*) (*Jr. 1926*) (*A.M. 1930*)

♂OATLEY, Henry Bigelow, Lieut., B.S., (Vermont '00), Vice-Pres., The Superheater Co. and American Throttle Co., 60 East 42nd St., New York, N.Y. (*H*) 33 Arleigh Rd., Kensington, Great Neck, L.I., N.Y. (*M. 1921*)

OATWAY, Harold Calahan, 2063 Stanley St., Montreal, Que. (*S. 1937*)

O'BRIEN, John A., Pres., M. J. O'Brien Ltd., 140 Wellington St., Ottawa, Ont. (*H*) 453 Laurier Ave. E. (*Affil. 1926*)

♂O'CONNOR, Garrett Daunt, Lieut., B.Sc., (Queen's '21), P.O. Box 316, Fort Erie North, Ont. (*Jr. 1921*) (*A.M. 1923*)

O'DAY, Martin F., B.Sc., (Man. '26), Address unknown. (*S. 1924*) (*A.M. 1931*)

ODDLEIFSON, A. L., B.Sc., (Man. '31), Winnipeg Electric Co., Seven Sisters, Man. (*S. 1929*) (*Jr. 1936*)

♂ODELL, Russell Kenneth, Chief, Development Divn., Bureau of Geology and Topography, Dept. of Mines and Resources, Ottawa, Ont. (*H*) 361 Daly Ave. (*A.M. 1937*)

O'DONNELL, John Gerard, B.Sc., (McGill '16), Mtce. Engr., D.P.W. and L., Parliament Bldgs., Quebec, Que. (*H*) 48 Couillard St. (*Jr. 1916*) (*A.M. 1921*)

O'DONOUGHUE, Gerald, 4209 Drolet St., Montreal, Que. (*S. 1937*)

OGILVIE, Gordon, Lt.-Col., C.M.G., Chairman, Indust. Investigation Comm., Dept. of National Defence, Ottawa, Ont. (*H*) 170 Laurier Ave. E. (*M. 1937*)

OGILVIE, Noel John, D.L.S., H.B.M. Intern. Boundary Commr.; Dom. Geodesist, Geodetic Survey of Canada, Dept. of Mines and Resources, Ottawa, Ont. (*H*) 96 Carling Ave. (*M. 1916*)

OGILVIE, Wm. M., B.Sc., Mining Engr., Cons. Mining and Smelting Co. Ltd., Manson Creek, B.C. (*H*) 55 Park Ave., Ottawa, Ont. (*S. 1895*) (*A.M. 1911*)

OGILVY, Jas. A., B.Sc., (McGill '30), Omega Gold Mines Ltd., Larder Lake, Ont. (*S. 1926*) (*A.M. 1935*)

OGILVY, Robert F., B.Sc., (McGill '25), M.Eng., '32, Engr., i/c Constrn., General Engineering Co. (Canada) Ltd., 100 Adelaide St. W., Toronto, Ont. (*H*) The Clarendon, 2 Clarendon Ave. (*S. 1922*) (*A.M. 1932*)

♂O'GRADY, B. T., Capt., M.C., Res. Engr., Coast Dist., B.C. Mineral Survey, 304 Federal Bldg., Vancouver, B.C. (*A.M. 1920*) (*M. 1936*)

O'HALLORAN, James, B.Sc., (McGill '21), Plant Engr., Anglo-Can. Pulp and Paper Mills, Ltd., Quebec, Que. (*H*) 26 Learmonth Ave. (*S. 1919*) (*Jr. 1922*) (*A.M. 1934*) (*M. 1938*)

♂O'LEARY, H. Gordon, B.A.Sc., (Tor. '04), Supt., C.N.R., Fort William, Ont. (*H*) 517 Lucie Court. (*S. 1906*) (*A.M. 1910*)

♂OLIVER, Cuthbert J., B.Sc., (McGill '23), Asst. Supt., Elec. Distrib., Rio de Janeiro Tramway Light and Power Co., Ltd., Caixo de Correo 571, Rio de Janeiro, Brazil, S.A. (*S. 1919*) (*Jr. 1924*) (*A.M. 1931*)

OLIVER, Ernest Warren, B.A.Sc., C.E., (Tor. '04), Cor. King and Dunn Sts., Oakville, Ont. (*M. 1912*)

OLIVER, James, B.Sc., (Alta. '37), c/o E. G. M. Cape & Co., R.R. 1, Chambly Basin, Que. (*S. 1936*)

OLIVER, Stuart Erskine, B.Sc., C.E., (McGill '11), Q.L.S., Land Surveys Dept., C.N.R., Montreal, Que. (*H*) 577 Roslyn Ave. (*S. 1909*) (*Jr. 1913*) (*A.M. 1919*)

OLSEN, Aleksander, Engr. and Supt., Atlas Constrn. Co., 679 Belmont St., Montreal, Que. (*H*) 4620 Draper Ave. (*A.M. 1934*)

OLSON, Haldor Theodore, Operator, Churchill River Power Co. Ltd., Island Falls, Sask., Via Flin Flon, Man. (*Affil. 1934*)

OLSSON, Harold Matias, (Strelitz '25), C. D. Howe & Co., Ltd., Port Arthur, Ont. (*H*) 53 Clayton St. (*A.M. 1936*)

OLTS, George L., B.Sc., (N.B. '37), D.P.W., N.B., Saint John, N.B. (*H*) 222 Waterloo Row, Fredericton, N.B. (*S. 1937*)

♂OMMANNEY, G. G., Major, Director, Dept. of Development, C.P.R., Windsor Sta., Montreal, Que. (*H*) Apt. 7, 2177 Lincoln Ave. (*M. 1921*)

O'NEILL, Geo. Wm., Riverside Iron Wks., Ltd., Calgary, Alta. (*H*) 1409-6A St., N.W., Calgary, Alta. (*A.M. 1936*)

♂OPENSHAW, John E., Lieut., B.Sc., (McGill), B.Eng., (Liverpool), Pres., Openshaw & Bennet, Ltd., 420 Lagauchetiere St. W., Montreal, Que. (*H*) 88 Church Hill Ave., Westmount, Que. (*S. 1909*) (*A.M. 1913*)

ORANGE, Frank Angel, B.Sc., (Queen's '27), Designer, International Nickel Co., Copper Cliff, Ont. (*H*) 188 Station St., Sudbury, Ont. (*S. 1927*) (*A.M. 1934*)

ORD, L. R., D.L.S., O.L.S., 19 Poplar Plains Rd., Toronto, Ont. (*A.M. 1887*) (*M. 1897*) (*Life Member*)

O'REILLY, Francis Joseph, B.C.L.S., Belmont House, Victoria, B.C. (*H*) 2616 Pleasant St. (*M. 1915*)

ORLANDO, Edward Eugene, B.Sc., (N.S.T.C. '27), Sales Engr., Can. Westinghouse Co. Ltd., Montreal, Que. (*H*) 746 Upper Lansdowne Ave., Westmount, Que. (*A.M. 1937*)

O'ROURKE, John Francis, Pres. and Cons. Engr., O'Rourke Engineering Construction Co., 17 Battery Pl., New York, N.Y., U.S.A. (*H*) 383 Park Ave. (*M. 1887*) (*Life Member*)

ORR, Fred'k. Ormond, Cons. Engr. and Geologist, Rm. 124, 815 Hastings St. W., Vancouver, B.C. (*H*) 3235 Point Grey Rd. (*A.M. 1920*) (*M. 1936*)

ORR, Walter Alyn, B.Sc., (Alta. '32), Flt.-Lieut., R.C.A.F., O.C. Wireless School, Dept. of Nat. Defence, Trenton, Ont. (*H*) 50 Chatham St., Belleville, Ont. (*S. 1932*) (*Jr. 1938*)

ORROCK, John Wilson, 62 Arlington Ave., Westmount, Que. (*A.M. 1896*) (*M. 1907*)

ORTIZ, Thos., 1011 Sherbrooke St. E., Montreal, Que. (*S. 1938*)

OS, Hartvik, (Grad. Trond. '23), Asst. Engr., D.P.W., Canada, Fort William, Ont. (*H*) 423 Rita St., Port Arthur, Ont. (*Jr. 1925*) (*A.M. 1931*)

OSBORN, John Follett, B.Sc., (Man. '36), Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*H*) 336 Downie St. (*S. 1936*)

OSBORNE, Gurdon Hoard, B.S., (Mich. State '11), Man'g. Dir., The Ventilating and Blow Pipe Co. Ltd., 714 St. Maurice St., Montreal, Que. (*H*) 836 Pratt Ave., Outremont, Que. (*A.M. 1921*)

O'SHAUGHNESSY, P. L., B.Sc., (McGill '23), L.S.N.B., Gananoque, Ont. (*A.M. 1937*)

OSTIGUY, Maurice, B.A.Sc., (Ecole Polytech., Montreal '38), Ecole Polytechnique, 1430 St. Denis St., Montreal, Que. (*S. 1936*)

♂O'SULLIVAN, John Joseph, Staff Captain, J. J. O'Sullivan, Inc., 103 Park Ave., New York, N.Y. (*M. 1921*)

O'SULLIVAN, Louis Leo., B.Sc., (McGill '21), Q.L.S., Transm. and Right of Way Engr., Montreal L., H. and P. Cons., Montreal, Que. (*H*) 4017 Grey Ave. (*S. 1919*) (*A.M. 1925*)

♂OTTEWELL, Barry, Lieut., B.Sc., M.Sc., (Birmingham '11), D.C. Engr., Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*H*) 460 Monaghan Rd. (*A.M. 1920*)

OUIMET, J. Alphonse, Jr., B.Eng., (McGill '32), Can. Broadcasting Corp., Keefer Bldg., Montreal, Que. (*H*) 3314 Van Horne Ave. (*S. 1931*) (*A.M. 1937*)

OULTON, Aubrey Ernest, Asst. Engr., C.N.R., Rm. 601, C.N. Express Bldg., McGill St., Montreal, Que. (*H*) 112 Vivian Ave., Town of Mount Royal, Que. (*Jr. 1920*) (*A.M. 1923*)

OWENS, Edward James, B.Sc., (N.B. '15), Office Engr. and Purchasing Agent, N.B. Electric Power Comm., P.O. Box 820, Saint John, N.B. (*H*) 15 De Monts St. (*Jr. 1919*) (*A.M. 1925*)

♂†OXLEY, J. Morrow, Major, Partner, Chapman & Oxley, archts., 372 Bay St., Toronto 2, Ont. (*H*) 12 Foxbar Rd. (*S. 1901*) (*A.M. 1908*) (*M. 1921*)

OXLEY, William M., (R.M.C., Kingston '36), 12 Foxbar Rd., Toronto, Ont. (*S. 1935*)

PACY, Ernest H., Pres. and Gen. Mgr., Pittsburgh Welding Corp., 1201 Ridge Ave., N.S., Pittsburgh, Pa., U.S.A. (*H*) Isabella Ave., Allison Park, Pa. (*S. 1907*) (*A.M. 1917*)

PAGET, James R., 207 Montreal Trust Bldg., Winnipeg, Man. (*A.M. 1920*)

PAGET, Thomas John, Foreman, Dept. of Highways, Ont., Toronto, Ont. (*H*) Sundridge, Ont. (*A.M. 1921*)

PAINCHAUD, Francois Benoit, B.A.Sc., (Ecole Polytech., Montreal '13), 38 Dubuisson St., Beauport, Que. (*S. 1912*) (*Jr. 1916*) (*A.M. 1928*)

PAINE, Arthur James Carman, B.Arch., (McGill '10), Staff Architect, Sun Life Assurance Co. of Canada, Montreal, Que. (*H*) 3856 Draper Ave. (*A.M. 1922*)

PAINE, Nathan Deane, B.Sc., (N.H. '13), Gen. Elec. Supt., Price Bros. & Co. Ltd., Box 84, Kenogami, Que. (*A.M. 1927*)

PAINTER, Gilbert W., B.Eng., (McGill '33), Can. Gen. Elec. Co., Ltd., 212 King St. W., Toronto, Ont. (*S. 1933*) (*Jr. 1936*)

PALMER, Fred. E., Can. Johns-Manville Co. Ltd., Montreal, Que. (*H*) 4124 Van Horne Ave. (*Jr. 1931*)

♂PALMER, Fred'k. Herbert, Lieut., M.C., S.B., C.E., (N.S.T.C. '13), Can. Trade Commr., 90 Queen St., Box 196, Melbourne, Australia. (*H*) 55 Marne St. (*A.M. 1919*)

♂PALMER, John, Lieut., B.Sc., (London '09), Dist. Engr., Can. Westinghouse Co., 1844 William St., Montreal, Que. (*H*) 4192 Marlowe Ave. (*A.M. 1923*)

PALMER, Kenneth Winfield, B.Sc., (Birmingham '37), Abrasive Co. of Canada, Arvida, Que. (*S. 1937*)

♂PALMER, P. E., Lieut., D.L.S., Bureau of Geology and Topography, Dept. of Mines and Resources, Ottawa, Ont. (*H*) 533 Percy St. (*A.M. 1920*)

†PALMER, Robert E., O.B.E., B.A.Sc., (McGill '87), 6-Q Bickenhall Mansions, Gloucester Pl., London, W.1, England. (*S. 1887*) (*A.M. 1891*) (*M. 1907*) (*Life Member*)

PALMER, Robert Kendrick, B.Sc., (Mich.), Chief Engr. and Vice-Pres., i/c Operations, Hamilton Bridge Co., Hamilton, Ont. (*H*) 93 Bold St. (*M. 1919*)

PALMER, Roland Foster, 45 Madeley Rd., Ealing Broadway, London, W.5, England. (*A.M. 1918*)

PALMQUIST, David E., B.Sc., (Man. '37), 1072 Pelissier St., Windsor, Ont. (*S. 1937*)

PAMENTER, Archibald Francis, B.Sc., (N.S.T.C. '32), N.S.L.S., Imperial Oil, Ltd., Talara, Peru, S.A. (*S. 1931*) (*Jr. 1935*)

PANGMAN, Arthur Henry, B.Sc., (McGill '30), C. E. Frosst & Co., 3571 St. Antoine St., Montreal, Que. (*H*) 4661 Queen Mary Rd. (*Jr. 1933*)

PAPINEAU, Gustave Jos., B.A.Sc., (Ecole Polytech., Montreal '12), Q.L.S., Private Practice, Rm. 507, Themis Bldg., 10 St. James St. W., Montreal, Que. (*H*) 3221 Maplewood Ave. (*A.M. 1928*)

PAPOFF, Wm. N., B.Sc., (Sask. '33), P.O. Box 393, Rossland, B.C. (*S. 1935*)

PAQUET, Jean M., B.A.Sc., (Ecole Polytech., Montreal '34), J. A. Y. Bouchard Ltd., Quebec, Que. (*H*) 62 de Salaberry. (*S. 1934*) (*Jr. 1938*)

PARADIS, Alphonse, B.A.Sc., (Ecole Polytech., Montreal '12), Chief Engr., Dept. Highways, Parliament Bldg., Quebec, Que. (*M. 1935*)

PARDOE, Wm. Sprague, B.A.Sc., C.E., (Tor. '05), Prof. of Hydraulics, Univ of Pennsylvania, Philadelphia, Pa., U.S.A. (*H*) Marion Station, Pa. (*A.M. 1909*) (*M. 1922*)

PARÉ, A. Euclide, B.A.Sc., (Ecole Polytech., Montreal '31), Hydraulic Service, Parliament Bldgs., Quebec, Que. (*H*) 397 Ste. Foye Rd. (*A.M. 1937*)

PARÉ, J. L., 201 Sherbrooke St. E., Montreal, Que. (*S. 1937*)

†PARHAM, John Bright, B.Sc., (McGill '08), Chief Engr., Shaw-Stuart Ltd., 708 Powell St., Vancouver, B.C. (*H*) 2474-33rd Ave. W. (*S. 1907*) (*A.M. 1913*) (*M. 1936*)

PARISEAU, Louis S., 3459 Berri St., Montreal, Que. (*A.M. 1887*) (*Life Member*)

PARK, Fillmore R., B.Sc., (Alta. '36), Northern Electric Co., Ltd., Calgary, Alta. (*S. 1936*)

♂PARKE, Charles Sager, Lieut., B.Sc., (McGill '18), Asst. Gen. Supt., The Harshaw Chemical Co., 1945 E. 97th St., Cleveland, Ohio, U.S.A. (*H*) 16616 Aldersyde Dr., Shaker Heights, Ohio. (*S. 1917*) (*Jr. 1921*) (*A.M. 1930*)

PARKER, Clarence Collins, B.A.Sc., (Tor. '29), M.A.Sc., '33, Asst. Engr., Bridge Office, Dept. of Highways, Ont., Toronto, Ont. (*H*) Apt. 245, 215 College St. (*S. 1926*) (*A.M. 1936*)

PARKER, Douglas Howard, Mech. Supt. and Prod. Mgr., The Montreal Daily Star, 245 St. James St., Montreal, Que. (*H*) 124 Notre Dame St., St. Lambert, Que. (*Affil. 1933*)

PARKER, E. N., B.Eng., (McGill '37), Dom. Bridge Co. Ltd., Lachine, Que. (*H*) 320 Broadway Ave. (*S. 1937*)

PARKER, John Spence, B.A.Sc., (Tor. '12), Gen. Mgr. of Distrib., Gatineau Power Co., Victoria Bldg., P.O. Box 88, Ottawa, Ont. (*H*) 82 Park Ave. (*A.M. 1928*)

PARKER, Samuel Rutherford, (Glasgow '07), Chief Engr., Sask. Power Comm., Regina, Sask. (*H*) 2460 Montague St. (*1938*)

♂PARKER, T. W. W., Lieut., Engr., Northern Construction and J. W. Stewart, Ltd., P.O. Box 177, Niagara Falls, Ont. Address: King Edward Hotel. (*A.M. 1921*)

G.PARKIN, J. H., B.A.Sc., (Tor. '12), M.E., (Tor. '19), Dir., Divn. of Mech. Engrg., National Research Council, Ottawa, Ont. (*H*) 290 Park Rd., Rockcliffe Park. (*M. 1930*)

♂PARKS, John H., Lt.-Col., O.B.E., D.S.O., Div. Engr., Board of Rly. Commrs., 525 Calgary Public Bldg., Calgary, Alta. (*H*) 615-30th Ave. W. (*A.M. 1902*) (*M. 1911*)

PARLEE, Rutherford J., B.Sc., (N.B. '31), Bureau of Geology and Topography, Dept. of Mines and Resources, Ottawa, Ont. (*H*) 343 Somerset St. W. (*S. 1931*)

PARMELEE, Edward Henry, Mgr., Eastern Dist., Ferranti Electric Ltd., Rm. 508, Power Bldg., Montreal, Que. (*H*) 5 Elmwood Ave., Senneville, Que. (*Affil. 1926*)

PARSONS, E. C., B.Sc., (N.S.T.C. '33), Ralph & Arthur Parsons, Windsor, N.S. (*H*) Walton, Hants Co., N.S. (*S. 1931*) (*Jr. 1937*)

PARSONS, R. A., B.Sc., (Alta. '38), Power Corp. of Canada, Noranda, Que. (*S. 1937*)

♂PARSONS, Robert H., Lieut., C. A. Parsons & Co. Ltd., Heaton Wks., Newcastle-on-Tyne, England. (*M. 1914*)

PARSONS, Roy Henry, B.S.C.E., (Mich. '97), City Engr., Peterborough, Ont. (*H*) 104 Douro St. (*M. 1915*)

♂PARTRIDGE, John Kenneth, Lieut., Sr. Asst. Engr., D.P.W., Canada, Toronto, Ont. (*H*) 84 Blantyre Ave. (*M. 1937*)

PASK, Arthur Henry, B.Sc., (Man. '35), Can. Industries Ltd., Windsor, Ont. (*H*) 905 Ouellette Ave. (*S. 1935*) (*Jr. 1937*)

♂PATERSON, Alexander Wilson, Capt., Res. Engr., C.P.R., Winnipeg, Man. (*A.M. 1921*)

PATERSON, Elwin L., B.A.Sc., (Tor. '20), Highway Engr., Imperial Oil Ltd., 56 Church St., Toronto, Ont. (*H*) Devonshire Apts., Vancouver, B.C. (*A.M. 1927*)

PATERSON, Jas. Wilson, Woods Mgr., The E. B. Eddy Co. Ltd., Hull, Que. (*H*) 300 Cooper St., Ottawa, Ont. (*A.M. 1936*)

PATERSON, Raymond Gordon, M.Sc., (Colorado '37), Geophysicist, Can. Western Natural G., L., H. and P. Co., 215-6th Ave. W., Calgary, Alta. (*H*) 718-6th Ave. W. (*Jr. 1932*)

PATERSON, Walter Howard, B.Sc., (Queen's '35), Engr., Tropical Oil Co., El Centro Barranca Bermeja, Colombia, S.A. (*H*) 940-6th Ave. E., Owen Sound, Ont., Canada. (*Jr. 1936*)

PATON, Charles P., B.Eng., (McGill '35), 210 Indian Rd., Toronto, Ont. (*S. 1935*)

PATRIARCHE, Valance Heath, B.Sc., (Man. '29), Gen. Traffic Mgr., Can. Airways Ltd., Airways Bldg., Winnipeg, Man. (*H*) 193 Oakwood Ave. (*A.M. 1937*)

PATRICK, Gilbert H., Canal Supt., D.N.R., C.P.R., "Drawer C," Strathmore, Alta. (*A.M. 1917*)

PATRIQUEN, Frank Andrew, B.Sc., (N.B. '31), D.P.W., Canada, Box 1417, Saint John, N.B. (*H*) 10 Manawagonish Rd., Fairville, N.B. (*S. 1930*) (*Jr. 1934*)

♂PATTERSON, Arthur L., Lieut., B.Sc., (McGill '14), Office Engr., Shawinigan Engineering Co., Power Bldg., Montreal, Que. (*H*) 4070 Trafalgar Rd. (*S. 1914*) (*A.M. 1926*)

PATTERSON, Earle Bedford, (Tor. '09), Water Power and Water Rights Br., Dept. of Mines and Natural Resources, Man., Rm. 250, Legislative Bldg., Winnipeg, Man. (*H*) 337 Brock St. (*A.M. 1919*)

PATTERSON, Elmer Goodwin, B.Sc., (Queen's '24), Northern Electric Co., Ltd., 1261 Shearer St., Montreal, Que. (*H*) 578 Claremont Ave., Westmount, Que. (*Jr. 1927*) (*A.M. 1936*)

PATTERSON, Harry W., McColl & Patterson, Imperial Bldg., Walkerville, Ont. (*H*) 2277 Lincoln Rd. (*Jr. 1919*) (*A.M. 1921*)

PATTERSON, Ian Stewart, B.Sc., (N.S.T.C. '28), Can. Gen. Elec. Co. Ltd., 1000 Beaver Hall Hill, Montreal, Que. (*H*) 4833 Melrose Ave., N.D.G. (*S. 1928*) (*Jr. 1931*) (*A.M. 1938*)

PATTERSON, Jas. F., B.Sc., (McGill '18), Supervising Engr., Northern Electric Co., Ltd., Montreal, Que. (*H*) 652 Prince Albert Ave., Westmount, Que. (*A.M. 1929*)

PATTERSON, Thos. Bilton, B.Sc., (Sask. '29), Drainage Engineering Co. of Canada, Guelph, Ont. (*H*) 462 Avenue Rd., Toronto, Ont. (*S. 1921*) (*Jr. 1926*) (*A.M. 1929*)

PATTERSON, Thos. MacMillan, B.A.Sc., (Tor. '25), 22 Byron St., Ottawa, Ont. (*Jr. 1926*)

PATTON, John McDonald, B.A.Sc., (Tor. '11), Designing Engr., Bridge Br., Dept. of Highways, Sask., Regina, Sask. (*H*) 2324 Rose St. (*A.M. 1917*) (*M. 1936*)

PAULIN, F. W., (Tor. '07), Pres. and Man'g. Dir., Can. Engineering and Contracting Co., 506 Imperial Bldg., Hamilton, Ont. (*H*) 153 Fairleigh Ave. S. (*S. 1907*) (*A.M. 1913*) (*M. 1922*)

PAULSEN, R. O., B.Sc., (Man. '29), Engr., Toronto Iron Wks., Toronto, Ont. (*H*) 2265 Queen St. E. (*Jr. 1930*) (*A.M. 1937*)

PAYAN, C. F., B.Eng., (McGill '37), Dom. Rubber Co. Ltd., Montreal, Que. (*H*) 3437 Peel St. (*S. 1937*)

PAYNE, Albert Irving, C.E., (Princeton '96), Mgr., Paynes Ltd., 10321 Jasper Ave., Edmonton, Alta. (*H*) 9933-104th St. (*M. 1920*)

PEACH, Wm. Herbert, C. D. Howe & Co., Port Arthur, Ont. (*H*) 359 North Algoma St. (*S. 1925*)

PEACHEY, Cyril Arthur, B.A., (Tor. '27), Mfg. Engr., Northern Electric Co. Ltd., Montreal, Que (*H*) 3417 Peel St. (*A.M. 1937*)

PEACOCK, Francis Toy, Pres., Peacock Bros., Ltd., University Tower, 660 St. Catherine St. W., Montreal, Que. (*M. 1905*)

PEACOCK, Robt. Fred., B.Sc., (N.B. '37), Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*H*) 336 Downie St. (*S. 1937*)

PEAKER, William James, (Tor. '04), Office Engr., Hydrographic and Map Service, Dept. of Mines and Resources, Ottawa, Ont. (*H*) 529 McLeod St. (*A.M. 1921*)

PEARCE, Kenneth K., B.A.Sc., (Tor.), St. John Drydock and Shipbuilding Co., Saint John, N.B. (*A.M. 1917*)

PEARSE, Langdon, A.B., (Harvard), B.Sc., M.Sc., (M.I.T.), Sanitary Engr., The Sanitary Dist. of Chicago, 910 S. Michigan Ave., Chicago, Ill., U.S.A. P.O. Drawer F., Winnetka, Ill. (*M. 1926*)

PEARSON, Vernon, Mech. Supt., D.P.W., Alta., Edmonton, Alta. (*H*) 9908-90th Ave. (*A.M. 1926*) (*M. 1937*)

♂PEARSTON, Gordon McGregor, Lieut., C.N.R., W.E., Rm. 466, Union Sta., Winnipeg, Man. (*H*) 948 Oakenwald Ave., Fort Garry P.O. (*A.M. 1920*)

♂PEART, John Davidson, B.A.Sc., (Tor. '14), Dist. Sales Engr., Northern Electric Co., Ltd., 65 Rorie St., Winnipeg, Man. (*H*) 85 Lenore St. (*A.M. 1920*)

♂PEDDER, Arthur Gillingham, D.S.M., Dept. of Justice, Kingston Penitentiary, Box 22, Kingston, Ont. (*H*) 111 Livingston Ave. (*A.M. 1921*)

PEDEN, Alexander, Mgr., Dom. Bridge Co., Ltd., P.O. Box 280, Montreal, Que. (*H*) 161 Strathearn Ave. N., Montreal West, Que. (*S. 1903*) (*A.M. 1908*) (*M. 1925*)

♂PEDEN, Ernest, Lieut., B.Sc., (McGill '12), 4854 St. Catherine St. W., Montreal, Que. (*S. 1907*) (*Jr. 1913*) (*A.M. 1919*)

PEEBLES, Archibald, B.A.Sc., (B.C. '34), Instr., Dept. of C.E., Univ. of B.C., Vancouver, B.C. (*H*) 2911-W. 15th Ave. (*S. 1927*) (*A.M. 1935*)

PEEK, Robert Lee, Cons. Metallurgist, International Nickel Co. of Can., Ltd., Copper Cliff, Ont. (*M. 1919*)

PEELE, Percy Frederick, B.A.Sc., (B.C. '24), Sales Engr., Can. Gen. Elec. Co. Ltd., 4th St. W. and 11th Ave., Calgary, Alta. (*H*) 112-8th Ave. N.W. (*A.M. 1934*)

PEFFERS, W. O., B.Sc., (Alta. '31), Capt., R.C.S.C., Can. Signal Training Centre, Dept. Nat. Defence, Barriefield, Ont. (*H*) 168 Johnson St., Kingston, Ont. (*S. 1930*) (*Jr. 1934*)

♂PELLETIER, Burroughs, Lieut., B.Sc., (McGill '18), Engr., Divn. of Mining Townsites, c/o Dept. of Mines, Que., Quebec, Que. (*H*) 84 St. Louis Rd. (*S. 1918*) (*A.M. 1923*)

PENDER, William David, Baltimore Rd., Winnipeg, Man. (*A.M. 1908*)

PENFOLD, Douglas Kent, Dist. Engr., Water Rights Br., B.C., Box 547, Kelowna, B.C. (*A.M. 1929*) (*M. 1936*)

PENGELLEY, C. Desmond, B.Eng., (McGill '37), Aeronautical Bldg., Mass. Inst. of Tech., Boston, Mass., U.S.A. (*H*) Tremom Mandeville, Jamaica, B.W.I. (*S. 1937*)

PENMAN, Alan Carleton, Mgr., Const. Contracts, Cons. Edison Co. of N.Y., Inc., 4 Irving Pl., New York, N.Y., U.S.A. (*H*) 1566 Macombs Rd. (*A.M. 1925*)

♂PENNOCK, Wm. Britton, Lieut., B.Sc., (McGill '15), Pennock Engineering, Co., 63 Sparks St., Ottawa, Ont. (*H*) 326 Waverley St. (*Jr. 1919*) (*A.M. 1936*)

PEPALL, Jas. Edward, (R.M.C., Kingston '34), B.A.Sc., (Tor. '36), Box 122, Arvida, Que. (*S. 1934*)

PEQUEGNAT, Jared Marc, B.Sc., (Queen's '35), 31 Gibson Ave., Hamilton, Ont. (*S. 1935*)

PEQUEGNAT, Marcel, B.A.Sc., (Tor. '08), O.L.S., D.L.S., Supt., Kitchener Waterworks, City Hall, Kitchener, Ont. (*H*) 245 Frederick St. (*Jr. 1912*) (*A.M. 1913*)

PEREGO, Henry Anthony, B.Eng., (McGill '34), Can. Car and Foundry Co., Montreal, Que. (*H*) 3837 Old Orchard Ave. (*S. 1931*) (*Jr. 1938*)

♂PERKINS, G. C., Address unknown. (*A.M. 1920*)

♂PERKINS, Harry William, Project Engr., Minnesota Dept. Highways, 1246 University Ave., St. Paul, Minn., U.S.A. (*H*) Detroit Lakes, Minn. (*A.M. 1919*)

PERLSON, E. H., (R.M.C., Kingston '30), B.Sc., (McGill '31), LL.B., (Alta. '38), Corp., R.C.M. Police, Drumheller, Alta. (*S. 1930*) (*Jr. 1937*)

PERRAULT, Lucien, B.A.Sc., (Ecole Polytech., Montreal '27), Pres., Industrial and Commercial Laboratories, Ltd., Rm. 608, 637 Craig St. W., Montreal, Que. (*H*) 4047 Vendome Ave., N.D.G. (*A.M. 1938*)

PERRIE, Wm. Wallace, Mtce. Engr., Sask. Govt., 2108 Princess St., Regina, Sask. (*1938*)

PERRIN, Alfred Thos., Wks. Mgr., Sawyer-Massey Ltd., Hamilton, Ont. (*A.M. 1915*) (*M. 1929*)

PERRIN, Vincent (*q*), 91 Mountain Rd., Hull, Que. (*A.M. 1898*)

PERRITON, Douglas Eric, B.Sc., (McGill '22), Mgr., McGregor-McIntyre Iron Wks. Ltd., Box 310, Terminal A, Toronto, Ont. (*H*) 329 Rose Park Dr. (*S. 1920*) (*Jr. 1924*) (*A.M. 1928*)

PERROTT, S. Wright, B.A., (T.C.D.), c/o R. B. Kirwan, Esq., "Merlewood Lodge," Cuddington, near Northwich, Cheshire, England. (*M. 1907*) (*Life Member*)

PERRY, Aubrey Huffman, B.A.Sc., (Tor. '30), Dist. Engr., Pacific Divn., Dept. of Pensions and National Health, P.O. Box 1012, Vancouver, B.C. (*H*) 1405 W. 11th Ave. (*A.M. 1935*)

♂PERRY, Brian R., Lieut., B.Sc., (McGill '15), Cons. Engr., 563 New Birks Bldg., Montreal, Que. (*H*) 5584 Queen Mary Rd. (*S. 1914*) (*A.M. 1923*) (*M. 1931*)

PERRY, Geo. Thos., 69 Strathcona Ave., Toronto, Ont. (*S. 1938*)

♂PERRY, Kenneth M., Lt.-Col., D.S.O., B.Sc., (McGill '08), 1374 Pine Ave. W., Montreal, Que. (*A.M. 1913*)

PERRY, Oliver Mowat, B.Sc., (Queen's '09), Mgr., Windsor Hydro-Elec. System, 111-115 Chatham St. W., Windsor, Ont. (*H*) 1111 Victoria Ave. (*M. 1921*)

PERRY, Philip Carleton, Div. Eng., C.N.R., Regina, Sask. (*H*) 2224 Cameron St. (*A.M. 1920*) (*M. 1935*)

†PETERS, Frederic H., (R.M.C., Kingston), D.L.S., A.L.S., Surveyor General and Chief, Hydrographic Service, Dept. of Mines and Resources, Ottawa, Ont. (*H*) 425 Daly Ave. (*S. 1904*) (*A.M. 1907*) (*M. 1914*)

PETERS, Henry F., B.Sc., (Man. '30), Res. Engr., D.P.W., Man., Winkler, Man. (*H*) Box 255. (*S. 1930*)

PETERS, James H., B.Sc., (N.B. '33), Indust. Engr., Can. Industries Ltd., Brownsburg, Que. (*S. 1935*)

PETERSON, Alfred, B.Eng., (McGill '34), 1313 Beaubien St. E., Montreal, Que. (*Jr. 1937*)

PETFORD, Herbert Stanley, B.Sc., (McGill '22), Supt., Frontenac Breweries, Ltd., 5930 de Gaspe Ave., Montreal, Que. (*H*) 5694 Hutchison St. (*A.M. 1925*)

PETRIE, John B., Mech. Supt., Dom. Steel and Coal Corp., Ltd., Wabana, Nfld. (*A.M. 1919*)

PETURSSON, Franklin, B.Sc., (Man. '28), P.O. Box 204, Dryden, Ont. (*S. 1928*) (*A.M. 1935*)

PETURSSON, H. J., B.Sc., (Man. '30), Instru'man., Dept. of Highways, Ont., Huntsville, Ont. (*Jr. 1932*)

PHELAN, Michael Alexander Austin, B.Sc., (Queen's '29), Mgr., Noranda Office, Peacock Bros. Ltd., P.O. Box 268, Noranda, Que. (*H*) 8-7th St. (*S. 1928*) (*A.M. 1936*)

PHELAN, Robt. Early, Gen. Mgr., Hudson Bay Mining and Smelting Co., 500 Royal Bank Bldg., Winnipeg, Man. (*1938*)

PHELPS, George, Engr. of Sewers, City of Toronto, Dept. of Works, City Hall, Toronto 2, Ont. (*H*) 362 Rochampton Ave. (*A.M. 1915*)

PHELPS, Geo. Dyson, Field Engr., Royalite Oil Co., Box 173, Turner Valley, Alta. (*A.M. 1936*)

PHEMISTER, Wm. Ian, 445 Morrison St., Niagara Falls, Ont. (*S. 1938*)

PHILIP, Patrick, Canada Creosoting Co., Canada Cement Bldg., Montreal, Que. (*A.M. 1917*) (*M. 1922*)

♂PHILIPS, Hector Somerville, Lieut., Designing Engr., City of Hamilton, Hamilton, Ont. (*H*) 35 Inverness Ave. W. (*A.M. 1915*) (*M. 1922*)

PHILLIPS, Edward Horace, D.L.S., S.L.S., Phillips, Stewart & Phillips, Central Chambers, Saskatoon, Sask. (*H*) 115 Saskatchewan Cres., W. (*A.M. 1917*)

PHILLIPS, Edward Kent, B.Sc., (Sask. '25), M.Sc., '27, D.L.S., S.L.S., Lecturer, Univ. of Saskatchewan, Saskatoon, Sask. (*H*) 1333 Elliott St. (*Jr. 1929*) (*A.M. 1936*)

PHILLIPS, Frederick Robert, (C.G.I.), 300 Winona Dr., Toronto 10, Ont. (*A.M. 1921*)

PHILLIPS, Fred. R., B.Eng., (McGill '32), 1122 Sherbrooke St. W., Montreal, Que. (*S. 1930*) (*Jr. 1938*)

PHILLIPS, George, 1416 St. David's St., Victoria, B.C. (*A.M. 1904*) (*Life Member*)

PHILLIPS, John B., B.Sc., (McGill '27); M.Sc., '28; Ph.D., '30; Lecturer, Chem. Engrg., McGill Univ., Montreal, Que. (*Jr. 1927*) (*A.M. 1934*)

PHILLIPS, Robt. W., B.Eng., (McGill '34), Bailey Meter Co. Ltd., Montreal, Que. (*H*) Box 31, Chambly Canton, Que. (*S. 1931*) (*Jr. 1938*)

PHIPPS, Chas. F., B.Sc., (McGill '24), Asst. Engr., Shawinigan Water and Power Co., Power Bldg., Montreal, Que. (*H*) 1205 St. Mark St. (*S. 1924*) (*Jr. 1931*) (*A.M. 1938*)

♂PHIPPS, Henry Robt., Major, M.C., Matheson, Ont. (*A.M. 1936*)

PHOMIN, B. L., B.Sc., (Man. '38), 395 Union Ave., Winnipeg, Man. (*S. 1937*)

PHRIPP, C. Frank, 286 Dupont St., Toronto, Ont. (*S. 1938*)

PICARD, Stanislas A., B.A.Sc., (Ecole Polytech., Montreal '27), Chemist-Engineer, Rock City Tobacco Co. Ltd., Quebec, Que. (*H*) 167 Cartier Ave. (*A.M. 1936*)

PICHÉ, Arthur, B.A.Sc., (Ecole Polytech., Montreal '30), D.P.W., Que., Quebec, Que. (*H*) Apt. 2, 26 Laval St. (*Jr. 1931*)

PICHÉ, Gustave C., M.A., (Laval '23), M.F., 874 Sherbrooke St. E., Montreal, Que. (*A.M. 1913*)

PICHÉ, Joseph Pierre, Terrebonne, Que. (*A.M. 1899*) (*Life Member*)

PICKERING, Albert Ernest, (Tor. '04), Vice-Pres. and Mgr., The Great Lakes Power Co. Ltd., Sault Ste. Marie, Ont. (*H*) 527 Queen St. E. (*M. 1921*)

PICKRELL, Wm. J., Master Mechanic, N.B. Dist., C.P.R., Box 324, McAdam, N.B. (*A.M. 1919*)

PIDOUX, John Leslie, B.Sc., (Alta. '34), M.Eng., (McGill '36), Strl. Designer, Dom. Bridge Co. Ltd., Lachine, Que. (*H*) Apt. 5, Mariette Apts., 6891 Sherbrooke St. W., Montreal, Que. (*S. 1930*) (*Jr. 1935*) (*A.M. 1938*)

PIERCE, Arthur Leonard, B.Sc., (Man. '30), 471 St. Patrick Sq., Port Arthur, Ont. (*A.M. 1936*)

PIERCE, John Wesley, O.L.S., D.L.S., M.L.S., Private Practice, Rm. 64, Bank of Commerce Bldg., Peterborough, Ont. (*H*) 492 Homewood Ave. (*M. 1933*)

PIERCY, Walter J., B.Sc., (N.B. '34), Thompson Cadillac Mine, Kewagama, Que., via Val d'Or. (*Jr. 1938*)

PIERS, E. O. Temple, B.Sc., (McGill '06), Asst. Prof. of Civil Engrg., Nova Scotia Technical College, Halifax, N.S. (*S. 1907*) (*A.M. 1913*)

PIETTE, G., Apt. 5, 2024 St. Denis St., Montreal, Que. (*S. 1938*)

PIGOT, Chas. Hugh, B.Sc., (McGill '26), Res. Engr., Beauharnois L., H. and P. Co., Ltd., Box 100, Beauharnois, Que. (*S. 1924*) (*A.M. 1931*)

PIMENOFF, C. J., B.Sc., (McGill '31), M.Eng., '32, Strl. Designer, Dom. Bridge Co. Ltd., Lachine, Que. (*H*) 4843 Cumberland Ave., N.D.G., Montreal, Que. (*S. 1931*) (*A.M. 1938*)

PINCHBECK, Geo. Reginald, B.Sc., (Alta. '31), 9809-91st Ave., Edmonton, Alta. (*Jr. 1936*)

PINDER, H. C., B.Eng., (McGill '37), Crane Ltd., 1170 Beaver Hall Sq., Montreal, Que. (*S. 1936*)

PINEAU, Maurice E., Engrg. and Indust. Sales Dept., Crane Ltd., 1170 Beaver Hall Sq., Montreal, Que. (*H*) 861-A Outremont Ave., Outremont, Que. (*Jr. 1932*)

PINHEY, Chas. H., (Tor. '87), O.L.S., D.L.S., 63 Sparks St., Ottawa, Ont. (*H*) 243 Clemow Ave. (*S. 1887*) (*A.M. 1894*)

PITFIELD, B. W., B.Sc., (Alta. '34), Asst. Engr., Northwestern Utilities Ltd., Edmonton, Alta. (*H*) 10213-124th St. (*S. 1933*) (*Jr. 1938*)

♂PITTS, Clarence MacLeod, Lieut., B.Sc., C.E., (McGill '14), Pres. and Gen. Mgr., The People's Gas Supply Co. Ltd.; The Pitts Constrn. Co., Ltd., 2-10 Mill St., Ottawa, Ont. (*H*) 331 Metcalfe St. (*S. 1913*) (*A.M. 1921*)

PITTS, Gordon McL., B.Sc., B.Arch., M.Sc., (McGill), Maxwell & Pitts, Arch'ts., 1158 Beaver Hall Sq., Montreal, Que. (*H*) Apt. 93, 900 Sherbrooke St. W. (*S. 1908*) (*A.M. 1914*)

PLAMONDON, Adrien, C.E., (Ecole Polytech., Montreal '09), Cons. Engr., 369 Mount Royal Ave. W., Montreal, Que. (*S. 1907*) (*Jr. 1913*) (*A.M. 1923*)

PLAMONDON, Sarto, B.Sc., (Ecole Polytech., Montreal '36), Sanitary Engr., Ministry of Health, Prov. of Quebec, Amos, Que. (*S. 1936*)

PLATT, P. L. W., P.O. Box 337, Hawkesbury, Ont. (*S. 1936*)

PLOW, John F., (R.M.C., Kingston '21), Chas. Warnock & Co., 1001 McGill Bldg., Montreal, Que. (*H*) 4870 Cote des Neiges Rd. (*S. 1921*) (*Jr. 1928*) (*A.M. 1930*)

PLUMMER, Alex. Alfred, Man'g. Dir., Plummer Craig, Ltd., 910 Credit Foncier Bldg., Vancouver, B.C. (*S. 1907*) (*Jr. 1916*) (*A.M. 1920*)

♂PLUMMER, Wm. Elfric, Res. Engr., Dept. of Highways, Ont. (*H*) 167 Mornington St., Stratford, Ont. (*Jr. 1919*) (*A.M. 1928*)

♂POE, Alexander S., Lieut., B.Sc., (McGill '17), H.E. and Str'l. Design, Shawinigan Engineering Co., Power Bldg., Montreal, Que. (*H*) Apt. 10, 6171 Sherbrooke St. W. (*S. 1916*) (*A.M. 1926*)

POITRAS, Paul E., B.A.Sc., (Ecole Polytech., Montreal '15), Mech. Engr., The Steel Co. of Canada Ltd., 525 Dominion St., Montreal, Que. (*H*) 4189 Northcliffe Ave. (*M. 1937*)

POLET, Maurice, Belgian Consul, Edmonton, Alta. (*A.M. 1919*)

POLISKIN, Jacob, B.Sc., (Queen's '38), 691 George St., Sydney, N.S. (*S. 1938*)

POLSON Jack Ambrose, B.Sc., (B.C. '37), Can. Gen. Elec. Co. Ltd., Toronto, Ont. (*H*) 1301 Lansdowne Ave. (*S. 1937*)

POOLE, Gordon Dean, B.Eng., (McGill '32), M.Eng., '36, Can. Johns-Manville Co., Asbestos, Que. (*H*) 30 Ballantyne Ave. S., Montreal West, Que. (*S. 1932*)

POOLE, John Edward, B.Sc., (Alta. '37), Poole Construction Co. Ltd., 733 Tegler Bldg., Edmonton, Alta. (*H*) 11716-100th Ave. (*S. 1937*)

POOLER, G. D., B.Sc., (Queen's '29), Woodroffe, Ont. (*S. 1928*) (*Jr. 1937*)

POPE, Francis Robt., B.Eng., (McGill '35), Bell Telephone Co. of Can. Ltd., Kingston, Ont. (*H*) 181 Division St. (*S. 1933*)

POPE, J. Morley, B.Sc., (McGill '29), Elec. Dept., Cons. Paper Corp. Ltd., Three Rivers, Que. (*H*) 2186 Laviolette Ave. (*S. 1927*) (*Jr. 1937*)

PORCHERON, Alphonse D., B.Sc., (McGill '03), Supt., Asbestos Corp. Ltd., Thetford Mines, Que.; British Can. Mines, Black Lake, Que. (*S. 1904*) (*A.M. 1912*)

♂PORTAS, John, Capt., B Sc., (London '21), Chief Engr., J. W. Cumming Mfg. Co. Ltd., New Glasgow, N.S. (*H*) 206 Washington St. (*A.M. 1927*) (*M. 1933*)

PORTEOUS, J. W., B.Sc., (Alta. '28), M.Sc., Lecturer, Univ. of Alberta, Edmonton, Alta. (*H*) 11142 University Ave. (*S. 1929*) (*Jr. 1934*)

†PORTER, John Bonsall, Ph.D., D.Sc., (Columbia), 3600 McTavish St., Montreal, Que. (*M. 1896*) (*Life Member*)

PORTER, John Earle, B.A.Sc., (Tor. '15), Chief Engr., Ford Motor Co. of Canada, Ltd., East Windsor, Ont. (*H*) 1509 Victoria Ave. (*S. 1914*) (*Jr. 1917*) (*A.M. 1919*)

PORTER, John William, Principal Asst. Engr., W.E., C.N.R., Rm. 460, Union Sta., Winnipeg, Man. (*H*) 339 Academy Rd. (*S. 1902*) (*A.M. 1910*) (*M. 1918*)

PORTER, Lawson Barron, 13 Germain St., Saint John, N.B. (*Jr. 1938*)

PORTER, Sam. G., B.Sc. in C.E., (M.I.T.); M.A., (Baylor), Mgr., Dept. of Nat. Resources, C.P.R., Calgary, Alta. (*H*) 2727 Wolfe St. (*M. 1914*) (*Past-President*)

PORTER, Wm. Thompson, Engrg. Dftsman., Foster Wheeler Co., St. Catharines, Ont. (*H*) R.R. 2, St. Catharines, Ont. (*A.M. 1930*)

POTTER, Alexander, Dr., Cons. Engr., 50 Church St., New York, N.Y., U.S.A. (*H*) Grand View-on-Hudson, Nyack, N.Y. (*A.M. 1893*) (*M. 1917*)

POTTINGER, Alex., B.A.Sc., (B.C. '27), Engr., Can. Westinghouse Co. Ltd., Hamilton, Ont. (*H*) 33 Barnesdale Ave., S. (*Jr. 1930*)

POTTLE, Walter Reginald, Radio Engr., Dom. Govt., 400-01 Post Office Bldg., Regina, Sask. (*1938*)

POUDRIER, Louis Philippe, B.A.Sc., (Ecole Polytech., Montreal '28), D.P.W., Que., Parliament Bldgs., Quebec, Que. (*H*) 459-1st Ave. (*A.M. 1936*)

POULIOT, P. L., B.A.Sc., (Ecole Polytech., Montreal '37), Shawinigan Water and Power Co., Shawinigan Falls, Que. (*H*) 98 Hemlock Ave. (*S. 1936*)

♂POUNDER, John Allan, B.A., (Tor. '12), D.L.S., Engr., International Boundary Comm., Dept. of Mines and Resources, Ottawa, Ont. (*H*) 82 Ossington Ave. (*A.M. 1923*)

POUNDER, Thos. Jas., B.Sc., (Man. '28), Asphalt Engr., British American Oil Co., Royal Bank Bldg., Toronto, Ont. (*H*) Apt. 34, 7 Broadway. (*A.M. 1931*)

POWELL, George Giles, B.Sc., (Tor. '03), Deputy City Engr., Wks. Dept., Toronto, Ont. (*H*) 129 Springhurst Ave. (*A.M. 1907*) (*M. 1913*)

POWELL, John Giles, B.A.Sc., (Tor. '32), Gore, Nasmith & Storrie, 1130 Bay St., Toronto, Ont. (*H*) 131 Westminster Ave. (*S. 1932*) (*Jr. 1936*)

POWELL, Morley Vincent, B.A.Sc., (Tor. '22), Calculator, Can. Gen. Elec. Co., Ltd., Peterborough, Ont. (*H*) 370 London St. (*S. 1921*) (*Jr. 1925*) (*A.M. 1930*)

POWELL, Robert M., (R.M.C., Kingston '35), B.A.Sc., (Tor. '37), Can. Industries Ltd., Shawinigan Falls, Que. (*H*) 290 Coltrin Rd., Rockcliffe Park, Ottawa, Ont. (*S. 1935*)

*M.G.*POWELL, W. H., B.Sc., (McGill '09), D.L.S., B.C.L.S., Engr., Greater Vancouver Water Dist., 1303 Sun Bldg., Vancouver, B.C. (*H*) 4489 Pine Cres. (*S. 1907*) (*A.M. 1913*) (*M. 1918*)

POWLES, Geo. Austin, Dept. of Highways, Ont., Box 302, New Liskeard, Ont. (*S. 1926*)

*D.G.*PRATLEY, Philip L., M.Eng., (Liverpool), Partner, Monsarrat & Pratley, Cons. Engrs., 909 Drummond Bldg., Montreal, Que. (*H*) 5 Thornhill Ave., Westmount, Que. (*S. 1907*) (*A.M. 1909*) (*M. 1917*)

♂PRATT, F. Millen, Capt., M.C., B.A.Sc., (Tor. '12), Mill Engr., Anglo Newfoundland Development Co., Grand Falls, Nfld. (*A.M. 1919*) (*M. 1927*)

PRATT, G. R., Cons. Engr., 586 Elgin Ave., Winnipeg, Man. (*A.M. 1918*)

PREFONTAINE, Rolland, B.A.Sc., Pres., Solex Co. Ltd., 4060 St. Lawrence Blvd., Montreal, Que.; Cons. Engr. (*S. 1903*) (*A.M. 1911*)

PRENDERGAST, R. M., B.A.Sc., (Tor. '21), Sales Engr., Can. Gen. Elec. Co. Ltd., Ottawa, Ont. (*H*) 412 Sunnyside Ave. (*A.M. 1930*)

PRESTON, Wm. Walford, B.Sc., (Queen's '35), Univ. of Alberta, Edmonton, Alta. (*S. 1935*) (*Jr. 1938*)

PREVEY, W. H. P., B Sc., (Alta. '34), Can. Gen. Elec. Co. Ltd., Toronto, Ont. (*H*) 68 Lyndhurst Ave. (*Jr. 1938*)

PREVOST, Edouard, B.Sc., (Ecole Polytech., Montreal '21), Civil Engr. and Contr., 727 Outremont Ave., Outremont, Que. (*S. 1920*) (*Jr. 1924*) (*A.M. 1932*)

PRICE, Charles Alex., i/c Precise Water Level Div., Hydrographic and Map Service, Dept. of Mines and Resources, Ottawa, Ont. (*H*) 33 Findlay Ave. (*A.M. 1921*)

PRICE, Harold B., B.Eng., (McGill '32), Can. Underwriters Assoc., Metropolitan Bldg., Toronto, Ont. (*S. 1931*)

♂PRICE, J. L. E., Lieut., Pres. and Gen. Director, J. L. E. Price & Co. Ltd., Bell Telephone Bldg., Montreal, Que. (*H*) 27 Brock Ave., Montreal West, Que. (*M. 1932*)

♂PRICE, Thomas Ernest, Lieut., B.A., B.Sc., (McGill '10), Div. Engr., C.P.R., Vancouver, B.C. (*H*) 6800 East Blvd. (*S. 1906*) (*A.M. 1912*)

PRIEUR, Henri, Sr. Asst. Engr., Canalization Dept., City of Montreal, Rm. 323, City Hall, Montreal, Que. (*H*) 5634 Canterbury Ave. (*S. 1911*) (*Jr. 1916*) (*A.M. 1926*)

PRINGLE, George H., B.Sc., (McGill '26), Asst. Divn. Engr., Mead Corp., Chillicothe, Ohio, U.S.A. (*H*) 244 Caldwell St. (*S. 1923*) (*Jr. 1927*) (*A.M. 1936*)

PRITCHARD, Geoffrey Rowland, B.Sc., (Man. '37), Can. Allis Chalmers Co. Ltd , Toronto, Ont. (*H*) Ste. 28, 35 Orchard View Blvd. (*S. 1937*)

PROCTOR, Edward Moore, B.A.Sc., (Tor. '09), James, Proctor & Redfern, Ltd., Cons. Engrs., 36 Toronto St., Toronto, Ont. (*H*) 177 Inglewood Dr. (*A.M. 1916*) (*M. 1928*)

PROKOPY, Peter J., St. Joseph's College, Univ. of Alberta, Edmonton, Alta. (*S. 1937*)

PROULX, Gilbert, Ecole Polytechnique, Montreal, Que. (*S. 1938*)

PROVOST, Roger, 4027 Harvard Ave., N.D.G., Montreal, Que. (*S. 1938*)

♂PULLAR, James, Asst. Engr., C.N.R., Moncton, N.B. (*H*) 20 Weldon St. (*A.M. 1921*)

♂PUNTIN, J. H., Lieut., Arch. and Civil Engr., 407 Darke Block, Regina, Sask. (*H*) 2059 Elphinstone St. (*A.M. 1918*)

PURSER, Ralph C., B.A.Sc., (Tor. '07), D.L.S., O.L.S., 211-5th Ave., Ottawa, Ont. (*A.M. 1919*)

PURVES, Wm. Franklin, B.Eng., (McGill '35), Schick Shaver Ltd., Stamford, Conn., U.S.A. (*S. 1935*)

PUTMAN, Clarence Victor, B.Sc., (Queen's '15), Chief, Organization Br., Civil Service Commission, Hunter Bldg., Ottawa, Ont. (*H*) 37 Butternut Terrace. (*Jr. 1917*) (*A.M. 1920*)

PYBUS, Ralph C., B.Sc., (Man. '22), B.Arch., '24, Engr., Carter-Halls-Aldinger Co. Ltd., 700 Taylor St., Vancouver, B.C. (*H*) 2187 W. 49th Ave. (*S. 1920*) (*Jr. 1923*) (*A.M. 1930*)

QUEVILLON, Olivier, 1820 Bennett St., Montreal, Que. (*S. 1938*)

QUINN, Onoric Chas., Price Bros. & Co. Ltd., Riverbend, Que. (*H*) Gomin Rd., Quebec, Que. (*Jr. 1937*)

RACEY, Herbert John, B.Sc., (Queen's '28), Shawinigan Engineering Co. Ltd., La Tuque, Que. (*S. 1928*) (*Jr. 1931*) (*A.M. 1938*)

RACEY, Herbert Wm., Supt. of Box Dept., Dom. Glass Co., Ltd., 1111 Beaver Hall Hill, Montreal, Que. (*H*) 4310 Montrose Ave., Westmount, Que. (*A.M. 1919*)

RACICOT, Jacques, 3834 St. Denis St., Montreal, Que. (*S. 1938*)

RAE, William, Chief Inspr. of Equip., Dept. of Rlys., B.C., Rm. 408, 602 W. Hastings St., Vancouver, B.C. (*H*) 5838 Churchill St. (*M. 1936*)

RALEY, Charles, 704 Rayside Ave., Burnaby, New Westminster, B.C. (*A.M. 1921*) (*Life Member*)

RALPH, John Arthur, B.Sc., (N.B. '37), Can. Gen. Elec. Co. Ltd., Toronto, Ont. (*H*) 99 Jamieson Ave. (*S. 1937*)

RALSTON, W. P., Hill & Dale, Port Hope, Ont. (*S. 1931*)

RAMSAY, Ensley M., Vice-Pres., The Ramsay Co., Patent Attorneys, 273 Bank St., Ottawa, Ont. (*H*) 328 Somerset St. W. (*Jr. 1923*)

RAMSAY, Robert, Mgr., Industrial Dept., Can. Vickers, Ltd., Montreal, Que (*H*) 217 Percival Ave., Montreal West, Que. (*A.M. 1924*)

RAMSAY, William, Dist. Engr., D.P.W., B.C., P.O. Box 690, Kamloops, B.C (*A.M. 1920*)

RAMSAY, Wm. Wallace, B.Sc., (Man. '33), Engr., Century Mining Corp. Ltd., Elbow Lake, Man. (*H*) 271 Evanston St., Winnipeg, Man. (*Jr. 1937*)

RAMSAY, Robert D., B.Sc., (Queen's '38), 147 Kathleen Ave., Sarnia, Ont (*S. 1938*)

RAMSDALE, Donald O. D., B.Eng., (McGill '33), Estimator, Bepco Canada Ltd., 43-45 Niagara St., Toronto 2, Ont. (*H*) 95 Bedford Rd. (*S. 1933*)

♂RANKIN, Garnet, Lieut., B.A.Sc., (Tor. '15), Tillsonburg, Ont. (*S. 1914*) (*A.M. 1921*)

RANNIE, John Leslie, B.A.Sc., (Tor. '09), D.T.S., Q.L.S., Chief of Triangulation Div., Geodetic Service of Canada, Dept. of Mines and Resources, Ottawa, Ont. (*H*) 19 Oakland Ave. (*A.M. 1918*) (*M. 1922*)

RAPLEY, Blake Parker, B.Sc., (Queen's '23), Chief Engr., International Petroleum Co. Ltd., Talara, Peru, S.A. (*S. 1922*) (*Jr. 1927*) (*A.M. 1934*)

RAVENOR, Maurice Augustus, Res. Engr., Air Ministry, Hullavington Aerodrome, Wilts, England. (*H*) Greenford, Hardenhurst, Chippenham, Wilts. (*M. 1929*)

RAWLAND, Arthur Gordon, B.Sc., (N.B. '37), Price Bros. & Co. Ltd., Kenogami, Que. (*S. 1937*)

RAY, Walter Reginald Gubbins, B.Sc., (McGill '25), Sales Engr., Can. Fairbanks-Morse Co. Ltd., 337 Blvd. Charest, Quebec, Que. (*H*) 21 Learmonth Ave. (*A.M. 1932*)

RAYMENT, Arthur Chas., Executive Engr., R. A. Rankin-Associates, 2039 Mansfield St., Montreal, Que. (*H*) 4804 Oxford Ave., N.D.G. (*M. 1938*)

RAYMER, Denzill Enwin, B.A.Sc., (Tor. '36), 99 Rose Park Dr., Toronto, Ont. (*Jr. 1938*)

RAYNER, Geo. Wm., C.E., (Tor. '05), Pres., Rayner Construction Ltd., 29 Commercial St., Leaside, Ont. (*H*) 92 MacLennan Ave., Toronto, Ont. (*M. 1920*)

READ, F. Cyril, 1 Bedford Rd., Toronto, Ont. (*S. 1938*)

READ, Herbert Wm., B.Sc., (McGill '08), Sec., The Read Stone Co. Ltd., Sackville, N.B. (*S. 1907*) (*A.M. 1913*)

REDFERN, Chas. Raimond, B.A.Sc., (Tor. '09), Pres., Redfern Construction Co. Ltd., 614 Excelsior Life Bldg., Toronto, Ont. (*H*) 100 Vesta Dr. (*M. 1931*)

♂REDFERN, W. Blaine, Lieut., B.A.Sc., (Tor. '09), Vice-Pres. and Sec.-Treas., James, Proctor & Redfern, Ltd., Cons. Engrs., 36 Toronto St., Toronto, Ont. (*H*) 458 Russell Hill Rd. (*A.M. 1920*) (*M. 1930*)

♂REDMAN, Wm. B., B.A.Sc., (Tor. '15), Asst. Engr., C.N.R., Toronto, Ont. (*H*) 25 Harding Blvd. (*S. 1914*) (*Jr. 1919*) (*A.M. 1921*)

REEKIE, Wm. Geo., B.Sc., (Man. '26), Res. Engr., Quebec North Shore Paper Co., Baie Comeau, Que. (*H*) Lyleton, Man. (*S. 1924*) (*Jr. 1927*) (*A.M. 1936*)

REES, Frederic, B.E., (N.S.T.C. '38), Bell Island, Nfld. (*S. 1935*)

REES, H. S., B.Sc., (Queen's '29), Asst. Engr., Aeronautical Engrg. Divn., Dept. National Defence, Ottawa, Ont. (*H*) 391 Ashbury Pl., Rockcliffe Park. (*S. 1928*) (*A.M. 1938*)

REEVELY, Fred. Richard, B.A., (Tor. '29), Indust. Engr., Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*H*) 52 Alexandra Ave., St. Lambert, Que. (*Jr. 1932*)

REGAN, F. E., Bepco Canada, Ltd., 45 Niagara St., Toronto 2, Ont. (*H*) 2837 Yonge St. (*Jr. 1930*)

♂REID, Anthony Meredith, Capt., M.C., B.A.Sc., (Tor. '23), Div. Plant Engr., Bell Telephone Co. of Canada, Ltd., 76 Adelaide St. W., Toronto, Ont. (*H*) 71 Alexandra Blvd. (*S. 1919*) (*Jr. 1925*) (*A.M. 1927*)

♂REID, Brian Lee, Lieut., M.C., Roadmaster, C.P.R., Outlook, Sask. (*A.M. 1922*)

REID, Chas. Roy, B.S., (Oregon '06), M.M.E., (Cornell '16), Gen. Supt., Shawinigan Water and Power Co., P.O. Box 6072, Montreal, Que. (*H*) 2070 Peel St. (*M. 1935*)

REID, Fraser Daniel, B.Sc., (Queen's '04), Gen. Mgr., Howey Gold Mines, 822 Federal Bldg., Toronto, Ont. (*H*) Lambton Mills, Ont. (*M. 1919*)

REID, Frederick Blair, B.A.Sc., (Tor. '06), D.L.S., Supervisor of Levelling, Geodetic Service of Canada, Dept. of Mines and Resources, Ottawa, Ont. (*H*) 57 Powell Ave. (*M. 1919*)

♂REID, G. C., Lieut., M.M., Res. Engr., Dept. of Highways, N.S., Halifax, N.S. (*H*) 328 Gottingen St. (*A.M. 1919*)

♂REID, James W., B.Sc., (McGill '14), Inspr., Board Transport Commrs., 525 Calgary Public Bldg., Calgary, Alta. (*H*) 3833-7th St. W. (*A.M. 1929*)

REID, John Alexander, B.Sc., (Queen's '02), Cons. Mining Engr., Rm. 1001, Federal Bldg., Toronto, Ont. (*H*) 85 Glendonwynne Rd. (*M. 1919*)

♂REID, John Garnet, Lt.-Col., D.S.O., Asst. Engr., C.P.R., Constrn. Dept., Prince Albert, Sask. (*S. 1905*) (*A.M 1908*) (*M. 1920*)

REID, Jean Marie, B.A.Sc., (Ecole Polytech., Montreal '17), Res. Engr., D.P.W., Que., Quebec, Que. (*H*) 405 St. Cyrille St. (*A.M. 1936*)

♂REID, John Herbert, B.Sc., (McGill '16), Gen. Supt., Trinidad Electricity Board, Port of Spain, Trinidad, B.W.I. (*H*) 7 Coblentz Ave. (*Jr. 1919*) (*A.M. 1924*) (*M. 1936*)

REID, Kenneth, B.Sc., (McGill '26), Street Lighting Dept., City of Victoria, Victoria, B.C. (*H*) 1336 Carnsew St. (*S. 1924*) (*Jr. 1929*)

REID, Wilfrid Thos., Pres., Crude Oil Engine and Engrg. Co., 1032 University Tower, Montreal, Que. (*H*) 102 Vivian Ave., Town of Mount Royal, Que. (*M. 1937*)

♂REID, Wm. Jos. Walter, B.A.Sc., (Tor. '24), Wks. Mgr., Otis-Fensom Elevator Co., Ltd., Hamilton, Ont. (*H*) 126 Dalewood Cres. (*S. 1920*) (*A.M. 1929*) (*M. 1937*)

REID, Wm. Murray, B.A.Sc., (McGill '86), Engr., Mtce. of Way and Structures, Montreal Tramways Co., 159 Craig St. W., Montreal, Que. (*H*) 559 Grosvenor Ave., Westmount, Que. (*S. 1887*) (*A.M. 1895*)

REIKIE, M. Ker Thomson, B.Sc., (Alta. '32), Hudson Bay Mining and Smelting Co. Ltd., Flin Flon, Man. (*S. 1932*)

REIKIE, W. Thorpe T., B.Sc., (Alta. '36), Okotoks, Alta. (*S. 1936*)

REILLY, Francis B., Partner, Reilly, Warburton and Reilly, 312 Westman Chambers, Regina, Sask. (*H*) 1548 Garnet St. (*A.M. 1918*)

REINHARDT, G. V., B.Sc., (N.S.T.C. '34), Dom. Bridge Co. Ltd., Montreal, Que. (*H*) 144-A 11th Ave., Lachine, Que. (*S. 1932*) (*Jr. 1937*)

RELYEA, John De Witte, B.A.Sc., (Tor. '21), Mech. Engr., D.P.W., Canada, 35 George St., Ottawa, Ont. (*H*) Skead Rd., Carleton Cty. (*M. 1937*)

RENOUF, Edward T., B.Sc., (McGill '23), Renouf Publishing Co., 1433 McGill College Ave., Montreal, Que. (*H*) 1550 Pine Ave. W. (*S. 1923*) (*A.M. 1936*)

RETTIE, James Robert, B.Sc., (Man. '35), Surveys Br., Dept. of Mines and Natural Resources, Rm. 346, Parliament Bldgs., Winnipeg, Man. (*H*) 428 McGee St. (*Jr. 1938*)

REYNOLDS, Geo. G., (R.M.C., Kingston '37), B.Sc., (Queen's '38), H.E.P.C. of Ontario, Toronto, Ont. (*H*) 26 Erindale Ave. (*S. 1938*)

REYNOLDS, Geo. Kenly, B.Eng., (McGill '35), Northern Electric Co. Ltd., Montreal, Que. (*H*) Apt. 2, 3737 De L'Oratoire. (*S. 1935*)

REYNOLDS, Philip, c/o Miss M. Reynolds, Bickenhill, Chiseldon, Wilts., England. (*M. 1932*)

REYNOLDS, Wm. M., B.Sc., (Queen's '23), Lang & Ross, Sault Ste. Marie, Ont. (*H*) 137 Kohler St. (*S. 1920*) (*A.M. 1926*)

RHODES, Donald, B.Sc., (McGill '28), Dist. Plant Engr., The Bell Telephone Co. of Canada, Ltd., 114 St. John St., Quebec, Que. (*H*) Apt. 4, 381 Ste. Foye Rd. (*S. 1926*) (*A.M. 1935*)

RHODES, Fred Norman, Chief Instr. in Elec., The Alberta Govt., Institute of Technology and Art, Calgary, Alta. (*H*) 912-19th Ave. N.W. (*A.M. 1928*)

♂RHODES, Sir Godfrey Dean, Brig.-Gen., C.B.E., D.S.O., (R.M.C., Kingston '07), Gen. Mgr., Kenya and Uganda Rlys. and Harbours, Nairobi, Kenya Colony, B.E.A. Address: c/o Lloyd's Bank, Cox's and Kings Branch, London, England. (*M. 1922*)

RICE, J. Donald, B.Eng, (McGill '35), International Petroleum Co. Ltd, Negritos, Peru, S.A. (*S. 1935*)

RICE, Walter L., Wks. Dept., City of Toronto, Rm. 320, City Hall, Toronto, Ont. (*H*) 288 Wolverleigh Blvd. (*Jr. 1933*)

RICHARDS, Carl Price, 511 St. Helens Court, 1131 S.W. Montgomery St., Portland, Ore., U.S.A. (*A.M. 1917*)

♂RICHARDS, E. G., Capt., Rly. Engr., H.M. Office of Wks., Royal Ordnance Factory, Chorley, Lancs., England. (*H*) Jones Farm, Dawson Lane, Whittle-le-Woods, Chorley, Lancs., England. (*A.M. 1919*)

RICHARDS, H. J. B., B.Sc., (Man. '34), P.O. Box 17, Bienfait, Sask. (*Jr. 1936*)

♂RICHARDSON, Bertram Poideven, Major, Constrn. Engr., 718 University Tower, Montreal, Que. (*H*) 2393 Madison Ave. (*M. 1921*)

RICHARDSON, Edward Wm., B.A.Sc., (B.C. '32), B.C.L.S., Engr., Wells Townsite Co., Wells, B.C. (*A.M. 1936*)

RICHARDSON, John M., B.Sc., (McGill), Southern Canada Power Co. Ltd., 355 St. James St. W., Montreal, Que. (*H*) 299 Ile Bigras, St. Dorothee, Que. (*S. 1928*)

♂RICHARDSON, Roderick McDougald, B.A., (Dalhousie '22), B.Sc., (McGill '24), Dist. Plant Supt., Bell Telephone Co. of Canada, Ltd., Plateau Bldg., Montreal, Que. (*H*) 5206 Westbury Ave. (*S. 1922*) (*Jr. 1926*) (*A.M. 1930*)

♂RICHARDSON, Wm. Augustus, Capt., M.C., B.A.Sc., (Tor. '12), Asst. Engr., D.P.W., Canada, New Westminster, B.C. (*H*) 317-6th St. (*S. 1910*) (*A.M. 1921*)

RICHARDSON, Wm. G., B.Sc., (Queen's '26), Can. Broadcasting Corp., 1440 St. Catherine St. W., Montreal, Que. (*Jr. 1930*) (*A.M. 1938*)

♂RICHARDSON, Wm. Henry, Lieut., M.C., B.C.E., (Man '14), Private Practice, 707 Columbia St., Kelso, Wash., U.S.A. (*S. 1911*) (*A.M. 1921*)

RICHER, Baxter Dollard, B.A.Sc., (Ecole Polytech., Montreal '37), Pilot Officer, R.C.A.F., Camp Borden, Ont. (*H*) 5854 Durocher St., Montreal, Que. (*S. 1936*)

RICKER, Herbert A., B.A.Sc., (Tor. '10), Mech. Engr., Can. Westinghouse Co., Ltd., Hamilton, Ont. (*M. 1928*)

♂RIDDELL, Arthur Gourlay, Major, M.C., B.Sc., (McGill '07), Cons. Engr., 73 Proctor Blvd., Hamilton, Ont. (*S. 1907*) (*A.M. 1913*)

♂RIDDELL, Wm. Forrest, B.Sc., (Man. '24), M.Sc., '31, Asst. Prof., Univ. of Manitoba, Winnipeg, Man. (*H*) 42 Dundurn Pl. (*S. 1922*) (*Jr. 1928*) (*M. 1936*)

♂RIDER, Ezra B., B.A., B.Sc., Engr., The Metropolitan Water Dist. of S. California, Los Angeles, Calif, U.S.A. (*H*) 1875 Alpha Rd., Glendale, Calif. (*S. 1907*) (*A.M. 1913*)

RIDGERS, Arthur Courtney, P.O., Rossland, B.C. (*Jr. 1929*) (*A.M. 1935*)

RIDLEY, Edmund N., Canal Supt., C.P.R., D.N.R., P.O. Box 269, Strathmore, Alta. (*S. 1905*) (*A.M. 1909*) (*M. 1929*)

♂RIDOUT, Geoffrey Swabey, B.Sc., (Tor. '22), Bell Telephone Co. of Canada Ltd., Catherine St., Ottawa, Ont. (*A.M. 1931*)

♂RIDOUT-EVANS, G. W. F., Major, M.C., Field Inspr., Lions' Gate Bridge, Monsarrat & Pratley, Vancouver, B.C. (*H*) St. Alice Hotel, N. Vancouver, B.C. (*S. 1905*) (*A.M. 1912*)

RIEHL, Wm. H., B.A.Sc., (Tor. '20), City Engr., City Hall, Stratford, Ont. (*H*) 35 Youngs St. (*S. 1919*) (*A.M. 1925*)

RIGGS, Henry Earle, A.B., (Kansas '86), C.E., (Mich. '10), Eng.D., '37, Hon. Prof., Civil Engrg., Univ. of Michigan, 303 West Engineering Bldg., Ann Arbor, Mich., U.S.A. (*H*) Underdown Rd., Barton Hills. (*M. 1935*)

RIGSBY, David L., 318 University Ave., Kingston, Ont. (*S. 1938*)

RIMMER, Ralph Horton, B.S., (N. Carolina '18), Asst. Supt., Alum. Plant, Aluminum Co. of Canada, Ltd., Arvida, Que. (*A.M. 1935*)

RINDAL, Harald, C.E., (Trond., '01), 1642-28th Ave. W., Vancouver, B.C. (*M. 1918*)

RINFRET, Guy R., B.Sc., (McGill '26), Shawinigan Engineering Co., Ltd., P.O. Box 85, La Tuque, Que. (*S. 1924*) (*Jr. 1927*) (*A.M. 1932*)

RINTOUL, W. V., B.Sc., (Queen's '35), Factory Supt., Allan's Beverages Ltd., 5130 Western Ave., Montreal, Que. (*H*) 3828 Marcil Ave., N.D.G. (*S. 1935*)

RIOUX, R. H., B.A.Sc., (Ecole Polytech., Montreal '38), 2376 Grant St., Montreal, Que. (*S. 1936*)

♂RIPLEY, Blair, Lt.-Col., C.B.E., D.S.O., Dist. Engr., Ont. Div., C.P.R., Union Sta., Toronto, Ont. (*H*) 43 Alvin Ave. (*A.M. 1907*) (*M. 1913*)

RIPLEY, H. A., B.Sc., (N.S.T.C. '33), Pres., Industrial Engineering Co. Ltd., 89 Hollis St., Halifax, N.S. (*H*) Fairview, N.S. (*S. 1930*)

RIPLEY, Wilfred Jamieson, B Sc., (McGill '14), Asst. Master Mechanic, International Nickel Co. of Canada, Box 260, Copper Cliff, Ont. (*A.M. 1923*) (*M. 1926*)

RISLEY, Wilfred Cary, B.S., (Dartmouth '00), Supt. Constrn., Dom. Coal Co., Sydney, N.S (*H*) 154 Whitney Ave. (*M. 1924*)

RITCHIE, Alexander, Whiting Corporation (Canada) Ltd., 54 Wellington St. W., Toronto, Ont. (*A.M. 1924*)

♂RITCHIE, Frederick Avery, Capt., M.C., Engr., Can. Refractories Ltd., Can. Cement Bldg., Montreal, Que. (*H*) 22 Prince Arthur St., St. Lambert, Que. (*A.M. 1920*)

RITCHIE, Hugh Crichton, (Tor. '10), City Engr. and Commr., City Hall, Moose Jaw, Sask. (*S. 1910*) (*A.M. 1913*) (*M. 1936*)

RIVA, Ronald Herrick, B Sc., (McGill '25), F. H. McGraw & Co. Inc., P.O. Box 39, Newtown, Conn., U.S.A. (*H*) South Main St. (*S. 1923*) (*Jr. 1928*)

ROAST, Harold Jas., (London '02), Owner, Roast Laboratories Reg'd., Vice-Pres., Can. Bronze Co. Ltd., 999 Delorimier Ave., Montreal, Que. (*H*) 197 Stanstead Ave., Town of Mount Royal, Que. (*M. 1932*)

ROBB, Charles A., B.Sc., (McGill '09), M.Sc., (M.I.T. '10), D.Eng., (Johns Hopkins '38), Prof., Mech. Engrg., Univ. of Alberta, Edmonton, Alta. (*H*) 10 University Campus. (*S. 1908*) (*A.M. 1913*) (*M. 1923*)

ROBERGE, J. Antonio, B.A.Sc., (Ecole Polytech., Montreal '26), Asst. Waterworks Engr., City of Quebec, City Hall, Quebec, Que. (*H*) 29 de Bienville Ave. (*A.M. 1932*)

ROBERT, Andre, B.Sc., (Man. '38), 3611 Hutchison St., Montreal, Que. (*S. 1938*)

♂ROBERTS, Alexander, Lieut., Mech. Engr., Can. and General Finance Co. Ltd., 25 King St. W., Toronto, Ont. (*H*) 96 Chudleigh Ave. (*A.M. 1921*)

ROBERTS, Arthur R., M.Sc., Prof. of Mech. Engrg., McGill Univ., Montreal, Que. (*H*) 1470 St. Matthew St. (*S. 1904*) (*A.M. 1911*)

♂ROBERTS, Charles Drury, Jr. Engr. and Designer, City of Toronto, Water Supply Sect., City Hall, Toronto, Ont. (*H*) 184 Albertus Ave. (*A.M. 1921*)

ROBERTS, J. Frank, B.Sc., (Wisc. '18), Principal Mech. Engr., Tennessee Valley Authority, 307 Union Bldg., Knoxville, Tenn., U.S.A. (*A.M. 1927*)

♂ROBERTS, John Randall, B.Sc., (Vermont '12), Sales Mgr. for Ont., Can. Bitumuls Co. Ltd., Leaside, Ont. (*H*) 20 Glenview Ave., Toronto, Ont. (*Jr. 1916*) (*A.M. 1917*)

ROBERTS, P. B., Sr. Civil Engr., 19 Everest Rd., Eltham, S.E.9, England. (*M. 1919*)

♂ROBERTS, Stanley O., Capt., D.L.S., Asst. Engr., Penitentiary Br., Dept. of Justice, Ottawa, Ont. (*H*) 234 Rideau Terrace. (*Jr. 1919*) (*A.M. 1923*)

♂ROBERTSON, Alex. K., Capt., Struan Lodge, Gen. Del., Kaleden, via Penticton, B.C. (*M. 1914*)

♂ROBERTSON, A. Ross, Capt., B.A.Sc., (Toronto '09), Mgr., Ont. Div., Dom. Bridge Co. Ltd., 1139 Shaw St., Toronto, Ont. (*H*) 118 Inglewood Dr. (*A.M. 1920*)

ROBERTSON, Gordon G. D., Surveys and Engrg. Br., Dept. of Mines and Resources, Box 34, Banff, Alta. (*H*) 205-2nd St. W., Calgary, Alta. (*S. 1928*) (*Jr. 1936*)

ROBERTSON, Hugh, Dept. of Highways, Ont., North Bay, Ont. (*A.M. 1916*)

ROBERTSON, Ian Ansley, Dftsman., Railway and Power Engineering Corp., 171 Eastern Ave., Toronto, Ont. (*H*) 274 Erskine Ave. (*Jr. 1936*)

ROBERTSON, James, B.Sc., (McGill '14), Engr., Pacific Divn., Dom. Bridge Co., Ltd., Vancouver, B.C. (*H*) 5888 Adera St. (*S. 1913*) (*A.M. 1916*) (*M. 1935*)

†ROBERTSON, J. F., M.Sc., (McGill '04), P.O. Box 502, Copper Cliff, Ont. (*S. 1904*) (*A.M. 1912*) (*M. 1914*)

†ROBERTSON, James McC., B.A.Sc., (Tor.), Cons. Engr., Keefer Bldg., 1440 St. Catherine St. W., Montreal, Que. (*H*) 618 Carleton Ave., Westmount, Que. (*A.M. 1906*) (*M. 1912*)

♂ROBERTSON, Randal Killaly, Capt., B.Sc., (McGill '14), Mgr., The Laprairie Co., Inc., 906 University Tower, Montreal, Que. (*H*) 369 Belmont Ave., Westmount, Que. (*A.M. 1923*)

♂ROBERTSON, Robert McFadzean, Capt., B.Sc., (McGill '20), Str'l. Engr., Dom. Bridge Co., Ltd., Lachine, Que. (*H*) 615 St. Joseph St. (*Jr. 1920*) (*A.M. 1927*)

ROBILLARD, Richard F., Asst. to Engr., Grinnell Co. of Can. Ltd., 700 Beaumont St., Montreal, Que. (*H*) 3076 Maplewood Ave. (*S. 1930*)

ROBINSON, A. H., B.Sc., (Man. '37), 149 Polson Ave., Winnipeg, Man. (*S. 1937*)

ROBINSON, Denis Owen, B.Sc., (Queen's '23), Sales Engr., Canada Cement Co., Montreal, Que. (*H*) 11 Relmar Rd., Toronto, Ont. (*A.M. 1932*)

ROBINSON, Gordon M., B.A.Sc., (Tor. '35), 28 Scott St., Brampton, Ont. (*Jr. 1938*)

ROBINSON, Leonard H., C.E., (Tor. '04), Div. Engr., C.N.R., Halifax, N.S. (*H*) 76 Young Ave. (*A.M. 1909*) (*M. 1927*)

ROBINSON, Roy C., (Tor. '08), Div. Engr., C.N.R., P.O. Box 501, Dauphin, Man. (*H*) 227-4th Ave. N.E. (*A.M. 1919*)

♂ROBINSON, W. C. E., Lieut., Divn. Engr., C.P.R., London, Ont. (*H*) 38 Grosvenor St. (*Jr. 1922*) (*A.M. 1926*)

♂ROBLIN, Herbert Leslie, Capt., M.C., B.A.Sc., (Tor. '13), Roadmaster, C.N.R., Union Sta., Regina, Sask. (*H*) 2249 Princess St. (*A.M. 1919*)

ROBSON, Richard Christopher, Western Bridge Co. Ltd., Vancouver, B.C. (*H*) 3298 Lonsdale Ave. (*Jr. 1932*)

ROBSON, Wm. John, B.Sc., (Alta. '33), M.A.Sc., (Tor. '35), Engr., S. M. Peterkin Co. Ltd., Rm. 525, Bloor Bldg., Toronto, Ont. (*H*) 97 Barton Ave. (*S. 1933*)

ROBY, Marcus A., 836 Pittock Block, Portland, Ore., U.S.A. (*A.M. 1909*)

ROCHE, Ivor Francis Rees, B.Sc., (McGill '13), Mgr., Fess Oil Burners of Can., 1405 Drummond St., Montreal, Que. (*H*) 5553 Queen Mary Rd. (*S. 1913*) (*A.M. 1920*)

♂ROCHESTER, Lloyd B., Capt., B.Sc., (McGill '21), Dir., McWalters Gold Mines Ltd. and Prospectors Airways Co., Ltd., Rm. 711, Blackburn Bldg., Ottawa, Ont. (*H*) "Maple Lawn," Richmond Rd., Westboro, Ont. (*S. 1914*) (*A.M. 1925*)

RODGER, Norman Elliot, B.Sc., (McGill '30), Capt., R.C.E., 136 King St., Kingston, Ont. (*S. 1930*) (*Jr. 1935*)

RODGER, Wm., Office Engr. and Dftsman., D.P.W. and Mines, N.S., Halifax, N.S. (*H*) 270 Portland St., Dartmouth, N.S. (*A.M. 1913*)

ROGERS, Alvah Burphee, Asst. Elec. Engr., Power Engineering Co., Power Bldg., Montreal, Que. (*H*) 4199 Hingston Ave. (*A.M. 1924*)

ROGERS, Carl L., B.Eng., (McGill '34), Can. Gen. Elec. Co. Ltd., Toronto, Ont. (*H*) 818-B Millwood Rd. (*S. 1931*)

♂ROGERS, Casimir S. G., Major, M.A., (Queen's '01), Bridge Engr., C.N.R., Moncton, N.B. (*H*) 164 Park St. (*A.M. 1910*)

ROGERS, Geo. Harold, The Bell Telephone Co. of Canada, Ltd., 74 Adelaide St. W., Toronto, Ont. (*H*) 116 Highbourne Rd. (*A.M. 1927*)

ROGERS, Howard W., B.Sc., (McGill '31), Can. Blower and Forge Co., 630 Dorchester St. W., Montreal, Que. (*S. 1931*)

ROGERS, Hubert David, B.Sc., (Queen's '13), Waterworks Supt., Gananoque Waterworks Comm., Box 570, Gananoque, Ont. (*S. 1913*) (*Jr. 1922*)

ROGERS, Jos. Victor, B.A.Sc., (B.C. '33), R.M.D. 3, Glanford Ave., Victoria, B.C. (*Jr. 1936*)

ROLAND, John Wilson, S.B., C.E., (M.I.T.), A.B., (Acadia), Monsarrat & Pratley, Cons. Engrs., Rm. 909, Drummond Bldg., Montreal, Que. (*M. 1918*)

ROLBIN, Max, B.Eng., (McGill '33), 4632 Esplanade Ave., Montreal, Que. (*S. 1933*)

♂ROLFSON, Orville, Lieut., M.A.Sc., D.L.S., O.L.S., A.L.S., Private Practice, Bartlett Bldg., Windsor, Ont. (*H*) 2292 Chilver Rd., Walkerville, Ont. (*S. 1907*) (*A.M. 1912*)

ROLLESTON, Philip R., Control Supt., Anglo-Canadian Pulp and Paper Co., Ltd., Quebec, Que. (*H*) 220 Fraser St. (*S. 1923*)

ROLPH, Frank Bernard, (R.M.C. '27), B.Sc., (McGill '28), Constrn. Engr., John S. Metcalf Co., 105 West Adams St., Chicago, Ill., U.S.A. Address: 7 Collingham Rd., London, S.W.1. (*A.M. 1937*)

ROMBOUGH, J. M., B.Sc., (Queen's '31), McColl Frontenac Oil Co., Montreal East, Que. (*H*) Apt. 9, 4954 St. Catherine St. E. (*S. 1928*) (*Jr. 1937*)

ROME, Robert, Asst. City Engr., City Hall, Vancouver, B.C. (*H*) 5891 Alma Rd. (*A.M. 1918*)

RONCARELLI, J. A., B.Eng., (McGill '38), 1429 Crescent St., Montreal, Que. (*S. 1938*)

RONEY, G. V., B.Sc., (Queen's '26), Mgr., Farand & Delorme Ltd., 385 St. Martin St., Montreal, Que. (*H*) Apt. 2, 343 Clarke Ave., Westmount, Que. (*S. 1925*) (*A.M. 1935*)

RORVIK, Ole Johan, P.O. Box 5443, Johannesburg, S.A. (*A.M. 1929*)

ROSE, Alexander, B.Eng., (McGill '35), National Research Council, Ottawa, Ont. (*H*) 171 McKay St. (*S. 1934*) (*Jr. 1938*)

ROSE, Hugh Grant, M.A., (Queen's '20), B.A.Sc., (Tor. '23), D.L.S., O.L.S., Land Surveyor, Bell Telephone Co. of Canada Ltd., 1399 Bathurst St., Toronto, Ont. (*H*) 23 Mount Royal Ave. (*S. 1921*) (*Jr. 1924*) (*A.M. 1928*)

♂ROSE, John Thoburn, Lieut., B.A.Sc., (Tor. '15), Pr. Dev. Engr., Dom. Water and Power Bureau, Dept. of Mines and Resources, 532 Dom. Public Bldg., Winnipeg, Man. (*H*) 383 Beaverbrook St. (*S. 1914*) (*Jr. 1920*) (*A.M. 1928*)

ROSE, Paul E., B.A.Sc., (Ecole Polytech., Montreal '37), Test Engr., Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*H*) 516 Charlotte St. (*S. 1936*)

♂ROSS, Alex. Daniel, Lieut., M.Sc., (M.I.T. '23), Mgr., Can. Comstock Co., Ltd., 1110 New Birks Bldg., Montreal, Que. (*H*) 5429 Monkland Ave. (*A.M. 1926*)

♂ROSS, Allan Crawford, Major, B.Sc., (McGill '11), Pres., Ross and Meagher Ltd., 7 Echo Dr., Ottawa, Ont. (*H*) 35 Goulburn Ave. (*M. 1933*)

ROSS, Archibald Holmes, Ross & Greig, 736 Notre Dame St. W., Montreal, Que. (*H*) 2111 Dorchester St. W. (*M. 1921*)

ROSS, A. LeB., B.Eng., (McGill '32), Can. Controllers Ltd., 171 Eastern Ave., Toronto, Ont. (*H*) 484 Duplex Ave. (*S. 1930*)

♂ROSS, A. M., Lieut., Atlin, B.C. (*A.M. 1919*)

ROSS, Sir Charles, Bart., Cons. Engr., 1619 Massachusetts Ave., Washington, D.C., U.S.A. (*M. 1918*)

ROSS, Donald, B.Sc., (N.B. '37), 126 Douglas Ave., Saint John, N.B. (*S. 1935*) (*Jr. 1938*)

♂ROSS, Donald Grant, B.Sc., (Dalhousie '22), Res. Engr., Saint John Harbour, National Harbours Bd., Union St., W. Saint John, N.B. (*Jr. 1924*) (*A.M. 1931*)

ROSS, Donald W., Donald W. Ross Co., Gen. Contrs., Rm. 603, Dom. Square Bldg., Montreal, Que. (*H*) 239 Kindersley Ave. (*A.M. 1902*) (*M. 1920*)

ROSS, George, B.Sc., (Alta. '38), 7201-104th St., Edmonton, Alta. (*S. 1937*)

ROSS, Geo. Victor, B.Sc., (N.S.T.C. '32), Asst. Engr., Engineering Service Co., Box 263, Halifax, N.S. (*S. 1930*) (*A.M. 1937*)

ROSS, Henry James, Jr. Engr. and Designer, City of Toronto, Dept. of Wks., Rm. 320, City Hall, Toronto, Ont. (*H*) 269 Strathmore Blvd. (*A.M. 1921*)

ROSS, Henry Urquhart, (R.M.C. '34), B.Eng., (McGill '36), M.Sc., '38, 3581 University St., Montreal, Que. (*S. 1936*)

ROSS, Hugh Campbell, B.A.Sc., (Tor. '29), Asst. Test. Engr., H.E.P.C. of Ont., 8 Strachan Ave., Toronto, Ont. (*H*) 63 Eastbourne Cres., Mimico, Ont. (*Jr. 1931*)

ROSS, Hugh G., B.Sc., (McGill '03), Cons. Engr., 150 Argyle Ave., Ottawa, Ont. (*S. 1925*) (*A.M. 1930*)

ROSS, John W. LeB., 8 McLeod St., Ottawa, Ont. (*A.M. 1897*) (*M. 1901*) (*Life Member*)

ROSS, Jos. Hope, B.Sc., Dir. of Youth Training, Govt. of Alta., Telephone Bldg., Calgary, Alta. (*H*) 204-27th Ave. N.W. (*A.M. 1922*)

ROSS, Jos. Hope, (R.M.C., Kingston '36), Men's Residence, East House, Univ. of Toronto, Toronto, Ont. (*S. 1936*)

♂ROSS, Kenneth Geo., Major, (Tor. '06), O.L.S., Vice-Pres., Lang & Ross, Ltd., Sault Ste. Marie, Ont. (*H*) 17 Summit Ave. (*A.M. 1919*) (*M. 1932*)

♂ROSS, Malcolm V., B.Sc., (McGill '23), Salesman, Ogden Minton Co. Ltd., 219 University Tower, Montreal, Que. (*H*) 4999 Grosvenor Ave. (*S. 1920*) (*Jr. 1926*) (*A.M. 1930*)

ROSS, Oakland Kenneth, B.Eng., (McGill '34), Asst. Plant Mgr., Continental Can Co., Montreal, Que. (*H*) 136 Clandeboye Ave. (*S. 1934*)

ROSS, Robert W., Div. Engr., C.N.R., 9914-104th Ave., Edmonton, Alta. (*H*) 11723-88th St. (*S. 1909*) (*Jr. 1911*) (*A.M. 1918*)

ROSS, Thos. W., B.Eng., (McGill '35), N.B. International Paper Co., Dalhousie, N.B. (*H*) Apt. 8, 1477 Atwater Ave., Montreal, Que. (*S. 1935*)

ROSS, W. Bruce, B.Sc., M.Sc., (McGill '31), Ph.D., '33, Lecturer in Mathematics, McGill Univ., Montreal, Que. (*H*) Douglas Hall, 3851 University St. (*S. 1929*) (*A.M. 1935*)

♂ROSS, Wm. Ewart, Lieut., Mgr., Apparatus Sales Dept., Can. Gen. Elec. Co. Ltd., 212 King St. W., Toronto, Ont. (*H*) 169 Golfdale Rd. (*Jr. 1920*) (*A.M. 1924*)

ROSS, Wm. Hope, Gen. Supt., Dom. Electric Power Co., Ltd., Regina, Sask. (*H*) 2237 Lorne St. (*1938*)

♂ROSS-ROSS, Donald de C., Sub.-Lieut., R.C.N., B.Sc. in M.E., (McGill '17), Chief Indust. Engr., Howard Smith Paper Mills, Ltd., Cornwall, Ont. (*H*) 516 Sydney St. (*S. 1916*) (*Jr. 1918*) (*A.M. 1921*) (*M. 1933*)

ROSTRON, John Robert, Cons. Engr., 570 St. James St., London, Ont. (*A.M 1921*) (*Life Member*)

ROTHMAN, S. M., B.A.Sc., (Tor. '36), 100 Auburn Ave., Toronto, Ont. (*S. 1936*)

ROTHWELL, Jas. M., B.Sc., (B.C. '27), Sr. Instr'man., Surveys Dept., City Engr.'s Office, Vancouver, B.C. (*H*) 3475 West 18th Ave. (*S. 1927*) (*A.M. 1938*)

♂ROUNTHWAITE, Francis George, Lieut., B.Sc., (McGill '16), Gen. Mgr. and Dir., The Bermuda Development Co., Ltd., Tucker's Town, Bermuda, B.W.I. (*S. 1916*) (*Jr. 1920*) (*A.M. 1922*) (*M. 1933*)

ROUSSEAU, Gabriel E., B.Sc., (M.I.T. '25), Dir., Les Ecoles d'Arts et Métiers, 25 E. St. James St., Montreal, Que. (*H*) 4325 Christophe Colomb St. (*A.M. 1935*)

ROUTLEDGE, Geo. Graham, Engr. i/c. Water Distrib., City of Toronto, 507 Richmond St. W., Toronto, Ont. (*H*) 332 St. Clair Ave. E. (*A.M. 1921*)

ROUTLY, Herbert Thos., C.E., (Tor. '05), D.L.S., O.L.S., Pres. and Gen. Mgr., Routly Construction Co., 21 Dundas Sq., Toronto, Ont. (*H*) 200 Dawlish Ave. (*A.M. 1912*) (*M. 1922*)

ROWAN, John J., B.Sc., (Ecole Polytech., Montreal '35), (M.I.T. '36), Imperial Oil Ltd., Montreal East, Que. (*H*) Apt. 8, 5105 St. Catherine St. E. (*S. 1935*)

ROWE, Gordon Wm., B.Sc., (Man. '27), Asst. Engr., National Harbours Bd., Churchill, Man. (*S. 1926*) (*Jr. 1931*) (*A.M. 1937*)

ROWELL, Lorne Archibald, B.Sc., (Sask. '33), B.Eng., (McGill '35), Indust. Engr., Imperial Tobacco Co. Ltd., 3710 St. Antoine St. W., Montreal, Que. (*S. 1935*)

ROWLEY, Harry William, B.Sc., (Mich. State '12), Watermaster, Box 20, Coaldale, Alta. (*A.M. 1922*)

ROY, Eugene, B.A., B.Sc., (Ecole Polytech., Montreal '20), Asst. Engr., City of Outremont, City Hall, Outremont, Que. (*H*) 1064 Bernard Ave. W. (*Jr. 1920*) (*A.M. 1926*)

ROY, J. A. Maurice, (R.M.C., Kingston '38), 79 Claire-Fontaine, Quebec, Que. (*S. 1937*)

ROY, J. E., Engr., Dept. of Colonization, Quebec, Que. (*H*) 129 Lockwell St. (*A.M. 1919*)

ROY, Leo, B.A.Sc., (Ecole Polytech., Montreal '30), B.Eng., (McGill '32), Pr. Sales Engr., Quebec Power Co., Quebec, Que. (*S. 1931*) (*Jr. 1936*)

ROY, Phil, B.Sc., (Queen's '29), Mtce. Engr., Can. Locomotive Co., Kingston, Ont. (*H*) 223 Bagot St. (*S. 1928*)

ROYER, Jacques, B.Eng., (McGill '36), 1990 Rachel St. E., Montreal, Que. (*S. 1934*)

RUBIN, L. J., B.A.Sc., (Tor. '38), 487 Markham St., Toronto, Ont. (*S. 1937*)

RUDDICK, James, Cons. Engr., 414 Power Bldg., Quebec, Que. (*H*) Chateau St. Louis Apts. (*M. 1916*)

RUGGLES, Edgar L., B.Sc., (Sask. '35), The Bird-Archer Co., Ltd., 413 McIntyre Block, Winnipeg, Man. (*H*) 2032 Athol St., Regina, Sask. (*Jr. 1936*)

RUNCIMAN, Arthur Salkeld, (Tor. '11), E.E., (Tor. '28), Supt. of Transm. Lines, Shawinigan Water and Power Co., Montreal, Que. (*H*) 68 Curzon St., Montreal West, Que. (*A.M. 1919*)

RUNDLE, Lewis Philip, B.S., (E.E.), Elec. Engr., Welland Ship Canal, Dept. of Transport, St. Catharines, Ont. (*H*) 28 Academy St. (*M. 1932*)

RUSH, Walter Albert, Controller of Radio, Dept. of Transport, Hunter Bldg., Ottawa, Ont. (*H*) 200 Rideau Terrace. (*A.M. 1921*)

RUSSEL, William B., (Tor. '91), Dir. and Engr., Chambers, McQuigge & McCaffray, Ltd., 1104 Hermant Bldg., Toronto, Ont. (*H*) 189 Wanless Ave. (*S. 1888*) (*A.M. 1899*) (*M. 1903*) (*Life Member*)

RUSSELL, Allan Hugh, Sales Engr., Lyons Fuel, Hardware and Supplies Ltd., Dundas St., Sault Ste. Marie, Ont. (*H*) 21 Lansdowne Ave. (*Jr. 1922*) (*A.M. 1925*)

RUSSELL, Benjamin, B.Sc., (McGill '09), D.L.S., Chief Engr., Water Development Committee, P.F.R., Dept. of Agriculture, Swift Current, Sask. (*S. 1907*) (*A.M. 1913*) (*M. 1924*)

RUSSELL, John Arthur, Chief Mech. Engr., Dom. Coal Co. Ltd., Sydney, N.S. (*H*) 418 Whitney Ave. (*Jr. 1930*) (*A.M. 1937*)

♂RUSSELL, John Hartley, Engr., Russell Construction Co., Ltd., 504 Harbour Commissioners Bldg., Toronto, Ont. (*H*) 48 Bedford Park Ave. (*Jr. 1920*) (*A.M. 1925*)

RUSSELL, Leonard J., B.A.Sc., (Tor. '35), Horton Steel Wks., Ltd., Box 471, Fort Erie North, Ont. (*Jr. 1938*)

♂RUST, Frederick Charles, Dist. Supt., H.E.P.C. of Ont., Toronto, Ont., 23 Rusholme Park Cres. (*S. 1909*) (*Jr. 1913*) (*A.M. 1922*)

♂RUST, Henry P., B.A.Sc., (Tor. '02), Whittle Springs Hotel, Knoxville, Tenn., U.S.A. (*S. 1899*) (*A.M. 1905*) (*M. 1914*)

RUTHERFORD, Andrew Scott, (R.M.C., Kingston), B.Sc., (McGill '22), J. L. E. Price & Co. Ltd., Beaver Hall Bldg., Montreal, Que. (*H*) 4059 Highland Ave. (*S. 1920*) (*A.M. 1928*)

RUTHERFORD, Jas. Forest, B.Sc., (McGill '26), 4685 Cote St. Catherine Rd., Montreal, Que. (*S. 1924*) (*A.M. 1933*)

RUTHERFORD, Stewart F. (q), B.Sc., (McGill '96), Commr., Quebec Streams Comm., 222 New Court House, Montreal, Que. (*H*) 465 Mt. Pleasant Ave., Westmount, Que. (*A.M. 1899*)

RUTLEDGE, Lewis Traver, B.A.Sc., (Tor. '10), Assoc. Prof. of Mech. Engrg., Queen's Univ., Kingston, Ont. (*H*) 602 Earl St. (*Jr. 1912*) (*A.M. 1914*) (*M. 1921*)

RUTLEDGE, Michael Jos., B.Sc., (N.B. '08), City Mgr., City Hall, St. Lambert, Que. (*Jr. 1916*) (*A.M. 1919*) (*M. 1923*)

♂RUTLEY, Frederick George, Capt., B.A.Sc., (Tor. '12), Vice-Pres., The Foundation Co. of Canada, Ltd., 1538 Sherbrooke St. W., Montreal, Que. (*H*) 3487 Atwater Ave. (*A.M. 1921*)

♂RUTTAN, John Douglas, Mgr., Chipman Chemicals Ltd., 1040 Lynn Ave., Winnipeg, Man. (*H*) 587 Stradbrooke Ave. (*A.M. 1921*)

♂RYAN, C. Cedric, Capt., M.C., M.Sc., (McGill '14), Res. Engr., B.C. Pulp and Paper Co. Ltd., Port Alice, B.C. (*S. 1913*) (*A.M. 1924*) (*M. 1936*)

RYAN, Charles Wilbert, B.Sc., (McGill '16), Pres., Ryan Contracting Corp., 340 E. 79th St., New York, N.Y., U.S.A. (*H*) 340 Palmer Rd., Yonkers, N.Y. (*S. 1915*) (*Jr. 1920*) (*A.M. 1927*)

RYAN, Edward A., B.Sc., E.E., (McGill '12), Cons. Engr., 1188 Phillips Place, Montreal, Que. (*H*) 4721 Western Ave., Westmount, Que. (*A.M. 1919*) (*M. 1927*)

RYAN, Ed., B.Sc., (Queen's '29), 232 Sydenham St., Kingston, Ont. (*Jr. 1937*)

RYAN, Hollis Franklin, B.Sc., (N.S.T.C. '26), Mgr., Apparatus Divn., Can. Gen. Elec. Co., Edmonton, Alta. (*H*) 11220–64th St. (*A.M. 1938*)

RYBKA, Karel R., B.Eng., (Prague), D.Sc., '37, Engr. i/c and Mgr., Walter J. Armstrong, Cons. Engr., Rm. 9, 989 Bay St., Toronto, Ont. (*H*) 5 Heath Cres. (*A.M. 1931*) (*M. 1938*)

RYCKMAN, John Hamilton, (Tor. '05), Asst. Engr., Water Works Design, D.P.W., Bureau of Engrg., Rm. 402, City Hall, Chicago, Ill., U.S.A. (*H*) 7653 Coles Ave. (*A.M. 1917*) (*M. 1920*)

RYDER, Frederick J., B.Sc., (McGill '29), Taylor & Gaskin, 3105 Beaufait St., Detroit, Mich., U.S.A. (*H*) 938 Giles Blvd. E., Windsor, Ont. (*S. 1928*) (*Jr. 1935*)

SABOURIN, A. G., (Ecole Polytech., Montreal), Supt'g. Engr., D.P.W., Canada, Hunter Bldg., Ottawa, Ont. (*H*) 40 Riverdale Ave. (*A.M. 1914*)

SADLER, Robert F., B.Sc., (N.B. '36), Chatham, N.B. (*S. 1935*)

SADLER, Wilfred R., 211 Belvidere St., Winnipeg, Man. (*S. 1937*)

♂SAGAR, Wm. Lister, Lieut., B.A.Sc., (Tor. '18), C.E., '37, Asst. Prof. in C.E., Univ. of Toronto, Rm. 13, Electrical Bldg., Toronto, Ont. (*H*) 38 Melrose Ave. (*A.M. 1926*)

SAINT JACQUES, Jean, B.A.Sc., (Ecole Polytech., Montreal '29), B.Sc., (McGill '31), Office Engr., Quebec Power Co., Quebec, Que. (*H*) 49 Moncton St. (*S. 1931*) (*A.M. 1937*)

SAINTONGE, Rosaire, B.A.Sc., (Ecole Polytech., Montreal '37), 3868 Berri St., Montreal, Que. (*S. 1936*)

SALE, Chas. P., B.A.Sc., (Tor. '21), Partner, Sale & Sale, 303 Murray Bldg., Windsor, Ont. (*H*) 1175 Argyle Rd., Walkerville, Ont. (*S. 1921*) (*Jr. 1923*) (*Affil. 1930*)

SALTER, Ernest Milton, B.A.Sc., (Tor. '11), 3 Ronan Ave., Toronto, Ont. (*S. 1911*) (*Jr. 1912*) (*A.M. 1916*)

♂SALTMAN, Fred. Everett, B.Sc., (Dalhousie '22), B.Sc., E.E., (N.S.T.C. '24), M.E., '33, Res. Engr., Dept. of Highways, N.S., Mahone Bay, N.S. (*A.M. 1925*)

SALVADGE, Chas. Harold, B.A.Sc., (Tor. '38), Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*H*) 489 King St. (*S. 1938*)

SAMIS, G. Roy, B.A.Sc., (Tor. '32), Designer, Dom. Bridge Co. Ltd., Montreal, Que. (*H*) 507 St. Joseph St., Lachine, Que. (*Jr. 1937*)

†SAMMETT, Matthew A., B.Sc., Hôpital Notre-Dame de la Merci, 667 Gouin Blvd. W., Montreal, Que. (*A.M. 1904*)

♂SAMPSON, Cyrus Dexter, P.L.S., Engr., International Coal Co. Ltd., Westville, N.S. (*Jr. 1923*) (*A.M. 1934*)

♂SAMPSON, Wm. Thomas, Mine Supt., Wright Hargreaves Mines, Ltd., Kirkland Lake, Ont. (*M. 1932*)

SAMUEL, Myron, (T.H.D. '21), Prop., Empire Engrg. Co., 11 Wellington St. E., Toronto, Ont. (*H*) 118 Spadina Rd. (*Affil. 1931*) (*A.M. 1935*)

SANCTON, Geo. Edward, Gen. Mgr., Fraser & Chalmers of Canada, Ltd., 1411 Crescent St., Montreal, Que. (*H*) 1463 Bishop St. (*M. 1934*)

SANCTON, R. A., Kilmar, Que. (*S. 1931*)

SANDERS, Geo. O., B.Sc., (Queen's '37), 232 Third St. E., Cornwall, Ont. (*S. 1937*)

SANDERS, Robt. L., 15 Union St., Kingston, Ont. (*S. 1938*)

SANDERSON, A. U., B.A.Sc., (Tor. '09), Chief Engr., Water Supply Sect., Dept. of Works, City Hall, Toronto, Ont. (*H*) 45 Poplar Plains Cres. (*A.M. 1921*)

♂SANDERSON, C. J. Lacy, Capt., Civil Aviation Br., P.O. Bldg., Lethbridge, Alta. (*A.M. 1921*)

SANDILANDS, A., Jr., B.Sc., (Man. '31), Power and Mines Supply Co., 123 Princess St., Winnipeg, Man. (*H*) 609 Goulding St. (*S. 1931*) (*A.M. 1938*)

♂SANDWELL, Percy, Lieut., Australian Newsmills Proprietary Ltd., A. M. P. Chambers, Hobart, Tasmania. (*A.M. 1923*) (*M. 1936*)

SANDWELL, Percy Ritchie, B.A.Sc., (B.C. '35), Dom. Engineering Co. Ltd., Lachine, Que. (*H*) 3637 University St., Montreal, Que. (*Jr. 1935*)

SANGER, John William, Chief Engr., City of Winnipeg Hydro-Electric System, 55 Princess St., Winnipeg, Man. (*H*) 62 Harvard Ave. (*A.M. 1921*) (*M. 1936*)

SANNE, Einar Trygue, Chief Dftsman., Montreal Locomotive Wks., Ltd., Montreal, Que. (*H*) 5770 Hutchison St. (*M. 1937*)

SANSOM, Ralph Thos., B.Sc., (N.B. '35), P.O. Box 614, Campbellton, N.B. (*S. 1935*)

SARA, Richard A., B.A.Sc., (Tor. '11 and '14), Mgr., Aladdin Homes Co. Ltd., Royal Bank Bldg., Winnipeg, Man. (*H*) 366 Yale Ave. (*Jr. 1914*) (*A.M. 1920*)

SARAULT, Gilles E., B.Eng., (McGill '34), Chief Engr., Station CBF, Can. Broadcasting Corp., Montreal, Que. (*H*) 791 Rachel St. E. (*S. 1932*)

SARGENT, Chas. D., 224 Second St. E., Cornwall, Ont. (*A.M. 1890*) (*M. 1894*) (*Life Member*)

SARGENT, John, B.Sc., (McGill '29), Coca-Cola Co. of Canada, 90 Broadview Ave., Toronto, Ont. (*S. 1928*) (*A.M. 1936*)

SAUDER, Penrose Melvin, (Tor. '04), Project Mgr., Lethbridge Northern Irrigation Dist., P.O. Box 630, Lethbridge, Alta. (*H*) 639–11th St. S. (*A.M. 1908*) (*M. 1914*)

SAUER, G. Douglas, B.Sc., (McGill '31), (R.M.C., Kingston), Hydraulic Dept., American Gas and Electric Co. Ltd., 30 Church St., New York, N.Y., U.S.A. (*H*) 26 Willow St., Brooklyn, N.Y., U.S.A. (*S. 1930*) (*A.M. 1934*)

SAUER, Max V., B.A.Sc., (Tor. '02), Hydraulic Engr. and Supt., Generating Stations, Montreal L., H. and P. Cons., Power Bldg., Montreal, Que. (*H*) Beauharnois, Que. (*S. 1904*) (*M. 1913*)

SAUNDERS, J. Bruce, B.Sc., (Queen's '23), 82 Albertus Ave., Toronto, Ont. (*S. 1922*)

♂SAUNDERS, Max Gordon, B.A., (Acadia '16), M.A., '17, B.Sc., (N.S.T.C. '23), Mech. Supt., Aluminum Co. of Canada, Arvida, Que. (*H*) 919 Moissan St. (*A.M. 1933*)

♂SAUNDERS, Reginald Geo., Capt., M.C., V.D., Airports Engr., Toronto Harbour Commrs., Fleet St., Toronto, Ont. (*H*) 17 Inglewood Dr. (*S. 1907*) (*Jr. 1911*) (*A.M. 1913*) (*M. 1919*)

♂SAUNDERS, Walter L., Lieut., Res. Engr., Dept. of Highways, Ont., 295 Albert St., Ottawa, Ont. (*H*) 82 Belmont Ave. (*S. 1910*) (*Jr. 1913*) (*A.M. 1920*)

SAUVAGE, Robt., B.A.Sc., (Ecole Polytech., Montreal '24), D.P.W. and L., Parliament Bldgs., Quebec, Que. (*H*) 46 Aberdeen Ave., Apt. 1. (*Jr. 1925*) (*A.M. 1934*)

SAVAGE, Palmer E., B.Sc., (McGill '31), M.Eng., '34, Strl. Designer, Dom. Bridge Co., Ltd., Lachine, Que. (*H*) 4645 Melrose Ave., N.D.G. (*S. 1930*) (*A.M. 1937*)

SAVARD, Guy, (R.M.C., Kingston '37), c/o Alfred Savard, K.C., 71 St. Pierre St., Quebec, Que. (*S. 1935*)

SAVARY, Romeo J. L., (Laval), Q.L.S. and C.E., 36 de Salaberry Ave., Quebec, Que. (*S. 1913*) (*Jr. 1916*) (*A.M. 1917*)

SAWLE, Ross T., B.Sc., (Queen's '34), M.A.Sc., Elec. Engr., English Electric Co. of Canada, Ltd., St. Catharines, Ont. (*S. 1934*)

SCADDING, Simcoe C., B.A.Sc., (Tor. '22), Statistician, Bell Telephone Co. of Canada, 1050 Beaver Hall Hill, Montreal, Que. (*H*) 4539 Oxford Ave., N.D.G. (*S. 1920*) (*Jr. 1930*)

SCALES, Wm., Cons. Engr., Comox, B.C. (*H*) Courtenay, V.I., B.C. (*M. 1936*)

SCANLAN, J. J. Rene, B.Sc., (McGill '26), Engr., Milton Hersey Co. Ltd., Montreal, Que. (*H*) 01088 Charlevoix St. (*S. 1925*) (*A.M. 1935*)

SCARLETT, Barnes K., B.Sc., (Man. '37), Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*H*) 45 Arlington St., Winnipeg, Man. (*S. 1936*)

SCHAEFFER, Jos. Godfrey, B.Sc., (Queen's '23), Sanitary Engr., Prov. Dept. of Health, Parliament Bldg., Regina, Sask. (*H*) 136 Connaught Cres. (*S. 1922*) (*A.M. 1927*)

SCHEAR, Philip M., B.Eng., (McGill '35), Buchans Mining Co. Ltd., Buchans, Nfld. (*S. 1935*)

SCHEEN, Marcel, B.A.Sc., (Ecole Polytech., Montreal '37), Lalonde & Valois, Canada Cement Bldg., Montreal, Que. (*H*) 1228 St. Hubert St. (*S. 1937*)

SCHEMAN, Carl Henry, B.S., (Iowa '10), Chicago Bridge and Iron Wks., 165 Broadway, New York, N.Y., U.S.A.. (*A.M. 1920*) (*M. 1925*)

SCHERMERHORN, H. L., Asst. Engr. of Municipal Roads, Napanee, Ont. (*A.M. 1937*)

SCHIPPEL, Walter H., B.Sc., (McGill '20), M.Eng., '36, Lecturer in Elec. Engrg., McGill Univ., Montreal, Que. (*H*) 327 Dresden Ave., Town of Mount Royal, Que. (*Jr. 1924*)

SCHLEMM, Leonard E., Town Planning Consultant, Rm. 100-01, 1178 Phillips Pl., Montreal, Que. (*A.M. 1913*) (*M. 1923*)

SCHNEDAR, Clarence C., B.Sc., (Sask. '31), 121 Annette St., Toronto, Ont. (*S. 1931*)

SCHNYDER, Max, B.Eng., (McGill '35), Apt. 5, 1865 St. Catherine St. W., Montreal, Que. (*S. 1934*) (*Jr. 1938*)

SCHOFIELD, Robert J. G., B.Eng., (McGill '35), Chemist, Can. Cottons Ltd., Milltown, N.B. (*S. 1935*)

SCHOFIELD, Wm., B.Eng., (McGill '33), Designing Engr., Alliance Paper Mills, Ltd., Merritton, Ont. (*S. 1931*) (*Jr. 1936*)

SCHREIBER, John W., M.E., (Pittsburgh '07), Asst. Chief Engr., Aluminum Co. of America, 801 Gulf Bldg., Pittsburgh, Pa., U.S.A. (*H*) 6320 Burchfield Ave. (*M. 1926*)

SCHULTE, Theodore, Supt., Telephones and Elec. Equipment, D.N.R., C.P.R., P.O. Box No. 1, Strathmore, Alta. (*A.M. 1923*)

SCHULTZ, Chas. D., B.A.Sc., (B.C. '31), British Columbia Timber Commnr., B.W.I., Res., The Liguanea Club, Cross Roads. Address: c/o Can. Bank of Commerce Bldg., Kingston, Jamaica, B.W.I. (*S. 1928*) (*Jr. 1932*)

SCHWARTZ, H. H., B.Eng., (McGill '38), 5230 Clarke St., Montreal, Que. (*S. 1937*)

SCOBIE, A. Gordon, 308 Pine St., Sudbury, Ont. (*S. 1934*)

SCOTT, Alexander, Div. Engr., C.N.R., Charlottetown, P.E.I. (*H*) 18 Euston St. (*A.M. 1921*)

♂SCOTT, Alex. Gordon, B.Sc., (McGill '14), Sec.-Treas., Footwear Findings of Can., Ltd., Cowansville, Que. (*A.M. 1920*)

♂SCOTT, Allen N., Capt., M.C., B.Sc., (McGill '12), Asst. Engr. Constrn., Electrical Comm., City of Montreal, Rm. 717, Tramway Bldg., Montreal, Que. (*H*) 111 Westminster Ave. N., Montreal West, Que. (*S. 1911*) (*A.M. 1921*)

SCOTT, Clarence W. H., B.Sc., (Queen's '27), Can. Bridge Co. Ltd., Walkerville, Ont. (*H*) 1225 Argyle Rd. (*A.M. 1936*)

SCOTT, Daniel S., 190 Fraser St., Quebec, Que. (*S. 1907*) (*A.M. 1910*)

SCOTT, Hew M., Pres., Hew M. Scott, 1103 Millwood Rd., Leaside, Ont. (*H*) 52 Eastbourne Ave., Toronto, Ont. (*M. 1920*)

SCOTT, Jas. M., B.Sc., (N.B. '37), Highway Div., D.P.W., N.B. (*H*) 190 Fraser St., Quebec, Que. (*S. 1937*)

SCOTT, Lewis John, B.Sc., (McGill '23), Engr., Stevenson & Kellogg, 970 Sun Life Bldg., Montreal, Que. (*H*) 4064 Trafalgar Rd., Westmount, Que. (*A.M. 1936*)

SCOTT, Lloyd G., B.Sc., (Man. '32), Asst. to Supt. of Bldgs., Hudson's Bay Co., Edmonton, Alta. (*H*) 9607-105th St. (*S. 1930*) (*Jr. 1936*)

SCOTT, Walter Kingston, 5388-10th Ave., Rosemount, Que. (*A.M. 1919*)

SCOTT, Walter Moffatt, B.A.Sc., (McGill '95), Chairman of Commrs., Greater Winnipeg Water Dist., Winnipeg, Man. (*H*) 188 Montrose St., River Heights. (*S. 1896*) (*A.M. 1902*) (*M. 1906*)

♂SCOTT, Wm. Beverly, Lieut., B.Sc., (McGill '20), Mgr., Laurentide Divn., Consolidated Paper Corp., Ltd., Grand'Mere, Que. (*Jr. 1920*) (*A.M. 1929*)

SCOTT, William Gordon, B.Sc., (McGill '08), Engr., Howard Smith Paper Mills, Ltd., 407 McGill St., Montreal, Que. (*H*) Apt. 24, 3514 Hutchison St. (*A.M. 1922*)

♂SCOTT, W. O. C., B.Sc., M.A.Sc., (B.C. '23), Asst. Plant Supt., Dom. Bridge Co. Ltd., 275 W. 1st Ave., Vancouver, B.C. (*H*) 3808 Slocan St. (*S. 1922*) (*Jr. 1926*) (*A.M. 1931*) (*M. 1936*)

SCOULAR, W. B., B.Sc., (Glasgow '23), Divn. Engr., Consolidated Paper Corp., Wayagamack Divn., Three Rivers, Que. (*H*) 459 St. Fraucois Xavier. (*A.M. 1930*)

SCOVIL, Stuart Southmayd, B.Sc., (Queen's '12), Cons. Hydraulic Engr., 492 Driveway, Ottawa, Ont. (*M. 1921*)

SCRIVENER, Richard H., B.A.Sc., (Tor. '36), Dom. Bridge Co. Ltd., Toronto, Ont. (*H*) 116 Cluny Dr. (*Jr. 1937*)

SCRIVER, Bruce M., B.Eng., (McGill '37), Apt. 2, 6000 Hutchison St., Montreal, Que. (*S. 1937*)

SCRYMGEOUR, Chas., Refinery Engr., Imperial Oil, Ltd., Box 490, Dartmouth, N.S. (*A.M. 1931*)

SCRYMGEOUR, D. Stuart, Sales Engr., London Structural Steel Co. Ltd., London, Ont. (*H*) 26 Langmuir Ave. (*A.M. 1935*)

SCULL, Boucher Pratt, B.Sc., (Sask. '29), Field Engr., Water Rights Br., Sask. Gov't., 501 Leader-Post Bldg., Regina, Sask. (*1938*)

SEABORNE, Rolfe L., B.A.Sc., (Tor. '16), Mgr., Woodlands, Mersey Paper Co., Ltd., Box 306, Liverpool, N.S. (*S. 1914*) (*A.M. 1920*)

SEARS, John Jos., B.Sc., (N.S.T.C. '16), Field Engr., N.S. Light and Power Co., Ltd., Capital Bldg., Halifax, N.S. (*H*) 87 Birmington St. (*A.M. 1924*)

SEATON, N. D., B.A.Sc., (Tor. '12), 11½ Spadina Rd., Toronto, Ont. (*A.M. 1919*)

SEELY, Harold Chipman, B.Sc., (N.B. '26), Siscoe Gold Mines Ltd., Siscoe, Que. (*A.M. 1937*)

SEELY, Wallace Errol, B.Sc., (N.B. '30), Siscoe Gold Mines Ltd., Siscoe, Que. P.O. Box 117. (*H*) 651 Union St., Fredericton, N.B. (*S. 1929*) (*Jr. 1935*)

♂SEFTON, Frank Hugh Cotteril, Chief Dftsman, Way Dept., Toronto Transportation Commrs., Toronto, Ont. (*H*) 393 Glencairn Ave. (*A.M. 1921*)

♂SEGRE, Beresford Henry, Lieut., B.A.Sc., (Tor. '13), D.L.S., Topographical Divn., Bureau of Geology and Topography, Dept. of Mines and Resources, Ottawa, Ont. (*H*) 132 Fentiman Ave. (*A.M. 1921*)

♂SEIBERT, Frederick Victor, B.A.Sc., (Tor. '12), O.L.S., D.L.S., A.L.S., S.L.S., Supt., Nat. Res. Dept., C.N.R., Winnipeg, Man. (*H*) 19-B Locarno Apts. (*A.M. 1920*) (*M. 1922*)

SEIFERT, Harold L. B., B.Eng., (McGill '37), Can. Cellucotton Products Co. Ltd., Niagara Falls, Ont. (*H*) 1443 Victoria Ave. (*S. 1936*)

SENICIE, Michael, B.Eng., (McGill '37), Thetford Mines, Que. (*H*) Ladywood, Man. (*S. 1935*)

SENKLER, Edmund John, B.A.Sc., (B.C. '35), Sales Engr., Faraud & Delorme, Montreal, Que. (*H*) 3637 University St. (*S. 1938*)

SENTANCE, Lawrence Crawley, B.E., (Sask. '35), M.Sc. '37, Can. Westinghouse Co., Hamilton, Ont. (*H*) 36 Gibson Ave. (*S. 1936*)

♂SERSON, Harold Victor, Lieut., (Tor. '05), Asst. Mech. Engr., Dept. of Justice, Penitentiary Br., Confederation Bldg., Ottawa, Ont. (*H*) 58 Willard Ave. (*A.M. 1909*)

SEVIGNY, Jos. Alfred, Dftsman., St. Lawrence Paper Mills Co., Ltd., Three Rivers, Que. (*H*) 733 St. Cecile St. (*S. 1925*) (*Jr. 1933*)

SEXTON, Jack Kenneth, B.Sc., (Sask. '28), Montreal Engineering Co. Ltd., P.O. Box 2400, Montreal, Que. (*H*) 10 Wickstead Ave., Town of Mount Royal, Que. (*S. 1927*) (*Jr. 1929*) (*A.M. 1934*)

SEYBOLD, Hugh G., B.Eng., (McGill '33), Drummond-McCall Co. Ltd., Montreal, Que. (*H*) 331 Lansdowne Ave., Westmount, Que. (*S. 1933*)

SEYMOUR, Horace L., C.E., B.A.Sc., (Tor. '13), D.L.S., O.L.S., Cons. Engr., 87 Cartier St., Ottawa, Ont. (*A.M. 1912*) (*M. 1923*)

SEYMOUR, Wm., B.S., (Mich. '04), Supt., Coke Ovens, Algoma Steel Corp., Sault Ste. Marie, Ont. (*H*) 141 Upton Rd. (*M. 1921*)

SHACKELL, Samuel Wm., Instr'man, C.N.R., Montreal, Que. (*H*) 476 Wood Ave. (*S. 1908*) (*Jr. 1913*) (*A.M. 1919*)

SHANKS, Graham Lawson, B.A.Sc., (Man. '12), M.S., Assoc. Prof., Agricultural Engrg., Univ. of Manitoba, Winnipeg, Man. (*H*) 848 North Dr. (*A.M. 1925*)

SHANKS, Victor, B.A.Sc., (Tor. '35), Lab. Asst., Sangamo Co. Ltd., 183 George St., Toronto, Ont. (*H*) 2 Le Roy Ave. (*S. 1932*) (*Jr. 1937*)

♂SHANLY, James, Lieut., Asst. Gen. Supt., Price Bros. & Co., Ltd., P.O. Box 228, Kenogami, Que. (*Jr. 1920*) (*A.M. 1933*)

SHANNON, John, Agent and Engr., Sir Wm. Arrol & Co., Ltd., 85 Dunn St., Bridgeton, Glasgow, Scotland. (*H*) 11 Gleneairn Dr., Pollokshields, Glasgow, Scotland. (*A.M. 1913*)

SHARP, Wm. Gray, B.Sc., (Alta. '33), Sharp Theatre Supplies, 1021–4th Ave. S.W., Calgary, Alta. (*S. 1933*) (*Jr. 1938*)

SHARPE, Albert Ernest, Asst. Engr., C.P.R., North Battleford, Sask. (*H*) 1132 York St. (*A.M. 1909*) (*M. 1922*)

SHARPE, D. Neville, (Tor. '11), M.L.S., D.L.S., Surveyor and Engr., Prov. of Man., Mines and Natural Resources, 346 Legislative Bldg., Winnipeg, Man. (*H*) 121 Sherburn St. (*S. 1907*) (*A.M. 1913*) (*M. 1927*)

SHATFORD, R. Grant, B.Sc., (Dalhousie '33), B.Sc., (N.S.T.C. '35), Imperial Oil Ltd., Imperoyal, N.S. (*H*) 310 North St., Halifax, N.S. (*S. 1932*)

SHATTUCK, Allan Wayne, B.Sc., (Sask. '30), City Engr., Weyburn, Sask. (*1938*)

SHAW, Charles Berford, R.R. 3, St. Catharines, Ont. (*Jr. 1919*) (*A.M. 1922*)

SHAW, F. W. B., B.Eng., (McGill '34), Steel Co. of Can. Ltd., 525 Dominion St., Montreal, Que. (*H*) 167 Birch Ave., St. Lambert, Que. (*Jr. 1937*)

SHAW, Gerald E., M.Sc., (McGill '25), Asst. Engr., C.P.R., Rm. 401, Windsor Sta., Montreal, Que. (*S. 1921*) (*Jr. 1928*) (*A.M. 1929*)

†SHAW, John Aitken, B.Sc., (McGill), Gen. Elec. Engr., C.P.R., Montreal, Que. (*H*) 448 Lansdowne Ave., Westmount, Que. (*S. 1899*) (*A.M. 1907*) (*M. 1917*)

SHAW, Keith Walker, B.Eng., (McGill '36), 448 Lansdowne Ave., Westmount, Que. (*S. 1936*)

SHAW, Wm. John, Jr., Divn. Engr., Michigan Central Rld., St. Thomas, Ont. (*A.M. 1919*)

SHAW, Wm. Ulric, B.A.Sc., (Tor. '25), Asst. Chief Engr., National Steel Car Corp., Ltd., Malton, Ont. (*H*) Woodbridge, Ont. (*A.M. 1937*)

♂SHEARER, George W., Major, M.Sc., (McGill '07), Pres., James Shearer Construction Co., Montreal, Que. (*H*) 4754 Roslyn Ave. (*S. 1907*) (*A.M. 1912*)

SHEARER, John Leabourne, B.Sc., (Queen's '28), Dept. of Highways, Ont. 295 Albert St., Ottawa, Ont. (*H*) 328 Clemow Ave. (*S. 1928*) (*A.M. 1936*)

SHEARWOOD, Alexander P., B.A., B.Eng., (McGill '30 and '32), Mech. Asst. to Pres., National Steel Car Corp., 437 St. James St., Montreal, Que. (*H*) 120 Aberdeen Ave., Westmount, Que. (*S. 1929*) (*A.M. 1935*)

†SHEARWOOD, Fred. Perry, Cons. Engr., Dom. Bridge Co., Ltd., Montreal, Que. (*H*) 120 Aberdeen Ave., Westmount, Que. (*A.M. 1892*) (*M. 1904*) (*Past-President*)

SHECTOR, Lindley, B.Eng., (McGill '37), Truscon Steel Co. of Can. Ltd., Montreal, Que. (*H*) 2241 Maplewood Ave. (*S. 1937*)

♂SHELDEN, Wm. Leslie, Designing Engr., Water Supply Sect., Wks. Dept., City of Toronto, Rm. 320, City Hall, Toronto, Ont. (*H*) 83 Duggan Ave. (*A.M. 1935*)

♂SHELTON, James Frederick, Dftsman., Welland Canals, Dept. of Transport, St. Catharines, Ont. (*H*) Martindale Rd., Grantham Tp. (*Jr. 1922*) (*A.M. 1936*)

♂SHEPHERD, David, Capt., B.Sc., (Edinburgh '05), Vice-Pres., Campbell & Shepherd, Ltd., 1608 Northern Ontario Bldg., Toronto, Ont. (*H*) 63 Warren Rd. (*A.M. 1921*)

♂SHEPHERD, Hugh W. R., Como, Que. (*S. 1909*) (*Jr. 1914*) (*A.M. 1926*)

SHEPPARD, Norman E. D., B.A.Sc., (Tor. '14) Pres. and Gen. Mgr., Can. Engineering Publications Ltd.; Man'g. Editor, "The Engineering Catalogue," Rm. 924, Confederation Bldg., Montreal, Que. (*H*) 8027 Western Ave., Montreal West, Que. (*S. 1914*) (*A.M. 1916*)

SHERMAN, Harry B., Operating Supt., The Calgary Power Co., Ltd., Insurance Exchange Bldg., Calgary, Alta. (*H*) 2917 Carlton St. (*A.M. 1919*)

♂SHERMAN, Norman Clarence, Lt.-Col., R.C.O.C., (Tor. '10), Ordnance Mech. Engr., Dept. Nat. Defence, H.Q., M.D. No. 3, Kingston, Ont. (*H*) 197 King St. (*Jr. 1911*) (*A.M. 1915*) (*M. 1927*)

SHERRIN, Philip, (Feldkirch '90), Dept. of Mines and Resources, Victoria Memorial Museum, Ottawa, Ont. (*H*) 9, The Kelso, 17 McDonald St. (*A.M. 1919*)

SHERWOOD, Benjamin H., B.Sc., (Alta '35), Imperial Oil Ltd., Calgary, Alta. (*H*) 328-4th Ave. E. (*Jr. 1937*)

♂SHERWOOD, Henry L., Major, R.C.E., (R.M.C., Kingston), Dist. Engr. Officer, Mil. Dist. No. 11, Work Point Barracks, Esquimalt, B.C. (*H*) 1376 Esquimalt Rd. (*S. 1903*) (*A.M. 1907*)

SHERWOOD, Harris Mitchell, B.Sc., (Alta. '33), Can. Industries Ltd., Brownsburg, Que. (*S. 1935*)

SHERWOOD, Luman, (R.M.C., Kingston), 4 Regent St., Ottawa, Ont. (*S. 1900*) (*A.M. 1902*) (*M. 1908*) (*Life Member*)

SHERWOOD, Marvin L., B.A.Sc., (Tor. '36), Plant Engr., The Barrett Co. Ltd., 5551 St. Hubert St., Montreal, Que. (*H*) 3437 Peel St. (*Jr. 1938*)

SHIELDS, Stanley O., B.A.Sc., (Tor. '24), Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*H*) 582 Bolivar St. (*S. 1920*) (*Jr. 1927*) (*A.M. 1936*)

SHIELDS, Wm. Fisher, B.A.Sc., (Tor. '27), 90 O'Brien Blvd., St. Laurent, Que. (*A.M. 1938*)

SHIER, Bruce B., B.Sc., (McGill '23), Can. Telephones and Supplies Ltd., 284 King St. W., Toronto, Ont. (*S. 1921*) (*A.M. 1928*)

♂SHILLINGLAW, Walter H., Capt., 302 Russell St., Brandon, Man. (*S. 1887*) (*A.M. 1900*) (*M. 1908*) (*Life Member*)

SHIRLEY, Ernest Roxford, B.A., B.Sc., (Queen's '12), Elec. Engr., Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*H*) 319 Frederick Ave. (*M. 1919*)

SHISKO, Nicholas, Ansonville, Ont. (*S. 1938*)

SHOTWELL, J. S. G., B.Sc., (McGill '25), Ph.D., (Columbia '32), Cons. Engr., 700 Ottawa Electric Bldg., Ottawa, Ont. (*S. 1917*) (*Jr. 1922*) (*A.M. 1928*)

SHUPE, Stanley, B.A.Sc., (Tor. '14), City Engr., Kitchener, Ont. (*H*) 174 Queen St. (*A.M. 1920*) (*M. 1923*)

SHUTTLEWORTH, Wilbur L., Apt. 5, 552 Gilmour St., Ottawa, Ont. (*Jr. 1932*) (*A.M. 1935*)

SIBBARD, Stanley W., B.A.Sc., (Tor. '37), Algoma Steel Corp. Ltd., Sault Ste. Marie, Ont. (*H*) Apt. 7, 676 Bay St. (*Jr. 1938*)

♂SILL, Albert Jennings, Lieut., Supervising Engr., C.N.R., Edmonton, Alta. (*M. 1917*)

SILLCOX, Lewis Ketcham, D.Sc., (Brussels '03), 1st Vice-Pres., The New York Air Brake Co., 420 Lexington Ave., New York, N.Y., U.S.A. (*H*) 519 Washington St., Watertown, N.Y. (*M. 1926*)

SILLIMAN, Justus M., C.E., 53 Kensington Ave., Kingston, Ont. (*S. 1907*) (*A.M. 1912*)

SILLITOE, Sydney, B.Sc., (Alta. '31), M.Sc., '33, Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*H*) 1494 Mackay St. (*S. 1930*) (*Jr. 1936*)

SILLS, Hubert R., B.Sc., (Queen's '21), Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*H*) 513 Gilmour St. (*S. 1921*) (*Jr. 1926*) (*A.M. 1936*)

SILVER, Benjamin L., B.A., (McGill '13), B.Sc., '17, 719–8th Ave., Brooklyn, N.Y., U.S.A. (*A.M. 1920*)

SILVER, Ralph C., B.Sc., M.Sc., (McGill '27 and '29), Protection Engr., Gatineau Power Co., P.O. Box 88, Ottawa, Ont. (*S. 1926*) (*A.M. 1937*)

SILVERBERG, David Max, B.Sc., (Man. '36), 291 Manitoba Ave., Winnipeg, Man. (*S. 1938*)

SIMARD, J. M., B.A.Sc., (Ecole Polytech., Montreal '37), 7527 St. Gerard St., Montreal, Que. (*S. 1936*)

♂SIMMERS, Jos. Adolph, Lieut., B.A.Sc., (Tor. '21), Designing Engr., The Ontario Paper Co. Ltd., Thorold, Ont. (*H*) 10 Wychwood Rd., St. Catharines, Ont. (*S. 1921*) (*Jr. 1926*) (*A.M. 1929*)

SIMMONS, Herbert John, B.Sc., (Queen's '31), General Steel Wares Ltd., London, Ont. (*H*) 517 William St. (*S. 1928*) (*Jr. 1936*)

SIMON, Robt. C., B.Sc., (McGill '26), Imperial Oil Ltd., Montreal East, Que. Address: Central Y.M.C.A., Drummond St., Montreal, Que. (*S. 1925*) (*Jr. 1931*) (*A.M. 1936*)

SIMPKIN, Douglas Benjamin, B.Sc., (Alta. '22), Noranda Mines Ltd., Box 152, Noranda, Que. (*S. 1919*) (*Jr. 1927*) (*A.M. 1933*)

SIMPSON, Albert Edward, B.Sc., (McGill '23), Supt., Aerial Surveys Divn., Can. Airways, Ltd., 480 Lagauchetiere St. W., Montreal, Que. (*H*) 4866 Cote des Neiges Rd. (*A.M. 1933*)

SIMPSON, Clarke Cecil, B.Sc., (Alta. '37), Northern Electric Co. Ltd., Edmonton, Alta. (*H*) 11631–95-A St. (*S. 1938*)

♂SIMPSON, Frederick Creswell, Sales Mgr., Herbert Morris Crane and Hoist Co. Ltd., Niagara Falls, Ont. (*H*) 1011 Armoury St. (*A.M. 1938*)

♂SIMPSON, Fred. John, Lt.-Col., V.D., Head of Dfting. Dept., T. J. Trapp Tech. High School, 236 Third Ave., New Westminster, B.C. (*A.M. 1936*)

SIMPSON, John H., B.Eng., (McGill '37), Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (*H*) 494 Charlotte St. (*S. 1937*)

SIMPSON, Philip, Sr. Dftsman., Handley Page Ltd., London, England. (*H*) 32 Crundale Ave., Kingsbury, London, N.W.9, England. (*A.M. 1923*)

♂SIMSON, D. C. Unwin, Major, Res. Engr., Can. Battlefields Memorials Comm., 53 Blvd. de Beausejour 53, Passy-Paris, 16e, France. (*A.M. 1921*)

SINCLAIR, Archie B., B.Sc., (Man. '27), Chief Operator, Kenogami Substation, Price Bros. & Co. Ltd., Kenogami, Que. P.O. Box 617. (*S. 1927*) (*Jr. 1928*) (*A.M. 1935*)

SINCLAIR, Geo., B.Sc., (Alta. '33), M.Sc., '35, Northern Broadcasting Corp., Ltd., CFGP, Grande Prairie, Alta. (*S. 1933*)

SINCLAIR, Malcolm, 108 Tupper Ave., Yorkton, Sask. (*A.M. 1917*)

SINNAMON, Alvin Wheeler, (Belfast T.C. '88), Factory Mgr., The Allied Metals Inc., Niles, Ohio, U.S.A. (*H*) 21 S. Crandon Ave. (*M. 1920*)

SINTON, James, Address unknown. (*A.M. 1911*)

SISE, Paul Fleetford, B.Sc., (McGill '01), Pres., Northern Electric Co. Ltd., Rm. 1600, 1050 Beaver Hall Hill, Montreal, Que. (*H*) 1266 Redpath Cres. (*M. 1920*)

SISSON, Chas. E., (Tor. '05), Wks. Engr., Can. Gen. Elec. Co. Ltd., 940 Lansdowne Ave., Toronto, Ont. (*H*) 24 The Kingsway. (*M. 1919*)

SISSON, Heber Percival, Dept. of Highways, Ont., 239 W. Amelia St., Fort William, Ont. (*H*) 11 Crown St., Port Arthur, Ont. (*Affil. 1936*)

SKAPERDAS, Geo. T., B.Eng., (McGill '36), Mass. Inst. of Tech., Graduate House, Cambridge, Mass., U.S.A. (*S. 1936*)

SKARIN, Emil R. T., B.Sc., (Alta. '18), Pres. and Supt., Crown Paving and Construction Co., Ltd., Edmonton, Alta. (*H*) 11115–89th Ave. (*M. 1936*)

SKELTON, C. Hastings, B.Sc., (McGill '30), Research Engr., Consolidated Paper Corp., Three Rivers, Que. (*H*) 1154 Royale, Three Rivers, Que. (*S. 1929*) (*Jr. 1935*)

SKERRY, Francis S., B.Eng., (N.S.T.C. '35), 7 Queensville Ave., Stafford, Staffordshire, England. (*Jr. 1938*)

SKOLFIELD, Herbert Nason, B.Sc., (C.E.), (Maine '14), Res. Engr., State of Maine Highway Dept., Ellsworth, Maine, U.S.A. (*A.M. 1919*)

SLATER, Stewart, (R.M.C., Kingston '37), 358 Brock St., Kingston, Ont. (*S. 1938*)

♂SLINN, Wm. Harmon, Lieut., B.Sc., (Queen's '16), Divn. Plant Engr., The Bell Telephone Co. of Can., 1399 Bathurst St., Toronto, Ont. (*H*) 14 Glenholme Ave. (*S. 1916*) (*Jr. 1918*) (*A.M. 1920*)

SMAILL, William, B.Sc., (McGill '90), Chief Engr., Northern Construction Co., 1101 Vancouver Block, Vancouver, B.C. (*M. 1918*)

SMALL, Frank S., B.Sc., (McGill '14), Duck River, Man. Address: c/o 911 McArthur Bldg., Winnipeg, Man. (*S. 1909*) (*A.M. 1917*) (*M. 1929*)

SMALLHORN, Edward Robert, B.Sc., (McGill '23), Man'g. Dir., Aerocrete Construction Co. Ltd., P.O. Box 132, Station Hochelaga, Montreal, Que. (*H*) 5076 Victoria Ave. (*S. 1923*) (*A.M. 1932*)

SMALLWOOD, Franklin, Chief Engr., Algoma Steel Corp., Ltd., Sault Ste. Marie, Ont. (*H*) 10 Forest Ave. (*M. 1921*)

SMALLWOOD, R. E., B.A.Sc., (Tor. '35), Dom. Engineering Co. Ltd., Lachine, Que. (*H*) 226 Redfern Ave., Westmount, Que. (*S. 1935*)

†SMART, Russel S., B.A., M.E., (Tor. '13), Smart & Biggar, 609 Victoria Bldg., Ottawa, Ont. (*Affil. 1908*) (*A.M. 1911*) (*M. 1921*)

SMART, Valentine Irving, Col., B.A., (Queen's '97), Deputy Minister, Dept. of Transport, Ottawa, Ont. (*H*) Chateau Laurier. (*M. 1917*)

SMILEY, Donald C., 124 Hamilton Ave., Ottawa, Ont. (*S. 1938*)

SMITH, Adam W. Simpson, B.Sc., (McGill '23), Asst. Engr., H.E.P.C. of Ont., Toronto, Ont. (*H*) 7 Edgewood Cres. (*S. 1921*) (*A.M. 1938*)

SMITH, Allan G., B.Eng., (McGill '37), Northern Electric Co. Ltd., Montreal, Que. (*H*) 7446 Wiseman Ave. (*S. 1937*)

SMITH, Allan J., M.E. and E.E., (Ohio State '23), M.A.Sc., (B.C. '33), Cons. Engr., 608 Pacific Bldg., Vancouver, B.C. (*H*) 2076 W. 49th Ave. (*M. 1936*)

SMITH, Arthur, (*q*), M.A., (Laval), Q L.S., Apt. 54, 220 Grande Allée, Quebec, Que. (*A.M. 1898*) (*Life Member*)

SMITH, Arthur Albert, Chief Engr., Dept. of Highways, Ont. (*H*) 160 Stibbard St., Toronto 12, Ont. (*M. 1921*)

SMITH, A. J. E., B.A.Sc., (Tor. '35), Sales Engr., Can. Allis-Chalmers Ltd., Winnipeg, Man. (*H*) 115 Gerard St. (*S. 1935*)

SMITH, A. T. Eric, B.A., (Sask. '18), S.B., (M.I.T. '21), Alkali Divn., Can. Industries Ltd., P.O. Box 10, Montreal, Que. (*A.M. 1929*)

SMITH, Carl C., B.Sc., (Queen's '32), Can. Westinghouse Co. Ltd., Hamilton, Ont. (*H*) 785 King St. E. (*S. 1928*) (*Jr. 1935*)

♂SMITH, David Rudolph, Lieut., B.A., B.Sc., (N.B.), D.L.S., Dir. of Wks., City of Saint John, Saint John, N.B. (*H*) 38 Wentworth St. (*Jr. 1914*) (*A.M. 1920*)

SMITH, Durnford D. P., B.Sc., M.Sc., (McGill '34, '36), 42 Windsor Ave., Westmount, Que. (*S. 1936*)

♂SMITH, Ernest, Asst. Dist. Engr., D.P.W., B.C., Court House, New Westminster, B.C. (*A.M. 1922*)

SMITH, Eugene Lloyd, B.Sc., (Alta. '30), Chem. Engr., City of Edmonton Pr. Plant, Edmonton, Alta. (*H*) 9844–103rd St. (*S. 1930*) (*A.M. 1936*)

SMITH, Frank Lawrence, Asst. Chief Dftsman., Hamilton Bridge Co., Ltd., Hamilton, Ont. (*H*) 46 Kensington Ave. (*A.M. 1921*)

SMITH, Fred. G., Bridge and Struct. Engr., D.P.W., Canada, Rm. 874, Hunter Bldg., Ottawa, Ont. (*H*) 146 Broadway Ave. (*A.M. 1918*)

♂SMITH, George Ellis, B.Sc., (N.B. '12), Chief Engr.'s Office, C.N.R., Moncton, N.B. (*A.M. 1921*)

SMITH, Gerald McRae, B.Sc., (Alta. '35), International Nickel Co , Sudbury, Ont. (*H*) 208 McKenzie St. (*S. 1935*)

SMITH, Gordon J., B.A., B.Sc., (C.E.), (Queen's), Sec.-Treas., Gen. Alumni Assoc.; Mgr., Employment Service Bureau, Queen's Univ., Kingston, Ont. (*H*) 266 Albert St. (*A.M. 1920*)

SMITH, Hamilton E., B.Sc., (McGill '25), Coverdale & Colpitts, Cons. Engrs., 120 Wall St., New York, N.Y., U.S.A. (*H*) 325 E. 41st St. (*S. 1925*) (*A.M. 1930*)

SMITH, James Norman, Supervising Engr., Pr. Plant, Glen Rd. Pr. House, City of Westmount, Westmount, Que. (*H*) 3072 The Boulevard. (*M. 1921*)

♂SMITH, J. Leslie, M.C. and Bar, B.Sc., (Leeds '22), Sr. Asst. Engr., Aeronautical Engrg. Divn., Dept. of Transport, Hunter Bldg., Ottawa, Ont. (*H*) 108 Russell Rd., Overbrook, nr. Ottawa, Ont. (*A.M. 1937*)

SMITH, Joseph A., B.A.Sc., Dist. Engr., Marine Services, Dept. of Transport, Quebec, Que. (*H*) 334 Grande Allée. (*S. 1908*) (*A.M. 1910*)

G.†SMITH, Julian C., M.E., (Cornell), LL.D., (Queen's '23), LL.D., (McGill '28), Pres., Shawinigan Water and Power Co., 611 Power Bldg., Montreal, Que. (*H*) 619 Sydenham Ave., Westmount, Que. (*S. 1904*) (*A.M. 1904*) (*M. 1911*) (*Past-President*)

SMITH, N. J. W., Capt., (R.M.C., Kingston), B.Eng., (McGill '32), 25 Rathnally Ave., Toronto, Ont. (*S. 1931*)

SMITH, Odric H., B.Eng., (McGill '35), Walter J. Armstrong, Cons. Engr., 989 Bay St., Toronto, Ont. (*H*) 11 Melbourne Ave., Westmount, Que. (*S. 1935*)

SMITH, Owen Leonard, Jr. Engr., Can. Comstock Co., Ltd., New Birks Bldg., Montreal, Que. Address: Central Y.M.C.A. (*S. 1935*) (*Jr. 1938*)

SMITH, Owen W., B.Eng., Asst. Dist. Engr., Prov. of B.C., Lillooet, B.C. B.C. (*H*) 1720 Beach Dr., Victoria, B.C. (*S. 1895*) (*A.M. 1901*) (*M. 1910*)

♂SMITH, Paul Moody, Mgr., P. M. Smith Construction Co., Vancouver, B.C. (*H*) 3241 Point Grey Rd. (*A.M. 1920*)

SMITH, Robert Melville, B.Sc., (Queen's '14), Deputy Minister, Dept. Public Highways, Ont., Parliament Bldgs., Toronto, Ont. (*A.M. 1921*)

SMITH, Wilfrid Ewart, B.Sc., (N.B. '35), 852 George St., Fredericton, N.B. (*S. 1934*)

SMITH, Wm. Chester, B.A.Sc., C.E., (Tor. '12, '17), Mgr., Engrg. Divn., The Cooksville Co. Ltd., 46 Bloor St. W., Toronto, Ont. (*H*) 204 Glen Rd. (*M. 1936*)

P.†SMITH, William Nelson, M.E., (Cornell), Report Engr., E. M. Gilbert Engrg. Corp., 412 Washington St., Reading, Pa., U.S.A. (*H*) 1518 Cleveland Ave., Wyomissing, Pa., U.S.A. (*M. 1919*)

♂SMITH, Wm. Raywood, Asst. County Engr., Middlesex, County Bldgs., London, Ont. (*H*) R.R. 3, Lambeth, Ont. (*A.M. 1918*)

SMITHER, Wm. James, B.A.Sc., (Tor. '05), Assoc. Prof. of Struct. Engineering, Univ. of Toronto, Toronto, Ont. (*H*) 35 Wilberton Rd. (*A.M. 1914*) (*M. 1925*)

♂SMYTH, Charles McDowall ,Major, M.M., Gen. Supt., Eastern Light and Power Co. Ltd , Sydney, N.S. (*H*) 46 Lorway Ave. (*Jr. 1920*) (*A.M. 1921*) (*M. 1931*)

SMYTH, Wm. Christopher, B.Eng., (McGill '36), c/o H. J. O'Connell Ltd., 509 Canada Cement Bldg., Montreal, Que. (*S. 1935*)

♂SMYTHE, R. Eric, Col., D.S.O., M.C., B.A.Sc., (Tor. '26), Dir., Technical Service Council, 2 Grosvenor St., Toronto, Ont. (*H*) 38 Duplex Ave. (*Jr. 1920*) (*A.M. 1929*) (*M. 1935*)

♂SMYTHIES, Reginald Eric, Lieut., R.N.V.R., R.R. 1, Cadboro Bay, B.C. (*A.M. 1924*) (*M. 1926*)

♂SNAPE, John Ball, Res. Engr., Dept. of Mines and Resources, Jasper, Alta. (*A.M. 1937*)

SNIDER, Arthur Melville, B.A.Sc., (Tor. '17), Gen Mgr., Sunshine Waterloo Co., Ltd., Waterloo, Ont. (*H*) 115 Allen St. W. (*S. 1917*) (*Jr. 1918*) (*A.M. 1922*)

SNYDER, Beverley Wells, B.Sc., (Alta. '31), Engr. Asst., Can. Western Natural Gas, L., H. and Pr. Co. Ltd., Calgary, Alta. (*H*) 923–18th Ave. W. (*A.M. 1937*)

♂SNYDER, Frederic Antes, Col., D.S.M., Engr., Hudson and Manhattan Railroad Co., Rm. 727, 30 Church St., New York, N.Y., U.S.A. (*H*) 105 Carnegie Ave., East Orange, N.J., U.S.A. (*M. 1915*)

SNYDER, Robt. Bertrum, B.Sc., (Sask. '38), Lashburn, Sask. (*S. 1938*)

SNYDER, W. G., B.Eng., (McGill '38), 2063 Stanley St., Montreal, Que. (*S. 1937*)

SOLES, Wm. E., B.Sc., (Queen's '35), Gaspesia Sulphite Co., Ltd., Chandler, Que. (*H*) Rock Island, Que. (*S. 1935*) (*Jr. 1938*)

SOMERS, Claude Judson, B.Sc., (N.B. '36), Howard Smith Paper Mills, Cornwall, Ont. (*H*) 217 First St. E. (*S. 1936*) (*Jr. 1937*)

SOMERVILLE, A. L. H., B.A.Sc., (B.C. '23), Dist. Airway Engr., Civil Aviation Br., Dept. of Transport, P.O. Bldg., Lethbridge, Alta. (*H*) 307–12th St. S. (*A.M. 1936*)

SOMMERVILLE, Donald B., B.A.Sc., (Tor. '35), 131 de Forest Rd., Toronto, Ont. (*Jr. 1937*)

SOUBA, Wm. Henry, M.E., (Minn. '09), 4601 Edina Blvd., Country Club Dist., Minneapolis, Minn., U.S.A. (*M. 1922*)

SPARK, Harry S., Asst. Engr., Port of Montreal, National Harbours Board, Montreal, Que. (*H*) Apt. 34, 223 Melville Ave., Westmount, Que. (*A.M. 1922*)

SPARKS, Wilbur Hamilton, B.A.Sc., (B.C. '35), Hydraulic Engr., Water Rights Br., Dept. of Lands, B.C., Victoria, B.C. (*H*) 1745 Foul Bay Rd. (*S. 1928*) (*Jr. 1934*)

SPARKS, Roderick F., B.Eng., (McGill '37), 544 Driveway, Ottawa, Ont. (*S. 1937*)

SPENCE, G. D., B.Sc., (N.S.T.C. '32), St. Croix, Hants Co., N.S. (*S. 1931*)

SPENCE, John Jas., (Tor. '09), Lecturer, Engrg. Drawing, Faculty of Applied Science and Engrg., Univ. of Toronto, Toronto, Ont. (*H*) 162 Glencairn Ave. (*A.M. 1926*)

SPENCER, G. H., (R.M.C., Kingston '38), Royal Military College, Kingston, Ont. (*S. 1938*)

♂SPENCER, Henry Cyril, Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*H*) 4321 Beaconsfield Ave., N.D.G. (*A.M. 1935*)

SPENCER, Raymond A., B.Sc., (Vermont '08), Asst. Gen. Mgr., The Can. Bridge Co., Ltd., Walkerville, Ont. (*H*) 1226 Chilver Rd. (*M. 1927*)

♂SPENCER, Roy Aubrey, Major, M.C. and Bar, B.Sc., M.Sc., (McGill), Prof. of C.E., Univ. of Saskatchewan, Saskatoon, Sask. (*H*) 915 Temperance St. (*S. 1907*) (*Jr. 1913*) (*A.M. 1919*)

SPOTTON, John Greer, B.A.Sc., (Tor. '22), Sales Engr., Mfrs.' Representative, 68 Parkdale Rd., Toronto, Ont. (*S. 1920*) (*Jr. 1924*) (*A.M. 1934*)

SPRATT, Maynard James, B.Sc., (McGill '22), Chief Engr., Sask. Pool Elevators Ltd., Regina, Sask. (*H*) 2302 Elphinstone St. (*S. 1921*) (*A.M. 1927*) (*M. 1936*)

♂SPRENGER, A. Reginald, Lt.-Col., (R.M.C., Sandhurst '97), (C.G.I.), Filmite Co. Reg'd., 3451 Colonial Ave., Montreal, Que. (*S. 1906*) (*A.M. 1908*) (*M. 1919*)

SPRIGGS, Robert Hayward, B.Sc., (McGill '24), The Bell Telephone Co. of Canada, Ltd., 320 Bay St., Toronto, Ont. (*H*) 552 Briar Hill Ave. (*S. 1920*) (*Jr. 1929*)

SPRINGFORD, Wm. R. H., B.Sc., (N.B. '37), 29 Allen St., Fredericton, N.B. (*S. 1937*)

♂SPROULE, George, Lieut., Exec. Engr., D.P.W., Nigeria, W.A. Address: Castle Lodge, Fintona, Tyrone, Ireland. (*A.M. 1917*)

P.†SPROULE, Gordon St. George, B.Sc., M.Sc., (McGill '08, '09), Assoc. Prof. of Metallurgy, McGill Univ., Montreal, Que. (*H*) 39 Thornhill Ave., Westmount, Que. (*S. 1904*) (*Jr. 1912*) (*A.M. 1920*) (*M. 1932*)

SPROULE, John Edmond, B.Sc., (McGill '16), Gen. Mgr., Can. Hoosier Engineering Co. Ltd., 5380 Cote St. Paul Rd., Montreal, Que. (*H*) 3774 Wilson Ave., N.D.G. (*A.M. 1926*)

STADLER, John, Industrial Engr., 1117 St. Catherine St. W., Montreal, Que. (*H*) 4334 Westmount Ave., Westmount, Que. (*M. 1921*)

STADLER, John Chas., B.Sc., (McGill '31), Station Mgr., CBM-CBF, Can. Broadcasting Corp., 1231 St. Catherine St. W., Montreal, Que. (*H*) 4334 Westmount Ave., Westmount, Que. (*S. 1927*) (*A.M. 1937*)

STAFFORD, J. W., B.Sc., (Alta. '37), Asst. Power Engr., Saguenay Power Co., Ltd., Box 58, Arvida, Que. (*S. 1936*)

♂STAIRS, Denis, B.E., (Dalhousie '09), Montreal Engineering Co., 244 St. James St., Montreal, Que. (*H*) 841 Lexington Ave. (*M. 1930*)

STAMFORD, Wm. Leonard, B.A.Sc., (Tor. '09), Acting Agent, Dept. of Transport, Prince Rupert, B.C. (*A.M. 1916*)

STANFIELD, John Y., (R.M.C., Kingston), B.Sc., (N.S.T.C. '33), Sales Engr., Anti Hydro of Canada Ltd., 309 Shaughnessy Bldg., Montreal, Que. (*H*) 17879 Gouin Blvd. W., St. Genevieve, Que. (*S. 1932*) (*Jr. 1937*)

STANLEY, James Norman, B.Sc., M.A., Beechwood Ave., R.R. 2, York Mills, Ont. (*S. 1908*) (*A.M. 1912*)

STANLEY, Jas. Paul, B.Eng., (McGill '38), Stevenson & Kellogg, 970 Sun Life Bldg., Montreal, Que. (*H*) 559 Lansdowne Ave., Westmount, Que. (*S. 1938*)

STANLEY, Thos. Douglas, B.Sc., (Alta. '32), M.Eng., (McGill '33), Asst. Engr., Calgary Power Co. Ltd., 205 McLeod Bldg., Edmonton, Alta. (*H*) Ste. 2, 11224-199th Ave. (*S. 1932*) (*Jr. 1937*)

P.†STANSFIELD, Alfred, D.Sc., (London), 3182 The Boulevard, Westmount, Que. (*Affil. 1904*) (*M. 1918*) (*Life Member*)

P.†STANSFIELD, Edgar, M.Sc., Chief Chem. Engr., Research Council of Alberta. Address: Univ. of Alberta, Edmonton, Alta. (*H*) 11009-88th Ave. (*M. 1918*)

STAPLETON, David O., B.Eng., (McGill '38), 1130 Sherbrooke St. W., Montreal, Que. (*S. 1938*)

STARKEY, J. Leonard, 4559 Madison Ave., Montreal, Que. (*S. 1933*)

♂STAVERT, R. Ewart, B.Sc., (McGill '14), Asst. to Pres., Cons. Mining and Smelting Co. of Can., 215 St. James St., Montreal, Que. (*H*) 625 Carleton Ave., Westmount, Que. (*Jr. 1919*) (*A.M. 1926*)

STEAD, Geoffrey, B.A., C.E., (N.B. '92), Dist. Engr., D.P.W., Canada, Box 1417, Saint John, N.B. (*H*) 257 Princess St. (*A.M. 1900*) (*M. 1921*) (*Life Member*)

STEAD, Harry G., Chief Dftsman., E. Leonard & Sons, Ltd., London, Ont. (*H*) 352 Piccadilly St. (*Jr. 1938*)

♂µ †STEDMAN, Ernest Walter, O.B.E., (A.R.C.S., London), Air Commodore, R.C.A.F., Chief Aero. Engr., Dept. of National Defence, Canadian Bldg., Ottawa, Ont. (*M. 1921*)

♂STEEL, Francis M., Lt.-Col., D.S.O., Petroleum Engr., Indian Affairs Br., Dept. of Mines and Resources, 503 Public Bldg., Calgary, Alta. (*H*) 515 Sunderland Ave. (*M. 1920*)

STEENBUCH, Harald L., B.A., Engrg. Dept., Shawinigan Water and Power Co., Power Bldg., Montreal, Que. (*A.M. 1912*)

µ.STEEVES, Beverley Hall, B.Sc., (McGill '23), Transformer Prod. Engr., Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*H*) 3469 Harvard Ave. (*A.M. 1929*)

STEEVES, John Trites R., B.Sc., (McGill '12), Dir., Imperial Tobacco Co. of Can., Ltd., 3810 St. Antoine St., Montreal, Que. (*H*) 4151 Hampton Ave. (*S. 1912*) (*A.M. 1917*)

STEEVES, Kenneth Leslie, Box 191, Univ. of Alberta, Edmonton, Alta. (*S. 1937*)

STEEVES, Samuel Merritt, B.Sc., (Man. '25), Topographical Engr., Dept. of Mines and Resources, Victoria Memorial Museum, Ottawa, Ont. (*H*) 36 Renfrew Ave. (*S. 1924*) (*A.M. 1930*)

♂STEIN, Chas. R. S., Lt.-Col., R.C.E., Royal Military College of Canada, Kingston, Ont. (*A.M. 1925*)

STEIN, Marcus, B.Eng., (McGill '34), 4660 Hutchison St., Montreal, Que. (*Jr. 1937*)

STEINMAN, David Barnard, B.S., (City of N.Y. '06), C.E. and A.M., (Columbia '09), Ph.D., '10, Cons Engr., Robinson & Steinman, 117 Liberty St., New York, N.Y., U.S.A. (*M. 1929*)

STEINMAYER, Otto C., B.S., (Illinois '02), Timber Preservation Supt., Canada Creosoting Co. Ltd., 423 Canada Cement Bldg., Montreal, Que. (*H*) 512 Prince Albert Ave., Westmount, Que. (*M. 1925*)

STENBOL, Carl, Mech. Supt., Algoma Steel Corp., Sault Ste. Marie, Ont. (*H*) 167 Simpson St. (*M. 1921*)

♂STENHOUSE, Ronald H., Div. Engr., C.P.R., Box 447, Farnham, Que. (*Jr. 1920*) (*A.M. 1922*)

STEPHEN, Gordon Robt., B.Sc., (McGill '23), Engr., Fraser, Brace Ltd., Power Bldg., Montreal, Que. (*H*) 4546 Kensington Ave. (*A.M. 1933*)

STEPHENS, Donald McGregor, B.Sc., (Man. '31), Office Engr., Dept. of Mines and Nat. Resources, 346 Parliament Bldgs., Winnipeg, Man. (*H*) 170 Chestnut St. (*Jr. 1934*) (*A.M. 1935*)

♂STEPHENS, George Leslie, Engr. Cmdr., R.C.N., Chief Engr., H.M.C. Dockyard, Esquimalt, B.C. (*A.M. 1919*) (*M. 1926*)

♂STEPHENS, John, Lieut., D.Sc., (N.B. '27), Prof., Mech. Engrg., University of N.B., Fredericton, N.B. (*H*) Waterloo Row. (*M. 1924*)

STEPHENSON, Daryl Courtenay, Dist. Mgr., Nanaimo Duncan Utilities Co. Ltd., Nanaimo, B.C. (*1938*)

♂STEPHENSON, George, Mech. Engr., The E. B. Eddy Co. Ltd., Hull, Que. (*H*) 376 Hinton Ave., Ottawa, Ont. (*A.M. 1931*)

♂STEPHENSON, Geo. Elgin, Lieut., B.A.Sc., (Tor. '20), County Engr. and Rd. Supt., Bruce County, Box 398, Walkerton, Ont. (*S. 1915*) (*Jr. 1921*) (*A.M. 1923*)

STEPHENSON, John, Box 117, Queen St., Sydney Mines, N.S. (*A.M. 1921*)

STEPHENSON, J. G., Elec. Supt., Teck Hughes Gold Mines, Ltd., Kirkland Lake, Ont. (*S. 1923*)

STEPHENSON, John G., (R.M.C., Kingston '38), 818 Victoria Rd., Windsor, Ont. (*S. 1937*)

STEPHENSON, S., Whiting Corp. (Canada) Ltd., 54 Wellington St. W., Toronto, Ont. (*H*) 63 Roehampton Ave. (*S. 1930*)

G.STERNS, Frank Ernest, M.Sc., (McGill '03), Engr., National Harbours Board, Ottawa, Ont. (*H*) 63 Cartier St. (*A.M. 1907*) (*M. 1926*)

STERNS, Laurence, B.Sc., (N.S.T.C. '24), N.B. International Paper Co., Dalhousie, N.B. (*S. 1923*) (*Jr. 1925*) (*A.M. 1929*)

♂STEVENS, Frederick, M.M., Squad Foreman, Can. Bridge Co. Ltd., Walkerville, Ont. (*H*) 690 Windermere Rd. (*A.M. 1923*)

STEVENS, Hugh E., Headquarters, B.C. (*A.M. 1917*)

STEVENS, Robt. Herbert, Tech. Engr., Waterworks Dept., City of Edmonton, Civic Block, Edmonton, Alta. (*H*) 9406-96th-A St. (*A.M. 1927*)

STEVENS, Robt. L., B.Sc., (Alta. '35), 185 Gilmour St., Ottawa, Ont. (*S. 1935*)

STEVENS GUILLE, H. Le Marchant, B.Sc., (Birmingham '24), Chem. Engr., Royalite Oil Co., Ltd., Turner Valley, Alta. (*A.M. 1936*)

STEVENSON, Chas. L., B.Sc., (N.B. '34), Can. Engrg. and Contracting Co. (Quebec) Ltd., Arvida, Que. P.O. Box 366. (*S. 1934*)

STEVENSON, H. I., B.Sc., (Man. '38), 73 Ethelbert St., Winnipeg, Man. (*S. 1938*)

STEVENSON, Millar Howes, Dist. Engr., Sask. Govt., North Battleford, Sask. (*1938*)

♂STEVENSON, William F., Lieut., Gen. Supt., Sterling Collieries, Ltd., 911 McLeod Bldg., Edmonton, Alta. (*H*) Sterco, Alta. (*A.M. 1910*)

STEVENTON, Harry Elgin, B.Sc., (Man. '33), Otis-Fensom Elevator Co., Hamilton, Ont. (*H*) Apt. 3, 75 Queen St. S. (*A.M. 1937*)

STEWART, Chas. J. R. B., B.A., (Cantab. '26), Asst. Engr., C. J. Brand, 263 Cambridge Rd., Bethnal Green, London. (*H*) 22 Welbeck Way, London, W.1, England. (*Jr. 1931*)

STEWART, Donald, B.Sc., (McGill '26), Div. Equipment Engr., The Bell Telephone Co. of Canada, Ltd., 87 Ontario St. W., Montreal, Que. (*H*) 15 Julien Ave., Pointe Claire, Que. (*S. 1924*) (*Jr. 1927*) (*A.M. 1933*)

STEWART, Donald Laughlin, B.Sc., (McGill '24), Gen. Bldgs. Engr., The Bell Telephone Co. of Canada, Ltd., Beaver Hall Bldg., Montreal, Que. (*H*) 4659 Melrose Ave., N.D.G. (*S. 1922*) (*A.M. 1927*)

STEWART, Fred. Choate, Asst. Engr., Greater Vancouver Water Dist., Vancouver, B.C. (*H*) 4767 Puget Dr. (*M. 1934*)

STEWART, Graeme M., B.A., (Tor. '00), Surveys Dept., C.N.R., Express Bldg., C.N.R., Toronto, Ont. (*H*) 31 Manor Rd. W. (*A.M. 1907*)

STEWART, John Robertson, Town Engr., Box 447, Renfrew, Ont. (*H*) 197 Argyle St. (*A.M. 1921*)

STEWART, John R., B.Sc., (McGill '27), Service Engr., Can. Liquid Air Co. Ltd., 1111 Beaver Hall Hill, Montreal, Que. (*H*) 1490 Fort St. (*S. 1925*) (*Jr. 1934*)

STEWART, L. B., B.Sc., (McGill '27), Shawinigan Water and Power Co., P.O. Box 70, Shawinigan Falls, Que. (*H*) 50-B Tamarac St. (*S. 1925*) (*Jr. 1932*)

♂STEWART, Malcolm Davidson, B.A.Sc., (Tor. '22), 122 Bedford Rd., Toronto, Ont. (*S. 1919*) (*Jr. 1924*) (*A.M. 1929*)

STEWART, Murray Alex., (Tor. '05), Principal Asst. Engr., Dept. Wks., City Hall, Toronto, Ont. (*H*) 282 Glencairn Ave. (*A.M. 1912*)

STEWART, Robert Bruce, B.Sc., (McGill '10), Pres. and Engr., I. Matheson & Co., Ltd., P.O. Box 620, New Glasgow, N.S. (*S. 1909*) (*Jr. 1913*) (*A.M. 1916*) (*M. 1918*)

STEWART, R. Meldrum, M.A., (Tor. '03), Dominion Astronomer, Dominion Observatory, Ottawa, Ont. (*M. 1924*)

STEWART, Ross Oliff, B.A.Sc., (Tor. '11), Asst. Engr., C.N.R., 6th Floor, Can. Express Bldg., Montreal, Que. (*H*) 101 Dobie Ave., Town of Mount Royal, Que. (*A.M. 1920*)

STEWART, Walter D., B.Sc., (Queen's '33), 132 Clandeboye Ave., Montreal, Que. (*S. 1933*)

STEWART, Wm. F., B.Sc., (McGill '26), Can. Gen. Elec. Co., Ltd., 1000 Beaver Hall Hill, Montreal, Que. (*H*) 4385 Western Ave. (*S. 1923*) (*Jr. 1929*)

STEWART, Wm. Lewis Reford, (R.M.C., Kingston '20), Man'g. Dir., Stewart Constrn. Co. Ltd., P.O. Box 735, Sherbrooke, Que. (*H*) 98 Quebec St. (*S. 1920*) (*A.M. 1928*)

STEWART, W. M., B.A.Sc., D.L.S., S.L.S., Phillips, Stewart & Phillips, 210–22nd St., Saskatoon, Sask. (*H*) 1034 University Dr. (*A.M. 1917*)

STIERNOTTE, Alfred, B.Sc., (Alta. '35), Royalite Oil Co., Ltd., Turner Valley, Alta. (*S. 1936*) (*Jr. 1938*)

STILES, John A., O.B.E., B.A.Sc., (Tor. '08), Chief Executive Commr., Boy Scouts Assoc. in Canada, 306 Metcalfe St., Ottawa, Ont. (*H*) 2 Seneca St. (*A.M. 1913*) (*M. 1916*)

STINSON, John Nichols, B.Sc., (Queen's '14), Supervising Engr., Engrg. and Constrn. Service, Dept. of Mines and Resources, Ottawa, Ont. (*H*) 15 Patterson Ave. (*S. 1912*) (*Jr. 1917*) (*A.M. 1919*)

♂STIRLING, John Bertram, B.A., B.Sc., (Queen's '11), Dir., E. G. M. Cape & Co., 960 New Birks Bldg., Montreal, Que. (*H*) 1612 Selkirk Ave. (*M. 1934*)

STIRLING, L. Brodie, B.Sc., (McGill '24), Asst. Engr., Shawinigan Water and Power Co., Shawinigan Falls, Que. (*H*) 120 Cedar Ave. (*S. 1921*) (*Jr. 1929*)

ST. JACQUES, Gustave F., B.A.Sc., (Ecole Polytech., Montreal), Quebec Public Service Comm., Court House, Quebec, Que. (*S. 1935*) (*Jr. 1938*)

ST. LAURENT, Jos. Emile, C.E., (Ecole Polytech., Montreal '09), Q.L.S., Chief Engr., River St. Lawrence Ship Channel, Dept. of Transport, 400 Youville Sq., Montreal, Que. (*H*) 4010 Grey Ave. (*M. 1922*)

STOBBART, Wm. Morley, Asst. Engr., Dom. Bridge Co. Ltd., Montreal, Que. (*H*) 5039 Glencairn Ave., N.D.G. (*A.M. 1935*)

STOCKETT, Lewis, 245 Vancouver Hotel, Vancouver, B.C. (*M. 1916*)

STOCKTON, Robert Summers, E.M., (Colorado), Cons. Engr., Irrigation and Land Development, Craigantler Ranch, Thompson Falls, Montana, U.S.A. (*M. 1918*)

STODART, James, Waterworks Engr., City of Hamilton, Ont. (*H*) 10 Stanley Ave. (*A.M. 1924*) (*M. 1929*)

♂STOKES, Percy Frank, Chief Dftsman., Indus. Dept., Can. Vickers, Ltd., Montreal, Que. (*H*) 4477 Notre Dame St. E. (*A.M. 1925*)

†STONE, Ernest A., Ma.E., (McGill '91), 122 St. George St., Toronto, Ont. (*S. 1888*) (*A.M. 1895*) (*M. 1906*) (*Life Member*)

STOREY, Gilbert Calder, B.A.Sc., (Tor. '15), Secy. and Mgr., Water Commrs., City Hall, Windsor, Ont. (*A.M. 1931*)

STOREY, Thos. Edward, B.Sc., (Man. '28), Chief Oper., (Slave Falls), City of Winnipeg Hydro-Elec. System. Address: Pointe du Bois, Man. (*S. 1926*) (*Jr. 1933*) (*A.M. 1935*)

†STORRIE, William, Gore, Nasmith & Storrie, Cons. Engrs., Charles-Bay Bldg., 1130 Bay St., Toronto, Ont. (*H*) 31 Alexandra Blvd. (*A.M. 1910*) (*M. 1917*)

STOTT, Joseph Duncan, Engr., Power Engineering Co., 107 Craig St. W., Montreal, Que. (*A.M. 1921*)

♂STOWE, Geo. Norman, Lieut., 1080 Burris St., Burnaby, New Westminster, B.C. (*A.M. 1920*)

♂STRATHY, R. L. A., Lieut., B.Sc., (McGill '14), 481 Prince Albert Ave., Westmount, Que. (*Jr. 1921*) (*A.M. 1922*)

STRATTON, Fred. Stephen, B.Sc., (Man. '30), Constrn. Supt., Montreal L., H. and Pr. Cons., Montreal, Que. (*H*) Apt. 31, Mountview Court, 3025 Sherbrooke St. W. (*S. 1928*) (*A.M. 1937*)

STRATTON, Leslie Robertson, B.Sc., (N.B. '30), National Harbours Bd., Quebec, Que. (*H*) 28 Exmouth St., Saint John, N.B. (*S. 1930*) (*Jr. 1936*)

STRATTON, W. Donald Geo., B.Sc., (N.B. '29), Dept. of Highways, N.B., Saint John, N.B. (*H*) 28 Exmouth St. (*S. 1929*) (*Jr. 1936*)

STREET, James Cunard, B.A.Sc., (Tor. '11), O.L.S., W.W. Supt., City of Welland, Welland, Ont. (*H*) 181 North Main St. (*S. 1909*) (*Jr. 1913*) (*A.M. 1914*) (*M. 1921*)

STREET, John Jos. Ambrose, B.A.Sc., (Tor. '29), Mgr., Concrete Products Ltd., Regina, Sask. (*H*) 2 Victoria Court. (*1938*)

STRICKLAND, Robert, 38 Montée Ste. Marie, Ste-Anne de Bellevue, Que. (*A.M. 1906*)

†STRICKLAND, T. P., M.Sc., (McGill '99), Chief Engr., Melbourne and Metropolitan Tramways Bd., 673 Bourke St., Melbourne, Australia. (*H*) 5 Washington St., Toorak, S.E.2. (*S. 1898*) (*M. 1910*)

STRIOWSKI, John Benjamin, B.Sc., (Man. '29), Cowin & Co., Pacific and Yeomans Sts., Winnipeg, Man. (*H*) 675 Ingersoll St. (*S. 1927*) (*Jr. 1935*)

♂STROME, Ivan Roy, Lieut., B.A.Sc., (Tor. '14), Water Pr. and Hydrometric Engr., Dom. Water and Pr. Bureau, Dept. of Mines and Resources, Ottawa, Ont. (*H*) 127 Metcalfe St. (*A.M. 1920*)

STRONG, John Ivor, B.E., (Sask. '29), Dist. Engr., Dom. Govt., P.F.R.A., Grant Hall Hotel, Moose Jaw, Sask. (*1938*)

STRONG, Robert Ambrose, B.Sc., (Illinois '15), Engr., Mines and Geology Br., Dept. of Mines and Resources, 552 Booth St., Ottawa, Ont. (*H*) 587 MacLaren St. (*A.M. 1921*)

STRONG, Robt. Lloyd, B.A.Sc., (Tor. '31), Can. Industries, Ltd., 1135 Beaver Hall Hill, Montreal, Que. (*H*) 4593 Royal Ave. (*S. 1932*)

STROYAN, Philip Bateman, B.A.Sc., (B.C. '24), Asst. Supt. and Engr., Vancouver Parks Board, Vancouver, B.C. (*H*) 1155 Lagoon Dr. (*A.M. 1938*)

♂STUART, Harold Brownlee, Major, B.A.Sc., (Tor. '09), Field Engr., Hamilton Bridge Co., Ltd., Hamilton, Ont. (*H*) 17 Highcliffe Ave. (*A.M. 1920*) (*M. 1935*)

STUART, H. Black, B.A.Sc., (McGill '92), Cons. Engr., 1 Toronto St., Toronto, Ont. (*H*) 85 Dawlish Ave. (*S. 1888*) (*A.M. 1898*)

♂STUART, Wm. Grey, Capt., Gen. Supt., Negus Mines Ltd., Yellowknife, N.W.T. (*H*) 10335-117th St., Edmonton, Alta. (*A.M. 1927*) (*M. 1937*)

♂STUART, Wm. Henry, Economist, c/o John E. Hammell, Organization, 930 Can. Bank of Commerce, 25 King St. W., Toronto, Ont. (*H*) 7 High Park Blvd. (*A.M. 1919*) (*M. 1932*)

STURDEE, Chas. Parker, B.Eng., (McGill '34), Gilbert & Barker Mfg. Co., Ltd., 207 Geary Ave., Toronto, Ont. (*H*) 48 Heath St. E. (*S. 1934*)

SUDDEN, E. A., B.A.Sc., (Tor. '26), H.E.P.C. of Ont. (*H*) 343 High Park Ave., Toronto, Ont. (*S. 1926*) (*Jr. 1928*)

SUITOR, Warren Douglas, B.Sc., (Alta. '34), Asst. Engr., Imperial Oil, Ltd., Calgary, Alta. (*H*) Ste. 3, 1321-13th Ave. W. (*Jr. 1936*)

SULLIVAN, Arthur Wm., Q.L.S., Private Practice and City Engr., P.O. Box 124, Valleyfield, Que. (*S. 1909*) (*Jr. 1914*) (*A.M. 1920*)

SULLIVAN, Wm. Henry, (R.M.C., Kingston '92), 11 Welland Ave., St. Catharines, Ont. (*A.M. 1899*) (*M. 1920*) (*Life Member*)

♂SUMMERSKILL, John Henry, B.Sc., (McGill '15), Consolidated Paper Corp. Ltd., Sun Life Bldg., Montreal, Que. (*H*) 6160 Notre Dame de Grace Ave., N.D.G. (*A.M. 1922*)

†SURVEYER, Arthur, B.A., B.A.Sc., C.E., D.Eng., Sr. Partner and Cons. Engr., Arthur Surveyer & Co., 1003 Dom. Square Bldg., Montreal, Que. (*H*) Acadia Apts., 1227 Sherbrooke St. W. (*S. 1899*) (*A.M. 1907*) (*M. 1912*) (*Past-President*)

SUTCLIFFE, Homer W., (Tor. '07), Pres., Sutcliffe Co., Ltd., New Liskeard, Ont. (*S. 1908*) (*A.M. 1913*)

SUTHERLAND, Alexander, B.Sc., (Acadia '11), Wolfville, N.S. (*A.M. 1920*)

SUTHERLAND, D. B., B.Sc., Arch., Guysboro Mines Ltd., Goldenville, N.S. (*S. 1932*)

SUTHERLAND, Donald H., B.Sc., (N.B. '38), Borden, P.E.I. (*S. 1938*)

SUTHERLAND, Duncan G., Investment Agent, Winnipeg Electric Co., Winnipeg, Man. (*H*) 1012 Jessie Ave. (*A.M. 1922*)

SUTHERLAND, Geo. MacKenzie, B.Sc., (N.S.T.C. '25), Can. Ingersoll-Rand Co. Ltd., Sherbrooke, Que. (*H*) Lennoxville, Que. (*S. 1924*) (*A.M. 1931*)

SUTHERLAND, Gordon A., B.Sc., (Man. '34), Designing Engr., Kipp-Kelly, Ltd., 68 Higgins Ave., Winnipeg, Man. (*H*) 99 Home St. (*Jr. 1938*)

SUTHERLAND, J. Gordon, B.Sc., (N.S.T.C. '35), Can. Westinghouse Co. Ltd., Hamilton, Ont. (*H*) 789 King St. E. (*S. 1935*)

♂SUTHERLAND, J. R. S., Lieut., 4 Greenhill Terrace, Edinburgh, Scotland. (*A.M. 1911*)

♂SUTHERLAND, L. H. D., Lieut., B.Sc., (McGill '09), Pres., Sutherland Construction Co., 1440 St. Catherine St. W., Montreal, Que. (*H*) 11 Richelieu Pl. (*M. 1926*)

♂SUTHERLAND, Ronald Douglas, Major, M.C., (R.M.C., Kingston '12), B.Sc., (McGill '14), Merchandise Mgr., Can. Westinghouse Co. Ltd., 400 McGill St., Montreal, Que. (*H*) 4615 Cedar Cres. (*A.M. 1920*)

SUTHERLAND, Wm. H., B.A.Sc., (Tor. '03), Chief Engr., C. J. Dryden Co., Ltd., 1434 St. Catherine St. W., Montreal, Que. (*H*) 28 Arlington Ave., Westmount, Que. (*A.M. 1910*) (*M. 1922*)

SUTHREN, Jos. W., B.Eng., (McGill '36), Can. Industries Ltd., Brownsburg, Que. (*S. 1936*)

SVARICH, John Paul, B.Sc., (Alta. '29), Dept. of Lands and Mines, Administration Bldg., Edmonton, Alta. (*H*) 11428-96th St. (*S. 1927*) (*Jr. 1934*)

SWABEY, Harold Wm. Birchfield, Capt., Indust. Investigation Committee, Dept. of Nat. Defence, Ottawa, Ont. (*H*) 336 Chapel St. (*A.M. 1910*) (*M. 1919*)

SWAIN, Douglas Smith, B.Sc., (Man. '38), 27 Fawcett Ave., Winnipeg, Man. (*S. 1937*)

SWAN, N. Stanley S., Ontario Paper Co., Thorold, Ont. (*H*) 1823 Lincoln Ave., Montreal, Que. (*A.M. 1936*)

SWAN, Russell G., B.A.Sc., (Tor. '09), C.E., Mgr., Water Resources and Statistical Dept., Shawinigan Water and Power Co., Power Bldg., Montreal, Que. (*H*) 6 Campbell Ave., Montreal West, Que. (*S. 1907*) (*A.M. 1913*)

♂SWAN, Wm. Geo., Major, D.S.O., C. de G., B.A.Sc., (Tor. '06), Cons. Engr., 814 Birks Bldg., Vancouver, B.C. (*H*) 1596 Balfour Ave. (*S. 1906*) (*A.M. 1910*) (*M. 1919*)

SWARTZ, Jos. Norman, B.Eng., (McGill '34), Ph.D., '37, Howard Smith Paper Mills Ltd., 749 Grey St., Montreal, Que. (*H*) 1401 Ford St., Fort William, Ont. (*S. 1934*)

SWEEZEY, Robt. Oliver, B.Sc., (Queen's), Pres., R. O. Sweezey & Co., Ltd., 132 St. James St., W., Montreal, Que. (*H*) 48 Belvedere Rd. (*S. 1907*) (*A.M. 1909*) (*M. 1916*)

SWIFT, John Wm., B.Eng., (McGill '35), Aluminum Co. of Canada, Shawinigan Falls, Que. (*H*) 5008 Victoria Ave., Westmount, Que. (*S. 1933*)

SWINGLER, Russell H., B.Sc., (Queen's '37), Jr. Engr., Civil Aviation Br., Dept. of Transport, Hunter Bldg., Ottawa, Ont. (*H*) 196 Lisgar St. (*S. 1937*)

♂SWINNERTON, Aylmer Aberffraw, B.A.Sc., (Tor. '19), Engr., Fuel Research Labs., Dept. of Mines and Resources, 560 Booth St., Ottawa, Ont. (*H*) 403 Hinton Ave. (*A.M. 1924*)

SYLVESTER, Jack Douglas, B.Sc., (Alta. '38), Univ. of Alberta, Edmonton, Alta. (*S. 1938*)

SYMES, Cyril Barron, City Engr., City Hall, Fort William, Ont. (*H*) 413 South Norah St. (*A.M. 1922*)

TABOR, Aubrey Clifton, B.Sc., (N.B. '97), Address unknown. (*A.M. 1922*)

TACHÉ, Joseph C., Rimouski, Que (*M. 1903*) (*Life Member*)

♂TACKABERRY, Stanley Gibson, Wing. Cmdr., B.A.Sc., (Tor. '14), R.C.A.F., Dept. of Nat. Defence, Canadian Bldg., Ottawa, Ont. (*H*) 11 Inglewood Ave. (*A.M. 1920*)

TAIT, Gordon Ewing, B.Sc., (McGill '30), Dom. Engineering Co., Ltd., P.O. Box 220, Montreal, Que. (*H*) Apt. 5, 5530 Cote St. Luc Rd. (*S. 1930*)

TAIT, Irving R., B.Sc., (McGill '13), Asst. Chief Engr., Can. Industries Ltd., Beaver Hall Bldg., Montreal, Que. (*H*) 4034 Oxford Ave., N.D.G. (*A.M. 1921*)

TAIT, Isaac Jos., Cons. Engr., and Marine Surveyor, 484 St. John St., Montreal, Que. (*H*) Apt. 16 2054 Sherbrooke St. W. (*A.M. 1918*) (*M. 1923*)

TAIT, J. L. M., Dom. Bridge Co., Ltd., Lachine, Que. (*H*) 113 Birch Ave., St. Lambert, Que. (*A.M. 1922*)

TALBOT, Charles, County Engr., Middlesex County, London, Ont. (*H*) 26 Cynthia St. (*A.M. 1921*)

TALMAN, Stephen G., Dftsman., Design and Tests, City of Toronto, 511 Richmond St. W., Toronto 2, Ont. (*H*) 88 Delaware Ave. (*A.M. 1914*) (*M. 1937*)

TAMES, John Alexander, B.Sc., (Alta. '25), Can. Westinghouse Co., 1418 Marine Bldg., Vancouver, B.C. (*H*) 1676 W. 12th Ave. (*S. 1924*) (*Jr. 1928*)

TANNENBAUM, J., B.Eng., (McGill '34), Prod. Mgr., W. R. Cuthbert & Co., Montreal, Que. (*H*) 5346 Jeanne Mance St. (*S. 1934*)

TANNER, Wm. John, 138 Longueuil St., Longueuil, Que. (*S. 1938*)

G.TAPLEY, Alexander G., Sr. Asst. Engr., D.P.W., Canada Federal Bldg., Halifax, N.S. (*H*) 65 Walnut St. (*S. 1904*) (*A.M. 1909*)

TAPLEY, Donald Gordon, B.Sc., (N.S.T.C. '34), Can. Gen. Elec. Co., Ltd., 4th St. W. and 11th Ave., Calgary, Alta. (*S. 1934*) (*Jr. 1936*)

TAPLEY, Frederick B., Engr., Mtce. of Way, C.N.R., Rm. 460, Union Station, Winnipeg, Man. (*H*) 198 Montrose St. (*A.M. 1910*) (*M. 1919*)

TARR, Francis G. A., B.A.Sc., (B.C. '26), Can. Gen Elec. Co. Ltd., Peterborough, Ont. (*H*) 387 Reid St. (*S. 1926*) (*A.M. 1937*)

TASCHEREAU, Jos. Roger Charles, B.A.Sc., (Ecole Polytech., Montreal '25), Contract Mgr., Commercial and Distribution Dept., Shawinigan Water and Power Co., Power Bldg., Montreal, Que. (*H*) 4875 Victoria Ave. (*A.M. 1938*)

TASSÉ, Yvon-Roma, B.A.Sc., (Ecole Polytech., Montreal '35), Can. Gen. Elec. Co. Ltd., Quebec, Que. (*S. 1934*)

TASSIE, Robt. Wilson, B.E., (Adelaide '07), M.E., (Cornell '09), c/o Emprezas Electricas Brasileiras, Caixa Postal 883, Rio de Janeiro, Brazil, S.A. (*M. 1929*)

TATE, Geo. Harold, B.A.Sc., (Tor. '26), Chief Engr., Can. Kodak Co., Ltd., Toronto, Ont. (*H*) Holland Landing, Ont. (*A.M. 1938*)

♂TATE, Harry Wm., Major, B.A.Sc., (Tor. '10), O.L.S., D.L.S., Asst. Mgr., Toronto Transportation Commrs., Public Utilities Bldg., 35 Yonge St., Toronto, Ont. (*H*) 14 Glengowan Rd. (*S. 1909*) (*A.M. 1913*) (*M. 1936*)

TATHAM, W. C., B.Eng., (McGill '35), 3647 University St., Montreal, Que. (*H*) Elora, Ont. (*S. 1935*)

♂TAUNTON, Arthur J. S., Major, D.S.O., B.Sc., (Man. '12), Man'g. Secy., Veterans Assistance Commission, Winnipeg Committee, 2nd Floor, Customs Bldg., Winnipeg, Man. (*H*) 930 Somerset Ave. (*S. 1909*) (*A.M. 1914*) (*M. 1936*)

TAYLOR, Alfred Jas. Towle, 1921 Marine Bldg., Vancouver, B.C. (*H*) Kew House, Marine Dr., W. Vancouver, B.C. (*M. 1925*)

TAYLOR, Andrew, B.Sc., (Man. '31), M.L.S., D.L.S., Tech. Dftsman., Dept. of Mines and Natural Resources, 346 Legislative Bldg., Winnipeg, Man. (*H*) Box 921, Flin Flon, Man. (*Jr. 1934*) (*A.M. 1934*)

TAYLOR, Bruce S., B.Sc., (Queen's '29), Bell Telephone Co. of Canada, Beaver Hall Bldg., Montreal, Que. (*S. 1929*)

TAYLOR, Charles, Town Engr., Box 121, Selkirk, Man. (*A.M. 1912*)

TAYLOR, Dudley Robt., B.Eng., (McGill '37), 4366 Oxford Ave., Montreal, Que. (*S. 1936*)

TAYLOR, E. Geo. T., Pres., Taylor Engineering and Construction Co., Ltd., 80 Richmond St. W., Toronto, Ont. (*H*) 154 Glen Manor Dr. (*M. 1936*)

TAYLOR, Frank, Rt. of Way and Tax Agent, C.P.R., Montreal, Que. (*H*) 599 Roslyn Ave., Westmount, Que. (*S. 1898*) (*A.M. 1903*) (*M. 1910*)

♂TAYLOR, Frank H., Capt., M.C., B.A.Sc., (Tor. '21), Lehigh Structural Steel Co., Rm. 1143, 17 Battery Pl., New York, N.Y., U.S.A. (*H*) 3532-168th St., Flushing, L.I. (*S. 1920*) (*A.M. 1925*)

TAYLOR, Fred. W., B.A.Sc., (Tor. '36), Asst. to E. A. Cross, Cons. Engr., 991 Bay St., Toronto, Ont. (*H*) 1198 Woodbine Ave. (*S. 1936*) (*Jr. 1938*)

TAYLOR, Gilbert Ferguson, Engr., Bridges and Structures, Corp. of the City of Ottawa, City Hall, Ottawa, Ont. (*H*) 130 MacLaren St. (*A.M. 1924*)

♂TAYLOR, Gordon R., Major, Grafton, Ont. (*Jr. 1912*) (*A.M. 1919*)

TAYLOR, Howard Smith, B.C.E., (Maine '04), 238 Grove Ave., Sarasota, Florida, U.S.A. (*M. 1923*)

TAYLOR, Jas. Lawrence, B.Sc., (Queen's '36), 28 Victoria Rd. E., Hebburn-on-Tyne, England. (*H*) Barriefield, Ont. (*S. 1934*)

♂TAYLOR, John, John Taylor & Co., Engrs. and Contractors, Bank of Toronto Bldg., Hamilton, Ont. (*H*) 21 Mount Royal Ave. (*A.M. 1908*)

TAYLOR, John M., Chief Elec. Engr., City of Saskatoon. (*H*) 114 Saskatchewan Cres. W., Saskatoon, Sask. (*1938*)

TAYLOR, Morley Gladstone, B.Sc., (N.S.T.C. '27), M.Sc., (M.I.T. '31), Gen. Mgr., Venezuela Power Co. Ltd., Maracaibo, Venezuela, S.A. (*H*) Parrsboro, N.S. (*S. 1927*) (*Jr. 1929*) (*A.M. 1938*)

TAYLOR, Thos. A. I. C., B.Sc., (Alta. '36), Plant Engr., Saguenay Power Co. Ltd., Isle Maligne, Que. (*Jr. 1937*)

TAYLOR, Wm. Irwin, B.Sc., (Man. '38), 218 Waterloo St., Winnipeg, Man. (*S. 1938*)

TAYLOR, W. R. C., B.Sc., (Man. '29), 780 Jessie Ave., Winnipeg, Man. (*S. 1928*) (*Jr. 1934*)

♂TAYLOR-BAILEY, F. W., Capt., M.C., B.Sc., (McGill '16), Vice-Pres. and Gen. Mgr., Dom. Bridge Co., Ltd., P.O. Box 280, Montreal, Que. (*H*) 3018 Trafalgar Ave. (*S. 1915*) (*A.M. 1919*) (*M. 1930*)

TEAGLE, Robt. Wills, B.A.Sc., (Tor. '25), Asst. Constrn. Mgr., Seigniory Club, Box 45, Montebello, Que. (*A.M. 1937*)

TEAZE, Moses Hay, B.Sc., (Worcester '17), Partner, H. S. Ferguson & Co., Cons. Engrs., 200-5th Ave., New York, N.Y., U.S.A. (*H*) 31 Clarendon Pl., Bloomfield, N.J. (*M. 1926*)

TÉLÉMAQUE, Lionel, B.A.Sc., (Ecole Polytech., Montreal '27), Prof., Ecole des Sciences Appliquées, Port-au-Prince, Haiti. (*A.M. 1936*)

♂TEMPEST, Frank C., Lieut., R.N.V.R., Imperial Oil Ltd., Calgary, Alta. (*H*) 3432-6th St. W. (*Jr. 1920*) (*A.M. 1926*)

TEMPEST, John Sugden, 3902-4th St. W., Calgary, Alta. (*A.M. 1907*) (*M. 1920*) (*Life Member*)

†TEMPLEMAN, Geo. Earl, Chief Engr., Elect. Commn. of the City of Montreal, Rm. 817, Power Bldg., Montreal, Que. (*H*) 147 Strathearn Ave., Montreal West, Que. (*A.M. 1919*) (*M. 1927*)

TENNANT, David Cowan, B.A.Sc., (Tor.), Engr., Dom. Bridge Co. Ltd., 1139 Shaw St., Toronto, Ont. (*H*) 1465 King St. W. (*A.M. 1906*) (*M. 1911*)

TETREAULT, Armand, 1322 Sherbrooke St. E., Montreal, Que. (*S. 1938*)

TETREAULT, Jacques, 1322 Sherbrooke St. E., Montreal, Que. (*S. 1938*)

♂THEAKSTON, Harold Raymond, Lieut., B.Sc., (N.S.T.C. '21), Prof. of Engrg. Drawing and Engr. i/c Bldgs. and Grounds, Dalhousie University, Halifax, N.S. (*H*) 27 Oakland Rd. (*Jr. 1921*) (*A.M. 1925*)

THEOBALDS, Thos. Reynolds, B.Sc., (McGill '28), Town Engr., "Castries Town Board," P.O. Box 51, St. Lucia, B.W.I. (*A.M. 1937*)

THEUERKAUF, Alexander Paul, B.A., Consultant, Dom. Steel and Coal Corp., Ltd., Sydney, N.S. (*H*) 5 Inglis St. (*M. 1921*)

♂THEXTON, Robert Donald, Major, D.P.W., N.S., Federal Bldg., Halifax, N.S. (*H*) 42 Inglis St. (*Jr. 1919*) (*A.M. 1922*)

THIAN, Prosper E., A.B., Cons. Engr., N.P. Ry. Co., St. Paul, Minn., U.S.A. (*M. 1906*)

THIBAUDEAU, Guy, B.A.Sc., (Ecole Polytech., Montreal '38), 136 Turnhill Ave., Quebec, Que. (*S. 1936*)

THIBAULT, J. G., B.Sc., (Man. '37), Can. Industries, Ltd., Montreal, Que. (*H*) 560 Lansdowne Ave. (*S. 1937*)

THICKE, J. Ernest, B.Sc., (Queen's '28), Elec. Engr., Aluminium Ltd., 1000 Dominion Sq. Bldg., Montreal, Que. (*S. 1926*) (*Jr. 1931*) (*A.M. 1936*)

THOM, J. Edwin, B.A.Sc., (Tor. '32), Plant Engr., Imperial Oil Ltd., Regina, Sask. (*H*) 2220 College Ave. (*S. 1932*) (*Jr. 1936*)

THOMAN, R. K., B.Sc., (Queen's '36), Prod. Mgr., Remington Rand, Ltd., Hamilton, Ont. (*H*) 13 Barnesdale Ave. N. (*S. 1936*) (*Jr. 1938*)

THOMAS, Arthur, Survey Engr., Geographical Section, Dept. of National Defence, Ottawa, Ont. (*H*) 39 Brighton Ave. (*A.M. 1926*)

THOMAS, C. Oldreive, 4225 Beaconsfield Ave., Montreal, Que. (*A.M. 1922*)

THOMAS, David Rhys, Mining Engr., 2001 Bloor St. W., Toronto, Ont. (*A.M. 1904*) (*M. 1913*)

THOMAS, Geo. Nevil, Mgr., Engrg. and Contract Sect., Can. Gen. Elec. Co., Ltd., Toronto, Ont. (*H*) 231 Wychwood Ave. (*M. 1924*)

THOMAS, J. L., B.Sc., (Queen's '30), McColl Frontenac Oil Co. Ltd., Montreal, Que. (*H*) 763 Bloomfield Ave., Outremont, Que. (*S. 1928*)

THOMAS, Jas. MacLeod, B.Sc., (N.B. '33), Res. Engr., Highways Div., D.P.W., N.B. (*H*) 236 Waterloo Row, Fredericton, N.B. (*S. 1935*) (*Jr. 1938*)

THOMAS, Sidney B., B.Sc., (N.B. '35), N.B. Elec. Power Comm., Castle Creek, N.B. (*H*) 254 Carmarthen St., Saint John, N.B. (*S. 1936*)

THOMAS, Wm. F., B.Sc., (McGill '30), M.Sc., Mine Overseer, Van Dyk Consolidated Mines Ltd. Address: P.O. Box 222, Boksburg, Transvaal, Union of South Africa. (*S. 1928*)

THOMLINSON, Walter Leonard, B.Eng., (McGill '38), 2063 Stanley St., Montreal, Que. (*S. 1937*)

THOMPSON, A. M., B.Sc., (Alta. '37), Can. Gen. Elec. Co., Ltd., Peterborough, Ont. (*H*) 541 Gilmour St. (*S. 1937*)

THOMPSON, Frank L., B.Sc., (N.S.T.C. '32), Tech. Service Engr., Imperial Oil Ltd., Box 490, Dartmouth, N.S. (*H*) 46-A Pleasant St. (*S. 1930*) (*Jr. 1935*) (*A.M. 1937*)

THOMPSON, Fred. Gerard, B.Sc., (N.B. '25), Dist. Highway Engr., D.P.W., N.B., Sussex, N.B. (*Jr. 1929*)

♂THOMPSON, George Harry, B.Sc., (McGill '13), Mgr., Calgary Power Co. Ltd., Insurance Exchange Bldg., Calgary, Alta. (*H*) 1035 Durham Ave. (*A.M. 1921*)

THOMPSON, Harry Alexander, B.Sc., (Sask. '27), 362 Spadina Rd., Toronto, Ont. (*S. 1927*) (*A.M. 1931*)

♂THOMPSON, Howard Grant, 2nd Lieut., B.A.Sc., (Tor. '22), Mgr., Aluminate Chemicals Ltd., 372 Bay St., Toronto, Ont. (*H*) 4 Dawlish Ave. (*S. 1920*) (*Jr. 1923*) (*A.M. 1928*)

THOMPSON, J. W. J., B.Sc., (N.S.T.C. '37), 7 Payzant Ave., Halifax, N.S. (*S. 1937*)

♂THOMPSON, Norman Albert, Major, B.Sc., (McGill '12), Hydraulic Engr., Dept. of Transport, 532 Hunter Bldg., Ottawa, Ont. Address: c/o Can. Bank of Commerce, Windsor, Que. (*A.M. 1921*)

THOMPSON, Philip Manly, B.A.Sc., (Tor. '08), Deputy Commr. of Bldgs., City of Toronto, Toronto, Ont. (*H*) 18 Glengowan E. (*A.M. 1921*)

♂THOMPSON, Trevor Creighton, B.Sc., (McGill '20), Engr., The Bell Telephone Co. of Canada, Montreal, Que. (*H*) 4820 Grosvenor Ave. (*Jr. 1921*) (*A.M. 1931*)

THOMPSON, Vincent Swire, (A.C.G.I. '21), Designer, Hamilton Bridge Co., Ltd., Hamilton, Ont. (*H*) 175 Hess St. S. (*A.M. 1931*)

THOMPSON, Wm. Lennox, B.A.Sc., (Tor. '27), Sales Engr., Bailey Meter Co. Ltd., Rm. 58, 980 St. Antoine St., Montreal, Que. (*S. 1923*) (*Jr. 1929*) (*A.M. 1935*)

THOMPSTONE, Robt. Edward, (R.M.C., Kingston '38), Royal Military College, Kingston, Ont. (*S. 1938*)

THOMSON, Alexander, Instr'man., Lethbridge Northern Irrigation Dist., Lethbridge, Alta. (*H*) 323-6th Ave. A.S. (*Jr. 1922*) (*A.M. 1925*)

THOMSON, Clarence, B.Sc., (McGill '97), Sec.-Treas., Fred Thomson Co. Ltd., 915 St. Genevieve St., Montreal, Que. (*H*) Apt. C-43, 3490 Cote des Neiges Rd. (*A.M. 1899*) (*M. 1931*)

THOMSON, Elihu, B.Sc., (McGill '31), Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*H*) Apt. 25, 5540 Queen Mary Rd. (*S. 1929*) (*A.M. 1936*)

THOMSON, John Alexander, B.Eng., (McGill '37), Montreal Engineering Co., Montreal, Que. (*H*) 3653 University St. (*S. 1936*)

G.†THOMSON, Lesslie R., B.A.Sc., (Tor. '06), Cons. Engr., 1062 New Birks Bldg., Montreal, Que. (*H*) 5626 Woodbury Ave. (*A.M. 1911*) (*M. 1919*)

THOMSON, Reginald Heber, A.B., A.M., Ph.D., Cons. Engr., 925 Seaboard Bldg., Seattle, Wash., U.S.A. (*H*) 1636-34th Ave. (*M. 1913*) (*Life Member*)

†THOMSON, T. Kennard, D.Sc., C.E., (Tor. '86), Cons. Engr., 32 West 40th St., New York, N.Y., U.S.A. (*H*) 30 Madeline Parkway, Yonkers, N.Y. (*M. 1905*) (*Life Members*)

†THOMSON, W. Chase, Engr., D.P.W., Que., Parliament Bldgs., Quebec, Que. (*H*) 220 Grande Allée. (*S. 1887*) (*A.M. 1894*) (*M. 1900*) (*Life Member*)

THOMSON, Wm. Jas. Renwick, B.Sc., (Tri State '20), Asst. Engr., Dept. of Highways, Ont., 295 Albert St., Ottawa, Ont. (*H*) 585 O'Connor St. (*A.M 1938*)

THOMSON, Wm. John, B.Sc., (Queen's '27), P.O. Box 401, Arvida, Que. (*Jr. 1931*) (*A.M. 1936*)

THORN, Richard, McDougall & Friedman, 1221 Osborne St., Montreal, Que. (*H*) Apt. 3, 1216 Crescent St. (*S. 1930*) (*Jr. 1936*)

THORNE, Benjamin Leonard, Mining Engr., Dept. Nat. Res., C.P.R., Calgary, Alta. (*M. 1914*)

THORNE, C. B., Knight Cmdr., Royal Order of St. Olav, Dr.Ing. h.c., Vice-Pres., Can. International Paper Co., Hawkesbury, Ont. (*M. 1914*)

THORNE, Harvey, B.A., (Dalhousie '05), B.A.Sc., (McGill '11), 17 Waegwoltic Ave., Halifax, N.S. (*A.M. 1914*) (*M. 1919*)

THORNE, H. L., B.A.Sc., (B.C. '34), 3027-6th St. S.W., Calgary, Alta. (*S. 1928*)

THORNTON, Louis Augustus, B.A., B.Sc., (Queen's '06), Chairman, Sask. Power Comm., 1739 Cornwall St., Regina, Sask. (*H*) 2244 Smith St. (*M. 1915*)

THORSSEN, LeRoy Allan, Box 85, Univ. of Alberta, Edmonton, Alta. (*S. 1937*)

THRUPP, E. C., 2547 Wallace Cres., West Point Grey, Vancouver, B.C. (*A.M. 1913*) (*M. 1935*)

♂THRUPP, F. E. M., Lieut., R.E., (Darmstadt '07), Man'g. Engr., The Buell Combustion Co., Ltd., National Steel Car Corp. Ltd., Hamilton, Ont. (*H*) 100 Charlton Ave. W. (*M. 1938*)

♂THURBER, Geo. Henry, D.P.W., Canada, Hunter Bldg., Ottawa, Ont. (*Jr. 1920*) (*A.M. 1923*)

THWAITES, Jos. Taylor, B.Sc., (Queen's '25), Engr., Can. Westinghouse Co., Hamilton, Ont. (*H*) 144 Stirton St. (*S. 1924*) (*Jr. 1928*)

TIBBITTS, A. G., B.Sc., (N.S.T.C. '31), Asst. Chief Engr., Acadia Sugar Refining Co. Ltd., P.O. Box 400, Woodside, Dartmouth, N.S. (*H*) Chadwick St. (*S. 1930*) (*A.M. 1936*)

†TIGHE, James L., B.A.Sc., (McGill '92), Cons. Engr., 189 High St., Holyoke, Mass., U.S.A. (*H*) 253 Maple St. (*S. 1890*) (*A.M. 1900*) (*M. 1906*)

TIMLECK, C. J., B.A.Sc., (B.C. '26), Sales Engr., Can. Ingersoll-Rand Co., Ltd., 175 McDermott Ave. E., Winnipeg, Man. (*H*) 574 Gertrude Ave. (*S. 1923*) (*Jr. 1931*)

TIMM, Charles Henry, Dom. Bridge Co. Ltd., Lachine, Que. (*H*) 343 Lansdowne Ave., Westmount, Que. (*A.M. 1919*)

TIMM, C. Ritchie, B.Sc., (McGill '30), Bepco (Canada) Ltd., 1050 Mountain St., Montreal, Que. (*H*) Apt. 4, 8031 Western Ave. (*S. 1928*) (*Jr. 1936*)

TIMMINS, W. W., B.A.Sc., (Tor. '23), Manufacturers Agent, 344 University Tower, Montreal, Que.; Owner, Zenith Engrg. Co. (*A.M. 1935*)

TIMMIS, Harold G., B.Sc., (McGill '23), Supt., Wood and Pulp Depts., Laurentide Div., Consolidated Paper Corp. Ltd., Grand'Mere, Que. (*H*) Fourth Ave. (*S. 1921*) (*A.M. 1929*)

TINKLER, Howard H., B.Eng., (McGill '33), Iron Fireman Mfg. Co. of Canada, 1124 Beaver Hall Hill, Montreal, Que. (*H*) Apt. 1, 4140 St. Urbain St. (*S. 1933*) (*Jr. 1938*)

♂TITUS, Harrison Burrell, Lieut., Transitman, 33 Archibald St., Moncton, N.B. (*A.M. 1921*)

TJONNAAS, Ole Hansen, (Oslo '21), Engr., Norwegian State Highway, Molde, Norway. (*A.M. 1931*)

TOBEY, Wilmot Maxwell, M.A., (Tor. '00), D.L.S., D.T.S., Asst. Dir., Geodetic Survey of Canada, Dept. of Mines and Resources, Ottawa, Ont. (*H*) 231 Fourth Ave. (*M. 1919*)

♂TODD, John Cecil, Lieut., Dist. Engr., Dept. Highways, Sask., Rosetown, Sask. (*A.M. 1921*)

TOLLINGTON, Gordon Chas., B.Sc., (Alta. '32), Can. Gen. Elec. Co., Ltd., Peterborough, Ont. (*H*) 525 Weller St. (*S. 1932*) (*Jr. 1937*)

♂TOOKER, Guy L., M.C., Asst. Engr., Roads Dept., City of Vancouver, B.C. (*H*) 1272 Connaught Dr. (*S. 1904*) (*Jr. 1913*) (*A.M. 1930*)

♂TOOKER, Hugh Wakefield, Div. Engr.'s Office, C.N.R., Calgary, Alta. (*H*) 822-A Hillcrest Ave., Mount Royal. (*A.M. 1920*)

♂TOOVEY, Thos. Wm., Pennsylvania Salt Mfg. Co., 1000 Widener Bldg., Philadelphia, Pa., U.S.A. (*H*) Alden Park Manor, Germantown, Pa. (*A.M. 1933*) (*M. 1937*)

TOUPIN, V., B.A.Sc., (Ecole Polytech., Montreal '25), Prof., Montreal Technical School, Montreal, Que. (*H*) 2186 Souvenir Ave. (*S. 1925*) (*Jr. 1928*) (*A.M. 1932*)

TOUZIN, Thos., B.Sc., (Ecole Polytech., Montreal '23), Montreal Water Bd., Montreal, Que. (*H*) 4214 Chambord St. (*Jr. 1925*)

TOVEE, Edward Harold, B.A.Sc., (Tor. '34), Can. Westinghouse Co., Hamilton, Ont. (*H*) 301 Charlton Ave. W. (*Jr. 1936*)

TOWLE, Harold M., 302 Cote de Liesse Rd., Town of Mount Royal, Que. (*S. 1937*)

♂TOWNSEND, Chas. Rowlatt, B.Sc., M.Sc., (N.B. '20, '23), 4155 Oxford Ave., Montreal, Que. (*Affil. 1927*) (*A.M. 1934*)

TOWNSEND, Gilbert S. B., Str'l. Engr., Ross & MacDonald, Inc., 1200 Dom. Square Bldg., Montreal, Que. (*H*) 4054 Highland Ave. (*A.M. 1909*)

TOY, Edwin L., B.Sc., (N.B. '31), 108 Shanley St., Toronto, Ont. (*S. 1932*)

TOYE, Arthur M., B.A.Sc., (Tor. '25), Asst. Highway Engr., Dept. Highways, Ont., Parliament Bldgs., Toronto, Ont. (*H*) 303 Avenue Rd. (*Jr. 1926*) (*A.M. 1934*)

TRAILL, J. J., B.A.Sc., (Tor. '06), (C.E., '19), Engr. of Tests, H.E.P.C. of Ont., 620 University Ave., Toronto, Ont. (*H*) 15 Fulton Ave. (*A.M. 1920*) (*M. 1926*)

TREBLE, Harold Edison, B.E.E., (Man. '27), Bureau of Geology and Topography, Dept. of Mines and Resources, Ottawa, Ont. (*H*) 596 King Edward Ave. (*S. 1924*) (*A.M. 1936*)

♂TREGARTHEN, Mark Elmer, B.E., (Sydney '21), Asst. Elec. Engr., Dept. of Road, Transport and Tramways, Philip House, Philip St., Sydney, Australia. (*H*) 20 Cooper St., Double Bay. (*A.M. 1927*)

TREGILLUS, Arthur Louis, D.P.W., Alta., Old Court House, Calgary, Alta. (*H*) 1328-18th St. W. (*A.M. 1933*)

TREMAIN, Kenneth H., B.Sc., (McGill '29), Mgr., Rogers Montreal, Ltd., Sun Life Bldg., Montreal, Que. (*H*) 5608 Queen Mary Rd. (*S. 1928*) (*Jr. 1935*)

♂TREMAYNE, John Ernest, Major, B.A.Sc., (Tor. '16), 82 Walker Ave., Toronto, Ont. (*A.M. 1921*)

TREMBLAY, Altheod, M.A., (Laval), D.L.S., Q.L.S., 274 Blvd. des Fosses, Quebec, Que. (*H*) 367 St. Cyrille St. (*S. 1903*) (*A.M. 1906*)

♂TREMBLAY, S. N., Major, Engr., Quebec Streams Comm., New Court House, Montreal, Que. (*H*) 22 Prince Arthur St., St. Lambert, Que. (*A.M. 1934*)

♂TREMBLAY, Thos. L., Brig.-Gen., C.M.G., D.S.O., Officer Legion of Honour (French), (R.M.C., Kingston), 131 Belvedere Rd., Quebec, Que. (*S. 1907*) (*A.M. 1912*)

♂TRIMINGHAM, James Harvey, B.Sc., (McGill '08), M.Sc., '20), Chief Engr., Power Corp. of Canada, Ltd., 355 St. James St. W., Montreal, Que. (*H*) 1700 MacGregor St. (*S. 1907*) (*A.M. 1913*) (*M. 1933*)

TRIPP, Geo. Mason, Gen. Supt., B.C. Electric Rly. Co., Victoria, B.C. (*A.M. 1919*) (*M. 1936*)

TRIPP, H. H., C.E., (Cornell '08), Div. Engr., C.P.R., Edmonton, Alta. (*H*) 10835–84th Ave. (*A.M. 1919*)

♂TROOP, Stewart, Lieut., (Acadia '07), Cons. Mining Engr., also Mgr., Chibougamau Properties, Ltd. and Cache Lake Chibougamau Lines, Ltd., St. Elie de Caxton, Que. (*A.M. 1919*)

TROREY, Lyle Graeme, B.Sc., (London '27), 4 Publicity Bldg., 710 Seymour St., Vancouver, B.C. (*H*) 2576 Wallace Cres. (*A.M. 1936*)

♂TROTTER, Harold L., Lt.-Col., D.S.O., (R.M.C., Kingston '03), Cons. Engr., 1111 Beaver Hall Hill, Montreal, Que. (*H*) P.O. Box 66, Iberville, Que. (*S. 1903*) (*A.M. 1907*) (*M. 1922*)

TROTTER, Wm. Beauchamp, Trotter & Morton, Ltd., 512–12th Ave., Calgary, Alta. (*H*) 1317–15th St. W. (*A.M. 1921*)

TROWSDALE, Russell S., Dist. Mgr., Can. Gen. Elec. Co. Ltd., Calgary, Alta. (*H*) 3607–7th St. W. (*A.M. 1919*)

TRUDEAU, Louis-Georges, B.A., (Laval), Dist. Engr., D.P.W., Canada, P.O. Bldg., Quebec, Que. (*S. 1910*) (*Jr. 1913*) (*A.M. 1916*)

TRUDEL, Alphonse, B.Eng., (McGill '37), Engrg. Dept., Can. International Paper Co. Ltd., Three Rivers, Que. (*H*) 208–5th St., Shawinigan Falls, Que. (*Jr. 1938*)

TRUDEL, Louis, B.A.Sc., (Ecole Polytech., Montreal '36), Production Engr., Marine Industries, Ltd., Sorel, Que. (*S. 1934*) (*A.M. 1938*)

TUCK, J. Howard, B.Sc., (Queen's '32), International Nickel Co., Port Colborne, Ont. Box T. (*S. 1928*) (*Jr. 1938*)

TUCKER, Ed. Francis, B.S., (Clarkson '32), Vice-Pres. and Mgr., Can. Stebbins Engineering and Mfg. Co. Ltd., 323 Drummond Bldg., Montreal, Que. (*H*) 5009 Grosvenor Ave. (*A.M. 1934*)

TUCKER, Robert Norman, B.A., 123 Chestnut Ave., Hamilton, Ont. (*S. 1934*)

♂TUFF, John Henry, 4 Parkthorne Close, North Harrow, Middlesex, England. (*A.M. 1938*)

♂TURNBULL, Aubrey Arnold, Major, B.Sc., (N.S.T.C. '22), Engr., N.B. Telephone Co. Ltd., Saint John, N.B. (*H*) 3 Mt. Pleasant Court. (*Jr. 1920*) (*A.M. 1926*)

TURNBULL, Donald Orton, (R.M.C., Kingston '29), Foundation Maritime Ltd., Liverpool, N.S. (*Jr. 1932*)

TURNBULL, Jas. Thomson, Dist. Highway Engr., D.P.W., N.B., Box 1268, Saint John, N.B. (*H*) Red Head, N.B. (*A.M. 1927*)

TURNBULL, John G., B.Sc., (Queen's '37), Test. Engr., Brunner Mond Canada, Amherstburg, Ont. (*Jr. 1938*)

TURNER, A. J., B.Sc., (Queen's '32), 119 Maple Ave., Hamilton, Ont. (*S. 1931*)

♂TURNER, Earle Oliver, S.B., (M.I.T. '14), Prof. of C.E., University of N.B., Fredericton, N.B. (*H*) Alexandra St. (*A.M. 1920*) (*M. 1937*)

♂TURNER, Enwin Stewart, Lieut., 144 River Rd., Welland, Ont. (*A.M. 1921*)

♂TURNER, Guy Roderick, Lt.-Col., R.C.E., D.C.M., M.C. and Bar, General Staff Officer, Dept. National Defence, Canada, c/o Imperial Defence College, 9 Buckingham Gate, London, S.W.1, England. (*S. 1914*) (*Jr. 1914*) (*A.M. 1920*)

TURNER, J. T., National Light and Power Co., Moose Jaw, Sask. (*1938*)

TURNER, Myron Wm., C.E., (Cornell '11), Chief Engr., Manitoba Paper Co. P.O. Box 71, Pine Falls, Man. (*A.M. 1921*)

TURTLE, Alfred Claude, Elec. and Gen. Engr., Holden Co., Ltd., 736 St. James St. W., Montreal, Que. (*H*) 2066 Decarie Blvd. (*Jr. 1921*) (*A.M. 1926*)

TWEEDDALE, Reginald Estey, B.Sc., (N.B. '35), Asst. Dist. Highway Engr., D.P.W., N.B. (*H*) Arthurette, Victoria Co., N.B. (*S. 1935*) (*Jr. 1937*)

♂TYLER, William Grant, Lieut., B.Sc., (McGill '15), Cable Engr., Northern Electric Co., Ltd., Montreal, Que. (*H*) 32 Brock Ave. N., Montreal West, Que. (*A.M. 1921*)

♂TYRER, Thos. Geo., Lieut.-Col., S.L.S., Deputy Chief Surveyor, Surveys Br., Land Titles Office, Regina, Sask. (*H*) 2708 Regina Ave. (*A.M. 1931*)

TYRRELL, J. W., C.E., (Tor. '83), J. W. Tyrrell & Co., Ont. and Dom. Land Surveyors, 7 Hughson St., S. Hamilton, Ont. (*H*) 97 Fairbolt Rd. (*M. 1919*) (*Life Member*)

♂TYRRELL, Wm. Grant, Col., D.S.O., (R.M.C., Kingston '03), Asst. Director of Transportation, War Office, London, England. (*H*) Lynton Dene, Headley, Bordon, Hants, England. (*S. 1906*) (*A.M. 1912*) (*M. 1921*)

TYSON, Albert Edmund, B.A.Sc., (Tor. '31), Mgr., Niparea Prospectors Ltd., Geraldton, Ont. (*Jr. 1933*)

ULMANN, Hans, (Fed. Polytech., Zurich '25), Research Engr., Dom. Engineering Co. Ltd., Lachine, Que. (*H*) 4871 Hampton Ave., Montreal, Que. (*A.M. 1931*)

UMPHREY, Fred. Ellsworth, Chairman, Drainage Mtce. Bds., Man., Rm. 248 Legislative Bldgs., Winnipeg, Man. (*H*) 182 Niagara St. (*A.M. 1920*)

UNDERWOOD, Jos. Edwin, (Tor. '09), Partner, Underwood & McLellan, Grain Bldg., Saskatoon, Sask. (*1938*)

G.†UNIACKE, R. F., B.E., (King's. Halifax), 710 Mount Royal, Marble Arch, London, W.1. (*M. 1887*) (*Life Member*)

UPTON, Virgil Stanley, B.Sc., (Sask. '35), Bennett Aircraft Inc., San Fernando, Cal., U.S.A. (*H*) 14458 S. Brand Blvd. (*S. 1935*)

URE, Wilfred Gordon, B.A.Sc., (Tor. '13), O.L.S., City and Cons. Engr. and L.S., Wilfred G. Ure, 9 Perry St., Woodstock, Ont. (*H*) 378 Ingersoll Ave. (*A.M. 1922*)

♂URRY, Douglas Percy, Lieut., R.N.V.R., Str'l. Engr., Dom. Bridge Co., Ltd., Vancouver, B.C. (*H*) 3422–1st Ave. W. (*A.M. 1924*)

VAILLANCOURT, J. L., 3225 Lacombe Ave., Montreal, Que. (*S. 1937*)

VAISON, Albert Felix, Tech. Adviser, Dept. of National Revenue, Connaught Bldg., Ottawa, Ont. (*H*) 122 Gilmour St. (*M. 1937*)

VALIQUETTE, Adrien, B.Sc., (Montreal '14), Design of Sewers, Tech. Service, City of Montreal, Montreal, Que. (*H*) 808 Rachel St. (*A.M. 1924*)

VALIQUETTE, Maurice, 2 Church St., St. Laurent, Que. (*S. 1938*)

VALIQUETTE, Zephirin, L'Abord-a-Plouffe, Que. (*S. 1938*)

VALLEE, Ivan E., B.A.Sc., Deputy Minister, D.P.W., Parliament Bldgs., Quebec, Que. (*H*) 138 St. Cyrille St. (*S. 1907*) (*Jr. 1913*) (*A.M. 1913*)

VALLIERES, Irenee A., B.Sc., (Ecole Polytech., Montreal '07), Asst. Chief Engr., Montreal Sewers Comm., City of Montreal, Rm. 404, City Hall, Montreal, Que. (*H*) 4107 Van Horne Ave. (*S. 1907*) (*A M. 1927*)

VANCE, Jas. A., Prop., Engr. and Mgr., J. A. Vance, 288 Light St., Woodstock, Ont. (*S. 1914*) (*Jr. 1919*) (*A.M. 1924*)

†VANDERVOORT, G. A., Gen. Supt., N.B. Electric Power Comm., Box 820, Saint John, N.B. (*H*) 130 Princess St. (*A.M. 1925*)

VanEVERY, Hugh D., Dom. Bridge Co. Ltd., Lachine, Que. (*H*) 3870 Melrose Ave., N.D.G. (*S. 1937*)

VanEVERY, Wm. Wishart, (Tor. '99), 108 Kohler St., Sault Ste. Marie, Ont. (*A.M. 1905*)

Van KOUGHNET, E. M., (R.M.C., Kingston '22), Engr., Provincial Electricity Board, Rm. 804, 132 St. James St. W., Montreal, Que. (*H*) 44 Lorne Ave., St. Lambert, Que. (*S. 1922*) (*Jr. 1928*) (*A.M. 1936*)

♂Van NORMAN, Clarence P., Lieut., B.A.Sc., Supt. of Materials, Toronto Transportation Comm., 35 Yonge St., Toronto, Ont. (*H*) 46 St. Germain Ave. (*S. 1909*) (*A.M. 1913*)

♂Van PATTER, Hugh Stanley, M.A., B.Sc., (Queen's '15), D.L.S., Chief Engr., Hydraulic Dept., Dom. Engineering Co., Ltd., Montreal, Que. (*H*) 612 Belmont Ave., Westmount, Que. (*A.M. 1920*)

VAN SCOYOC, Henry Stewart, B.Sc. in C.E., (Penn. '07), Cons. Engr., Canada Cement Co. Ltd., Sta. B, Box 290, Montreal, Que. (*H*) 205 Brock Ave. N., Montreal West, Que. (*A.M. 1915*) (*M. 1921*)

VARLEY, Percy, Elec. Engr., Can. Industries Ltd., P.O. Box 1260, Montreal, Que. (*H*) 4413 Girouard Ave., N.D.G. (*Jr. 1932*) (*A.M. 1935*)

VATCHER, Allan, B.A.Sc., (Tor. '10), Cons. Engr., New Martin Bldg., P.O. Box 86, St. John's, Nfld. (*M. 1924*)

VATCHER, Chesley H., 65 St. George St., Toronto, Ont. (*S. 1938*)

VAUGHAN, Frank P., M.Sc., (N.B. '22), Engr. and Mgr., Vaughan Electric Co. Ltd., 94 Germain St., Saint John, N.B. (*H*) 41 Duke St. (*A.M. 1919*) (*M. 1920*)

†VAUGHAN, Henry Hague, Pres., Can. Foreign Investment Corp. Ltd., 1111 Beaver Hall Hill, Montreal, Que. (*H*) 1539 MacGregor St. (*M. 1906*) (*Past-President*)

VAUGHAN, H. W., B.Sc., (McGill '21), Asst. Supt. and Engr., Light and Pr. Divn., Elec. Dept., City of Montreal, Box 144, Station B, Montreal, Que. (*S. 1920*) (*A.M. 1926*)

♂VAUGHAN, Rupert Henry, Lieut., Res. Engr., D.P.W., B.C., Duncan, V.I., B.C. (*A.M. 1921*)

♂VEITCH, James, Inspecting Engr., Western Canada Fire Underwriters Assoc., Winnipeg, Man. (*H*) Ste. 27, Riverview Mansions. (*A.M. 1920*)

♂VEITCH, W. M., Lt.-Col., M.C. and Bar, C.E., (R.T.C. Glasgow), City Engr., City of London, Ont. (*H*) 357 Dufferin Ave. (*A.M. 1922*)

VENNES, Harald J., B.A., (Minn. '16), Special Products Engr., Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*H*) 53 Curzon St., Montreal West, Que. (*A.M. 1923*)

VERCOE, Harold Linnell, (Tor. '98), 5635 Upper Lachine Rd., Montreal, Que. (*M. 1920*)

VERGE, Gerard Arthur, 109 Murray Ave., Quebec, Que. (*S. 1934*)

VERMETTE, J. A., Sr. Asst. Engr., D.P.W., Canada, Rm. 835, Hunter Bldg., Ottawa, Ont. (*H*) Apt. 4, 370 Elgin St. (*A.M. 1914*)

VERMETTE, Narcisse J. A., C.E. and E.E., (Ecole Polytech., Montreal '15), Q.L.S., City Mgr., Shawinigan Falls, Que. (*H*) 182 Broadway Ave. (*S. 1913*) (*A.M. 1920*)

VERNOT, Geo. E., B.Sc., (McGill '26), Asst. Engr., Montreal Sewers Comm., City Hall, Montreal, Que. (*H*) Apt. 3, 5617 Gatineau Ave. (*S. 1923*) (*Jr. 1928*)

VERSCHOYLE, Patrick D., B.Eng., (McGill '35), Lafarge Aluminous Cement Co., Ltd., Fondu Wks., West Thurrock, Grays, Essex, England. (*H*) 24 Byron Mansions, Upminster, Essex. (*Jr. 1936*)

♂VESSOT, Chas. U. R., M.Sc., (McGill '22), Wks. Engr., Fry-Cadbury, Ltd., 2025 Masson St., Montreal, Que. (*H*) 845 Kenilworth Rd. (*S. 1916*) (*A.M. 1925*)

VIBERG, Ernest F., B.Sc., (McGill '29), Mech. Engr., Steel Foundry Divn., Can. Car and Foundry Co. Ltd., Montreal, Que. (*H*) 4823 Wilson Ave., N.D.G. (*A.M. 1936*)

VICKERS, Harold, Cons. Mining and Smelting Co., Trail, B.C. (*H*) 2008 Topping St. (*A.M. 1930*)

VICKERSON, Geo. L., B.Sc., (McGill '25), G. R. Locker Co., 1467 Mansfield St., Montreal, Que. (*S. 1925*) (*Jr. 1928*) (*A.M. 1938*)

VIENS, Ephrem, B.A., (McMaster '05), Dir., Laboratory for Testing Materials, D.P.W., Canada, Rm. 38, West Block, Ottawa, Ont. (*H*) Britannia Heights, Ont. (*A.M. 1919*) (*M. 1925*)

VILLEMURE, J. Philéas, Supt. of City Wks., City of Grand'Mere, Grand'Mere, Que. (*H*) 170 St. Georges St. (*S. 1931*) (*Jr. 1937*)

VINCENT, Arthur, Q.L.S., Private Practice, 517 St. Lawrence Blvd., Montreal, Que. (*H*) 25 St. Alexandre, Longueuil, Que. (*A.M. 1898*)

VINCENT, Roch Arthur, B.A.Sc., (Ecole Polytech., Montreal '18), Q.L.S., Asst. Engr., D.P.W., City of Montreal, Montreal, Que. (*H*) 1704 St. Hubert St. (*A.M. 1927*)

VINCENT, Paul, B.A.Sc., (Ecole Polytech., Montreal '34), Dist. Engr., Roads and Bridges Divn., Dept. of Colonization, Prov. of Quebec, Rm. 263, Parliament Bldgs., Quebec, Que. (*S. 1934*) (*Jr. 1935*)

♂VINET, Eugene, Lieut., B.Sc., (McGill '11), Edison General Electric Appliance Co., Inc., 5600 West Taylor St., Chicago, Ill., U.S.A. (*H*) The Orrington, Evanston, Ill., U.S.A. (*S. 1907*) (*Jr. 1912*) (*A.M. 1917*) (*M. 1925*)

VINET, Pierre Paul, B.A.Sc., (Ecole Polytech., Montreal '28), B.Sc., (M.I.T. '29), Prof., Ecole Polytechnique, 1430 St. Denis St., Montreal, Que.; also Cons. Engr. (*H*) 5584 Canterbury Ave. (*A.M. 1937*)

*G.*VOGAN, Geo. Oliver, B.Sc., (Queen's '17), Engr., National Electricity Syndicate, 59 St. James St. W., Montreal, Que. (*H*) 4509 Harvard Ave. (*Jr. 1919*) (*A.M. 1928*)

VOGIN, Maurice A., B.Eng., (McGill '33), Engr., D.P.W., Canada, Montreal, Que. (*H*) Apt. 2, 1276 St. Joseph Blvd. E., Montreal, Que. (*S. 1930*) (*A.M. 1936*)

VOKES, Christopher, (R.M.C., Kingston '25), B.Sc., (McGill '27), Major, R.C.E., Dept. National Defence, Rm. 518, Woods Bldg., Ottawa, Ont. (*A M. 1932*)

♂VOLLMER, George Frederick, Capt., M.Sc., (Victoria), Private Practice, 120 York St., St. Catharines, Ont. (*M. 1920*)

von ABO, C. V., B.Sc., M.A., (Cape Town '19), Ph.D., (McGill '22), Chief C.E. Dept., S.A. Rlys. and Harbours, Johannesburg, S.A. (*S. 1920*) (*Jr. 1921*) (*A.M. 1930*)

♂VROOM, Harold Heard, Lieut., R.N.V.R., B.Sc., (McGill '10), Supt. of Inspection, Northern Electric Co., Ltd., 1261 Shearer St., Montreal, Que. (*H*) 32 Union Ave., St. Lambert, Que. (*S. 1908*) (*Jr. 1913*) (*A.M. 1922*)

♂WADDINGTON, Geo. Wilfred, M.M., B.A.Sc., (B.C. '27), Chief Engr., Britannia Mining and Smelting Co., Ltd., Britannia Beach, B.C. (*A.M. 1927*)

WADE, Mark Leighton, B.Sc., (McGill '12), Cons. Elec. and Hydraulic Engr., P.O. Box 14, Kamloops, B.C. (*Jr. 1914*) (*A.M. 1917*) (*M. 1936*)

WAGNER, Gordon D., Address unknown. (*S. 1932*)

WAGNER, Norman, (Tor. '10), Cons. Str'l. Engr., 378 Queen St. S., Hamilton, Ont. (*A.M. 1921*)

WAIN, John Bernard, Office Engr., Valuation Dept., C.N.R., 1 Toronto St., Toronto, Ont. (*H*) 89 Broadway Ave. (*A.M. 1920*)

WAINWRIGHT, James G. R., B.A.Sc., (McGill '92), Chief Engr., Toronto Harbour Commrs., 50 Bay St., Toronto, Ont. (*H*) 63 Heath St. (*S. 1890*) (*A.M. 1899*)

WAIT, Eric Holloway, B.Sc., (McGill '22), Engr., Mines and Geology Br., Dept. of Mines and Resources, Ottawa, Ont. (*H*) 73 Park Ave. (*S. 1922*) (*A.M. 1926*)

WAKE, Harold Robert, B.Sc., (Nebraska '12), Secy., Aluminum Co. of Canada, Ltd., 1000 Dom. Square Bldg., Montreal, Que. (*H*) Apt. 8, 3489 Atwater Ave. (*A.M. 1926*)

♂WAKEFIELD, Wm. E., Supervisor of Timber Tests, Forest Products Labs. of Canada, Lands, Parks and Forests Br., Dept. of Mines and Resources, Ottawa, Ont. (*H*) 11 Allan Pl. (*A.M. 1927*)

WAKEHAM, C. A., B.Sc., (N.B. '28), Can. Industries, Ltd., Windsor, Ont. (*H*) 155 Oak Ave. (*S. 1927*)

WALCOT, John Bevan, D.L.S., 479 Grosvenor Ave., Westmount, Que. (*Jr. 1919*) (*A.M. 1923*)

♂WALCOTT, Wm. D., B.A.Sc., (Tor. '12), Asst. Laboratory Engr., H.E.P.C. of Ont., Toronto, Ont. (*H*) 13 Parkview Gardens. (*S. 1911*) (*A.M. 1919*)

WALKDEN, William, Bridge Engr., C.N.R., 469 Union Sta., Winnipeg, Man. (*H*) 91 Ferndale Ave., Norwood, Man. (*Jr. 1913*) (*A.M. 1917*)

♂WALKEM, Geo. Alex., Major, B.Sc., (McGill '96), Pres. and Man'g. Dir., Vancouver Machinery Depot, Ltd., 1155-6th Ave. West, Vancouver, B.C. (*H*) 5775 Sperling St. (*A.M. 1906*) (*M. 1920*) (*Past-President*)

WALKEM, Richard, (R.M.C., Kingston '32), Vancouver Iron Wks., 1155 W. 6th Ave., Vancouver, B.C. (*S. 1929*) (*Jr. 1937*)

WALKER, Alex. Harold, B.Sc., (N.B. '34), British Reinforced Concrete Engrg. Co. Ltd., Stafford, England. (*H*) "Glen Burn," Ashleigh Rd., Leicester, England. (*S. 1928*)

WALKER, Alfred Paverley, O.L.S., D.L.S., 138 Lascelles Blvd., Toronto 12, Ont. (*A.M. 1888*) (*M. 1898*) (*Life Member*)

WALKER, Andrew, Chief Engr., Fred Thomson & Co. Ltd., Montreal, Que. (*H*) 866 Hartland Ave., Outremont, Que. (*A.M. 1910*) (*M. 1925*)

♂WALKER, John, (Heriot Watt '05), Div. Engr., C.N.R. (*H*) 12 Dunlop St., Barrie, Ont. (*A.M. 1921*) (*M. 1936*)

♂WALKER, J. Alexander, Lieut., B.A.Sc., C.E., B.C.L.S., Civil, Town Planning and Landscape Engr.; Partner, Macpherson & Walker, 626 W. Pender St., Vancouver, B.C. (*H*) 5612 Laval Ave. (*S. 1909*) (*Jr. 1911*) (*A.M. 1917*) (*M. 1935*)

WALKER, John Marshall, Designer and Jr. Engr., Wks. Dept., City of Toronto, Toronto, Ont. (*H*) 7 Hammersmith Ave. (*A.M. 1934*)

WALKER, Melvyn Lothian, B.Sc., (McGill '19), Designing Engr., Imperial Oil Ltd., Sarnia, Ont. (*H*) 230 Shepherd St. (*Jr. 1920*) (*A.M. 1930*)

WALKER, Robt. Samuel, B.Sc., (Queen's '30), Designing Engr., Spruce Falls Power and Paper Co., Kapuskasing, Ont. (*S. 1929*) (*A.M. 1936*)

WALKER, Roy Edward, B.E., (Sask. '32), Mech. Engr., U.S.A. Federal Govt. Treasury Dept., P.W. Br. (*H*) 700 Erie Ave., Takoma Park, Md., U.S.A. (*Jr. 1936*)

WALKER, Roy Marshall, B.A.Sc., (Tor. '12), Asst. Engr., Engrg. Dept., Montreal L., H. and P. Cons., Montreal, Que. (*H*) 46 First Ave., St. Lambert, Que. (*S. 1910*) (*Jr. 1913*) (*A.M. 1921*)

WALKER, William, Dist. Engr., C.N.R., McGill St., Montreal, Que. (*H*) 8 Douglas Ave., Westmount, Que. (*A.M. 1910*)

WALKEY, Arthur Wallace, B.Sc., (Man. '31), Jr. Engr., D.P.W., Canada, 3rd Floor, Customs Bldg., Winnipeg, Man. (*H*) Ste. 15, Wolseley Apts. (*A.M. 1937*)

P.†WALL, Arthur Stanford, Dom. Bridge Co. Ltd., Montreal, Que. (*H*) 23 Fenwick Ave. (*A.M. 1917*) (*M. 1927*)

WALL, Edward Walter, Sc.B. in C.E., (Brown '10), Vice-Pres. and Gen. Supt., The Atlas Construction Co. Ltd., Montreal, Que. (*H*) 5757 Plantagenet St. (*M. 1923*)

♂WALLACE, George A., Lieut., B.Sc., (McGill '19), (M.Sc., '21), Assoc. Prof., Elec. Engrg., McGill Univ., Montreal, Que. (*H*) 4138 Hingston Ave. (*S. 1917*) (*Jr. 1920*) (*A.M. 1925*)

WALLACE, Gordon Leslie, B.A.Sc., (Tor. '12), Cons. Engr., Private Practice, 36 Evelyn Cres., Toronto, Ont. (*A.M. 1923*) (*M. 1938*)

WALLACE, Keith B., B.Sc., (McGill '30), Chief Engr., Barry & Staines Linoleum (Canada) Ltd., P.O. Box 233, Farnham, Que. (*S. 1929*) (*A.M. 1938*)

WALLACE, R. H., (R.M.C., Kingston), B.Sc., (McGill '26), Plant Engr., Canada Starch Co., Ltd., Cardinal, Ont. (*S. 1924*) (*Jr. 1929*) (*A.M. 1936*)

WALLER, J. J., B.Eng., (McGill '36), 3797 Decarie Blvd., Montreal, Que. (*S. 1937*)

WALLER, Stephen J. H., Asst. Dist. Engr., C.N.R., Champlain Market Sta., Quebec, Que. (*H*) Apt. 2, 284 St. Cyrille St. (*S. 1907*) (*A.M. 1912*)

♂WALLIS, James Harold, Major, Mgr., Dom. Engineering Co. Ltd.; Gen. Mgr., Dom. Hoist and Shovel Co., Ltd., P.O. Box 3150, Montreal, Que. (*H*) 603 St. Joseph St., Lachine, Que. (*A.M. 1921*)

WALLIS, W. H. C., B.Sc., (N.B. '36), Inspr., Donald Inspection, Ltd., 1181 Guy St., Montreal, Que. (*H*) 3447 Drummond St. (*S. 1936*)

WALLMAN, Clifford Geo., B.Sc., (Man. '34), B.Eng., (McGill '38), Canada Starch Co., Cardinal, Ont. Box 24. (*S. 1934*)

WALLS, John Abbet, 1611 Lexington Blvd., Baltimore, Md., U.S.A. (*S. 1904*) (*A.M. 1904*)

WALSH, N. Steven, Chief Inspr. of Steam Boilers and Pressure Vessels, Dept. of Labour, Que., 88 St. James St. E., Montreal, Que. (*H*) 3434 St. Antoine St. (*A.M. 1923*)

WALSH, Wm. E., Chief Dev. Engr., Illinois Tool Wks., 2501 No. Keeler Ave., Chicago, Ill., U.S.A. Address: P.O. Box 1302, Chicago, Ill. (*Jr. 1921*)

WALSTON, Timothy Cragg, B.Sc., (Man. '37), Clark Iron Inc., 20101 S. Normandie, Los Angeles, Calif., U.S.A. (*H*) 4709 Cimarron St. (*Jr. 1937*)

WALTER, John, B.Sc., (Queen's '33), 304 Cairngorm Apts., Windsor, Ont. (*S. 1933*) (*Jr. 1936*)

WALTON, Clarke Gibbs, B.Sc., (Queen's '15), 2973 Peter St., Windsor, Ont. (*A.M. 1928*)

♂WALTON, Frederick Stanley, Roadmaster, C.N.R., P.O. Box 205, Prince Rupert, B.C. (*Jr. 1921*) (*A.M. 1926*)

WANG, Sigmund, (Oslo '09), Chem. Engr. and Mgr. of Laboratories, Can. International Paper Co., Box 350, Hawkesbury, Ont. (*A.M. 1919*) (*M. 1931*)

WANGEL, Reinhold, C.E., (Finland '19), Designer, Warden King Ltd., Montreal, Que. (*H*) 1193 Mackay St. (*A.M. 1937*)

WANLESS, Graham Geo., B.Sc., (McGill '34), Chemist, Dom. Rubber Co., Ltd., 420 Lagauchetiere St., Montreal, Que. (*H*) 2095 Grey Ave., N.D.G. (*Jr. 1938*)

WARD, Frank Noel, Vice-Pres. and Managing Dir., Reavell & Co. (Canada) Ltd., 745 Canada Cement Bldg., Montreal, Que. (*H*) 4430 Rosedale Ave. (*A.M. 1936*)

WARD, Herbert James, Supt. of Property, Shawinigan Water and Power Co., Ltd., P.O. Box 305, Shawinigan Falls, Que. (*A.M. 1924*)

WARD, John Wilmot, B.A.Sc., (Tor. '21), Asst. Elec. Engr., Aluminum Co. of Canada, Ltd., Arvida, Que. (*H*) 917 Moisson St. (*A.M. 1929*)

WARD, Kenneth Roy, 476 Victoria St., Kingston, Ont. (*S. 1938*)

WARDLE, Edward B., B.Sc., (Dartmouth '99), Chief Engr., Consolidated Paper Corp., Ltd., Grand'Mere, Que. (*H*) 5 Van Horne Ave. (*M. 1929*)

WARDLE, James Morey, B.Sc., (Queen's '12), Dir., Surveys and Engrg. Br., Dept. of Mines and Resources, Ottawa, Ont. (*H*) 320 Hillcrest Rd. (*Jr. 1913*) (*A.M. 1916*) (*M. 1925*)

WARDLEWORTH, Theophilus Hatton, B.Sc., (McGill '25), Designer, Aerocrete Construction Co. Ltd., Montreal, Que. (*H*) 168 Cote St. Antoine Rd., Westmount, Que. (*S. 1923*) (*Jr. 1931*) (*A.M. 1937*)

WARKENTIN, C. P., B.Sc., (Man. '26), Designing Engr., Imperial Oil Ltd., Sarnia, Ont. (*H*) 398 London Rd. (*S. 1924*) (*Jr. 1927*)

♂WARNER, John Edwin Archibald, Lieut., M.C., B.Sc., (McGill '12), Chief Engr., Haverhill Boxboards, Haverhill, Mass., U.S.A. (*A.M. 1920*)

WARNICK, Wm. Maurice, B.Sc., (Queen's '36), Dom. Foundries and Steel Co., Hamilton, Ont. (*H*) 67 Ontario Ave. (*S. 1936*)

WARNOCK, R. N., (R.M.C., Kingston '30), B.Sc., (McGill '31), Vice-Pres., Chas. Warnock & Co. Ltd., Ste. 1001, McGill Bldg., Montreal, Que. (*H*) 528-A Grosvenor Ave., Westmount, Que. (*S. 1931*) (*Jr. 1936*) (*A.M. 1938*)

WARREN, Hector de la G., B.Sc., C.E., (Queen's), Private Practice, Pointe-au-Pic, Que. (*A.M. 1918*)

WARREN, Pierre, B.A.Sc., (Ecole Polytech., Montreal '32), Zachee Langlais, Cons. Engr., 105 Cote de la Montagne, Quebec, Que. (*H*) 11 Hamel St. (*S. 1932*)

WARREN, R. W., P.F.R.A., 910 McCallum-Hill Bldg., Regina, Sask. (*S. 1938*)

†WASS, Silas B., (Tor. '03), Terminal Engr., Toronto; Div. Engr., C.N.R., St. Thomas, Ont. Address: 70 Southwick St., St. Thomas, Ont. (*A.M. 1909*)

♂WATERHOUSE, George Kerby, Lieut., B.Sc., (Queen's '19), 292 St. Joseph Blvd. W., Montreal, Que. (*Jr. 1921*) (*A.M. 1930*)

WATEROUS, Charles A., B.Sc., (McGill), 69 Dufferin Ave., Brantford, Ont. (*S. 1898*) (*A.M. 1903*) (*M. 1909*)

WATERS, Allan J., Supt. of Constrn., Staffordshire, Worcestershire, Shropshire Electric Power Corp., Stourport-on-Severn, Worcs., England. (*H*) Linkfield Corner, Redhill, Surrey. (*M. 1935*)

WATERS, Donald S., B.Sc., (Alta. '37), Can. Bridge Co., Ltd., Walkerville, Ont. (*H*) 1087 Windermere Rd. (*S. 1937*)

WATERS, Wm., C.N.R. (*H*) 2215 Cameron St., Regina, Sask. (*1938*)

WATERS, William L., E.E., M.E., C.E., (London), Cons. Engr., 137 McGill St., Montreal, Que., and 150 Nassau St., New York, N.Y., U.S.A. (*H*) Roslyn Heights, New York, N.Y. (*M. 1918*)

WATIER, A. H., B.Eng., (McGill '32), Shawinigan Water and Power Co., Shawinigan Falls, Que. (*H*) 37-8th St. (*S. 1931*) (*Jr. 1936*)

WATSON, Alexander, Asst. Marine Supt., Dept. of Transport, Rm. 416, Customs Bldg., Montreal, Que. (*H*) 600 Berwick Ave., Town of Mount Royal, Que. (*M. 1937*)

♂†WATSON, Geo. L., Col., C. de G., D.Eng., (Rutgers '29), Cons. Engr., 11 West 42nd St., New York, N.Y., U.S.A. (*H*) 22 Arcularius Terrace, Maplewood, N.J., U.S.A. (*S. 1906*) (*A.M. 1907*) (*M. 1922*)

WATSON, H. D., B.A.Sc., (B.C. '31), Br. Mgr., Linde Can. Refrigeration Co. Ltd., 124 King St., Winnipeg, Man. (*H*) 61 Furby St. (*S. 1931*)

WATSON, Hugh Monroe, Jr., B.Sc., (McGill '11), Contracting Engr., Dom. Bridge Co. Ltd., P.O. Box 280, Montreal, Que. (*H*) 660 Belmont Ave., Westmount, Que. (*A.M. 1927*)

♂WATSON, John P., Lieut., B.A.Sc., (Tor. '06), Mech. Design Dept., Dom. Bridge Co., Ltd., Lachine, Que. (*H*) 4186 Melrose Ave., Montreal, Que. (*S. 1907*) (*Jr. 1912*) (*A.M. 1920*)

WATSON, John Tait, City Mgr., Lethbridge, Alta. (*H*) 634-9th St. S. (*A.M. 1925*)

♂WATSON, M. Barry, Major, B.A.Sc., C.E., M.E., (Tor. '10), Dir., Dept. of Military Studies, Univ. of Toronto, and Cons. Engr., 184 College St., Toronto, Ont. (*H*) 121 Welland Ave. (*Jr. 1912*) (*A.M. 1919*)

WATSON, Robt. Geo., Pr. Supt., City of Edmonton, Alta. (*H*) 13122-102nd Ave. (*A.M. 1921*)

WATTERS, E. Steen, B.Sc., (N.B.), Radio Control Rm. Operator, James S. Neill & Sons, Ltd., CFNB, Fredericton, N.B. (*H*) 627 Union St. (*S. 1934*)

♂WAUGH, Bruce Wallace, B.A.Sc., (Tor. '08), D.L.S., Chief of Party, Surveys and Engrg., Dept. of Mines and Resources, Ottawa, Ont. (*M. 1922*)

WAY, Ernest Owen, Dir., Weights and Measures, Dept. of Trade and Commerce, West Block, Ottawa, Ont. (*H*) 195 McLeod St. (*A.M. 1919*)

WAY, Wm. Russell, B.Sc., (McGill '18), Supt. of Operations, Shawinigan Water and Power Co., P.O. Box 2670, Montreal, Que. (*H*) 4622 Draper Ave (*S. 1916*) (*Jr. 1919*) (*A.M. 1934*)

WEATHERBE, D'Arcy, c/o Chartered Bank of India, Bishopsgate St., London, E.C., England. (*A.M. 1901*) (*M. 1905*) (*Life Member*)

♂WEATHERBE, Karl, Major, M.C., B.A., B.Sc., Box 407, 1441 Drummond St., Montreal, Que. (*A.M. 1904*) (*M. 1906*)

WEATHERBIE, Weston E., B.Sc., (N.S.T.C. '31), Asst. Res. Engr., Dept. Highways, N.S. (*H*) 36 Young St., Truro, N.S. (*S. 1931*) (*Jr. 1932*)

WEBB, Christopher E., B.A.Sc., (Tor. '09), (C.E., '34), Dist. Chief Engr., Dom. Water and Power Bureau, Dept. of Mines and Resources, 739 Hastings St. W., Vancouver, B.C. (*H*) 1842 Collingwood St. (*S. 1911*) (*A.M. 1913*) (*M. 1928*)

WEBB, D. Roland, B.Sc., (N.B. '35), Mgr., The Webb Electric Co., 107 Germain St., Saint John, N.B. (*H*) 226½ Rockland Rd. (*S. 1933*)

WEBB, Harry R., M.Sc., (Alta. '22), Asst. Prof., Dept. of C.E., Univ. of Alberta, Edmonton, Alta. (*H*) 8125-112th St. (*S. 1919*) (*Jr. 1927*) (*A.M. 1932*) (*M. 1938*)

WEBSTER, Chas. Wm., Asst. Res. Engr., Dept. of Highways, Ont., Grimsby, Ont. (*A.M. 1932*)

WEBSTER, Ernest B., (Tor. '97), Dist. Supt., Sask. Govt., Goldfields, Sask. (*1938*)

WEBSTER, R. C. P., B.Sc., (McGill '23), Mgr. and Partner, Maitland Charts, Maitland, Ont. (*S. 1922*) (*A.M. 1931*)

WEBSTER, Frederick H. T., Chief Engr., Homoeopathic Hospital, Montreal, Que. (*H*) Apt. 8, 6058 Sherbrooke St. W. (*Affil. 1935*)

♂WEEKS, Otis, B.Sc., Div. Engr., Southern Pacific Co., Rm. 201, Union Sta., Ogden, Utah, U.S.A. (*H*) 2529 Eccles Ave. (*A.M. 1907*)

♂WEIBEL, Emil Edwin, Lieut., B.Sc., (McGill '18), Ph.D., Instructor in Mech. Engrg., Univ. of California, International House, Berkeley, Cal., U.S.A. (*S. 1916*) (*Jr. 1921*) (*A.M. 1924*)

WEIR, Harold McIvor, B.Sc., (Tor. '01), Asst. City Engr., City of Saskatoon, City Engr.'s Office, Saskatoon, Sask. (*1938*)

WEIR, Jas., B.Sc., (McGill '13), Asst. Prof. of Geodesy, McGill Univ., Montreal, Que. (*H*) 416 Wiseman Ave., Outremont, Que. (*A.M. 1922*)

WEIR, Ronald Stanley, Industrial Sales Engr., Imperial Oil Ltd., Montreal, Que. (*H*) 4876 Cote des Neiges Rd. (*S. 1924*) (*A.M. 1934*)

WEIR, Wm. Cecil, B.E., (Sask. '36), Mech. Engr., Hudson Bay Mining and Smelting Co. Address: Hotel Flin Flon, Flin Flon, Man. (*Jr. 1937*)

♂WELCH, Henry Richard, B.Sc., (Queen's '18), Pres., Welch & Johnston, Ltd., 474 Bank St., Ottawa, Ont. (*H*) 477 Island Park Dr. (*S. 1917*) (*Jr. 1923*) (*A.M. 1930*)

WELDON, G. H., B.Sc., (Man '36), Power Corp. of Canada, Gogama, Ont. (*H*) 267 Woodlawn St., Winnipeg, Man. (*S. 1937*)

WELDON, Richard Laurence, M.Sc., (McGill '17), Pres., Bathurst Power and Paper Co., Ltd., Rm. 620, 1050 Beaver Hall Hill, Montreal, Que. (*H*) Glen Eagles, Cote des Neiges Rd. (*S. 1915*) (*Jr. 1918*) (*A.M. 1921*) (*M. 1931*)

WELLWOOD, F. Elwin, B.A.Sc., (Tor. '25), Engr., Dept. of Bldgs., City of Toronto. City Hall, Toronto, Ont. (*H*) 240 Deloraine Ave. (*S. 1921*) (*Jr. 1929*)

♂WELLWOOD, Henry, Major, 282 Bayswater Ave., Ottawa, Ont. (*M. 1921*)

♂WELSFORD, Hubert Gray, Lieut., Gen. Mgr., Dom. Engineering Co. Ltd., P.O. Box 220, Montreal, Que. (*H*) 27 Barat Rd., Westmount, Que. (*S. 1914*) (*A.M. 1920*)

WELSH, James Gordon, B.A.Sc., (Tor. '33), Horton Steel Wks. Ltd., Fort Erie, Ont. (*S. 1935*)

WESELAKE, Ed. J., B.Sc., (Man. '30), Ste. 1, 503½ Selkirk Ave., Winnipeg, Man. (*S. 1927*) (*Jr. 1937*)

WESLEY, W. G., B.Eng., (McGill '37), Apt. E, 1445 Van Horne Ave., Outremont, Que. (*S. 1936*)

WEST, Arthur E., Operating Mgr., Can. Bridge Co. Ltd , Walkerville, Ont. (*H*) 2448 Gladstone Ave., Windsor, Ont. (*A.M. 1922*) (*M. 1930*)

♂WEST, Chas. Wm., Capt., B.A.Sc., (Tor. '15), Supt. Engr., Welland Ship Canal, Dept. of Transport, St. Catharines, Ont. (*Jr. 1915*) (*A.M. 1920*)

♂WEST, Frank L., Lieut., M.A., B.Sc., (McGill '16), Prof. of Engrg., Mount Allison Univ., Box 711, Sackville, N.B. (*S. 1915*) (*A.M. 1920*) (*M. 1927*)

WEST, Thomas Macdonald, B.A.Sc., (Tor. '21), Sec.-Treas., J. & J. Taylor Safe Wks Ltd., 145 Front St. E., Toronto, Ont. (*H*) Stop 10, Kingston Rd. (*S. 1921*) (*Jr. 1924*)

WESTON, Benjamin Thomas, B.C.E., (Maine '00), Sr. Engr., Maine State Highway Bridge Divn., Madison, Maine, U.S.A. (*M. 1921*)

WESTON, Norman O., B.Sc., (Alta. '35), Can. Westinghouse Co., Ltd., Hamilton, Ont. (*H*) 95 Spadina Ave. (*S. 1935*)

WESTON, Robert Spurr, B.S., M.A., Cons. Engr., Weston & Sampson, 14 Beacon St., Boston, Mass., U.S.A. (*H*) 81 Griggs Rd., Brookline, Mass., U.S.A. (*M. 1913*)

WESTON, Samuel Raymond, B.Sc., (N.B. '14), Chief Engr., N.B. Electric Power Comm., Saint John, N.B. (*H*) 6 DeMonts St. (*A.M. 1922*) (*M 1925*)

WESTOVER, Channing Spaulding, 135 De Breslay St., Pointe Claire, Que. (*Affil. 1937*)

WHEATLEY, Eric E., B.Sc., (McGill '30), Chief Dftsman., Canada Iron Foundries, Ltd., Three Rivers, Que. (*H*) 1673 Blvd. des Forges (*S. 1930*) (*Jr. 1935*)

WHEATLEY, J. Howard, B.Sc., (McGill '12), Supt., General Shops, Montreal L., H. and P. Cons., Montreal, Que. (*H*) 5135 Hingston Ave. (*A.M. 1919*)

WHEATON, Lewis H., Locating Engr., Dept. of Highways, N.S., Halifax, N.S. (*H*) 122 Morris St. (*A.M. 1894*) (*Life Member*)

♂WHELEN, Morland P., B.Sc., (McGill '21), M.Sc., (Tor. '22), Tech. Power Engr., Toronto Hydro-Electric System, 14 Carlton St., Toronto, Ont. (*H*) 132 Lawrence Cres. (*S. 1919*) (*Jr. 1923*) (*A.M. 1929*)

WHILLANS, Thos. O., B.Sc., (Queen's '17), Patent Examiner, Patent Office, Ottawa, Ont. (*H*) 22 Sunset Blvd. (*A.M. 1922*)

WHITAKER, A. W., Jr., B.S., (Penn. '13), Gen. Supt., Aluminum Co. of Canada, Ltd., Arvida, Que. (*H*) 1 Radin Rd. (*A.M. 1931*) (*M. 1938*)

WHITBY, Eugene Mortimer, Deputy City Engr., City Engrs. Office, City Hall, Hamilton, Ont. (*H*) 176 John St. N. (*M. 1938*)

WHITE, Arthur Floyd Engr., T.H. & B. Rly., Hamilton, Ont. (*H*) 128 Eastbourne Ave. (*A.M. 1937*)

WHITE, Chas. Edward, Asst. Engr., C.N.R., Rm. 1, Union Sta., Ottawa, Ont. (*H*) 214 Third Ave. (*A.M. 1914*)

WHITE, Clifford Hubert, B.Sc., (Man. '38), C. A. Parsons & Co., Ltd., Newcastle-on-Tyne, England. (*H*) "Bambro," 398 Chillingham Rd., North Heaton, Newcastle-on-Tyne 6, England (*S. 1938*)

♂WHITE, Donald Alex., Major, D.S.O., (R.M.C., Kingston '09), Pres., D. A. White & Co Ltd., 880 Lagauchetiere St. W., Montreal, Que.; Pres., Canada Firebrick Co. Ltd., 4741 St. Ambroise St., Montreal, Que. (*H*) 1628 Seaforth Ave. (*S. 1909*) (*Jr. 1914*) (*A.M. 1922*)

WHITE, Frank O., B.S. (C.E.), (Maine '05), Chief Engr., Fraser Cos., Ltd., Edmundston, N.B. (*M. 1919*)

WHITE, Harry Manning, (Tor. '10), Chief Engr., Western Divn., Dom. Bridge Co. Ltd., Winnipeg, Man. (*H*) 981 Grosvenor Ave. (*A.M. 1920*) (*M. 1936*)

♂WHITE, Jas. Alex. Gordon, Major, D.S.O., M.C., B.Sc., (McGill '11), Field Engr., H.E.P.C. of Ont., 620 University Ave., Toronto, Ont. (*H*) 12 Ridley Blvd. (*S. 1909*) (*A.M. 1920*)

♂WHITE, Jos. Jas., B.Sc., (Sask. '25), Bldg. Inspector, City of Regina, City Hall, Regina, Sask. (*H*) 3320 Pike Ave. (*S. 1924*) (*A.M. 1928*) (*M. 1936*)

WHITE, Robert, Sales Engr., Williams & Wilson, Ltd., 544 Inspector St., Montreal, Que. (*H*) 720 Davaar Ave., Outremont, Que. (*Jr. 1912*) (*A.M. 1914*)

WHITE, Ross, B.S., (Iowa), Gen. Mgr., Brown, Rout & McKenzie, Austin, Texas, U.S.A. (*H*) 7 Niles Rd. (*M. 1928*)

WHITE, Thos. Hy., 1676-16th Ave. W., Vancouver, B.C. (*M. 1887*) (*Life Member*)

WHITE, Thomas W., Dist. Engr., C.N.R., Rm. 217, C.N.R. Depot, Edmonton, Alta. (*H*) 11132-88th Ave. (*A.M. 1909*)

WHITE, Walter Edmund, B.A.Sc., (Tor. '28), E.E., (Tor. '36), Development Engr., Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*H*) 3577 Peel St. (*Jr. 1931*)

WHITE, Wm. B., B.Sc., (Man. '37), 1322 Wolseley Ave., Winnipeg, Man. (*S. 1937*)

WHITEHOUSE, Lloyd Armor Blachford, 238 Queen St. S., Hamilton, Ont. (*Jr. 1921*)

WHITEHOUSE, Ralph John, B.Eng., (McGill), Consolidated Mining and Smelting Co., Trail, B.C. (*S. 1933*)

WHITELEY, Eric, B.A.Sc., (Tor. '37), Can. Gen. Elec. Co., Ltd., Peterborough, Ont. (*H*) 301 Reid St. (*S. 1937*)

WHITEWAY, Lorne B., B.Sc., (N.S.T.C. '34), D.P.W. and Highways, Summerside, P.E.I. (*Jr. 1938*)

♂WHITING, Harold John, A/Capt., Engr., Can. International Paper Co. Ltd., Hawkesbury, Ont. (*H*) 24 Smerdon Ave. (*Jr. 1921*) (*A.M. 1926*)

♂WHITMAN, Clyde O., B.Sc., (N.S.T.C. '21), 3534 Marlowe Ave., Montreal, Que. (*Jr. 1919*) (*A.M. 1923*)

♂WHITMAN, Karl Ewart, B.Sc., C.E., (N.S.T.C. '14), Chief Designing Engr., N.S. Power Comm., Halifax, N.S. (*H*) Upper Vaughan, Hants Co., N.S. (*A.M. 1919*) (*M. 1938*)

WHITSON, Duncan David, B.A.Sc., (Tor. '26), Strl. Engr., Dept. of Bldgs., City of Toronto, City Hall, Toronto, Ont. (*H*) 617 Huron St. (*S. 1926*) (*A.M. 1935*)

♂WHITTAKER, David, Lieut., Dept. of Transport, Canal Office, Cornwall, Ont. (*S. 1909*) (*Jr. 1913*) (*A.M. 1919*) (*M. 1931*)

♂WHITTAKER, Herbert James, H.M. Office of Wks., Usk, Mon., England. (*Jr. 1921*) (*A.M. 1922*)

*P.*WHITTEMORE, Carl Raymond, M.Sc.,(McGill '24), Metallurgist, Dom. Bridge Co., Ltd., Box 280, Montreal, Que. (*S. 1921*) (*A.M. 1927*)

♂WHITTIER, Albert Ronald, Capt., B.Sc., (Queen's '20), O.L.S., Asst. Engr., Dept. of Transport, Rideau Canal Office, Birks Bldg., Ottawa, Ont. (*H*) 84 Grove Ave. (*Jr. 1920*) (*A.M. 1922*)

WHITTIER, Chas. Comfort, B.C.E., (Maine), Pres., Standard Chemical and Mineral Corp., 332 S. Michigan Ave., Chicago, Ill., U.S.A. (*H*) 6025 University Ave. (*M. 1915*)

†WHITTON, Corbett F., Pres., Construction Products Ltd., 11 MacNab St. S., Hamilton, Ont. (*S. 1907*) (*A.M. 1913*)

♂WHYTE, Keith Ogilvie, Elec. Engr., Dom. Bridge Co. Ltd., Box 280, Montreal, Que. (*H*) 111-34th Ave., Lachine, Que. (*A.M. 1920*)

WHYTOCK, Jas. W., 318 Heath St. E., Toronto, Ont. (*S. 1932*)

♂†WICKENDEN, Alfred A. (*q*), C.E., (Columbia '01), Q.L.S., Mgr., Lands and Engrg. Dept., Consolidated Paper Corp. Ltd., 1515 Sun Life Bldg., Montreal, Que. (*H*) 387 Roslyn Ave., Westmount, Que. (*Jr. 1911*) (*A.M. 1913*)

♂WICKENDEN, John F., B.Sc., (McGill '20), General Contractor, Private Practice, 353 St. Francois Xavier St., Three Rivers, Que. (*Jr. 1921*) (*A.M. 1929*)

WICKWIRE, J. L., B.Sc., (McGill '24), Div. Engr., Dept. Highways, N.S., Middleton, N.S. (*Jr. 1927*)

WICKWIRE, W. A. Keith, B.Sc., 56 Edward St , Halifax, N.S. (*S. 1932*)

WIEBE, Victor, B.Sc., Dept. of Marine, Canada, 319 P.O. Bldg., Victoria, B.C. (*S. 1930*)

WIGDOR, Edward I., B.Eng., (McGill '35), M.Eng., 1568 Van Horne Ave., Outremont, Que. (*S. 1934*)

WIGGS, G. Lorne, B.Sc., (McGill '21), Cons. Engr., 509 University Tower, Montreal, Que. (*H*) 4797 Grosvenor Ave. (*S. 1916*) (*A.M. 1927*) (*M. 1937*)

WIGHT, Cecil D., B.Sc., (Queen's '28), O.L.S., Asst. W.W. Engr., City of Ottawa, 48 Rideau St., Ottawa, Ont. (*H*) 401 Huron Ave. (*A M. 1931*)

WIGHTMAN, John, B.Sc., (McGill '22), Supt., Cons. Mining and Smelting Co. Ltd., Caribou Gold Mines, Halifax Co., N.S. (*S. 1920*) (*Jr. 1928*) (*A.M. 1934*)

♂WIGHTMAN, John Fredrick Carman, Capt., Town Mgr. and Engr., Kentville, N.S. (*A.M. 1920*) (*M. 1937*)

♂WIGMORE, Roy Douglas Hazen, B.Sc., (Acadia '23), Asst. Mill Supt., Omega Gold Mines Ltd., Larder Lake, Ont. (*A.M. 1931*)

WILBUR, George Percival, Mgr. of Sales, Ontario Div., Dom. Bridge Co. Ltd., 1139 Shaw St., Toronto, Ont. (*H*) 167 Balsam Ave. (*A.M. 1921*)

♂WILCOX, Sydney Chas., Major, B.Eng., Div. Engr., C.P.R., Brandon, Man. (*S. 1906*) (*A.M. 1911*)

WILDE, Wm. Clayton, B.Sc., (Alta. '36), Sales Engr., Can. Telephones and Supplies, Ltd., 612 Lancaster Bldg., Calgary, Alta. (*H*) 334-14th Ave. W. (*Jr. 1938*)

WILFORD, Frederick R., Pres. and Mgr., F. R. Wilford & Co. Ltd., Lindsay, Ont. (*H*) 24 William St. S. (*A.M. 1894*) (*M. 1903*) (*Life Member*)

WILFORD, H. D., B.A.Sc., (Tor. '25), County Engr. and Rd. Supt., County of Victoria, Court House, Lindsay, Ont. (*H*) 18 Regent St. (*Jr. 1924*)

WILFORD, John R., Supt. and Sec., F. R. Wilford & Co., Ltd., P.O. Box 119, Lindsay, Ont. (*H*) 4 William St. S. (*S. 1920*) (*A.M. 1934*)

♂WILGAR, William P., Lt.-Col., D.S.O., B.Sc., (Queen's '03), Prof. of C.E., Queen's Univ., Kingston, Ont. (*H*) 56 Earl St. (*S. 1902*) (*A.M. 1905*) (*M. 1909*)

WILHJELM, Frits Erik, B.Sc., (R.T.C., Copenhagen '20), Tatamagouche, N.S. (*A.M. 1931*)

WILKIE, Edward T., 56 Marmaduke St., Toronto, Ont. (*A.M. 1904*) (*M. 1916*) (*Life Member*)

WILKINS, Ronald E., (R.M.C., Kingston '35), B.Sc., (Queen's '36), Lieut., R.C.E., Work Point Barracks, Dept. of Nat. Defence, Esquimalt, B.C. (*S. 1935*) (*Jr. 1938*)

♂WILKINSON, J. B., Lieut., B.Sc., Colas Roads, Ltd., 21 Dundas Sq., Toronto, Ont. (*H*) 574 Johnson St., Kingston, Ont. (*A.M. 1918*)

WILKINSON, Wm. C., B.Sc., (N.B. '37), Campbellton, N.B. (*S. 1937*)

WILLIAMS, Arthur S., B.Sc., (Man. '21), Chief Operator, Winnipeg Electric Co., Seven Sisters Falls, Man. (*S. 1920*) (*Jr. 1924*) (*A.M. 1928*)

WILLIAMS, Charles Gunning, B.A.Sc., (Tor. '05), Prof. of Mining Engrg., University of Toronto, Toronto, Ont. (*H*) 417 Rosemary Rd. (*M. 1938*)

WILLIAMS, C. Scott, B.Sc., (N.S.T.C. '32), P.O. Box 209, Antigonish, N.S. (*S. 1932*)

WILLIAMS, DAVID G., B.Sc., (Alta. '33), (M.Sc., '35), Officers' Mess, R.C.A.F. Station, Trenton, Ont. (*S. 1933*)

WILLIAMS, DONALD D., 359 Laurier Ave. W., Montreal, Que. (*S. 1937*)

WILLIAMS, EDW. C., Mgr., Air Conditioning Divn., Can. Gen. Elec. Co. Ltd., 212 King St. W., Toronto, Ont. (*H*) 109 Old Orchard Grove. (*Jr. 1930*) (*A.M. 1934*) (*M. 1938*)

WILLIAMS, FRANK, Mech. Engr., C.N.R., Rm. 700, Can. Nat. Express Bldg., Montreal, Que. (*H*) 592 Davaar Ave. (*A.M. 1921*)

†WILLIAMS, GUY MORRIS, B.Sc., C.E., (Nebraska '11), Prof. of Civil Engrg., Univ. of Saskatchewan, Saskatoon, Sask. (*A.M. 1920*)

WILLIAMS, J. T., B.Sc., (Queen's '38), 241 Wellington St., Sarnia, Ont. (*H*) Clandeboye, Ont. (*S. 1937*)

WILLIAMS, LESLIE CHEVERS, B.Sc., (Queen's '32), Dom. Engineering Co., Ltd., P.O. Box 220, Montreal, Que. (*H*) 23 Ossington Ave., Ottawa, Ont. (*S. 1934*)

WILLIAMS, RICHARD LOUIS, B.Sc., (McGill '31), 159-24th Ave., Lachine, Que. (*S. 1930*) (*Jr. 1933*) (*A.M. 1937*)

WILLIAMS, STANLEY CHEVERS, B.Sc., (Queen's '35), Dom. Engineering Co. Ltd., P.O. Box 220, Montreal, Que. (*H*) 23 Ossington Ave., Ottawa, O t. (*S. 1935*)

WILLIAMSON, DAVID ALLEN, B.A.Sc., (Tor. '99), Superv. Engr., Chief Architect's Br., D.P.W., Canada, Ottawa, Ont. (*H*) 728 Echo Dr. (*A.M. 1912*)

WILLIS, RALPH R., B.Sc., (N.B. '31), Ross Engineering of Canada, Ltd., 906 Dom. Square Bldg., Montreal, Que. (*S. 1931*) (*Jr. 1936*)

WILLIS, R. W., B.Sc., (Queen's '27), Designing Engr., Rly. and Bridge Section, Dept. of Wks., Rm. 313, City Hall, Toronto, Ont. (*H*) 373 Castlefield Ave. (*Jr. 1929*) (*A.M. 1935*)

WILLOWS, FRED., B.Sc., (Man. '29), 442 Boyd Ave., Winnipeg, Man. (*S. 1929*) (*Jr. 1936*)

♂WILLSON, ARTHUR GEORGE, Capt., (C.G.I.), 1026-6th Ave. S.W., Calgary, Alta. (*A.M. 1920*)

♂WILMOT, L. ALLAN, Major, M.C., (R.M.C., Kingston '11), C.E., (Wis. '14), Customs Consultant, 67 Yonge St., Toronto, Ont. (*H*) 217 Glengrove Ave. W. (*A.M. 1929*)

♂WILSON, ALEXANDER, Lieut., B.Sc., (McGill '10), 1537 St. Matthew St., Montreal, Que. (*A.M. 1920*)

WILSON, A. McD., B.Sc., (Queen's '28), Asst. Engr., Algoma Central and Hudson Bay Rly., Sault Ste. Marie, Ont. (*H*) 11 Summit Ave. (*Jr. 1929*) (*A.M. 1935*)

WILSON, BERTRAM H. J., B.Sc., (Man. '37), Sherritt-Gordon Mines, Ltd., P.O. Box 101, Sherridon, Man. (*H*) 149 Monck Ave., Winnipeg, Man. (*S. 1937*)

WILSON, CLIFFORD ST. J., B.Sc., (McGill '11), Pickings & Wilson, 521 Roy Bldg., Halifax, N.S. (*H*) 9 Waegwoltic Ave. (*Jr. 1913*) (*A.M. 1919*)

♂WILSON, ELDON PARKER, Capt., B.Sc., (McGill '20), Brompton Pulp and Paper Co. Ltd., East Angus, Que. (*Jr. 1920*) (*A.M. 1927*)

WILSON, H. ALTON, Sales Engr., Can. Foundries and Forgings, Ltd., Welland, Ont. (*H*) Apt. 6, Leslie Apts., 6 Griffith St. (*A.M. 1922*)

♂WILSON, JAS. CLARENCE, B.A.Sc., (Tor. '16), Special Representative, Caterpillar Tractor Co., Peoria, Ill., U.S.A. (*H*) 19 Golfdale Rd., Toronto, Ont. (*S. 1914*) (*A.M. 1925*)

WILSON, JAS. HARVEY, B.Sc., (Man. '25), 4621 Harvard Ave., Montreal, Que. (*S. 1924*) (*A.M. 1929*)

♂WILSON, JOHN ARMISTEAD, Controller of Civil Aviation, Dept. of Transport, Ottawa, Ont. (*H*) 178 Rideau Terrace. (*A.M. 1910*) (*M. 1936*)

WILSON, JOHN P., B.Sc., (Queen's '38), Civil Aviation Divn., Dept. of Transport, Hunter Bldg., Ottawa, Ont. (*H*) 460-A Gilmour St. (*S. 1937*)

♂WILSON, JOHN S., Lieut., M.C., B.A.Sc., (Tor. '20), Gen. Mgr., Dryden Paper Co., Ltd., Dryden, Ont. (*Jr. 1919*) (*A.M. 1923*) (*M. 1930*)

♂†WILSON, LEROY Z., Major, M.C., B.A.Sc., (Tor. '11), Engr. i/c Operations, Evans, Deakin-Hornibrook Construction Pty. Ltd., Ryan House, Charlotte St., Brisbane, Australia. (*S. 1910*) (*Jr. 1913*) (*A.M. 1915*) (*M. 1923*)

WILSON, MURRAY E., B.Sc., (N.B. '37), 34 Enterprise St., Moncton, N.B. (*S. 1937*)

♂WILSON, NORMAN, Lieut., B.Sc., (C.E.), (N.B. '13), Aids to Navigation Br., Dept. of Transport, 254 Hunter Bldg., Ottawa, Ont. (*H*) 68 Brighton Ave. (*S. 1912*) (*Jr. 1916*) (*A.M. 1919*)

WILSON, NORMAN D., B.A.Sc., (Tor. '04), C.E., D.L.S., O.L.S., Wilson & Bunnell, Cons. Engrs., 388 Yonge St., Toronto, Ont. (*H*) 128 Glen Rd. (*S. 1905*) (*A.M. 1910*) (*M. 1925*)

WILSON, ROBERT S. L., B.Sc., (McGill '11), Dean of the Faculty of Applied Science and Prof. C.E. and Municipal Engrg., Univ. of Alberta, Edmonton, Alta. (*S. 1907*) (*A.M. 1913*) (*M. 1926*)

♂WILSON, SELWYN HAMILTON, Lieut., M.C., B.Sc., (McGill '22), Waterous Ltd., Ottawa, Ont. (*H*) 309 Stewart St. (*S. 1920*) (*A.M. 1925*)

WILSON, THOS. W., B.A.Sc., (Tor. '33), Hugh C. MacLean Publications, Ltd., Toronto, Ont. (*H*) 13 Fairview Blvd. (*S. 1932*) (*Jr. 1938*)

WILSON, WM. BOWMAN, B.Sc., (McGill '13), Res. Engr., R.C.A.F. Station, Dept. of Nat. Defence, Trenton, Ont. (*H*) P.O. Box 774. (*A.M. 1937*)

♂WILSON, WM. FAIRBAIRN, Cons. Engr., R.R. 1, East Sooke, V.I., B.C. (*A.M. 1934*)

WILSON, WM. SEATH, B.Sc., (McGill '07), Field Engr., Algoma Steel Corp., Sault Ste. Marie, Ont. (*H*) 210 McGregor Ave. (*S. 1906*) (*A.M. 1911*)

WILSON, WILLIAM SMITH, Chief Engr., Dom. Steel and Coal Corp. Ltd., Sydney, N.S. (*H*) 847 George St. (*A.M. 1921*)

♂WILSON, WM. STEWART, Major, B.A.Sc., (Tor. '21), Secy., Faculty of Applied Science and Engrg., Univ. of Toronto, Toronto, Ont. (*H*) 20 Humewood Dr. (*S. 1921*) (*A.M. 1926*) (*M. 1935*)

♂WILSON, WM. THOMAS, Major, D.S.O., M.C. and Bar, "Tower of Lettrick," Dunscore, Dumfriesshire, Scotland. (*A.M. 1906*)

♂WINDELER, HENRY STANTON, Major, M.C., B.Sc., (McGill '14), Chief Engr., Anglo-Newfoundland Development Co. Ltd., Grand Falls, Nfld. (*S. 1912*) (*A.M. 1921*)

WINDER, JOHN, Elec. Engr., Molsons Brewery Ltd., 1670 Notre Dame St. E., Montreal, Que. (*H*) 5596 Jeanne Mance St. (*Affil. 1934*)

WINDSOR, MAURICE, Can. Mgr., Armstrong Siddeley Motors Ltd., Slater St., Ottawa, Ont. (*H*) 282 Wilbrod St. (*A.M. 1935*)

WINFIELD, JAMES HENRY, Man'g. Dir., Maritime Telegraph and Telephone Co. Ltd., P.O. Box 110, Halifax, N.S. (*M. 1918*)

WINFIELD, W. A., Gen. Mgr., Maritime Telegraph and Telephone Co. Ltd., P.O. Drawer 110, Halifax, N.S. (*H*) 100 Oakland Rd. (*M. 1920*)

WING, DANIEL OSCAR, (Tor. '08), D.L.S., B.C.L.S., Engr., Gas Divn., Montreal L. H. and P. Cons., Montreal, Que. (*H*) 4078 Hampton Ave. (*A.M. 1917*)

WING, ERNEST, Plant Engr., Can. and Dom. Sugar Co. Ltd., 1410 Montmorency St., Montreal, Que. (*A.M. 1938*)

WINGFIELD, ALEX HAMILTON, B.A.Sc., (Tor. '21), Ph.D., '27, Teacher, High School of Commerce, Hamilton, Ont. (*H*) 16 Queen St. N. (*A.M. 1929*)

WINN, JAMES, B.Eng., (McGill '35), Anglo-Can. Pulp and Paper Mills, Quebec, Que. (*H*) 45 Bourgainville Ave. (*S. 1935*)

♂WINSLOW, KENELM MOLSON, Lieut., B.Sc., (McGill '21), Sales Engr., Dom. Engineering Co. Ltd., P.O. Box 220, Montreal, Que. (*H*) 22 Riverside Dr., Lachine, Que. (*Jr. 1922*) (*A.M. 1934*)

WINSLOW-SPRAGGE, E., B.Sc., (McGill '08), Gen. Mgr., Can. Ingersoll-Rand Co. Ltd., 620 Cathcart St., Montreal, Que. (*H*) 55 Aberdeen Ave., Westmount, Que. (*A.M. 1920*)

WINTER, F. E., B.Sc., (McGill '26), Montreal Engineering Co., 244 St. James St. W., Montreal, Que. (*S. 1924*) (*A.M. 1938*)

WIREN, ROBT. C., B.A.Sc., (Tor '26), Lecturer, Univ. of Toronto, Rm. 14, Mech. Bldg., Toronto, Ont. (*H*) East House Men's Residence. (*A.M 1929*) (*M. 1936*)

WISDOM, CHAS. S. C., B.C., (McGill '35); (R.M.C., Kingston), Shawinigan Chemical Co., Shawinigan Falls, Que. (*S. 1935*)

WISE, ALFRED J., B.Sc., M.Sc., (McGill '27), Inspr. and Elec. Engr., Can. Underwriters Assoc., Coristine Bldg., Montreal, Que. (*H*) 6648-3rd Ave., Rosemount. (*S. 1925*) (*A.M. 1937*)

WISHART, W. D., B.Sc., (Man. '31), Lieut., Dist. Signal Officer, Dept. of Nat. Defence, M.D. No 1, National Defence Bldg., London, Ont. (*S. 1932*) (*Jr. 1934*)

WITHROW, J. FREDERICK D., (Tor. '00), Reg'd. Patent Attorney and Engr., Hazard & Miller, 706 Central Bldg., Los Angeles, Calif., U.S.A. (*H*) 5251 La Roda Ave., Eagle Rock P.O. (*A.M. 1921*)

WOLFF, AAGE OSCAR, Asst. Dist. Engr., C.P.R., Rm. 333, Union Station, Toronto, Ont. (*A.M. 1920*) (*M. 1926*)

WOLFF, MARTIN, 442 Argyle Ave., Westmount, Que. (*S. 1906*) (*A.M. 1911*)

WONG, HENRY G., B.Eng., (McGill '35), 1090 Chenneville St., Montreal, Que. (*S. 1934*)

WOOD, ALBERT L., B.Sc., (N.S.T.C. '33), 109-A Charles St., Halifax, N.S. (*S. 1930*)

WOOD, CHARLES O., 154 Cameron St., Ottawa, Ont. (*A.M. 1904*)

WOOD, D. W., B.Sc., (Sask. '31), Can. Westinghouse Co. Ltd., Hamilton, Ont. (*H*) 163 Jackson St. W. (*S. 1931*)

♂G.†WOOD, FREDERICK MORRIS, M.A., B.Sc., (Queen's '14), Asst. Prof., McGill Univ., Engrg. Bldg., Montreal, Que. (*H*) 6-44th Ave., Lachine, Que. (*A.M. 1920*)

♂WOOD, GEORGE HOWARD, Lieut., B.A.Sc., (Tor. '17), C.E., '30, Asst. Engr., Dom. Water and Power Bureau, Dept. of Mines and Resources, Rm. 1, Ontario Power Co., Niagara Falls, Ont. (*H*) 1929 Delaware St. (*Jr. 1921*) (*A.M. 1922*)

WOOD, JAS. ROBT., (A.R.T.C. '11), Asst. City Engr., City Hall, Calgary, Alta. (*H*) 818-18th Ave. W. (*A.M. 1919*) (*M. 1935*)

WOODARD, SILAS H., B.Sc., (Mich. '99), Cons. Engr., 10 East 40th St., New York, N.Y., U.S.A. (*M. 1910*)

WOODFIELD, RAYMOND P., 303 Gwendoline St., Winnipeg, Man. (*S. 1938*)

WOODHALL, T. L., B.Sc., (Man. '30), (M.Sc., '34), 441 College Ave., Winnipeg, Man. (*S. 1930*)

WOODMAN, JOHN, 504 River Ave., Winnipeg, Man. (*A.M. 1896*) (*M. 1897*) (*Life Member*)

WOODS, FRANCIS CEDRIC, B.Sc., (N.B. '27), Engrg. Dept., City of Westmount, City Hall, Westmount, Que. (*H*) 759 Moffat Ave., Verdun, Que. (*S. 1927*) (*A.M. 1936*)

WOODS, JOS. EDWARD, 252 Wilbrod St., Ottawa, Ont. (*A.M. 1887*) (*Life Member*)

WOODSIDE, JAS., B.A.I., (Dublin '14), Asst. Hydraulic Engr., Gatineau Power Co., 140 Wellington St., Ottawa, Ont. (*H*) 37 Fulton Ave. (*A.M. 1926*)

WOODYATT, JAMES BLAIN, B.Sc., (McGill), Pres. and Gen. Mgr., Southern Canada Power Co. Ltd., 355 St. James St., Montreal, Que. (*H*) 3197 Westmount Blvd., Westmount, Que. (*S. 1907*) (*A.M. 1916*) (*M. 1931*)

WOOLSEY, JOHN T., (R.M.C., Kingston), Lieut., Work Point Barracks, R.C.A., Dept. of Nat. Defence, Esquimalt, B.C. (*S. 1932*)

♂WOOLWARD, CHARLES DESMOND, B.Sc., (McGill '23), Engr., Anglin-Norcross Quebec Ltd., 892 Sherbrooke St. W., Montreal, Que. (*H*) Apt. 10, 3546 Durocher St. (*S. 1921*) (*Jr. 1926*) (*A.M. 1930*)

WOOTTON, ALLAN S., Chief Engr. and Supt., Bd. of Parks Commrs., Stanley Park, Vancouver, B.C. (*H*) 975 Lagoon Dr. (*M. 1923*)

WORCESTER, WOLSEY GARNET, (Ohio '99), Prof., Ceramic Engrg., Univ. of Saskatchewan, Saskatoon, Sask. (*M. 1923*)

WORKMAN, WM. ROSS, B.A.Sc., (B.C. '30), Res. Engr., D.P.W., B.C., New Denver, B.C. (*S. 1927*) (*Jr. 1936*)

WORLD, HARRY P., Mech. and Strl. Designer, c/o Col. Mackenzie Waters, 96 Bloor St. W., Toronto, Ont. (*H*) 30 Rosewell Ave. (*A.M. 1936*)

WORSFOLD, CUTHBERT COLEMAN, 325-4th St., New Westminster, B.C. (*S. 1893*) (*A.M. 1898*) (*M. 1901*) (*Life Member*)

WORTHINGTON, WM. ROBERT, B.A.Sc., (Tor. '05), Pres., W. R. Worthington Constrn. Co. Ltd., Toronto, Ont. (*H*) 57 Lascelles Blvd. (*A.M. 1916*)

WRANGELL, K. FREDERICK, Mech. Engr., E. B. Eddy Co. Ltd., Hull, Que. (*Jr. 1931*) (*A.M. 1935*)

WRIGHT, ARCH'D. E., West Kootenay Power and Light Co. Ltd., Box 76, Rossland, B.C. (*M. 1920*)

♂WRIGHT, ATHOL C., Capt., National Parks Bureau of Canada. (*H*) 55 Renfrew Ave., Ottawa, Ont. (*S. 1908*) (*A.M. 1919*) (*M. 1922*)

WRIGHT, A. MEADE, 2349 Grand Blvd., N.D.G., Montreal, Que. (*S. 1938*)

WRIGHT, C. A., B.Sc., (N.S.T.C., '35), Can. Gen. Elec. Co. Ltd., 212 King St. W., Toronto, Ont. (*H*) 173 Geoffrey St. (*S. 1930*)

WRIGHT, C. H., B.A.Sc., (McGill '96), Dist. Mgr. for Maritime Provinces, Can. Gen. Elec. Co. Ltd., 129 Hollis St., Halifax, N.S. (*H*) 110 Oxford St. (*M. 1918*)

WRIGHT, ERROL HARCOURT, B.Sc., (Queen's '35), Jr. Engr., Northwestern Utilities Ltd., Edmonton, Alta. (*H*) 10234-121st St. (*A.M. 1937*)

WRIGHT, H. SINCLAIR, B.Sc., (N.S.T.C. '27), Gen. Supt., Demerara Elec. Co., Ltd., Georgetown, British Guiana. (*H*) St. Peter's, N.S., Canada. (*S. 1922*) (*Jr. 1931*)

WRIGHT, JAMES A., James A. Wright & Associates, P.O. Box 25, Ontario, Cal., U.S.A. (*H*) 1229 S. Palmetto Ave. (*M. 1922*)

WRIGHT, JOHN WM., c/o R. E. Wright, 1865 de Maricourt St., Cote St. Paul, Montreal, Que. (*S. 1935*)

WRIGHT, L. Austin, B.A.Sc., (Tor. '10), General Secretary, The Engineering Institute of Canada, 2050 Mansfield St., Montreal, Que. (*H*) 2349 Grand Blvd., N.D.G. (*Jr. 1914*) (*A.M. 1938*)

WRIGHT, Noel N., B.Sc., (Illinois '28), Sales Engr., Ferranti Electric Ltd., 508 Power Bldg., Montreal, Que. (*H*) 487 Victoria Ave., Westmount, Que. (*Jr. 1928*) (*A.M. 1938*)

WURTELE, John Stone Hunter, Vice-Pres. and Plant Mgr., Southern Canada Power Co.; Plant Mgr., Power Corp. of Canada, 355 St. James St., Montreal, Que. (*H*) 756 Upper Lansdowne Ave., Westmount, Que. (*M. 1917*)

WYCKOFF, Edwin Gerald, B.A.Sc., (Tor. '30), Otis-Fensom Elevator Co., Ltd., Hamilton, Ont. (*H*) 116 Blake St. (*A.M. 1938*)

♂WYMAN, Hugh Kennedy, Lieut., M.C., M.M., B.A.Sc., (Tor. '15), 15 Champlain St., Shawinigan Falls, Que. (*A.M. 1925*)

♂WYMAN, John Kirby, Major, B.Sc., (McGill '10), Gen. Supt., Grain Elevators, Nat. Harbours Bd., 357 Common St., Montreal, Que. (*H*) 71 Ballantyne Ave., Montreal West, Que. (*S. 1907*) (*A.M. 1912*)

WYNN, Guy Montague, Vice-Pres., T. Pringle & Son, Ltd., Rm. 706, 485 McGill St., Montreal, Que. (*H*) 2985 Cedar Ave. (*A.M. 1915*) (*M. 1926*)

WYNN, Earle Murray, Dftsman., Mathews Conveyor Co., Box 584, Port Hope, Ont. (*A.M. 1919*)

♂YACK, Wilfrid Laurier, B.A.Sc., (Tor. '22), Babcock-Wilcox & Goldie-McCulloch Ltd., Montreal, Que. (*H*) 4452 Oxford Ave., N.D.G. (*A.M. 1929*)

YARROW, N. A., Pres., Yarrows, Ltd., P.O. Box 835, Victoria, B.C. (*H*) 925 Foul Bay Rd. (*A.M. 1918*)

YAPP, Raymond A., B.Sc., (London '21), Sales Mgr., Bepco Canada Ltd., 1050 Mountain St., Montreal, Que. (*H*) 5027 Glen Cairn Ave. (*A.M. 1934*)

YATES, John Munro, Instr. in Drfting., Central Tech. School, 275 Lippincott St., Toronto, Ont. (*H*) 677 Broadview Ave. (*S. 1933*)

YEOMANS, R. H., B.Sc., (McGill '30), Northern Electric Co. Ltd., 1261 Shearer St., Montreal, Que. (*H*) 5453 Earnscliffe Ave. (*S. 1928*) (*Jr. 1933*)

YORGAN, Wm. Jas., Supt., Gas Mains and Services, Montreal L., H. and P. Cons., 107 Craig St. W., Montreal, Que. (*H*) 3791 Vendome Ave. (*A.M. 1932*)

YORK, Fred. Gilbert, B.Eng., (McGill '35), Asst. to Line Supt., Ottawa Hydro-Elec. Comm., 75 Laurier Ave. W., Ottawa, Ont. (*H*) 28 Broadway Ave. (*S. 1935*) (*Jr. 1936*)

YORSTON, Wm. G., (R.M.C., Kingston), Queen St., Truro, N.S. (*M. 1914*) (*Life Member*)

YOST, Winfield Hancock, Pres., Yost Railway Supplies Ltd., Montreal, Que. (*H*) 4050 Marlowe Ave. (*A.M. 1924*)

♂†YOUNG, Alexander A., Major, B.Sc., (McGill '10), Box 119, Grimsby Beach, Ont. (*S. 1909*) (*A.M. 1913*)

YOUNG, Angus F., B.E., (N.S.T.C. '37), 1369 Victoria Rd., Sydney, N.S. (*S. 1936*)

†YOUNG, Clarence R., Major, B.A.Sc., C.E., (Tor. '05), Prof. of Civil Engineering, Univ. of Toronto, Toronto, Ont.; Cons. Engr. (*H*) 119 Glenayr Rd. (*S. 1903*) (*A.M. 1908*) (*M. 1913*)

YOUNG, Frank, Field Engr., City of Saskatoon, Saskatoon, Sask. (*1938*)

♂YOUNG, Frank Bennet, Major, N.B.L.S., Asst. Canal Supt., D.N.R., C.P.R., Box 11, Strathmore, Alta. (*Jr. 1919*) (*A.M. 1923*)

YOUNG, Jacob Ridgely, Mgr., Sun Electric Co., Regina, Sask. (*H*) 1943 Scarth St., Regina, Sask. (*1938*)

YOUNG, James W., Chemist, Glenmore Water Supply, City of Calgary. (*H*) 1710–14th Ave. W., Calgary, Alta. (*A.M. 1936*)

YOUNG, John, (Tor. '07), 201 Scotia St., Winnipeg, Man. (*A.M. 1920*)

YOUNG, John Douglas, B.Sc., (Queen's '27), Sales Engr., Bailey Meter Co. Ltd., 980 St. Antoine St., Montreal, Que. (*Jr. 1931*) (*A.M. 1936*)

♂YOUNG, John Paterson, B.Sc., (Queen's '22), Asst. Supt. of Constrn., D.P.W., Canada. (*H*) 41–5th Ave., St. Thomas, Ont. (*A.M. 1938*)

†YOUNG, Roderick Bearce, B.A.Sc., (Tor. '13), (C.E., '19), Testing Engr., H.E.P.C. of Ontario, 620 University Ave., Toronto, Ont. (*H*) 30 Brummell Ave. (*S. 1911*) (*Jr. 1916*) (*A.M. 1918*) (*M. 1923*)

YOUNG, Ross A., B.Sc., (Man. '25), Can. Car and Foundry Co. Ltd., Montreal, Que. (*H*) Apt. 2, 5275 Cote St. Luc Rd. (*A.M. 1938*)

YOUNG, Stewart, B.A.Sc., (Tor. '12), Dir., Divn. of Municipal Planning, Govt. of Sask., Parliament Bldgs., Regina, Sask. (*H*) 2822 Rae St. (*A.M. 1917*) (*M. 1935*)

♂YOUNG, W. Brand, Lieut., Trail's End Lodge, Quesnel Lake, Likely P.O., B.C. (*A.M. 1919*)

YOUNG, Wm. Hugh, B.Sc., (Queen's '34), Howard Smith Paper Mills, Ltd., Cornwall, Ont. (*H*) 147 Strathcona Ave., Westboro, Ont. (*Jr. 1936*)

YOUNGER, H. R., B.Sc., (McGill '10), Div. Engr., C.P.R., Box 534, Nelson, B.C. (*H*) 221 Mill St. (*A.M. 1913*)

♂YUILL, A. C. R., Lieut., R.N.V.R., O.B.E., Cons. Engr., 675 Hastings St. W., Vancouver, B.C. (*H*) 5162 Marguerite St. (*A.M. 1919*) (*M. 1927*)

♂YUILL, Russell, Lieut., B.Sc., (McGill '15), Dept. of Transport, 317 West Block, Ottawa, Ont. (*S. 1914*) (*A.M. 1920*)

♂ZEALAND, Edward Lamport, Lieut., B.A.Sc., (Tor. '24), Res. Engr., Pigot Constrn. Co., Box 964, St. Thomas, Ont. (*H*) 424 Main St. E., Hamilton, Ont. (*S. 1920*) (*Jr. 1924*) (*A.M. 1928*)

ZION, Alfred Bernard, B.Eng., (McGill '35), Prod. Engr., Dom. Lock Co. Ltd., 3770 Henri Julien Ave., Montreal, Que. (*H*) 5280 Byron St. (*S. 1935*)

ZWICKER, B. H. C., B.Sc., (N.S.T.C. '30), 4 Tower Terrace, Halifax, N.S. (*S. 1928*)

GEOGRAPHICAL LIST OF MEMBERS

CORRECTED TO NOVEMBER 15th, 1938

ZONE A

(*The four Western Provinces.*)

Victoria Branch District

(*Vancouver Island and the Gulf Islands Tributary to Vancouver Island.*)

Albert Head (Br. Res.), Member, J. H. Gray.
Bamberton, Tod Inlet (Br. Non-Res.), Associate Member, J. H. McIntosh.
Cadboro Bay (Br. Res.), Member, R. E. Smythies.
Courtenay (Br. Non-Res.), Member, W. Scales.
Duncan (Br. Non-Res.), Associate Member, R. H. Vaughan.
East Sooke (Br. Res.) Associate Member, W. F. Wilson.
Headquarters (Br. Non-Res.), Associate Member, H. E. Stevens.
James Island (Br. Non-Res.), Junior, H. B. Brewer.
Nanaimo (Br. Non-Res.), Associate Member, A. G. Graham.
Port Alice (Br. Non-Res.), Member, C. C. Ryan.
Sidney (Br. Non-Res.), Associate Member, L. S. Daynes.
Victoria (Br. Res.),

Honorary Member

C. A. Magrath.

Members

R. A. Bainbridge, A. L. Carruthers, E. Davis, G. M. Duncan, R. C. Farrow, S. H. Frame, C. W. Gamble, F. C. Green, J. E. Griffith, A. E. Hodgins, H. T. Hughes, G. M. Irvin, E. W. Izard, J. C. MacDonald, K. Moodie, F. J. O'Reilly, G. L. Stephens, G. M. Tripp.

Associate Members

J. N. Anderson, I. C. Barltrop, J. H. Blake, H. F. Bourne, R. F. Davy, K. Dixon, W. S. Drewry, A. W. Ferguson, H. N. Gahan, A. J. Gray, E. I. W. Jardine, D. MacBride, A. S. G. Musgrave, G. Phillips, H. L. Sherwood, N. A. Yarrow.

Juniors

W. M. Davidson, M. C. Nesbitt, K. Reid, J. V. Rogers, W. H. Sparks, R. E. Wilkins.

Students

M. S. Brown, R. J. Carson, G. R. Davidson, L. M. Evans, W. S. B. Latta, V. Wiebe, J. T. Woolsey.

Vancouver Branch District

(*The balance of British Columbia, except that allocated to Lethbridge Branch.*)

Barkerville (Br. Non-Res.), Student, H. N. Curry.
Britannia Beach (Br. Non-Res.), Associate Member, G. W. Waddington.
Clinton (Br. Non-Res.), Student, B. V. Moss.
Deer Park (Br. Non-Res.), Associate Member, C. S. Moss.
Fredrick's Arm (Br. Non-Res.), Associate Member, M. J. Evans.
Kaleden (Br. Non-Res.), Member, A. K. Robertson.
Kamloops (Br. Non-Res.), Member, M. L. Wade; Associate Member, W. Ramsay.
Kelowna (Br. Non-Res.), Hon. Member, Grote Stirling; Members, F. W. Groves, D. K. Penfold
Ladner (Br. Res.), Associate Member, C. E. Cooper.
Likely (Br. Non-Res.), Associate Member, W. P. Young.
Lillooet (Br. Non-Res.), Member, O. W. Smith.
Manson Creek (Br. Non-Res.), Associate Member, W. M. Ogilvie.
Minto (Br. Non-Res.), Member, J. A. Mackenzie.
Nelson (Br. Non-Res.), Member, A. L. McCulloch; Associate Member, H. R. Younger.
New Westminster (Br. Res.), Members, L. B. Elliot, F. L. Macpherson, C. C. Worsfold; Associate Members, H. Balmforth, G. B. Dixon, C. F. P. Faulkner, W. E. Keyt, J. B. Lambert, F. O. Mills, C. Raley, W. A. Richardson, F. J. Simpson, E. Smith, G. N. Stowe.
Ocean Falls (Br. Non-Res.), Associate Members, H. M. Lewis, C. W. E. Locke.
Okanagan Landing (Br. Non-Res.), Student, R. T W. Allen.
Oliver (Br. Non-Res.), Associate Member, D. G McCrae.
Penticton (Br. Non-Res.), Members, F. H. Latimer, A. McCulloch, T. E. Naish; Associate Member, R. A. Barton.
Pioneer Mine (Br. Non-Res.), Student, H. L. Thorne.
Pouce Coupe (Br. Non-Res.), Associate Member, H. L. Hayne.
Powell River (Br. Non-Res.) Members, D. A. Evans, W. Jamieson; Associate Member, N. Beaton; Junior, J. G. D'Aoust.
Prince Rupert (Br. Non-Res.), Associate Members, W. L. Stamford, F. S. Walton.
Radium Hot Springs (Br. Non-Res.), Member, G. F. Horsey.
Revelstoke (Br. Non-Res.), Associate Member, G. B. Alexander.
Rock Creek (Br. Non-Res.), Associate Member, V. J. Melsted.
Rossland (Br. Non-Res.), Member, A. E. Wright; Associate Member, A. C. Ridgers; Student, W. N. Papoff.
Ruskin (Br. Non-Res.), Associate Member, J. C. Johnstone.
Salmon Arm (Br. Non-Res.), Associate Member, G. Macleod.
Smithers (Br. Non-Res.), Associate Member, R. C. Davidson.
South Slocan (Br. Non-Res.), Associate Member, A. S. Mansbridge.
Squamish (Br. Non-Res.), Member, C. L. Eates; Junior, W. A. Madeley.
Trail (Br. Non-Res.), Members, L. A. Campbell, H. A. Moore; Associate Members, G. H. Bancroft, J. P. Coates, J. E. MacDonald, C. E. Marlatt, S. C. Montgomery, H. Vickers; Junior, C. A. Broderick; Students, J. E. Craster, J. H. Nicholson, R. J. Whitehouse.
Vancouver (Br. Res.),

Members

W. Anderson, F. H. Ballou, R. Bell-Irving, W. R. Bonnycastle, C. Brakenridge, P. P. Brown, P. H. Buchan, E. E. Carpenter, E. F. Carter, J. Chalmers, E. A. Cleveland, G. S. Conway, F. P. V. Cowley, A. D. Creer, C. R. Crysdale, C. A. Davidson, V. Dolmage, A. C. Eddy, J. N. Finlayson, J. P. Forde, A. E. Foreman, W. T. Fraser, H. W. Frith, A. S. Gentles, G. M. Gilbert, J. R. Grant, J. Green, J. B. Holdcroft, W. N. Kelly, N. J. Ker, A. T. Kerr, F. Lee, H. F. G. Letson, D. O. Lewis, D. C. Mackenzie, J. P. Mackenzie, H. J. MacLeod, H. N. Macpherson, W. O. Marble, H. St. J. Montizambert, W. T. Moodie, H. B. Muckleston, W. G. Murrin, B. T. O'Grady, F. O. Orr, J. B. Parham, W. H. Powell, W. Rae, H. Rindal, J. Robertson, J. W. Roland, W. O. Scott, W. Smaill, A. J. Smith, F. C. Stewart, L. Stockett, W. G. Swan, A. J. T. Taylor, E. C. Thrupp, G. A. Walkem, J. A. Walker, C. E. Webb, T. H. White, A. S. Wootton, A. C. R. Yuill.

Associate Members

H. P. Archibald, J. B. Barclay, T. V. Berry, R. T. Blair, J. E. Buerk, H. L. Cairns, A. W. G. Clark, S. H. Davis, C. W. Deans, A. Dickson, W. R. Duckworth, S. Farquharson, W. P. Ferguson, H. C. Fitz-James, M. L. Gale, A. Granger, W. B. Greig, C. T. Hamilton, J. B. Hamilton, H. B. Hicks, W. E. Jenkins, G. O. Johnson, A. J. Jones, T. W. Lazenby, R. J. Lecky, E. C. Luke, A. H. Macfarlane, J. McHugh, R. G. MacKenzie, R. M. Martin, H. H. Minshall, A. Peebles, A. H. Perry, A. A. Plummer, T. E. Price, R. C. Pybus, G. W. F. Ridout-Evans, R. Rome, J. M. Rothwell, P. M. Smith, P. B. Stroyan, G. L. Tooker, L. G. Trorey, D. P. Urry.

Juniors

D. C. Crothers, W. L. Kent, K. Y. Lochhead, R. C. Robson, J. A. Tames, R. Walkem.

Students

E. R. Carswell, R. K. Cheng, E. L. Hartley.

Affiliate

G. E. Herrman.

Wells (Br. Non-Res.), Associate Member, E. W. Richardson; Junior, D. W. Miller.
Woodfibre (Br. Non-Res.), Associate Member, W. A. Bain.
Yale (Br. Non-Res.), Member, W. K. Gwyer.

Calgary Branch District

(*The territory in Alberta included between the north boundary of township thirteen from Saskatchewan to the British Columbia boundary, northerly on the interprovincial boundary to the north boundary of township forty-two; east to the east boundary of range twelve (west of the fourth meridian); south to the north boundary of township thirty-seven; east on the north boundary of township thirty-seven to the Saskatchewan boundary; and south on the interprovincial boundary to township thirteen.*)

Banff (Br. Non-Res.), Member, P. J. Jennings; Associate Member, C. K. LeCapelain; Junior, C. R. Cornish.
Black Diamond (Br. Non-Res.), Student, G. A. Connell.
Brooks (Br. Non-Res.), Associate Member, C. C. Elliott; Junior, W. Crook.
Calgary (Br. Res.),

Members

F. K. Beach, P. T. Bone, E. W. Bowness, S. G. Coultis, J. B. deHart, J. Dow, W. S. Fetherstonhaugh, A. Griffin, J. Haddin, R. C. Harris, O. H. Hoover, T. Lees, J. E. McKenzie, J. H. Parks, S. G. Porter, F. M. Steel, J. S. Tempest, B. L. Thorne, J. R. Wood.

Associate Members

J. M. Anderson, W. Anderson, E. Avery, T. Barnecut, F. G. Bird, G. P. F. Boese, R. L. Bonham, W. H. Broughton, J. E. Brown, A. C. Chapman, S. J. Davies, F. S. Dyke, P. A. Fetterley, R. H. Goodchild, L. Green, J. J. Hanna, F. J. Heuperman, J. M. Ireton, M. W. Jennings, H. B. LeBourveau, A. W. P. Lowrie, A. T. McCormick, H. J. McEwen, W. T. McFarlane, R. MacKay, H. J. McLean, S. F. McLeod, J. McMillan, W. St. J. Miller, H. H. Moore, J. S. Neil, V. A. Newhall, G. W. O'Neill. P. F. Peele, J. W. Reid, F. N. Rhodes, J. H. Ross, H. B. Sherman, B. W. Snyder, F. C. Tempest, G. H. Thompson, H. W. Tooker, A. I. Tregillus, W. B. Trotter, R. S. Trowsdale, A. G. Willson, J. W. Young.

Juniors

I. A. Abramson, D. F. Becker, H. W. Becker, C. A. Colpitts, J. C. Dale, W. J. Gold, H. L. Hurdle, G. D. Kellam, L. H. McManus, R. G. Paterson, G. G. D. Robertson, W. G. Sharp, B. H. Sherwood, W. D. Suitor, D. G. Tapley, W. C. Wilde.

Students

J. Blair, R. W. Brews, C. R. Hamilton, C. M. Harding, A. W. Howard, D. C. Jones, E. G. Law, F. R. Park, H. L. Thorne.

Canmore (Br. Non-Res.), Associate Member, C. S. Dewis.
Drumheller (Br. Non-Res.), Junior, E. H. Perlson.
Exshaw (Br. Non-Res.), Associate Member, V. C. Hamilton.
Okotoks (Br. Res.), Junior, J. F. Langston; Student, W. T. T. Reikie.
Olds (Br. Non-Res.), Member, G. N. Houston
Patricia (Br. Non-Res.), Associate Member, H. B. Miller.
Seebe (Br. Non-Res.), Junior, G. V. Eckenfelder; Student, C. W. Elliott.
Strathmore (Br. Non-Res.), Member, E. N. Ridley; Associate Members, G. H. Patrick, T. Schulte, F. B. Young.
Turner Valley (Br. Non-Res.), Associate Members, G. D. Phelps, H. L. Stevens Guille; Junior, A. Stiernotte.

Edmonton Branch District

(*All the Province of Alberta north of the northern boundary of the Calgary Branch.*)

Derwent (Br. Non-Res.), Student, C. A. Algot.
Edmonton (Br. Res.),

Members

J. D. Baker, J. Callaghan, L. C. Charlesworth, W. J. Dick, R. M. Dingwall, C. E. Garnett, J. Garrett, A. J. Gayfer, R. J. Gibb, G. H. N. Monkman, W. R. Mount, A. I. Payne, V. Pearson, C. A. Robb, A. J. Sill, E. Skarin, E. Stansfield, H. R. Webb, R. S. L. Wilson.

Associate Members

A. M. Allen, H. A. Bowden, F. A. Brownie, J. W. S. Chappelle, W. E. Cornish, E. G. Cullwick, P. L Debney, J. M. Forbes, E. D. Greening, F. L. Grindley, A. W. Haddow, D. A. Hansen, R. M. Hardy, H. P. Keith, J. F. McDougall, W. I. McFarland, E. Nelson, M. Polet, R. W. Ross, H. F. Ryan, E. I. Smith, R. H. Stevens, H. H. Tripp, R. G. Watson, T. W. White, E. H. Wright.

Juniors

W. W. Fotheringham, P. Hargrove, H. R. Hayes, G. R. Pinchbeck, B. W. Pitfield, J. W. Porteous, W. W. Preston, L. G. Scott, T. D. Stanley, J. P. Svarich.

Students

W. B. Adamson, E. W. Bogart, E. H. Davis, L. J. Ehly, L. Gads, F. J. Hastie, V. A. Hayward, F. J. Heath, J. H. Hole, W. G. Hole, C. K. Hurst, F. P. Johnson, D. F. Kobylnyk, G. F. McAulay, J. E. Poole, P. J. Prokopy, G. Ross, C. C. Simpson, K. L. Steeves, J. D. Sylvester, L. A. Thorssen.

Grande Prairie (Br. Non-Res.), Student, G. Sinclair.
Jasper (Br. Non-Res.), Associate Member, J. B. Snape.
McLennan (Br. Non-Res.), Member, H. G. Dimsdale.
Peace River (Br. Non-Res.), Associate Member, J. H. Johnston.
Sterco (Br. Non-Res.), Associate Member, W. F. Stevenson.
Vegreville (Br. Non-Res.), Associate Member, J. G. MacGregor.
Vermilion (Br. Non-Res.), Associate Member, B. E. Bury.

Lethbridge Branch District

(*The territory in Alberta and British Columbia included between the United States boundary from Saskatchewan to the 117th degree of longitude in British Columbia; north to the 50th parallel; east to the Alberta boundary; northerly on the interprovincial boundary to the north boundary of township thirteen in Alberta; east to the Saskatchewan boundary, and south on the interprovincial boundary to the United states boundary.*)

Cranbrook, B.C. (Br. Non-Res.), Associate Member, C. E. MacKinnon.
Coaldale (Br. Res.), Associate Members, R. S. Lawrence, H W. Rowley.
Diamond City (Br. Res.), Associate Member, C. S. Clendening.
Fernie, B.C. (Br. Non-Res.), Associate Member, G. E. Elkington; Student, B. J. Hawkey.
Lethbridge (Br. Res.),

Members

F. G. Cross, R. Livingstone, P. M. Sauder.

Associate Members

R. F. P. Bowman, N. H. Bradley, G. S. Brown, J. M. Campbell, C. L. Dodge, G. S. Donaldson, J. Haimes, W. L. McKenzie, W. Meldrum, C. J. L. Sanderson, A. L. H. Somerville, A. Thomson, J. T. Watson.

Junior

R. B. McKenzie.

STUDENT

E. A. Lawrence.

Macleod (Br. Non-Res.), ASSOCIATE MEMBER, N. A. Link.

Magrath (Br. Res.), ASSOCIATE MEMBER, M. F. R. Lloyd.

Medicine Hat (Br. Non-Res.), MEMBER, D. W. Hays; ASSOCIATE MEMBERS, A. C. Gardner, C. M. Moore; STUDENT, F. McCallum.

Michel, B.C. (Br. Non-Res.), ASSOCIATE MEMBER, A. Cox.

Monarch (Br. Res.), STUDENT, A. P. Alexander.

New Denver, B.C. (Br. Non-Res.), JUNIOR, W. R. Workman.

Picture Butte (Br. Res.), ASSOCIATE MEMBER, A. J. Branch; JUNIOR, W. R. Craig.

Redcliff (Br. Non-Res.), STUDENT, H. A. McColeman.

Vulcan (Br. Non-Res.), STUDENT, E. L. McPherson.

Saskatchewan Branch District

(*The Province of Saskatchewan.*)

Blenfait (Br. Non-Res.), JUNIOR, H. J. B. Richards.

Carlyle (Br. Non-Res.), ASSOCIATE MEMBER, W. E. Denley.

Claybank (Br. Non-Res.), ASSOCIATE MEMBER, S. Matthews.

Eastend (Br. Non-Res.), ASSOCIATE MEMBER, S. H. Hawkins; JUNIOR, W. N. McCann.

Estevan (Br. Non-Res.), ASSOCIATE MEMBERS, N. W. Dubois, R. J. Lee.

Goldfields (Br. Non-Res.), ASSOCIATE MEMBERS, W. G. Jewitt, E. B. Webster.

Island Falls (Br. Non-Res.), ASSOCIATE MEMBER, E. C. King; AFFILIATE, H. T. Olson.

Kamsack (Br. Non-Res.), ASSOCIATE MEMBER, J. M. Bloomfield.

Lashburn (Br. Non-Res.), STUDENT, R. B. Snyder.

Lloydminster (Br. Non-Res.), ASSOCIATE MEMBER, S. E. Durant.

Moose Jaw (Br. Non-Res.), MEMBERS, H. R. Miles, H. C. Ritchie; ASSOCIATE MEMBERS, C. K. Buchbach, A. W. E. Fawkes, R. M. Henderson, D. S. MacDonald, J. V. McNab, H. I. Nicholl, J. I. Strong; JUNIORS, R. W. Johnson, J. Lundie, J. T. Turner.

North Battleford (Br. Non-Res.), MEMBER, A. E. Sharpe; ASSOCIATE MEMBER, M. H. Stevenson; JUNIOR, J. D. George.

Outlook (Br. Non-Res.), ASSOCIATE MEMBER, B. L. Reid.

Prince Albert (Br. Non-Res.), MEMBERS, W. Christie, J. G. Reid; ASSOCIATE MEMBERS, G. H. L. Dempster, W. J. Dyer, J. B. Hamilton, H. J. Hermanson, J. Jonsson; JUNIOR, D. Lazorka.

Punnichy (Br. Non-Res.), ASSOCIATE MEMBER, S. Harding.

Regina (Br. Res.),

MEMBERS

R. W. Allen, H. S. Carpenter, J. W D Farrell, A C. Garner, D. W. Houston, A. P. Linton, D. A. R. McCannel, C. J. McGavin, T. McGuinness, H. R. MacKenzie, M. H. Marshall, S. R. Muirhead, J. M. Patton, P. C. Perry, M. J. Spratt, L. A. Thornton, S. Young, J. J. White.

ASSOCIATE MEMBERS

J. E. Bennett, W. H. Bentley, C. H. Biddell, E. W. Bull, R. A. Campbell, E. S. C. Carpenter, W. P. Cheney, F. C. Christie, D. C. M. Davies, F. C. Dempsey, H. J. deSavigny, S. G. Dethridge, E. Dickinson, C. W. Doody, E. E. Eisenhauer, G. G. Fitzgerald, H. Forbes-Roberts, W. L. Foss, R. J. Fyfe, P. R. Genders, J. R. Guildford, W. H. Hastings, T. Hogg, R. W. Jickling, W. J. Johnston, H. A. Jones, S. T. Lewis, L. W. Llewellyn, W. O. Longworthy, E. E. Lord, D. D. Low, O. W. Martyn, P. G. McAra, T. S. McKechnie, G. L. MacKenzie, J. C. Meade, J. Mould, J. R. Paget, S. R. Parker, W. W. Perrie, R. E. Phelan, W. R. Pottle, J. H. Puntin, F. B. Reilly, H. L. Roblin, W. H. Ross, J. G. Schaeffer, B. P. Scull, D. C. Stephenson, J. J. A. Street, T. G. Tyrer, W. Waters, J. R. Young.

JUNIORS

N. R. Crump, E. J. Durnin, R. A. Emerson, A. F. S. Fuller, E. C. Hay, J. W. Leach, J. E. Thom, R. W. Warren.

Rosetown (Br. Non-Res.), ASSOCIATE MEMBER, J. C. Todd.

Saskatoon (Br. Non-Res),

MEMBERS

A R. Greig, W. E. Lovell, C. J. Mackenzie, W. G. Worcester.

ASSOCIATE MEMBERS

G. D. Archibald, A. L. Cole, C. A. Cook, I. M. Fraser, N. B. Hutcheon, A. M. Macgillivray, R. A. McLellan, F. J. Martin, A. A. Murphy, E. H. Phillips, E. K. Phillips, R. A. Spencer, W. M. Stewart, J. M. Taylor, J. E. Underwood, H. McI. Weir, G. M. Williams, F. Young.

STUDENTS

M. Fast, C. R. Forsberg, D. S. McArthur.

Swift Current (Br. Non-Res.), MEMBER, B. Russell; ASSOCIATE MEMBER, L. F. Creighton.

Tisdale (Br. Non-Res.), ASSOCIATE MEMBER, J. E. Mollard.

Weyburn (Br. Non-Res.), ASSOCIATE MEMBER, A. W. Shattuck.

Yorkton (Br. Non-Res.), ASSOCIATE MEMBERS, H. M. Bailey, M. Sinclair.

Winnipeg Branch District

(*The Province of Manitoba.*)

Brandon (Br. Non-Res.), MEMBER, W. H. Shillinglaw; ASSOCIATE MEMBERS, E. C. Cowan, S. C. Wilcox.

Churchill (Br. Non-Res.), ASSOCIATE MEMBERS, G. Coutts, G. W. Rowe.

Dauphin (Br. Non-Res.), ASSOCIATE MEMBER, R. C. Robinson.

Duck River (Br. Non-Res.), MEMBER, F. S. Small.

Flin Flon (Br. Non-Res.), ASSOCIATE MEMBER, A. Taylor; JUNIORS, J. T. Nichols, W. C. Weir; STUDENTS, R. H. Moore, M. K. T. Reikie.

Fort Whyte (Br. Res.), ASSOCIATE MEMBER, C. W. Edmonds.

Garson (Br. Non-Res.), ASSOCIATE MEMBER, C. H. Blanchard.

Lydiatt (Br. Non-Res.), MEMBER, W. A. James.

Pine Falls (Br. Non-Res.), ASSOCIATE MEMBER, M. W. Turner.

Pointe du Bois (Br. Non-Res.), ASSOCIATE MEMBER, T. E. Storey.

Rivers (Br. Non-Res.), STUDENT, M. J. Messel.

Selkirk (Br. Res.), ASSOCIATE MEMBERS, J. F. Cunningham, C. Taylor; JUNIORS, G. J. Henrikson, C. H. Martin.

Seven Sisters Falls (Br. Non-Res.), ASSOCIATE MEMBER, A. S. Williams; JUNIOR, A. L. Oddleifson.

Souris (Br. Non-Res.), STUDENT, R. J. Bridges.

The Pas (Br. Non-Res.), ASSOCIATE MEMBERS, H. P. Fuller, J. G. MacLachlan; JUNIOR, W. L. Bunting.

Transcona (Br. Res.), JUNIOR, W. Dubesky.

Virden (Br. Non-Res.), ASSOCIATE MEMBER, D. A. Livingston.

Winckler (Br. Non-Res.), STUDENT, H. F. Peters.

Winnipeg (Br. Res.),

MEMBERS

F. W. Alexander, W. P. Brereton, W. Burns, E. V. Caton, C. H. Dancer, C. Ewart, E. P. Fetherstonhaugh, A. W. Fosness, C. H. Fox, J. P. Fraser, N. M. Hall, F. B. Hazel, H. B. Henderson, G. H. Herriot, J. C. Holden, T. Kipp, A. E. Macdonald, D. A. MacDougall, W. M. Macphail, W. A. Mather, V. Michie, E. R. Millidge, W. Newman, J. W. Porter, W. F. Riddell, J. W. Sanger, W. M. Scott, F. V. Seibert, D. N. Sharpe, F. B. Tapley, A. J. Taunton, H. M. White, J. Woodman.

ASSOCIATE MEMBERS

G. Affleck, R. H. Andrews, C. V. Antenbring, C. H. Attwood, C. T. Barnes, H. J. A. Bird, H. B. Brehaut, F. M. Brickenden, H. C. D. Briercliffe, H. L. Briggs, D. C. Bryden, E. W. R. Butler, A. Campbell, G. W. Campbell, V. H. Campbell, A. L. Cavanagh, J. L. Charles, G. Clark, C. A. Clendening, G. E. Cole, G. C. Davis, V. W. Dick, H. A. Dixon, T. H. Doherty, J. E. Duncan, J. T. Dyment, J. H. Edgar, C. T. Eyford, F. S. Fowler, W. Fulton, E. Gauer, J. Gordon, J. L. Gordon, F. F. Griffin, C. P. Haltalin, S. G. Harknett, W. E. Harry, W. E. Hobbs, B. B. Hogarth, J. Hoogstraten, L. M. Hovey, W. D. Hurst, D. Hutchison, W. J. Johnston, V. C. Jones, E. S. Kent, T. H. Kirby, A. M. Kirkpatrick, G. M. Lyon, S. E. McColl, G. McDermid, J. A. MacGillivray, W. J. MacKenzie, D. L. McLean, H. W. McLeod, T. C. Main, R. W. Moffatt, H. J. Muir, G. N. Munro, J. R. Paget, A. W. Paterson, V. H. Patriarche, E. B. Patterson, G. M. Pearston, J. D. Peart, W. D. Pender, G. R. Pratt, J. T. Rose, J. D. Ruttan, A. Sandilands, R. A. Sara, G. L. Shanks, D. M. Stephens, D. G. Sutherland, F. E. Umphrey, J. Veitch, W. Walkden, A. W. Walkey, J. Young.

JUNIORS

A. I. Bereskin, E. S. Braddell, W. A. Capelle, R. P. Fraser, G. S. G. Henson, C. M. Hovey, L. Mackay, J. L. McMahon, W. W. Ramsay, J. R. Rettie, E. L. Ruggles, J. B. Striowski, G. A. Sutherland, W. R. C. Taylor, C. J. Timleck, E. J. Weselake, F. Willows.

STUDENTS

E. Arnason, G. S. Baldry, A. E. Bradley, N. S. Bubbis, J. M. Dale, W. H. H. Dean, J. W. Demcoe, G. P. Duncan, D. M. Dunlop, F. P. Findlay, M. Gershfield, A. R. Goddard, R. T. Harland, E. R. Hyman, W. F. Jarrett, W. B. Korcheski, W. G. McIntosh, W. B. F. MacKay, B. L. Phomin, A. H. Robinson, W. R. Sadler, D. M. Silverberg, A. J. E. Smith, H. I. Stevenson, D. S. Swain, W. I. Taylor, D. H. Watson, G. H. Weldon, W. B. White, B. H. J. Wilson, R. P. Woodfield, T. L. Woodhall.

AFFILIATES

G. E. Baldry, W. Hurst, C. C. Kent.

ZONE B

(*The Province of Ontario.*)

Lakehead Branch District

(*The Counties of Kenora, Thunder Bay, Rainy River, Patricia.*)

Dryden (Br. Non-Res.), MEMBER, J. S. Wilson; ASSOCIATE MEMBER, F. Petursson.

Fort Frances (Br. Non-Res.), ASSOCIATE MEMBER, G. H. Lowry.

Fort William (Br. Res.),

MEMBERS

P. E. Doncaster, W. R. Grant,

ASSOCIATE MEMBERS

D. Boyd, G. R. Duncan, K. A. Dunphy, E. M. G. MacGill, W. E. MacLennan, H. G. O'Leary, C. B. Symes.

JUNIOR

J. R. Mathieson.

STUDENTS

J. I. Carmichael, G. R. Duncan, K. R. Dunphy, E. H. McCann.

Geraldton (Br. Non-Res.), JUNIOR, A E. Tyson.

Hudson (Br. Non-Res.), ASSOCIATE MEMBER, C. M. Low.

Kenora (Br. Non-Res.), MEMBERS, E. A. Kelly, C. D. MacKintosh; JUNIORS, W. C. Byers, S. I. Gislason, M. N. McEwen.

Madsen (Br. Non-Res.), ASSOCIATE MEMBER, J. A. Aitkens.

Nakina (Br. Non-Res.), ASSOCIATE MEMBER, F. L. Davis.

Port Arthur (Br. Res.),

MEMBERS

J. Antonisen, T. S. Armstrong, R. J. Askin, G. H. Burbidge, R. B. Chandler, J. M. Fleming, S. E. Flook.

ASSOCIATE MEMBERS

C. T. Anderson, C. F. Cockshutt, B. A. Culpeper, E. J. Davies, G. Ericksen, E. L. Goodall, F. C. Graham, C. G. J. Luck, A. J. Mickelson, H. A. Oaks, H. M. Olsson, H. Os, A. L. Pierce.

JUNIOR

C. Fraser.

STUDENT

W. H. Peach.

AFFILIATE

H. P. Sisson.

Red Lake (Br. Non-Res.), STUDENT, S. Fromson.

Red Rock (Br. Non-Res.), MEMBER, A. T. Hurter.

Sioux Lookout (Br. Non-Res.), ASSOCIATE MEMBER, G. R Hill.

White River (Br. Non-Res.), ASSOCIATE MEMBER, W. J. Bishop.

Sault Ste. Marie Branch District

(*The Counties of Algoma, Cochrane, Nipissing (north of the Mattawa River), Sudbury (including Manitoulin Island), Timiskaming, Ont., and the area in the United States within a radius of twenty-five miles of Sault Ste. Marie.*)

Ansonville (Br. Non-Res.), STUDENT, N. Shisko.

Chaput-Hughes (Br. Non-Res.), JUNIOR, N. S. Haines.

Copper Cliff (Br. Non-Res.), MEMBERS, R. L. Peek, W. J. Ripley, J. F. Robertson; ASSOCIATE MEMBERS, L. O. Cooper, C. O. Maddock; JUNIOR, F. J. DeStefano.

Englehart (Br. Non-Res.), ASSOCIATE MEMBER, W. O. Collis.

Falconbridge (Br. Non-Res.), ASSOCIATE MEMBERS, T. S. Mathieson, E. W. Neelands; JUNIOR, J. Hunt.

Haileybury (Br. Non-Res.), MEMBER, J. W. Morrison.

Kapuskasing (Br. Non-Res.), ASSOCIATE MEMBERS, C. W. Boast, G. R. Connor, J. Gilchrist, D. N. McCormack, C. R. Murdock, R. S. Walker; JUNIORS H. R. M. Acheson, C. G. Biesenthal, J. R. B. Milne, G. M. Minard.

Kirkland Lake (Br. Non-Res.), MEMBER, W. T. Sampson; ASSOCIATE MEMBER, A. J. Bennett; JUNIOR, C. F. V. McKnight; STUDENT, J. G. Stephenson.

Larder Lake (Br. Non-Res.), ASSOCIATE MEMBERS, J. A. Ogilvy, R. D. H. Wigmore.

Levack (Br. Non-Res.), JUNIOR, G. Benjafield.

Matheson (Br. Non-Res.), ASSOCIATE MEMBER, H. R. Phipps.

New Liskeard (Br. Non-Res.), ASSOCIATE MEMBERS, E. A. Beman, F. D. Gifford, H. W. Sutcliffe; JUNIORS, J. S. Cooper, J. N. McCarey; STUDENT, G. A. Powles.

North Bay (Br. Non-Res.), MEMBERS, S. B. Clement, C. H. N. Connell, S. B. McConnell; ASSOCIATE MEMBERS, R. G. Boast, J. V. Ludgate, T. J. Moore, H. Robertson; JUNIOR, E. Miall.

Pamour (Br. Non-Res.), STUDENT, W. M. Benson.

Sault Ste. Marie (Br. Res.),

MEMBERS

J. L. Lang, R. S. McCormick, G. G. W. MacLeod, E. M. MacQuarrie, A. E. Pickering, K. G. Ross, W. Seymour, F. Smallwood, C. Stenbol.

ASSOCIATE MEMBERS

G. B. Anderson, LeR. Brown, R. A. Campbell, W. B. Crombie, C. W. Holman, H. J. Leitch, J S. Macleod, W. M. Reynolds, A. H. Russell, W. W. VanEvery, A. M. Wilson, W. S. Wilson.

JUNIORS

A. G. Clarkson, N. C. Cowie, O. A. Evans, C. G. Kauth, F. J. McMulkin, F. A. Masse, J. H. Meldrum, S. W. Sibbard.

STUDENTS

M. Conklin, H. M. Martin, C. Neufeld.

Schumacher (Br. Non-Res.), MEMBER, A. D. Campbell; ASSOCIATE MEMBER, H. Idsardi.

South Porcupine (Br. Non-Res.), ASSOCIATE MEMBER, K. E. Buchmann; STUDENT, C. Macdonald.

Sturgeon Falls (Br. Non-Res.), ASSOCIATE MEMBER, G. W. Holder.

Sudbury (Br. Non-Res.), ASSOCIATE MEMBERS, L. M. Duclos, P. C. Kirkpatrick, H. J. Kurtz, W. F. Miller, F. A. Orange; JUNIOR, G. H. Morrison;

Students, F. Bricault, B. Corbett, H. E. Hewitt, N. Klodniski, A. G. Scobie, G. M. Smith.
Timagami (Br. Non-Res.), Associate Member, W. B. Crossing.
Timmins (Br. Non-Res.), Associate Member, W. G. Heslop; Juniors, P. L. Climo, F. D. Greenwood; Students, D. E. Coombes, B. R. Heavysege.

Border Cities Branch District

(*The Counties of Essex, Kent, Lambton, and the area in the United States within a radius of twenty-five miles of Windsor.*)

Amherstburg (Br. Non-Res.), Associate Members, J. E. Hinchliffe, W. M. Mitchell; Junior, J. G. Turnbull.
Chatham (Br. Non-Res.), Members, T. M. S. Kingston, G. A. McCubbin; Associate Members, C. Harvey, C. K. S. Macdonell, H. McMillan; Junior, W. L. Dutton.
Detroit, Mich. (Br. Res.), Associate Members, J. H. Bradley, W. J. Campbell, H. J. Coulter, A. McWilliam.
Leamington (Br. Non-Res.), Student, J. C. Elliott.
Sandwich (Br. Res.), Associate Member, B. Candlish.
Sarnia (Br. Non-Res.), Members, J. A. Baird, T. Montgomery; Associate Members, R. W. Dunlop, J. W. MacDonald, M. L. Walker; Juniors, G. A. M. Bradford, C. P. Warkentin; Students, J. P. Callum, J. O. Giles, J. C. Maguire, R. D. Ramsay, J. T. Williams.
Walkerville (Br. Res.),

Members

P. E. Adams, D. T. Alexander, C. M. Goodrich, F. H. Kester, S. E. McGorman, R. A. Spencer, A. E. West.

Associate Members

J. G. Campbell, H. J. A. Chambers, E. Chorolsky, G. V. Davies, E. M. Krebser, I. Leebosh, R. C. Leslie, H. W. Patterson, C. W. H. Scott, F. Stevens.

Students

F. C. Ansley, W. H. Kester, D. C. R. Miller, D. S. Waters.
Wayne, Mich. (Br. Non-Res.), Associate Member, J. E. Letson.
Windsor (Br. Res.),

Members

H. B. R. Craig, J. J. Newman, O. M. Perry.

Associate Members

C. G. R. Armstrong, A. J. M. Bowman, J. F. Bridge, H. S. Clark, J. E. Daubney, C. F. Davison, W. D. Donnelly, W. J. Fletcher, T. H. Jenkins, H. L. Johnston, J. C. Keith, G. W. Lusby, E. J. McIntire, V. W. MacIsaac, H. C. McMordie, G. E. Medlar, J. E. Porter, O. Rolfson, C. G. Walton.

Juniors

H. C. Butler, E. W. Driedger, A. H. Pask, F. J. Ryder, J. Walter.

Students

G. A. Lowles, T. J. Morrison, D. E. Palmquist, J. G. Stephenson, C. A. Wakeham.

Affiliate

C. P. Sale.

London Branch District

(*The Counties of Elgin, Middlesex, Oxford, Perth, Huron, Bruce.*)

Auburn (Br. Non-Res.), Student, A. R. Asquith.
Ingersoll (Br. Non-Res.), Junior, N. Allen.
London (Br. Res.),

Members

S. W. Archibald, H. F. Bennett, E. V. Buchanan, F. Leonard, A. H. Morgan.

Associate Members

W. E. Andrewes, F. C. Ball, D. M. Bright, R. S. Charles, M. Dillon, J. Ferguson, G. F. Fry, R. W. Garrett, H. L. Hayman, S. G. Johre, D. H. McDonald, T. L. McManamna, H. A. McKay, V. A. McKillop, W. C. E. Robinson, J. R. Rostron, D. S. Scrymgeour, W. R. Smith, C. Talbot, W. M. Veitch.

Juniors

J. D. Adams, H. J. Simmons, H. G. Stead, W. D. Wishart.

Students

A. F. Hertel, C. H. Hillier, A. D. Kent, G. H. W. McKee, W. R. Mitchell, H. A. Mullins.
St. Thomas (Br. Res.), Member, W. C. Miller; Associate Members, F. A. Bell, W. Dalziel, W. H. Herold, W. J. Shaw, S. B. Wass, J. P. Young; Students, A. M. Campbell, K. W. Campbell.
Stratford (Br. Non-Res.), Member, A. B. Manson; Associate Members, W. E. Plummer, W. H. Riehl.
Tillsonburg (Br. Non-Res.), Members, C. V. Corless, J. H. Johnson; Associate Member, G. Rankin.
Walkerton (Br. Non-Res.), Associate Member, G. E. Stephenson.
Woodstock (Br. Res.), Associate Members, J. Carnwath, F. T. Julian, W. G. Ure, J. A. Vance; Student, M. C. Archibald.

Hamilton Branch District

(*The Counties of Wentworth, Norfolk, Brant, Waterloo, Halton West (Townships of Nelson and Nassagaweya), Wellington, Haldimand.*)

Acton (Br. Non-Res.), Member, G. H. Kohl.
Ancaster (Br. Res.), Member, P. Ford-Smith.
Bartonville (Br. Non-Res.), Student, P. J. McNally.
Brantford (Br. Res.), Members, H. E. Mott, C. A. Waterous; Associate Members, F. P. Adams, G. J. Manson.
Cayuga (Br. Non-Res.), Associate Member, W. F. Campbell.
Dundas (Br. Res.), Member, H. G. Bertram; Students, J. E. Gordon, L. S. Lauchland; Affiliate, J. F. Crowley.
Galt (Br. Res.), Students, H. E. G. Dupuy, E. B. Hymmen.
Guelph (Br. Non-Res.), Members, L. E. Jones, F. McArthur; Associate Members, E. P. Bowman, W. H. Keith, C. G. Kingsmill, D. D. McQueen, H. S. Nicklin.
Hamilton (Br. Res.),

Members

W. D. Black, J. B. Carswell, G. A. Colhoun, E. H. Darling, L. W. Gill, W. G. Hewson, W. Hollingworth, C. H. Hutton, F. I. Ker, O. E. Leger, A. Love, H. A. Lumsden, J. A. McFarlane, W. L. McFaul, J. J. Mackay, W. G. Milne, E. P. Muntz, R. K. Palmer, F. W. Paulin, A. T. Perrin, H. S. Philips, W. J. W. Reid, H. A. Ricker, J. Stodart, H. B. Stuart, F. E. M. Thrupp, J. W. Tyrrell, E. M. Whitby.

Associate Members

G. W. Arnold, G. M. Bayne, C. L. Preithaupt, J. A. W. Brown, R. E. Butt, D. W. Callander, C. E. Church, F. M. Coles, W. H. Collins, L. S. Collison, E. D. W. Courtice, N. L. Crosby, J. R. Dunbar, H. M. Fletcher, W. P. Ford, W. A. T. Gilmour, T. S. Glover, J. P. Gordon, W. Greenwood, L. Grime, A. R. Hannaford, N. L. Hartmann, F. W. Hubbard, E. P. N. Innes, S. R. Job, L. S. MacDonald, E. G. MacKay, W. L. Miller, G. Moes, J. C. Nash, A. G. Riddell, F. L. Smith, H. E. Steventon, J. Taylor, V. S. Thompson, N. Wagner, C. W. Webster, A. F. White, C. F. Whitton, A. H. Wingfield, E. G. Wyckoff, E. L. Zealand.

Juniors

D. E. Bridge, W. E. Brown, G. G. Gates, F. S. Hutton, J. R. Hutton, D. B. Leightner, W. R. McColl, H. F. McLachlan, W. C. McLeod, A. F. McPherson, C. S. Neilson, A. Pottinger, C. C. Smith, R. K. Thoman, J. T. Thwaites, E. H. Tovee, N. O. Weston, L. Whitehouse.

Students

S. M. Baker, M. F. Baird, D. S. Blaine, H. P. Boone, F. Candlish, M. C. Edwards, J. M. Elliott, W. Hindle, A. Hopkins, A. E. Hyde, E. R. Love, J. E. McClung, J. J. MacKenzie, A. M. McLeod, E. G. MacNutt, J. M. Pequegnat, L. C. Sentance, J. G. Sutherland, R. N. Tucker, A. J. Turner, W. M. Warnick, N. O. Weston, D. W. Wood.

Affiliate

J. A. M. Galilee.
Kitchener (Br. Non-Res.), Members, W. H. Breithaupt, S. Shupe; Associate Members, D. J. Emrey, M. Pequegnat; Student, L. D. McGee.
Preston (Br. Non-Res.), Member, F. H. Midgley.
Simcoe (Br. Non-Res.), Associate Members, J. F. LaPlant, G. R. Marston.
Waterdown (Br. Non-Res.), Associate Member, F. R. Leadley.
Waterloo (Br. Non-Res.), Associate Member, A. M. Snider.

Niagara Peninsula Branch District

(*The Counties of Lincoln, Welland, and the area in the United States within a radius of twenty-five miles of Niagara Falls, Ontario.*)

Buffalo, N.Y. (Br. Non-Res.), Member, N. R. Gibson; Associate Member, J. D. Burbank; Students T. E. Martin, A. G. Mellor.
Chippawa (Br. Res.), Associate Member, G. C. Mountford.
Fort Erie (Br. Res.), Student, J. G. Welsh.
Fort Erie North (Br. Res.), Associate Members, C. S. Boyd, G. D. O'Connor, L. C. McMurtry, W. R. Manock; Junior, L. J. Russell; Students, A. G. Asplin, C. E. Craig, D. W. Brown, H. W. S. LeBel.
Grimsby (Br. Non-Res.), Associate Members, F. D. Austin, G. F. Hanning, A. A. Young.
Humberstone (Br. Res.), Associate Member, E. C. Little.
Merriton (Br. Non-Res.), Junior, W. Schofield.
Niagara Falls, N.Y. (Br. Res.), Member, C. J. H. Moritz; Associate Member, E. W. Dill.
Niagara Falls, Ont. (Br. Res.),

Members

H. G. Acres, H. L. Bucke, R. L. Hearn, W. Jackson, H. M. King.

Associate Members

T. A. Barnett, W. D. Bracken, C. G. Cline, G. H. E. Dennison, P. A. Dewey, A. M. Fennis, L. L. Gisborne, T. L. Hughson, J. H. Ings, M. F. Ker, R. C. McMordie, A. W. F. McQueen, J. L. Miller, T. W. W. Parker, F. C. Simpson, G. H. Wood.

Juniors

W. H. Kribs, A. M. MacDonald.

Students

K. L. Bellamy, J. M. Cameron, W. I. Pheinister, H. L. B. Seifert.

Affiliate

C. St. C. Crosse.
Port Colborne (Br. Res.), Associate Member, C. N. Geale; Juniors, A. C. Harvie, H. Tuck.
St. Catharines (Br. Res.),

Members

M. B. Atkinson, A. J. Grant, L. P. Rundle, W. H. Sullivan, G. F. Vollmer.

Associate Members

A. C. Blue, H. W. Bloxham, R. A. Bradley, H. M. Campbell, W. Campion, J. V. Fahey, E. Grummitt, S. Hairsine, A. G. Herr, W. R. Hughson, M. H. Jones, R. V. H. Keating, A. W. Lash, J. B. McAndrew, A. I. McPhail, C. G. Moon, W. T. Porter, C. B. Shaw, J. F. Shelton, C. W. West.

Juniors

J. H. Dyer, J. A. Laughton, R. A. Moore.

Students

T. S. Drake, R. T. Sawle.
Thorold (Br. Res.), Associate Members, S. Bowen, P. E. Buss, G. E. Griffiths, J. A. Simmers; Junior, J. L. McDougall; Student, J. G. Hoba; Affiliate, J. C. Halliday.
Welland (Br. Res.), Members, C. H. McL. Burns, G. Morrison, J. C. Street; Associate Members, N. K. Cameron, H. D. Davison, E. S. Turner, H. A. Wilson; Junior, D. V. McIntyre; Student, F. S. Durdan.

Toronto Branch District

(*The Counties of Ontario, York, Peel, Halton East (Townships of Trafalgar and Esquesing), Dufferin, Grey, Simcoe, Muskoka, Parry Sound, Nipissing (south of Mattawa River).*)

Bala (Br. Non-Res.), Associate Member, A. L. Malcolm; Student, G. G. Reynolds.
Barrie (Br. Non-Res.), Member, J. Walker.
Birch Cliff (Br. Res.), Member, R. Harrison.
Brampton (Br. Res.), Member, F. H. Kitto; Associate Member, W. P. Dale; Junior, G. M. Robinson; Student, R. E. Bates.
Burwash (Br. Non-Res.) Associate Member, W. S. E. Morrison.
Camp Borden (Br. Non-Res.), Student, G. M. Billings.
Clarkson (Br. Res.), Member, A. S. Cook.
Gravenhurst (Br. Non-Res.), Affiliate, A. D. Hurst.
Holland Landing (Br. Res.), Associate Member, G. H. Tate.
Huntsville (Br. Non-Res.), Junior, H. J. Petursson.
Lakeview (Br. Res.), Member, H. M. Cawthra-Elliot.
Leaside (Br. Res.), Member, H. Horsfall; Associate Members, J. R. Burgess, W. H. Hooper, J. R. Roberts; Juniors, G. W. Lawson, D. A. Mitchell.
Long Branch (Br. Res.), Associate Members, J. A. C. Bowen, J. S. Galletly.
Malton (Br. Res.), Associate Member, W. U. Shaw.
Mimico (Br. Non-Res.), Associate Member, Y. R. Anderson; Junior, H. C. Ross.
Mount Dennis (Br. Res.), Member, A. B. Cooper.
Oakville (Br. Res.), Members, C. Johnston, E. W. Oliver; Associate Member, C. Connell.
Orillia (Br. Non-Res.), Member, L. G. McNeice; Associate Member, W. A. Dawson.
Oshawa (Br. Non-Res.), Member, F. Chappell; Junior, W. O. Hart.
Owen Sound (Br. Non-Res.), Member, S. A. Cummiford; Associate Members, T. D. Kennedy, R. McDowall, R. C. McKnight.
Port Stanley (Br. Non-Res.), Student, J. A. Ferguson.
Stouffville (Br. Non-Res.), Student, M. R. Lemon.
Sundridge (Br. Non-Res.), Associate Member, T. J. Paget.
Toronto (Br. Res.),

Honorary Member

R. W. Angus.

Members

W. D. Adams, A. Aeberli, E. A. Allcut, J. R. W. Ambrose, O. V. Anderson, A. V. Armstrong, R. A. Baldwin, J. E. Beatty, F. J. Bell, A. E. Berry, A. W. K. Billings, A. L. Bishop, H. A. Bodwell, F. L. C. Bond, W. E. Bonn, H. A. Brazier, W. P. Chapman, J. R. Cockburn, A. W. Connor, E. L. Cousins, C. R. Coutlee, G. H. Crase, A. B. Crealock, E. A. Cross, C. J. Crowley, A. G. Dalzell, V. A. G. Dey, W. P. Dobson, W. E. P. Duncan, H. K. Dutcher, F. C. Dyer, F. R. Ewart, R. Fleming, T. F. Francis, D. M. Fraser, F. A. Gaby, D. G. Geiger, A. M. German, R. G. Godson, F. B. Goedike, G. Grant, J. Grieve, C. B. Hamilton, A. H. Harkness, D. W. Harvey, H. E. T. Haultain, A. Hay, M. C. Hendry, C. S. L. Hertzberg, E. G. Hewson, T. H. Hogg, J. Hole, A. R. Holmes, J. H. Jackson, L. M. Jones, R. E. Jones, J. G. G. Kerry, A. A. Kinghorn, C. R. Kinnear, J. A. Knight, H. J. Lamb, W. J. LeClair, L. A. C. Lee, T. R. Loudon, A. F. Macallum, M. J. McHenry, W. Maclachlan, W. A. McLean, A. T. C. McMaster, J. A. McNicol, N. MacNicol, D. MacPherson, H. G. McVean, R. C. Manning, A. J. Matheson, E. A. H. Menges, J. A. Michaud, E. S. Miles, C. H. Mitchell, E. V. Moore, J. L. Morris, W. P. Near, I. H. Nevitt, L. R. Ord, J. M.

Oxley, J. K. Partridge, G. G. Powell, E. M. Proctor, G. W. Rayner, C. R. Redfern, W. B. Redfern, F. D. Reid, J. A. Reid, B. Ripley, H. T. Routly, W. B. Russel, K. R. Rybka, R. G. Saunders, H. M. Scott, C. E. Sisson, A. A. Smith, W. C. Smith, W. J. Smither, R. E. Smythe, E. A. Stone, W. Storrie, W. H. Stuart, S. G. Talman, H. W. Tate, E. G. T. Taylor, D. C. Tennant, D. R. Thomas, G. N. Thomas, J. J. Traill, A. P. Walker, G. L. Wallace, E. T. Wilkie, C. G. Williams, E. C. Williams, N. D. Wilson, W. S. Wilson, R. C. Wiren, A. O. Wolff, C. R. Young, R. B. Young.

Associate Members

J. K. Affleck, T. C. Agnew, H. V. Armstrong, W. T. Ashbridge, W. F. Auld, R. N. Austin, H. A. Babcock, L. A. Badgley, H. C. Baker, T. B. Ballantyne, W. Barber, F. G. F. Barr, D. C. Beam, A. E. Beck, F. A. Becker, S. G. Bennett, A. L. Birrell, H. M. Black, S. W. B. Black, F. J. Blair, E. J. Bolger, E. J. Boswell, J. H. W. Bower, E. T. J. Brandon, H. E. Brandon, J. Breakey, E. T. Bridges, W. J. Bruce, W. W. Brumby, L. G. Buck, C. E. Bush, A T. Cairncross, D. Cameron, J. S. Campbell, F. C. Carley, C. D. Carruthers, J. F. Cassidy, G. H. Chalmers, E. R. Clarke, G. R. Conrod, W. A. M. Cook, N. M. Cooke, J. H. Cornish, J. P. M. Costigan, A. W. Crawford, T. L. Crossley, R. A. Crysler, W. O. Cudworth, P. D. Dalton, C. D. Dean, W. L. Dickson, W. L. Dobbin, H. L. Dowling, W. B. Dunbar, E. B. Dustan, J. W. Dyer, F. C. Eley, F. G. Engholm, C. G. Ericson, G. E. Evans, J. W. Falkner, O. M. Falls, T. H. Fenner, O. L. Flanagan, C. D. Fleming, D. Forgan, J. H. Fox, C. E. Fraser, S. R. Frost, R. J. Fuller, F. Gaskill, P. W. Geldard, C. Gerow, A. Gibson, J. M. Gibson, E. F. Good, H. M. Goodman, J. M. Gordon, E. R. Grange, A. G. Grant, P. N. Gross, W. W. Gunn, H. N. Gzowski, A. Hadley, S. W. Hall, F. J. Hancox, C. E. Hawke, M. N. Hay, G. Hemmerick, R. Henham, O. Holden, E. B. Hubbard, A. M. Hudson, J. W. Hughes, E. E. H. Hugli, A. M. Humble, W. B. Hutcheson, J. T. Irving, G. R. Jack, H. C. Kendall, D. S. Laidlaw, J. A. Langford, W. H. M. Laughlin, R. F. Legget, A. D. LePan, J. F. Lester, D. S. Lloyd, G. R. Lord, W. C. Lumbers, E. W. McBride, H. L. McClelland, H. R. McClymont, J. A. McCouhrey, K. D. McDonald, N. G. McDonald, P. J. MacDonald, A. McIntee, D. G. MacKenzie, J. A. Mackenzie, J. E. McKinney, J. Mackintosh, D. L. McLaren, J. F. MacLaren, K. R. McLennan, J. A. P. Marshall, D. Massey, F. S. Milligan, G. Mitchell, J. R. Montague, H. R. Montgomery, C. F. Morrison, J. A. Morrison, E. K. Mueller, W. V. Mumford, T. A. S. Munford, E. Nicholson, D. Norman, R. K. Northey, H. B. Norwich, A. E. Nourse, J. C. Nutter, R. F. Ogilvy, C. C. Parker, E. L. Paterson, T. B. Patterson, R. O. Paulsen, D. E. Perriton, G. Phelps, F. R. Phillips, T. J. Pounder, W. B. Redman, A. M. Reid, A. Ritchie, A. Roberts, C. D. Roberts, A. R. Robertson, G. H. Rogers, H. G. Rose, H. J. Ross, W. E. Ross, G. G. Routledge, J. H. Russell, F. C. Rust, W. L. Sagar, E. M. Salter, M. Samuel, A. U. Sanderson, J. Sargent, N. D. Seaton, F. H. C. Sefton, W. L. Sheldon, D. Shepherd, B. B. Shier, W. H. Slinn, A. W. S. Smith, R. M. Smith, J. J. Spence, J. G. Spotton, M. A. Stewart, G. M. Stewart, M. D. Stewart, H. B. Stuart, H. A. Thompson, H. G. Thompson, P. M. Thompson, A. M. Toye, J. E. Tremayne, C. P. Van Norman, J. B. Wain, J. G. R. Wainwright, W. D. Walcott, J. M. Walker, M. B. Watson, M. P. Whelen, J. A. G. White, D. D. Whitson, G. P. Wilbur, R. W. Willis, L. A. Wilmot, J. C. Wilson, H. P. World, W. R. Worthington.

Juniors

J. H. Addison, E. A. Attenborough, E. M. Baird, J. A. Baker, F. W. Barnhouse, H. C. Bates, W. R. Benny, M. D. Perry, J. W. G. Boyd, J. B. Bryce, H. R. Brownell, M. S. Carson, A. C. Davidson, P. W. Doddridge, A. H. Douglas, W. K. Dow, E. C. Evans Fox, F. N. Harshaw, C. Hershfield, H. L. Hewitt, E. C. Higgins, W. T. Holgate, M. W. Huggins, G. E. Humphries, E. V. Hunt, K. W. Irwin, K. A. Jackson, G. J. Jarrell, O. E. Johnston, J. M. Jordan, J. S. Kyle, J. A. Lamb, W. J. Lind, W. S. Mills, J. G. Moloney, V. L. Mueller, D. I. Nattress, G. W. Painter, J. G. Powell, W. H. P. Prevey, D. E. Raymer, F. E. Regan, W. L. Rice, I. A. Robertson, R. H. Scrivener, V. Shanks, D. B. Sommerville, R. H. Spriggs, E. A. Sudden, F. W. Taylor, F. E. Wellwood, T. M. West, T. W. Wilson.

Students

W. R. Alexander, R. G. Allan, A. B. Anglin, J. E. Beach, G. L. Bodwell, R. Bowering, D. E. Burnham, E. T. Burns, M. F. Carriere, J. D. Christian, R. L. Christie, P. D. Corkum, E. Davey, C. F. Dobson-Smith, J. D. Duncan, J. B. Eldridge, W. F. Elford, J. S. Green, J. B. Hanly, E. A. Harvey, E. W. Henselwood, A. C. Herbert, R. Hewitt, G. L. Hood, L. M. Hunter, W. D. Johnston, L. E. Jones, W. D. Kirkland, J. A. K. Leger, S. D. Levine, J. A. Loutit, D. C. McCrady, F. W. MacLaren, E. D. B. Magee, F. S. Nation, A. B. C. Northover, W. M. Oxley, C. P. Paton, G. T. Perry, C. I. Phripp, J. A. Polson, H. B. Price, G. R. Pritchard, J. A. Ralph, D. O. D. Ramsdale, F. C. Read, G. G. Reynolds, W. J. Robson, C. L. Rogers, A. LeB. Ross, J. H. Ross, S. M. Rothman, L. J. Rubin, J. B. Saunders, C. C. Schnedar, N. J. W. Smith, O. H. Smith, S. Stephenson, C. P. Sturdee, E. L. Toy, C. H. Vatcher, J. W. Whytock, C. A. Wright, J. M. Yates.

Affiliates

S. W. Beaney, A. Burrows, R. E. Claridge, R. C. Mold.

Uxbridge (Br. Non-Res.), Associate Member, G. E. Booker.

Weston (Br. Res.), Student, M. H. Hastings.

Whitby (Br. Non-Res.), Member, D. J. Kean.

Whiteside (Br. Non-Res.), Member, F. A. Dallyn.

Woodbridge (Br. Res.), Associate Member, J. Mack.

York Mills (Br. Res.), Associate Members, J. S. Galbraith, J. N. Stanley.

Peterborough Branch District

(*The Counties of Hastings, Northumberland, Peterborough, Haliburton, Victoria, Durham.*)

Bancroft (Br. Non-Res.), Associate Members, M. Levin, T. V. McCarthy, A. M. Mills.

Belleville (Br. Non-Res.), Member, F. S. Lazier; Associate Members, D. W. Bews, W. L. Langlois, E. R. Logie; Junior, C. H. Davis; Student, T. F. S. Aman.

Campbellford (Br. Non-Res.), Associate Members, F. A. Burgar, G. Hawthorne.

Grafton (Br. Non-Res.), Associate Member, G. R. Taylor.

Lindsay (Br. Non-Res.), Member, F. R. Wilford; Associate Member, J. R. Wilford; Junior, H. D. Wilford.

Peterborough (Br. Res.)

Members

A. E. K. Bunnell, R. L. Dobbin, G. R. Langley, L. D. Magie, H. A. Morrow, R. H. Parsons, J. W. Pierce, E. R. Shirley.

Associate Members

J. Barnes, F. Bowness, B. I. Burgess, J. Cameron, W. M. Cruthers, G. A. Cunningham, V. R. Currie, A. L. Dickieson, D. J. Emery, W. T. Fanjoy, V. S. Foster, A. B. Gates, T. E. Gilchrist, R. E. Hinton, A. L. Killaly, W. A. Logan, I. F. McRae, A. H. Munroe, B. Ottewell, M. V. Powell, S. Shields, H. R. Sills, F. G. A. Tarr.

Juniors

W. B. Brown, F. A. Fleming, O. J. Frisken, A. J. Girdwood, R. S. Hull, A. R. Jones, J L. McKeever, A. L. Malby, G. C. Tollington.

Students

F. A. P. Athey, R. A. Baker, W. Begley, W. H. Bergman, A. J. Bonney, E. V. Briceland, Y. DeGuise, A. DeMaio, J. R. Desmarais, L. R. Douglas, D. A. Drynan, R. E. Edson, J. L. Gray, G. H. Hall, M. Laflamme, C. E. Lewis, D. R. McGregor, W. F. McMullen, C. B. Muir, J. F. Osborn, R. F. Peacock, P. E. Rose, C. H. Salvadge, B. K. Scarlett, J. H. Simpson, A. M. Thompson, E. Whiteley.

Affiliate

S. G. Alexander.

Port Hope (Br. Non-Res.), Associate Members, F. H. Barnes, H. W. Burri, E. M. Wynn; Student, W. P. Ralston.

Trenton (Br. Non-Res.), Associate Members, H. B. Godwin, D. C. M. Hume, J. J. Macnab, W. B. Wilson; Juniors, M. M. Hendrick, A. Orr; Student, D. G. Williams.

Tweed (Br. Non-Res.), Student, D. J. LaFontaine.

Kingston Branch District

(*The Counties of Prince Edward, Lennox, Addington, Frontenac, Leeds.*)

Barriefield (Br. Res.), Student, J. L. Taylor.

Brockville (Br. Non-Res.), Associate Member, L. Grant; Student, H. R. Frizzle.

Cardinal (Br. Non-Res.), Associate Members, A. S. Fraser, R. H. Wallace; Student, C. G. Wallman.

Gananoque (Br. Res.), Associate Member, P. L. O'Shaughnessy; Junior, H. D. Rogers.

Kingston (Br. Res.),

Honorary Member

A. L. Clark.

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Associate Members

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Juniors

R. L. Franklin, L. Katz, W. O. Peffers, N. E. Rodger, E. Ryan.

Students

K. B. Andre, G. V. Bourbonnais, L. H. Brown, M. A. Dolan, C. M. R. Elmsley, P. M. Hopkins, W. A. Joyce, C. O. P. Klotz, D. Lantier, A. J. McDonald, D. D. C. McGeachey, A. D. McGinnis, R. K. Mackenzie, K. H. McKibbin, H. L. K. Mason, E. C. Mayhew, J. F. Morazain, F. R. Pope, D. L. Rigsby, P. Roy, R. L. Sanders, S. Slater, G. H. Spencer, R. E. Thompstone, K. R. Ward.

Napanee (Br. Res.), Associate Member, H. L. Schermerhorn.

Picton (Br. Non-Res.), Student, J. W. Leavens.

Ottawa Branch District

(*The Counties of Grenville, Stormont, Dundas, Glengarry, Prescott, Russell, Carleton, Lanark, Renfrew, Labelle, Que., Ottawa, Ont., Pontiac, Que., Temiskaming, Que., Yukon, and the North West Territories.*)

Almonte (Br. Non-Res.), Member, M. C. MacFarlane.

Amos, Que. (Br. Non-Res.), Associate Member, J. Dumont; Students, G. H. Dumont, S. Plamondon.

Arnprior (Br. Non-Res.), Associate Member, N. Malloch.

Arntfield, Que. (Br. Non-Res.), Student, C. M. Hare.

Bourlamaque, Que. (Br. Non-Res.), Associate Member, A. R. Moffat; Juniors, W. G. Cosser, A. L. Denton.

Buckingham, Que. (Br. Res.), Associate Members, J. K. Davidson, W. H. Kelly; Student, W. A. Baldwin.

Carleton Place (Br. Non-Res.), Student, R. Bruce.

Cornwall (Br. Non-Res.), Members, W. G. Magwood, D. Ross-Ross, C. D. Sargent, D. Whittaker; Associate Members, A. L. Farnsworth, H. E. Meadd; Juniors, C. J. Somers, W. H. Young; Students, C. I. Bacon, G. Sanders.

Cumberland (Br. Non-Res.), Junior, W. G. McLaughlin.

Dawson, Y.T. (Br. Non-Res.), Associate Member, A. G. Barrett.

Dupuy, Que. (Br. Non-Res.), Student, L. J. Lichty.

Eganville (Br. Non-Res.), Associate Member, K. R. MacGregor.

Fort Coulonge, Que. (Br. Non-Res.), Associate Member, H. I. Mulligan.

Hawkesbury (Br. Non-Res.), Members, H. Anvik, C. B. Thorne, S. Wang; Associate Members, R. Boismenu, H. J. Whiting; Junior, W. P. Nesbitt; Student, P. L. W. Platt.

Hull, Que. (Br. Res.), Member, A. N. Ball; Associate Members, A. V. Gale, W. F. Hadley, R. G. Johnstone, W. S. Kidd, D. O. McLennan, J. W. Paterson, V. Perrin, G. Stephenson, K. F. Wrangell.

Kewagama, Que. (Br. Non-Res.), Member, E. N. Martin; Junior, W. J. Piercy.

Latchford (Br. Non-Res.), Associate Member, W. N. Cann.

Low, Que. (Br. Non-Res.), Associate Member, G. H. Desbarats.

Maitland (Br. Non-Res.), Associate Member, R. C. P. Webster.

Merrickville (Br. Non-Res.), Associate Member, W. H. Abbott.

Montebello, Que. (Br. Non-Res.), Associate Member, R. W. Teagle.

Mont Laurier, Que. (Br. Non-Res.), Associate Member, J. C. McIntosh.

Morrisburg (Br. Non-Res.), Associate Member, G. L. Brown.

Noranda, Que. (Br. Non-Res.), Associate Members, J. R. Bradfield, J. Handley, W. M. Harvey, C. W. Justice, M. A. Phelan, D. B. Simpkin; Student, R. A. Parsons.

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Farley, S. D. Fawcett, A. Ferrier, R. H. Field, W. H. G. Flay, J. L. Foreman, T. Foulkes, A. N. Fraser, E. V. Gilhert, W. G. C. Gliddon, F. G. Green, S. L. Grenzebach, R. W. Guy, R. E. Hanson, S. Hardcastle, J. Hardouin, J. F. Harkom, A. K. Hay, R. E. Hayes, C. T. Heeney, J. P. Henderson, F. C. Higgins, L. J. M. Howard, J. W. Hughson, L. McL. Hunter, L. A. B. Hutton, J. H. Irvine, C. M. Johnston, W. M. Johnstone, E. B. Jost, M. Katz, W. R. Kenny, G. Kydd, A. K. Laing, H. F. J. Lambart, A. Langlois, J. E. Larochelle, S. D. Lash, W. L. Laurie, G. A. Lindsay, J. W. Lucas, F. C. C. Lynch, W. R. McClelland, D. G. McCrone, J. A. Macdonald, W. E. MacDonald, W. S. McDonald, T. A. McElhanney, G. G. McEwen, T. E. McGrail, S. McIlwain, W. L. Mackenzie, M. A. MacKinnon, D. McMillan, A. E. McNicoll, A. E. MacRae, N. B. MacRostie, M. S. Madden, H. E. Maple, E. S. Martindale, O. M. Meehan, R. S. Millett, J. T. Mitchell, L. N. Moore, W. C. Murdie, E. P. Murphy, J. J. Murphy, S. J. Murphy, A. Murray, J. H. H. Nicolls, W. H. Norrish, R. K. Odell, P. E. Palmer, J. S. Parker, W. J. Peaker, W. B. Pennock, C. H. Pinhey, C. M. Pitts, J. A. Pounder, R. M. Prendergast, C. A. Price, R. C. Purser, C. V. Putman, H. S. Rees, G. S. Ridout, S. O. Roberts, L. B. Rochester, H. G. Ross, W. A. Rush, A. G. Sahourin, W. L. Saunders, B. H. Segre, H. V. Serson, J. L. Shearer, P. Sherrin, J. S. G. Shotwell, W. I. Shuttleworth, R. C. Silver, F. G. Smith, J. L. Smith, S. M. Steeves, J. N. Stinson, I. R. Strome, R. A. Strong, A. A. Swinnerton, S. G. Tackaberry, G. F. Taylor, A. Thomas, W. J. R. Thomson, G. H. Thurher, H. E. Trehle, J. A. Vermette, C. Vokes, E. H. Wait, W. E. Wakefield, E. O. Way, H. R. Welch, T. O. Whillans, C. E. White, A. R. Whittier, C. D. Wight, D. A. Williamson, N. Wilson, S. H. Wilson, M. Windsor, C. O .Wood, J. E. Woods, J. Woodside, R. Yuill.

Juniors

W. M. Askwith, G. E. Beament, J. W. Craig, H. F. Crain, C. W. Crossland, R. L. Drake, J. R. Dunlop, C. V. Dunne, J. H. Ferguson, H. S. V. Gihhon, A. D. Hogg, H. D. Hyman, M. P. Jolley, H. B. MacCarthy, E. M. MacLeod, T. M. Patterson, E. M. Ramsay, A. Rose, F. G. York.

Students

L. G. Askwith, R. C. C. Brown, S. G. Gamhle, A. G. Garvock, R. S. Lockeherg, C. D. Low, A. R. L. McNaughton, W. A. Marshall, R. D. Meagher, L. Miller, R. J. Parlee, R. M. Powell, D. C. Smiley, R. F. Sparks, R. L. Stevens, R. H. Swingler, J. P. Wilson.

Affiliates

A. J. Ames, J. A. O'Brien.

Pembroke (Br. Non-Res.), Associate Members, J. L. H. Bogart, W. J. Moore.
Perron, Que. (Br. Non-Res.), Associate Member, J. A. Black.
Perth (Br. Non-Res.), Member, G. C. Dunn.
Petawawa (Br. Non-Res.), Student, A. B. Connelly.
Prescott (Br. Non-Res.), Member, W. L. LeRoy; Junior, G. H. Kingston; Students, J. G. Kerfoot, E. L. Kingston.
Renfrew (Br. Non-Res.), Associate Member, J. R. Stewart.
St. Elie de Caxton, Que. (Br. Non-Res.), Associate Member, S. Troop.
Siscoe, Que. (Br. Non-Res.), Associate Member, H. C. Seely; Junior, W. E. Seely.
Smith's Falls (Br. Non-Res.), Associate Member, F. R. V. Billie.
Spencerville (Br. Non-Res.), Member, C. H. Ellacott.
Sullivan, Que. (Br. Non-Res.), Associate Member, I. M. Marshall; Junior, G. M. McLean.
Temiskaming, Que. (Br. Non-Res.), Member, A. K. Grimmer; Associate Members, J. J. Freeland, B. Grav, W. G. Hardy, J. G. MacLaurin.
Thurso, Que. (Br. Non-Res.), Student, A. Clairmont.
Val d'Or, Que. (Br. Non-Res.), Associate Member, H. Mugaas.
Westboro (Br. Res.), Member, A. E. Hopper.
Williamstown (Br. Non-Res.), Associate Members, I. G. Henderson, D. D. MacCrimmon.
Woodroffe (Br. Res.), Junior, G. D. Pooler.
Yellowknife, N.W.T. (Br. Non-Res.), Member, W. G. Stuart.

ZONE C

(*The Province of Quebec.*)

Montreal Branch District

(*The Counties of Compton, Stanstead, Sherbrooke, Richmond, Wolfe, Arthabaska, Megantic, Chambly, Drummond, Yamaska, Richelieu, St. Hyacinthe, Bagot, Shefford, Rouville, Brome, Missisquoi, Iberville, St. Johns, Napierville, La Prairie, Verchères, Chateauguay, Huntingdon, Beauharnois, Jacques Cartier, Laval, Two Mountains, Terrebonne, L'Assomption, Montcalm, Joliette, Berthier, Maskinongé, Argenteuil, Vaudreuil, Soulanges, and also all other territory in Canada not allocated.*)

Asbestos (Br. Non-Res.), Students, W. G. Baker, E. R. Brannen, J. J. Donovan, H. B. Howe.
Beauharnois (Br. Non-Res.), Associate Members, H. F. Abbott, B. K. Boulton, P. H. Morgan, C. H. Pigot.
Beebe (Br. Non-Res.) Student, W. B. Haselton.
Black Lake (Br. Non-Res.), Associate Member, A. D. Porcberon.
Boucherville (Br. Res.), Member, E. S. Mattice.
Brownsburg (Br. Non-Res.), Associate Members, J. W. Houlden, C. H. Jackson; Students, G. F. Clarke, J. H. Peters, H. M. Sberwood, J. W. Suthren.
Bury (Br. Non-Res.), Associate Member, E. F. Hawley.
Cedars (Br. Non-Res.), Associate Member, J. B. Barnum.
Chambly Canton (Br. Non-Res.), Junior, R. W. Phillips.
Como (Br. Non-Res.), Associate Member, H. W. R. Shepherd.
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Danville (Br. Non-Res.), Junior, C. R. Engler.
Drummondville (Br. Non-Res.), Associate Member, F. A. Chisbolm; Juniors, N. W. Kershaw, O. N. Mann; Student, W. B. Guihan.
East Angus (Br. Non-Res.), Associate Member, E. P. Wilson.
Eustis (Br. Non-Res.), Student, H. P. Godard.
Farnham (Br. Non-Res.), Associate Members, R. H. Stenhouse, K. B. Wallace; Student, L. P. L'Homme.
Georgeville (Br. Non-Res.), Associate Member, W. A. Murray.
Granby (Br. Non-Res.), Student, P. R. Martin.
Kilmar (Br. Non-Res.), Associate Member, J. A. Creaser; Student, R. A. Sancton.
Knowlton (Br. Non-Res.), Junior, H. A. Gray.
Lennoxville (Br. Non-Res.), Associate Member, G. M. Sutherland; Student, K. S. Crawford.
McMasterville (Br. Non-Res.), Junior, M. V. MacDonald; Student, A. T. Fell.
Montreal (Br. Res.), (Tbe Island of Montreal),

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P. Ackerman, J. A. Adam, G. R. Adams, G. Agar, H. Allchurch, C. A. Allen, D. G. Anglin, F. W. Angus, J. C. Antliff, D. B. Armstrong, J. E. Armstrong, O. F. C. Armstrong, J. K. Ashworth, T. H. Bacon, C. D. Bailey, A. M. Bain, R. H. Balfour, M. Balls, S. R. Banks, R. G. Barbour, N. M. Barclay, F. R. Barnsley, R. W. Bastable, E. Baty, J. A. Beauchemin, E. A. Beck, A. N. Beer, P. A. Beique, H. H. Bell, C. M. Benett, W. H. Bennet, A. Benjamin, W. H. B. Bevan, O. Biedermann, J. L. Bieler, G. F. Binns, L. H. Birkett, C. L. Blackmore, S. Blumentbal, A. T. Bone, J. I. Boulian, O. B. Bourne, C. R. Bown, P. E. Bourbonnais, H. C. T. Boyd, P. G. A. Brault, J. M. Breen, J. F. Brett, C. L. Brooks, J. S. Bryant, A. N. Budden, L. H. Burket, L. H. Burpee, H. W. Buzzell, N. Cageorge, R. M. Calvin, J. D. Calvin, H. D. Cameron, J. S. Cameron, K. G. Cameron, N. C. Cameron, N. M. Campbell, H. Cantwell, E. G. Carey, R. M. Carmichael, C. A. Carniel, J. G. Caron, J. R. Carter, J. P. B. Casgrain, A. R. 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Eardley-Wilmot, W. H. Eastlake, N. I. Edwards, G. B. Elliot, J. A. Ellis, N. L. Engel, L. E. Ennis, W. G. Enouy, B. A. Evans, C. D. Evans, D. E. Evans, J. M. Evans, T. O. Evans, J. W. Fagan, J. M. Fairbairn, H. W. Fairlie, E. W. Farmer, R. W. Farmer, A. J. Farrell, J. R. Fenwick, A. A. Ferguson, A. W. Finlayson, H. F. Finnemore, C. B. Fisher, R. C. Flitton, J. H. Forbes, W. H. Fong, R. Ford, E. Fortin, V. A. Fournier, A. J. Foy, J. A. Freeland, R. P. Freeman, C. E. Frost, A. E. Fry, E. B. Fry, J. D. Fry, E. V. Gage, E. G. Gagnon, L. Galler, W. McG. Gardner, M. Gerin, H. A. Gibeau, G. H. Gillett, F. T. Gnaedinger, C. Godin, H. A. Goldman, E. A. Goodwin, C. H. Gordon, H. J. Gordon, W. W. Graham, D. F. Grahame, A. J. Grant, E. Grant, B. Griesbach, W. Grieshach, H. S. Grove, E. Gruenig, R. A. Gurnham, G. R. Hale, M. B. Halpenny, R. W. Hamilton, A. F. Hanly, H. B. Hanna, A. I. Harkness, F. N. Harling, J. R. Hartney, St. G. Harvey, H. H. Hawkes, E. H. Hayes, J. A. H. Henderson, T. H. Henry, W. Herhison, C. E. Herd, F. S. B. Heward, J. S. Hewson, B. C. Hicks, C. E. Hogarth, J. H. Holden, F. E. Holland, A. L. Huber, G. M. Hudson, W. C. Hulhurd, G. D. Hulme, A. B. Hunt, L. Hurtubise, A. Hutcbison, F. Irvine, C. H. Jackson, W. Jackson. E. R. Jacobsen, W. A. James, W. T. Jamieson, W. H. Jarand, L. Jehu, H. Johnsen, G. W. F. Johnston, H. C. Johnston, H. W. Johnston, F. S. Jones, R. B. Jones, E. B. Jubien, C. S. Kane, H. C. Karn, J. A. Kearns, E. S. Kelsey, C. G. Kemp, J. C. Kemp, H. C. Kennedy, L. A. Kenyon, A. J. Kerry, M. W. Kerson, W. A. Ketchen, D. A. Killam, W. D. Kirk, E. Klein, E. W. Knapp, L. E. Krehser, E. Kugel, P. L. Kuhring, W. H. Kyle, E. Lacroix, L. Laferme, D. A. S. Laing, J. M. M. LaForest, J. A. Lalonde, J. L. Lalonde, J. A. Lamoureux, R. Langlois, J. H. Landry, C. C. Langstroth, R. Laplante, C. A. Laverty, A. J. Lawrence, H. W. Lea, C. J. LeBlanc, J. LeBlanc, B. Leman, L. J. Leroux, D. J. Lewis, C. C. Lindsay, C. R. Lindsey, H. R. Little, R. S. Logan, G. B. Lomer, J. A. Loy, F. R. Lunn, H. M. Lyster, J. W. McCammon, T. C. McConkey, C. R. McCort, L. McCoy, M. McCrady, H. E. McCrudden, O. J. McCulloch, L. B. McCurdy, L. R McCurdy, S. G. MacDermot, C. K. McDonald, D. J. McDonald, J. C. McDougall, A. B. McEwen, W. H. McGaan, M. S. Macgillivray, A. McGugan. W. N. McGuinness, F. J. McHugh, W. S. McIlquham, E. D. McIntosb, L. F. MacKay, A. M. Mackenzie, T. R. McLagan, J. H. McLaren, H. J. G. McLean, G. R. McLennan, C. K. McLeod, J. W. McMahon, H. W. McMillan, K. L. MacMillan, R. E. McMillan, S. D. MacNah, M. F. Macnaughton, J. J. McNiven, J. B. Macphail, D. C. Macpherson, H. R. McQueen, H. L. Mahaffy, E. H. Manley, W. J. Manning, R. Marchand, R. H. Matber, R. J. Mattson, J. H. Maude, J. O. Meadows, F. C. Mechin, A. A. Mellor, W. A. Messenger, G. H. Midgley, P. Miller, E. C. Miller, J. J. H. Miller, H. Miller, C. N. Mitchell, F. L. Mitchell, R. W. Mitcbell, S. Mitcheson, H. B. Montizambert, G. D. Moon, F. M. Mooney, W. H. Moore, T. 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Roy, A. S. Runciman, A. S. Rutherford, J. F. Rutherford, S. F. Rutherford, F. G. Rutley, M. A. Sammett, P. E. Savage, J. J. R. Scanlan, A. N. Scott, L. J. Scott, W. G. Scott, W. K. Scott, J. K. Sexton, S. W. Shackell, G. E. Shaw, G. W. Shearer, A. P. Sberwood,

N. E. D. Sheppard, W. F. Shields, R. C. Simon, A. E. Simpson, J. Sinton, E. R. Smallhorn, A. T. E. Smith, H. S. Spark, H. C. Spencer, J. E. Sproule, J. C. Stadler, R. E. Stavert, H. L. Steenbuch, B. H. Steeves, J. T. Steeves, G. R. Stephen, D. Stewart, D. L. Stewart, R. O. Stewart, W. M. Stobbart, P. F. Stokes, J. D. Stott, R. L. A. Strathy, F. S. Stratton, J. H. Summerskill, R. D. Sutherland, N. S. S. Swan, R. G. Swan, I. R. Tait, J. R. C. Taschereau, J. E. Thicke, C. O. Thomas, T. C. Thompson, W. L. Thompson, E. Thomson, C. H. Timm, W. W. Timmins, V. Toupin, C. R. Townsend, G. Townsend, S. N. Tremblay, E. F. Tucker, A. C. Turtle, W. G. Tyler, H. Ulmann, A. Valiquette, I. A. Vallieres, E. M. Van Koughnet, H. S. Van Patter, P. Varley, H. W. Vaughan, H. J. Vennes, C. U. Vessot, E. F. Viberg, G. L. Vickerson, A. Vincent, R. A. Vincent, P. P. Vinet, G. O. Vogan, M. Vogin, H. R. Wake, J. B. Walcot, W. Walker, G. A. Wallace, J. H. Wallis, N. S. Walsh, R. Wangel, F. N. Ward, T. H. Wardleworth, R. N. Warnock, G. K. Waterhouse, H. M. Watson, J. P. Watson, W. R. Way, J. Weir, R. S. Weir, H. G. Welsford, J. H. Wheatley, D. A. White, R. White, C. O. Whitman, C. R. Whittemore, K. O. Whyte, A. A. Wickenden, F. Williams, R. L. Williams, A. Wilson, J. H. Wilson, D. O. Wing, K. M. Winslow, E. Winslow-Spragge, E. Wing, F. E. Winter, A. J. Wise, M. Wolff, F. M. Wood, F. C. Woods, C. D. Woolward, L. A. Wright, N. N. Wright, J. K. Wyman, W. L. Yack, R. A. Yapp, W. J. Yorgan, W. H. Yost, J. D. Young, R. A. Young.

Juniors

H. B. Abbott-Smith, L. Allaire, V. Andersen, J. R. Auld, I. S. Backler, C. A. Barbour, M. J. Barrett, J. F. Benjafield, A. Benjamin, J. Benoit, B. A. Berger, H. E. Blachford, J. P. Borbey, R. Boucher, W. S. Bowles, J. M. Cape, W. F. S. Carter, H. E. Chaplin, C. Craig, W. R. Davis, J. L. Dery, G. Dorais, L. A. Duchastel, W. E. Dyke, D. C. Esmond, L. W. Elliott, F. S. Fisher, S. T. Fisher, M. Fleury, J. B. Francis, A. D. W. Fraser, F. Gersovitz, B. H. D. Giles, H. B. Goodman, H. J. Gordon, G. Graham, A. L. Gravel, A. J. Groleau, A. W. Grunsten, W. G. H. Holt, G. W. Jarvis, J. R. Johnson, R. Johnson, F. G. Kerry, D. S. Kirkbride, H. Kirsh, J. W. Koehler, M. Lamoureux, M. J. Layton, J. G. Lefrancois, S. G. Lochhead, G. S. Lyons, J. F. McGuire, W. P. Malone, J. H. Mellor, J. R. Menzies, C. A. Miller, P. S. A. Morton, D. J. Munro, M. Nathanson, F. E. Palmer, A. H. Pangman, H. A. Perego, A. Peterson, F. R. Phillips, M. E. Pineau, G. V. Reinhardt, J. M. Rombough, G. R. Samis, P. R. Sandwell, S. C. Scadding, W. H. Schippel, M. Schnyder, M. L. Sherwood, S. Sillitoe, O. L. Smith, J. Y. Stanfield, M. Stein, J. R. Stewart, W. F. Stewart, R. Thorn, C. R. Timm, H. H. Tinkler, T. Touzin, K. H. Tremain, G. E. Vernot, G. G. Wanless, W. E. White, R. R. Willis, R. H. Yeomans.

Students

A. Aird, J. A. Alexander, L. J. Arcand, G. Archambault, J. L. Armstrong, G. C. Arthey, H. Asselin, D. J. O. Barry, S. J. Becker, C. E. Bedford-Jones, P. Z. Bedoukian, F. P. Béique, G. Belanger, M. Belanger, A. P. Benoit, L. Berenstein, H. Bernier, J. B. Block, M. Boisclair, A. Bolduc, C. Boulva, J. D. Bourne, P. Bousquet, T. T. Boutilier, H. Branchaud, L. Brossard, E. F. Brown, G. J. Brown, O. R. Brumell, M. I. Bubbis, A. A. Buchanan, L. Buteau, J. A. T. Butler, A. K. Cameron, L. Cartier, F. Chadillon, J. Calder, H. E. Chalk, R. Chambers, S. M. Chapman, E. Charland, S. A. Charters, A. C. S. Chennell, C. E. Cleveland, A. H. Cole, J. L. Connolly, K. G. Cook, S. Coppick, G. Coupienne, Y. Cousineau, E. Coutts, R. E. Cox, P. G. Cranston, G. E. M. Crepeau, D. H. Cross, H. E. Cunningham, L. G. Daignault, E. R. Davis, M. F. Dean, Y. Decarie, L. Delisle, T. Dembitzky, R. Desjardins, D. DesOrmeaux, F. A. Dibblee, W. A. Dick, R. N. Dobson, P. E. Douville, C. H. Drury, P. A. Duchastel, W. A. Duckett, R. J. F. Dunlop, J. T. Dunn, C. A. Duranceau, J. Dussault, H. M. Esdaile, E. N. Evans, B. Exelrod, D. H. Ferguson, R. N. Ferguson, G. L. Field, P. Filion, A. C. Findlay, A. Fish, J. Flahault, A. M. Forster, M. A. Forsythe, G. Frechette, P. B. French, R. A. Frigon, A. Gervais, W. F. P. Gildea, R. E. Gohier, A. E. Gregoire, G. H. Griffiths, R. E. Grout, J. A. P. Guenette, J. H. Hall, P. Hallé, J. C. R. Hamelin, R. E. Hammond, E. A. Hankin, W. L. Hare, G. G. Harley, R. A. H. Hayes, C. R. Hebert, G. R. S. Henry, A. G. Hibbard, T. Holland, W. O. Horwood, J. R. Houghton, J. S. Houghton, S. F. Hubbard, W. F. Hughes, W. S. Hunt, J. E. Hurtubise, M. Hurtubise, D. S. Jacobs, J. S. Jeffrey, R. E. Jess, S. Jones, B. E. A. Kay, H. E. Kennedy, G. H. Kimpton, B. W. King, D. King, E. N. Kingsland, R. E. Kirkpatrick, L. Kirsch, H. Klein, V. G. Kosnar, J. Lacombe, J. Lacroix, J. A. Lalonde, M. Lamarche, H. Lamb, G. A. Lapointe, J. Laurence, J. Lavallee, R. LeBel, R. F. Leblanc, F. Lecavalier, J. P. Lecavalier, J. Lefebvre, J. Lefort, E. B. A. LeMaistre, H. J. Lemieux, J. P. Leroux, R. Lessard, C. J. Ley, P. E. L'Heureux, H. Little, J. S. Lochhead, C. K. Lockwood, W. A. Logie, J. C. Loiselle, H. J. Loiselle, J. G. M. Loomis, M. J. Lupton, J. H. K. Lyons, R. I. McCabe, R. M. Macfarlane, J. A. MacGibbon, W. H. MacGowan, L. S. McGregor, I. N. MacKay, N. A. MacKay, M. D. McLean, D. N. Macleod, G. Macleod, G. R. Macleod, J. McMath, G. A. Mailhot, F. Marchand, P. Martel, J. A. Martin, G. A. R. Mason, R. Ménard, J. M. Mercier, E. L. Miller, J. J. Miller, R. W. Mitchell, A. Monti, A. Morin, H. K. Morris, J. D. Morrison, S. C. Moseley, C. G. Motherwell, G. W. Moule, D. F. Murphy, G. A. Mussen, L. M. Nadeau, M. Nantel, S. Nathanson, W. A. Nelson, A. D. Nesbitt, P. D. Normandeau, B. C. Nowlan, H. C. Oatway, G. O'Donoughue, J. Oliver, T. Ortiz, M. Ostiguy, J. L. Pare, E. N. Parker, C. F. Payan, G. Piette, H. C. Pinder, G. D. Poole, G. Proulx, R. Provost, Q. Quevillon, J. Racicot, G. K. Reynolds, J. M. Richardson, B. D. Richer, W. V. Rintoul, R. H. Rioux, A. Robert, R. F. Robillard, H. W. Rogers, M. Rolbin, H. U. Ross, O. K. Ross, T. W. Ross, J. J. Rowan, L. A. Rowell, J. A. Royer, R. Saintonge, G. E. Sarault, M. Scheen, H. H. Schwartz, B. M. Scriver, E. J. Senkler, H. G. Seybold, K. W. Shaw, L. Shector, J. M. Simard, R. E. Smallwood, A. G. Smith, D. Smith, W. C. Smyth, W. G. Snyder, W. R. H. Springford, J. P. Stanley, D. O. Stapleton, J. L. Starkey, W. D. Stewart, R. I. Strong, J. N. Swartz, J. W. Swift, G. E. Tait, J. Tannenbaum, W. J. Tanner, W. C. Tatham, B. S. Taylor, D. R. Taylor, A. Tetreault, J. Tetreault, J. G. Thibault, J. L. Thomas, L. Thomlinson, J. A. Thomson, H. M. Towle, J. L. Vaillancourt, M. Valiquette, Z. Valiquette, H. D. Van Every, G. A. Verge, J. J. Waller, W. H. C. Wallis, W. G. Wesley, E. I. Wigdor, D. D. Williams, L. C. Williams, S. C. Williams, H. G. Wong, A. M. Wright, J. W. Wright, A. B. Zion.

Affiliates

F. Atkinson, P. M. Chaussee, F. Hankin, J. D. Johnson, F. P. Jones, S. F. Kelly, P. W. MacFarlane, W. H. C. Mussen, E. H. Parmelee, F. H. T. Webster, C. S. Westover, J. Winder.

Nantel (Br. Non-Res.), Junior, C. J. Krendel.
North Hatley (Br. Non-Res.), Associate Member, C. L. Cate.
Plessisville (Br. Non-Res.), Student, J. Doucet.
Rigaud (Br. Non-Res.), Member, O. Fogarty.
Ste. Anne de Bellevue (Br. Non-Res.), Associate Member, R. Strickland.
Ste. Agathe (Br. Non-Res.), Student, A. Mendelsohn.
St. Hyacinthe (Br. Non-Res.), Associate Members, J. Bouchard, C. Chapais.
St. Jerome (Br. Non-Res.), Junior, D. C. Dobbin.
St. Johns (Br. Non-Res.), Students, J. Collingwood, J. C. P. Leahey.
St. Lambert (Br. Res.), Member, M. J. Rutledge; Associate Members, C. D. Norton, F. A. Ritchie, J. L. M. Tait, H. H. Vroom, R. M. Walker; Juniors, F. R. Reevely, F. W. B. Shaw; Student, M. P. Gunning; Affiliate, D. H. Parker.
St. Marguerite (Br. Non-Res.), Associate Member, A. G. Moore.
St. Remi d'Amherst (Br. Non-Res.), Associate Member, J. H. Legg.
Sherbrooke (Br. Non-Res.), Associate Members, G. M. Dick, E. T. Harbert, F. H. Hibbard, S. R. Newton, W. L. R. Stewart; Junior, A. A. B. McMath; Students, B. P. Clarke, R. B. McRae.
Sorel (Br. Non-Res.), Member, F. Bridges; Associate Member, L. Trudel; Student, L. P. Cousineau.
Terrebonne (Br. Res.), Associate Member, J. P. Piche.
Thetford Mines (Br. Non-Res.), Associate Members, H. R. Lynn, W. J. Johnson, G. A. McClintock; Students, G. Beaudet, M. K. Senicie.
Valleyfield (Br. Non-Res.), Associate Members, R. Belanger, L. McGillis, A. W. Sullivan; Junior, R. Billette.
Victoriaville (Br. Non-Res.), Associate Member, S. C. Hill.
Windsor (Br. Non-Res.), Associate Member, N. A. Thompson.
Windsor Mills (Br. Non-Res.), Junior, T. W. Houghton.

St. Maurice Valley Branch District

(*The Counties of Champlain, Nicolet and St. Maurice.*)

Cap de la Madeleine (Br. Res.), Student, P. R. Descoteaux.
Grand'Mere (Br. Res.), Member, E. B. Wardle; Associate Members, F. W. Bradshaw, V. Jepson, W. B. Scott, H. G. Timmis; Juniors, J. L. Jomini, J. P. Villemure; Student, R. J. Mahoux.
La Tuque (Br. Non-Res.), Associate Members, J. Asselin, J. W. H. Ford, H. J. Racey, G. R. Rinfret; Junior, C. E. Nix; Students, J. A. Burke, G. Dufour, I. M. Foster.
Rapide Blanc (Br. Non-Res.), Associate Member, T. H. Ayer.
Shawinigan Falls (Br. Res.),

Associate Members

A. G. M. L. Atwood, R. D. Bennett, M. Eaton, A. H. Heatley, N. J. A. Vermette, H. J. Ward, H. K. Wyman.

Juniors

E. T. Buchanan, L. B. Stewart, L. B. Stirling, A. H. Watier.

Students

P. N. Evans, R. Frigon, A. S. Holder, E. D. Lavergne, J. H. P. Matheson, P. I. Pouliot, C. S. C. Wisdom.

Three Rivers (Br. Res.),

Members

F. X. T. Berlinguet, H. O. Keay.

Associate Members

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Juniors

G. B. Baxter, G. Heroux, R. T. Morgan, J. M. Pope, J. A. Sevigny, C. H. Skelton, A. Trudel, E. E. Wheatley.

Quebec Branch District

(*The Counties of Gaspé, Bonaventure, Matane, Rimouski, Témiscouata, Kamouraska, L'Islet, Montmagny, Bellechasse, Dorchester, Beauce, Frontenac, Anticosti, Lotbinière, Levis, Charlevoix, Montmorency, Quebec, Portneuf.*)

Beauceville (Br. Non-Res.), Student, J. G. Belle-Isle.
Beauport (Br. Res.), Member, J. F. Guay; Associate Members, G. D. O'Connor, F. B. Painchaud; Junior, L. P. Gravel.
Beaupre (Br. Res.), Associate Member, H. O. Brown.
Carleton (Br. Non-Res.), Junior, G. Demers.
Chandler (Br. Non-Res.), Associate Member, A. M. S. Jones; Junior, W. E. Soles.
Donnacona (Br. Non-Res.), Associate Members, W. D. MacKinnon, J. E. Morisset.
Hervey Junction (Br. Non-Res.), Associate Member, J. Brooke.
Isle Verte (Br. Non-Res.), Associate Member, J. N. T. Bertrand.
Lauzon (Br. Res.), Associate Member, M. Bourget.
Levis (Br. Res.), Associate Member, L. C. Dupuis.
Loretteville (Br. Res.), Associate Member, C. B. Bate.
Montmagny (Br. Non-Res.), Associate Member, H. A. Gauvin.
Pointe-au-Pic (Br. Non-Res.), Associate Member, H. Warren.
Portneuf (Br. Non-Res.), Member, C. A. Buchanan.
Quebec (Br. Res.),

Members

G. K. Addie, H. Cimon, A. R. Decary, A. O. Dufresne, P. A. Dupuis, E. A. Evans, A. Gratton, C. V. Johnson, H. Kennedy, L. B. Kingston, A. Lariviere, J. A. Lefebvre, A. A. MacDiarmid, J. O. Martineau, J. O. Montreuil, A. B. Normandin, J. O'Halloran, A. Paradis, J. Ruddick, W. C. Thomson.

Associate Members

A. W. Ahern, A. Amos, J. U. Archambault, L. Beaudry, J. L. Bizier, C. H. Boisvert, T. J. Boivin, W. S. Buchanan, W. R. Caron, G. H. Cartwright, J. P. Chapleau, J. E. Chevalier, R. E. Cumming, T. M. Dechene, O. Desjardins, A. Dick, A. V. Dumas, R. Dupuis, R. H. Farnsworth, J. Fortin, L. Gagnon, E. D. Gray-Donald, J. F. Grenon, M. L. Guimont, H. E. Huestis, J. P. P. Joncas, A. Laframboise, J. H. A. Laplante, E. Laurence, W. S. Lawrence, P. Lefebvre, C. C. Lessard, J. C. Longstaff, C. Luscombe, R. B. McDunnough, L. Martin, P. Méthé, C. Milot, G. Molleur, J. G. O'Donnell, A. E. Paré, B. Pelletier, S. A. Picard, L. P. Poundrier, W. R. G. Ray, J. M. Reid, D. Rhodes, A. Roberge, J. E. Roy, R. Sauvage, R. J. L. Savary, J. Saint Jacques, D. S. Scott, A. Smith, J. A. Smith, A. Tremblay, T. L. Tremblay, L. G. Trudeau, I. E. Vallee, S. J. H. Waller.

Juniors

M. G. Archer, R. J. Chambers, G. Lemieux, H. W. Love, J. Morency, J. M. Paquet, A. Piche, L. Roy, G. F. St. Jacques, P. Vincent.

Students

W. J. Ahearn, H. F. Béique, G. A. E. Couture, R. Gauthier, P. de Lamirande, L. L'Allier, M. G. LaRiviere, R. A. Lemieux, E. L. Neal, P. R. Rolleston, G. Savard, J. M. Scott, Y. R. Tasse, G. Thibaudeau, G. A. Verge, P. Warren, J. Winn.

Rimouski (Br. Non-Res.), Member, J. C. Tache; Associate Member, B. Grandmont.
St. Anselme (Br. Non-Res.), Student, P. E. Cadrin

Saguenay Branch District

(*The Counties of Saguenay, Chicoutimi, Lake St. John.*)

Arvida (Br. Res.),

Members

M. DuBose, F. L. Lawton, A. W. Whitaker.

Associate Members

B. E. Bauman, F. T. Boutilier, T. A. Carter, A. I. Cunningham, J. R. Hango, A. C. Johnston, R. Lanctot, C. Miller, G. B. Moxon, R. H. Rimmer, M. G. Saunders, W. J. Thomson, J. W. Ward.

Juniors

O. Chaput, J. J. Fortin, R. M. Fullerton, G. T. Malby, R. Marcotte.

Students

W. E. Cooper, C. B. McMillan, K. W. Palmer, J. E. Pepall, J. W. Stafford, C. L. Stevenson.

Affiliates

E. G. Allwright, A. G. Joyce.

Chicoutimi (Br. Res.), Member, E. Lavoie; Associate Members, R. Belanger, J. L. Delisle, R. E. Joron, G. E. LaMothe; Student, R. B. Brosseau.
Baie Comeau (Br. Non-Res.), Associate Members, D. Anderson, A. Babin, W. G. Reekie; Student, R. Dupuy.
Dolbeau (Br. Res.), Associate Members, E. Cowan, A. C. Jacques, H. P. Moller.
Escoumains (Br. Non-Res.), Member, J. Joyal.
Franquelin (Br. Non-Res.), Student, T. B. Fraser.
Isle Maligne (Br. Res.), Junior, T. A. I. C. Taylor.
Kenogami (Br. Res.), Associate Members, A. Cunningham, J. W. Gathercole, G. F. Layne, W. P. C. LeBoutillier, W. H. Malone, N. D. Paine, J. Shanly, A. B. Sinclair; Junior, K. A. Booth; Students, R. A. Kerr, G. Rawland, L. R. Beath.
Port Alfred (Br. Res.), Associate Member, J. C. H. Jette; Junior, D. A. Forbes.
Riverbend (Br. Res.), Member, S. J. Fisher; Associate Members, E. B. Horton, G. H. Kirby, N. F. McCaghey; Junior, O. C. Quinn.
St. Joseph d'Alma (Br. Res.), Associate Member, J. M. Gilchrist.

ZONE D

(*The Maritime Provinces.*)

Moncton Branch District

(*The Counties of Albert, Westmorland, Kent, Northumberland, Restigouche, Gloucester, and the Province of Prince Edward Island.*)

Bathurst (Br. Non-Res.), Students, W. C. Baggs, H. I. King, W. P. London.
Borden, P.E.I. (Br. Non-Res.), Student, D. H. Sutherland.
Campbellton (Br. Non-Res.), Students, R. T. Sanson, W. C. Wilkinson.
Charlottetown, P.E.I. (Br. Non-Res.), Member, E. I. Miles; Associate Members, H. E. Miller, A. Scott.
Chatham (Br. Non-Res.), Junior, W. R. Godfrey; Students, G. J. Hayes, R. F. Sadler.
Dalhousie (Br. Non-Res.), Associate Member, L. Sterns.
Ferry Road (Br. Non-Res.), Associate Member, W. C. MacDonald.
Lewisville (Br. Non-Res.), Member, E. R. Evans.
Moncton (Br. Res.),

Member

F. O. Condon.

Associate Members

B. E. Bayne, V. C. Blackett, H. G. Crudge, G. L. Dickson, T. H. Dickson, J. G. Dryden, R. H. Emmerson, J. R. Freeman, F. B. Fripp, A. S. Gunn, J. G. Mackinnon, E. B. Martin, J. Pullar, C. S. G. Rogers, G. E. Smith.

Junior

W. L. Dickson.

Students

N. B. Eagles, J. W. P. Fogarty, E. M. Nason, M. E. Wilson.

Sackville (Br. Res.), Members, H. W. McKiel, F. L. West; Associate Members, F. Binns, H. W. Read; Juniors, R. P. Carey, C. F. Johns.
Summerside, P.E.I. (Br. Non-Res.), Junior, L. B. Whiteway.
Vernon P.E.I. (Br. Non-Res.), Student, R. L. Murray.

Saint John Branch District

(*The Counties of Saint John, Charlotte, Kings, Queens, Sudbury, York, Carleton, Victoria, Madawaska.*)

Arthurette (Br. Non-Res.), Junior, R. E. Tweeddale.
Chipman (Br. Non-Res.), Associate Member, R. A. Clarke.
Edmundston (Br. Non-Res.), Member, F. O. White; Associate Members, J. E. Cade, E. W. G. Chapman; Junior, P. A. Charest; Student, F. R. Killam.
Fairville (Br. Res.), Junior, F. A. Patriquen.
Fredericton (Br. Non-Res.),

Members

A. F. Baird, M. W. Black, D. W. Burpee, J. Stephens, E. O. Turner.

Associate Members

A. R. Babbitt, A. A. Colter, C. G. Grant, B. H. Hagerman, W. J. Lawson, J. F. MacKenzie.

Juniors

A. R. Bonnell, S. B. Cassidy, J. F. Lynch, J. R. C. Macredie, J. M. Thomas.

Students

D. J. Brewer, C. B. Cameron, G. A. Campbell, H. K. Corbett, L. E. Dryden, H. N. Goodspeed, D. D. Gorman, R. W. Gough, D. L. MacKinnon, G. L. Olts, W. E. Smith, E. S. Watters.

Grand Falls (Br. Non-Res.), Associate Member, L. W. Bailey.
Jacquet River (Br. Non-Res.), Student, T. S. McMillan.
McAdam (Br. Non-Res.), Associate Member, W. J. Pickrell.
Milltown (Br. Non-Res.), Student, R. J. G. Schofield.
Minto (Br. Non-Res.), Associate Members, S. W. Babbitt, N. W. Brittain.
Newcastle Creek (Br. Non-Res.), Junior, D. D. Cunningham.
North Devon (Br. Non-Res.), Junior, J. M. MacPherson.
Norton (Br. Non-Res.), Student, J. H. Huggard.
Oromocto (Br. Non-Res.), Associate Member, E. B. Allan.
Saint John (Br. Res.),

Members

A. R. Crookshank, J. R. Freeman, A. Gray, G. G. Hare, H. T. Hazen, C. C. Kirby, T. C. Macnabb, G. G. Murdoch, G. Stead, F. P. Vaughan, S. R. Weston.

Associate Members

W. H. Blake, V. S. Chesnut, D. A. Duffy, J. N. Flood, J. D. Garey, G. N. Hatfield, S. Hogg, J. H. McKinney, T. S. Moffat, J. P. Mooney, H. F. Morrisey, E. J. Owens, K. K. Pearce, D. G. Ross, D. R. Smith, A. A. Turnbull, J. T. Turnbull, G. A. Vandervoort.

Juniors

W. B. Akerley, F. L. Black, G. M. Donohoe, L. G. Lilley, H. P. Lingley, L. B. Porter, D. Ross, L. R. Stratton, W. D. G. Stratton.

Students

D. C. Campbell, W. B. Cuthbertson, G. Y. Dow, G. A. Mackie, G. G. Miller, S. B. Thomas, D. R. Webb.

Affiliate

G. C. McAvity.

Sussex (Br. Non-Res.), Member, E. G. Evans; Junior, F. G. Thompson.
Woodstock (Br. Non-Res.), Associate Member, G. M. MacPhail; Student, E. A. Connell.

Halifax Branch District

(*The Counties of Halifax, Lunenburg, Queens, Shelbourne, Yarmouth, Digby, Annapolis, Kings, Hants, Colchester, Cumberland, Pictou.*)

Amherst (Br. Non-Res.), Associate Members, H. F. Donkin, E. A. Crawley, S. W. Crowell, J. F. F. Mackenzie, G. T. Medforth; Student, C. D. Martin.
Barrington Passage (Br. Non-Res.), Student, A. D. Brannen.
Bedford (Br. Res.), Member, H. W. L. Doane.
Bridgewater (Br. Non-Res.), Associate Member, F. G. McPherson.
Cariboo Gold Mines (Br. Non-Res.), Associate Member, J. Wightman.
Charleston (Br. Non-Res.), Associate Member, H. A. Morey.
Chester Basin (Br. Non-Res.), Junior, J. T. Lang.
Clyde River (Br. Non-Res.), Associate Member, J. K. McKay.
Dartmouth (Br. Res.), Members, J. L. Allan, J. S. Misener; Associate Members, G. W. Christie, C. S. Creighton, R. L. Dunsmore, J. D. Fraser, W. Rodger, C. Scrymgeour, F. L. Thompson, A. G. Tibbitts; Juniors, G. I. Colpitts, E. K. Lewis; Student, K. E. Bentley.
Fairview (Br. Non-Res.), Student, H. A. Ripley.
Halifax (Br. Res.),

Members

S. Ball, F. A. Bowman, A. E. Cameron, J. G. W. Campbell, W. P. Copp, K. L. Dawson, F. W. W. Doane, C. A. D. Fowler, H. S. Johnston, H. F. Laurence, R. W. McColough, A. Macgillivray, I. P. MacNab, W. P. Morrison, L. H. Robinson, H. Thorne, J. H Winfield, W. A. Winfield, C. H. Wright.

Associate Members

C. A. Anderson, E. L. Baillie, J. E. Belliveau, C. S. Bennett, G. H. Burchill, C. J. Carey, D. A. Chisholm, N. L. Cooke, O. S. Cox, G. J. Currie, W. J. DeWolfe, G. V. Douglas, J. B. P. Dunbar, M. Dwyer, H. Fellows, S. L. Fultz, S. W. Gray, A. W. Gregory, J. B. Hayes, F. R. Henshaw, J. R. Kaye, P. C. King, P. A. Lovett, A. J. Macdonald, W. G. Macdonald, J. A. MacKay, R. D. McKay, R. M. McKinnon, A. G. Mahon, H. W. Mahon, J. W. March, R. R. Murray, A. D. Nickerson, R. L. Nixon, W. H. Noonan, E. O. T. Piers, G. C. Reid, G. V. Ross, J. J. Sears, A. G. Tapley, H. R. Theakston, R. D. Thexton, L. H. Wheaton, C. St. J. Wilson.

Juniors

G. F. Bennett, G. A. Burlton, G. T. Clarke, A. D. Foulis, P. C. Hamilton, W. G. Muir.

Students

W. H. Ackhurst, E. W. Cheeseman, M. F. Dean, F. X. Granville, M. Harrigan, A. R. Harrington, W. M. Hunt, J. S. Matheson, R. L. Norman, R. G. Shatford, J. W. J. Thompson, W. A. K. Wickwire, A. L. Wood, B. H. C. Zwicker.

Affiliate

M. H. McManus.

Imperoyal (Br. Res.), Junior, I. M. Fraser.
Kentville (Br. Non-Res.), Member, J. F. C. Wightman.
Liverpool (Br. Non-Res.), Member, C. H. L. Jones; Associate Members, H. E. Barnett, J. H. M. Jones, R. L. Seaborne; Junior, D. O. Turnbull.
Lunenburg (Br. Non-Res.), Junior, O. B. Berringer.
Mahone Bay (Br. Non-Res.), Associate Member, F. E. Saltman.
Malagash (Br. Non-Res.), Student, R. A. Lombard.
Middleton (Br. Non-Res.), Junior, J. L. Wickwire.
New Glasgow (Br. Non-Res.), Members, G. D. Macdougall, J. Portas, R. B. Stewart; Associate Member, J. W. MacLeod; Students, G. M. Mackie, A. H. McKinnon.
Oldham (Br. Non-Res.), Junior, W. G. Hamilton.
Pictou (Br. Non-Res.), Students, J. R. Carson, J. B. Ferguson.
St. Croix (Br. Non-Res.), Student, G. D. Spence.
Springhill (Br. Non-Res.), Junior, H. G. Mosley.
Stellarton (Br. Non-Res.), Member, D. H. McDougall.
Tatamagouche (Br. Non-Res.), Associate Member, F. E. Wilhjelm.
Truro (Br. Non-Res.), Members, A. B. Blanchard, W. G. Yorston; Junior, W. E. Weatherbie.
Upper Lakeville (Br. Non-Res.), Associate Member, R. A. Logan.
Upper Musquodoboit (Br. Non-Res.), Student, G. E. MacDonald.
Upper Vaughan (Br. Non-Res.), Member, K. E. Whitman.
Walton (Br. Non-Res.), Junior, E. C. Parsons.
Westville (Br. Non-Res.), Associate Member, C. D. Sampson.
Windsor (Br. Non-Res.), Member, H. C. Burchell; Associate Member, W. E. L. Hall; Student, T. B. Akin.
Wolfville (Br. Non-Res.), Associate Member, A. Sutherland.
Yarmouth (Br. Non-Res.), Member, E. H. Morley; Junior, P. Colgan.

Cape Breton Branch District

(*The Counties of Guysborough, Antigonish, Richmond, Inverness, Victoria, Cape Breton, and Newfoundland.*)

Antigonish (Br. Non-Res.), Associate Member, W. R. Chisholm; Student, C. S. Williams.
Bay Roberts, Nfld. (Br. Non-Res.), Student, G. A. Myers.
Bell Island, Nfld. (Br. Non-Res.), Student, F. Rees.
Bridgeport, (Br. Non-Res.), Associate Member, F. V. Burgess.
Buchans, Nfld. (Br. Non-Res.), Junior, J. C. Mews; Student, P. M Schear.
Cheticamp (Br. Non-Res.), Associate Member, W. L. Ball.
Corner Brook, Nfld. (Br. Non-Res.), Associate Member, C. Brain.
Deer Lake, Nfld. (Br. Non-Res.), Associate Member, C. M. Bang; Junior, E. Hinton.
Dominion (Br. Res.), Student, E. M. Johnston.
Glace Bay (Br. Res.), Member, A. L. Hay; Associate Member, J. R. Morrison; Junior, D. P. Macneil; Student, A. L. MacDonald.
Goldenville (Br. Non-Res.), Student, D. B. Sutherland.
Grand Falls, Nfld. (Br. Non-Res.), Member, F. M. Pratt; Associate Members, D. G. Elliot, H. S. Windeler; Student, D. B. Sutherland.
Hattie's Camp, Nfld. (Br. Non-Res.), Member, K. R. Chestnut; Associate Member, F. C. Jewett.
New Waterford (Br. Non-Res.), Student, A. M. Miller.
St. John's, Nfld. (Br. Non-Res.), Members, J. W. Morris, A. Vatcher; Associate Members, J. B. Baird, S. J. Hayes; Junior, C. A. Knight; Student, J. B. Angel.
Sydney (Br. Res.), Members, M. W. Booth, W. E. Clarke, F. W. Gray, T. L. McCall, S. C. Mifflen, W. C. Risley, C. M. Smyth, A. P. Theuerkauf; Associate Members, C. M. Anson, W. E. Bown, I. W. Buckley, M. F. Cossitt, H. S. Dunn, J. A. MacLeod, S. G. Naish, J. A. Russell, W. S. Wilson; Juniors, H. C. M. Gordon, R. F. McAlpine; Students, J. Poliskin, A. F. Young; Affiliate, M. R. Chappell.
Sydney Mines (Br. Res.), Associate Members, Y. C. Barrington, J. Stephenson.
Wabana, Nfld. (Br. Non-Res.), Associate Members, C. B. Archibald, J. B. Petrie.

Great Britain and Ireland
England and Wales

Beckenhill, Member, P. Reynolds.
Birmingham, Student, J. H. Budden.
Broadstone, Associate Member, H. G. Angell.
Caernarvon, Associate Member, J. Griffith.
Carbis Bay, Associate Member, G. O. Nancarrow.
Chatham, Student, B. H. Darwin.
Chorley, Associate Member, E. G. Richards.
Cuddington, Member, S. W. Perrott.
Derby, Junior, G. N. Martin.
Eltham, Member, P. B. Roberts.
Exeter, Member, F. J. Bellamy.
Fleetwood, Associate Member, G. H. Brunner.
Forest Row, Member, C. B. Kingston.
Gerrards Cross, Member, H. V. Haight.
Hardenhurst, Member, M. A. Ravenor.
Headley, Member, W. G. Tyrrell.
Hebburn-on-Tyne, Junior, J. G. Horn.
High Wycombe, Member, J. R. Cosgrove.
Horrabridge, Member, N. P. Dalziel.
Hyde, Junior, W. E. Adlington.
Llanfyrnach, Associate Member, D. H. James.
Lynton Dene, Member, W. G. Tyrrell.
London,

Honorary Members

His Royal Highness The Duke of Connaught, The Right Hon. The Earl of Bessborough, P.C., G.C.M.G., The Hon. The Marquess Willingdon, G.C.S.I., G.C.M.G., G.C.I.E., G.B.E., Sir Alexander Gibb.

Members

H. Beaver, G. E. Bell, R. T. Bell, R. E. Cleaton, E. V. Collier, C. G. DuCane, H. B. Fergusson, E. H. Harrison, Sir Henry Japp, A. C. Macdonald, C. B. R. Macdonald, R. E. Palmer, R. F. Uniacke, D. Weatherbe.

Associate Members

J. S. Bates, J. K. Brooks, H. M. Gibb, J. W. Houghton, H. C. Lott, H. M. Mathews, W. M. Miller, R. F. Palmer, C. H. Oakes, F. B. Rolph, P. Simpson, G. R. Turner.

Juniors

C. B. Charlewood, C. J. Ingles, C. J. R. B. Stewart.

Students

A. P. E. Hopkins, J. E. Jackson.

Affiliate

G. P. Loggie.

Leicester, Student, A. H. Walker.
Lincoln, Associate Member, H. P. Heywood.
Manby South, Associate Member, C. R. Dunlap.
Manchester, Member, A. L. Mieville.
Newcastle-on-Tyne, Member, R. H. Parsons; Student, C. H. White.

North Cray, Member, H. B. Dickens.
North Harrow, Associate Member, J. H. Tuff.
Princes Risborough, Member, C. J. Chaplin.
Redhill, Member, A. J. Waters.
Rugby, Associate Member, R. J. Cobbold.
Salterton, Member, H. A. Elgee.
Shorne, Associate Member, C. A. Abbott.
Stafford, Associate Member, H. C. Beck, Junior, F. S. Skerry.
Stanmore, Associate Member, E. C. Hague.
St. Merryn, Associate Member, B. H. Hughes.
Usk, Associate Member, H. J. Whittaker.
Warrington, Associate Member, P. E. Cooper.
West Thurrock, Junior, P. D. Verscholye.

Scotland

Annan, Associate Member, J. B. Newton.
Dumbarton, Associate Member, N. M. Brydon.
Dunscore, Associate Member, W. T. Wilson.
Edinburgh, Associate Member, J. R. S. Sutherland.
Glasgow, Member, J. McGregor; Associate Member, J. Shannon.
Isle of Skye, Member, W. H. Hunt.
Kilmarnock, Associate Member, R. M. Herbison.
Lockerbie, Associate Member, W. M. B. Macdonald.

Ireland

Bray Head, Associate Member, N. F. Harrison.
Fintona, Associate Member, G. Sproule.

Other Countries

Argentina

Basavilbaso, Associate Member, G. W. Coward.

Australia

Brisbane, Member, LeR.Wilson; Associate Member, F. Bowman.
Melbourne, Member, T. P. Strickland; Associate Member, F. H. Palmer.
Sydney, Associate Member, M. E. Tregarthen.

Barbados

Black Rock, Associate Member, J. G. Layne.

Bermuda

Tucker's Town, Member, F. G. Rounthwaite.

Bolivia

La Paz, Student, J. Kazakoff.

Brazil

Rio de Janeiro, Member, R. W. Tassie; Associate Members, L. H. Armstrong, C. J. Oliver.

British East Africa

Nairobi, Member, Brig.-Gen. Sir G. D. Rhodes.

British Guiana

Georgetown, Junior, H. S. Wright.
McKenzie, Junior, J. G. Bradley.

China

Tientsin, Member, H. F. Barnes.

Colombia

Barranca Bermeja, Juniors, R. V. Anderson, C. V. Duff, M. A. Matheson, W. H. Paterson; Student, L. E. Mitchell.

Denmark

Espergaerde, Associate Member, J. Z. Nicolaisen.

Dominica

Roseau, Associate Member, A. Holland.

Egypt

Cairo, Associate Member, C. A. Doherty.

France

Paris, Honorary Members, H.R.H. Edward, Duke of Windsor, Jacques Rabut; Associate Member, D. C. Unwin Simson; Student, G. Bertrand.

Germany

Freiburg, Associate Member, W. A. Miescher.

Haiti

Port-au-Prince, Associate Member, L. Telemaque.

India

Bombay, Member, R. K. Nariman.
Howrah, Associate Member, F. S. Gumley.
Quetta, Associate Member, W. N. Bostock.
Rasul, Associate Member, L. S. Adlard.

Jamaica

Ewarton, Associate Member, O. M. Clarke.
Kingston, Junior, C. D. Schultz; Student, H. T. Hart.
Montego Bay, Associate Member, A. M. Alberga.

Mexico

Mexico City, Members, G. R. G. Conway, F. S. Easton.

Newfoundland

Bay Roberts, Student, G. A. Myers.
Bell Island, Student, F. Rees.
Buchans, Junior, J. C. Mews; Student, P. M. Schear.
Corner Brook, Associate Member, C. Brain.
Deer Lake, Associate Member, C. M. Baug; Junior, E. Hinton.
Grand Falls, Member, F. M. Pratt; Associate Member, D. G. Elliot, H. S. Windeler; Student, D. B. Sutherland.
Hattie's Camp, Member, K. R. Chestnut; Associate Member, F. C. Jewett.
St. John's, Members, J. W. Morris, A. Vatcher; Associate Members, J. B. Baird, S. J. Hayes; Junior, C. A. Knight; Student, J. B. Angel.
Wabana, Associate Members, C. B. Archibald, J. B. Petrie.

Norway

Molde, Associate Member, O. H. Tjonnaas.

Peru

Negritos, Student, J. D. Rice.
Talara, Associate Members, G. E. Kent, B. P. Rapley; Junior, A. F. Pamenter.

Philippine Islands

Cebu, Associate Member, G. R. Ewart.

Portuguese East Africa

Beira, Associate Member, D. Kennedy.

St. Lucia

Port Castries, Associate Member, T. R. Theobalds.

South Africa

Boksburg, Student, W. F. Thomas.
Johannesburg, Associate Members, O. J. Rorvik, C. V. von Abo.
Maseru, Associate Member, S. C. Carver.
Nkana, Member, A. M. Morton.

Tasmania

Hobart, Member, P. Sandwell.

Trinidad

Pointe-a-Pierre, Associate Member, R. W. Emery.
Port of Spain, Member, J. H. Reid.
St. Joseph, Associate Member, L. R. Gransaull.
Tunapuna, Associate Member, P. R. Gransaull.

Turkey

Ankara, Member, J. N. Aggiman.

Venezuela

Maracaibo, Associate Member, M. G. Taylor.

United States of America

Alameda, Cal., Associate Member, G. B. Ashcroft.
Albany, N.Y., Member, A. W. Harrington.
Amherst, Mass., Associate Member, C. A. Leighton.
Ann Arbor, Mich., Member, H. E. Riggs.
Ashland, Ky., Associate Member, H. F. Fyfe.
Astoria, N.Y., Associate Member, C. M. Barnes.
Austin, Tex., Member, R. White.
Badin, N.C., Junior, S. L. Coulter.
Bakersfield, Vt., Member, C. P. Howrigan.
Baltimore, Md., Associate Member, J. A. Walls.
Berkeley, Cal., Associate Member, E. E. Weibel.
Berlin, N.H., Member, M. Jacobs.
Black River, N.Y., Junior, W. V. Delaney.
Bloomfield, N.J., Member, M. H. Teaze.
Bloomington, Ind., Associate Member, T. Goby.
Boston, Mass., Members, F. A. Barbour, F. H. Fay, R. S. Weston; Associate Member, G. A. Jenkins; Students, T. J. Mullen, C. G. Pengelley; Affiliate, I. B. Crosby.
Brewer, Me., Associate Member, F. D. Farnsworth.
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Buffalo, N.Y., Member, N. R. Gibson; Associate Member, J. D. Burbank; Students, T. E. Martin, A. G. Mellor.
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Abstracts of Current Literature

Power-Plant Requirements of a Distillery

By Hiram L. Walton, Mechanical World, September, 2, 1938.

Abstracted by F. G. Green, A.M.E.I.C.

In brief, the operation of a distillery consists:

(*a*) in grinding the grain to meal;
(*b*) mixing this meal with water and steam-cooking it to expand the cells and gelatinize the starch;
(*c*) saccharifying this "mash" by malt;
(*d*) adding yeast to the "wort" so formed;
(*e*) distilling off the alcohol (or whiskey) from the fermented product resulting from the last step (this fermented product is colloquially known as "beer").

By-products include the spent grain sold as "distiller's grains" and, in some cases, dry ice and vegetable oil.

The spent grain is found as suspended matter in the dealcoholized beer or "slop" and is recovered by straining it out. The liquid remaining is known as "thin slop" and, if no stream-pollution regulations exist, is usually run into the district drainage system. If this is not permissible it is concentrated in multiple effect evaporators, mixed with the spent grain and the whole passed through the grain dryers. Dry ice is, naturally, made by compressing the carbon dioxide given off in the fermenting process. Its recovery may require up to 10 per cent of the power used by the distillery.

The Peoria plant of Hiram-Walker-Gooderham and Worts has a mashing capacity of 22,000 bushels per day. A bushel (to the distiller) is 56 lb. regardless of kind of grain used and a yield of five proof gallons of alcohol per bushel is considered fair distilling operation.

The Peoria plant is completely motorized, power being supplied by two non-condensing extraction turbines of 1,500 kw. capacity each. These turbines are supplied with steam at 250 lb. gauge and 100 deg. F. superheat. They exhaust at 20 lb. back pressure and provide for the extraction of steam at 90 lb. pressure. The plant is inter-connected with the power system of the local utility company under agreement so that power may be transferred in either direction as the load conditions for steam and electric power may require. Usually the flow is to the power company's system.

In carrying out the distilling processes, saturated steam is required at 90 lb. pressure for mashing and cooking; at 60-20 lb. for distilling; at 20 lb. for thin-slop evaporation and at 125 lb. for grain drying. Mechanical power is required for conveying, milling, agitation and pumping.

Distribution of steam consumed at Peoria is approximately as under:—

20 lb. steam—	Evaporators	33⅓%	71⅓%
	Distillery	22 %	
	Power house	10 %	
	Heating	6 %	
90 lb. steam—	Stills	3 %	12%
	Cookers	9 %	
125 lb. steam—	Driers	16⅔%	16⅔%

Electric power utilization is as follows:—

Power house	20%	Dry ice	9%
Wells	16%	Bottling	9%
Milling and mashing	15%	Warehouses	6%
Distilling	5%	Miscellaneous	4%
Slop disposal	16%		

The Louisville, Ky., Walkerville, Ont. and Dumbarton, Scotland, plants are also briefly described.

The Cost of Substitute Motor Fuel in Europe

By Dr. Gustave Egloff, Industrial and Engineering Chemistry, October 1938.

Abstracted by A. A. Swinnerton, A.M.E.I.C.

This article discusses the attempts of the various European countries to provide motor fuels from native resources and gives figures showing the costs of these nationalistic efforts.

A number of European nations, directly and indirectly, subsidize indigenous motor fuels by high taxes on imported motor fuels, reduction of taxes on native fuels and on vehicles using such fuels, and in some cases by direct subsidy. The appended table shows the motor fuel consumption, crude oil production, and production of various substitute fuels in 1937 in various European countries.

Motor Fuel Consumption, Production of Crude Oil, and Substitute Motor Fuels—1937
(Thousands of barrels)

	Motor Fuel Consumption	Crude Oil Production	Motor Fuel from Coal Hydrogenation	Benzol
Great Britain	44,200	.....	1,300	1,800
France	25,000	532	110	640
Germany	20,000	3,077	6,400	3,400
Italy	5,200	150	.....	.....
Estonia	.....	.....	.....	.....
All Europe	95,000	263,000*	7,810	6,500

	Compressed Gas (Gasoline equivalent)	Power Alcohol	Producer Gas from Wood, etc. (Gasoline equivalent)	Shale Spirit
Great Britain	.....	130	.....	200
France	.....	1,200	} 500 (France, Germany, Italy)	{ 12
Germany	1,200	1,700		.....
Italy	320	300		.....
Estonia	.....	.....	.....	58
All Europe	2,000	4,000	500	310

*Includes Russia.
The conversion factor, tons to barrels, has been taken as 8 to 1.

Coal

The primary substitute motor fuel in Europe is derived from the hydrogenation of coal, or carbon monoxide (produced from coal or coke). The synthetic liquid motor fuel production in Germany will be at the rate of about 17,000,000 barrels a year, when all plants are in operation. In England, about 1,300,000 barrels of gasoline a year are produced by direct hydrogenation of coal. France is producing about 110,000 barrels a year of motor fuels from water gas. In Europe, it is estimated that the cost of a U.S. gallon of motor fuel, produced by either coal or carbon monoxide hydrogenation, is about $0.18. This compares with a cost of approximately $0.05 a U.S. gallon for gasoline, f.o.b. Gulf terminals. Gasoline costs approximately 59.6 cents per gal. in Germany, of which 36 cents is direct tax on imported gasoline. It is landed in Hamburg at 9 cents per U.S. gal., so that there is a spread of about 50 cents a gallon. Hydrogenated gasoline in England enjoys a preference of 18 cents a gallon. The synthetic gasoline in France enjoys a tariff preference of over £16 per ton, approximately 25 cents a gallon, as well as certain subsidies.

Benzol Motor Fuel

The primary source of benzol is the high temperature carbonization of coal for coke and gas production. The benzol is obtained by stripping the gas, the average yield being about 3 gal. per ton of coal. The production of benzol is dependent on the activity of coke-ovens and gas works, and is, therefore, capable of only slight expansion. Furthermore, in case of war it would be reserved for the manufacture of explosives. Egloff estimates that, in 1937, the extra cost to European consumers, due to using benzol motor fuel in place of gasoline, was more than $49,000,000, equivalent to 20 cents a gallon.

Compressed Gas

Combustible gases obtained from coal carbonization, oil cracking, and natural gas wells, are a growing source of substitute motor fuels in Europe. The greatest development in the use of compressed gases has been in Germany, where it is estimated that there are more than 25,000 motor vehicles using compressed gas as fuel, and that (in 1938) more than 150,000 tons of gasoline will be replaced by using compressed gas. The cost of compressed gas in Germany is equivalent to gasoline at 40 to 60 cents a gallon.

Italy has developed a natural gas field, near Milan, which yields nearly pure methane. The gas is compressed to 3,000 lb. per sq. in., and is distributed, from filling stations, in cylinders, to about 500 trucks and buses in Milan and Florence. At the present time (1938), in Italy, the natural gas fuel used is equivalent to about 40,000 tons of gasoline a year, and for all Europe the amount used is equivalent to 250,000 tons of gasoline a year.

Power Alcohol

The use of power alcohol by European countries is supported by heavy government subsidies, and increased from 59,000 tons in 1930 to 648,000 tons in 1936. However, from now on, the use will probably decrease, due to large economic losses and to its encroachment upon the food supply. The loss of income during 1937 is estimated as equivalent to $105,000,000. Germany and France have been the largest consumers of power alcohol in Europe, and their supply is derived mainly from potatoes and sugar beets. German regulations require a 10 per cent blend of alcohol, and in France the proportion varies from 10-35 per cent. The German subsidy to alcohol producers is about 39 cents a gallon, and the French about 36 cents a gallon. Both in Germany and France the consumption of power alcohol is decreasing due to the diversion of alcohol to munition manufacture and to the drain on the food supply (potatoes, etc.).

Producer Gas from Wood and Coal

Producer gas from wood and coal is not very important as a substitute for motor fuel even in those countries that are urging its wider adoption. France has about 4,500 wood-burning vehicles, Germany about 2,200, and Italy 2,200, and wood filling stations are found in all three countries. The use of wood is desired primarily to replace imported petroleum, the estimated consumption, in Germany, France, and Italy, being 450 million lb., equivalent to 18 million gallons of gasoline. There are, apparently, no figures available as to the number of coal-burning vehicles in Europe, but the number is probably small.

Oil Shales

Oil shales are found in many countries in Europe, but they are developed commercially only in Great Britain, Estonia, and France. Since these countries produce no crude oil, the exploitation of the shale deposits has become increasingly important from the nationalistic standpoint. In all three countries they receive governmental assistance in one form or another, the cost above imported gasoline being nearly $2,000,000. In loss of taxes, the use of shale motor fuel costs the various governments about 18 cents an Imperial gallon.

Other Substitutes

The desperate need of some countries to make themselves self-sufficient in motor fuels is reflected in the attempts to use ammonia, acetylene, and hydrogen in motor vehicles, but so far they are only in the experimental stage. In 1937, the production of substitute motor fuels in Europe was equivalent to about 17 million barrels of gasoline, or about 20 per cent of requirements. In 1938, it is estimated that 25 per cent of the motor fuel requirements will come from substitute fuels. In 1937, the extra cost to the consumer and state, due to the use of substitute fuel was $235,000,000, equivalent to 32 cents a gallon. In 1938, this extra cost will probably reach $300,000,000.

Rubber-Tyred Electric Train

Railway Gazette, October 14, 1938

The French National Railways have just put into experimental service on the Paris suburban lines of the ex-Etat system, a novel experimental electric three-car train, built by the Michelin Company at Clermont-Ferrand. The new vehicle has the characteristic pneumatic tyres of the maker. It is operated on the standard third-rail system, with a nominal voltage of 650. A triple-car articulated arrangement has been adopted, and measures 125 ft. overall. Each of the four bogies has eight pneumatic-tyred wheels, and the construction is similar to that of the bogies on the latest Michelin types of petrol-engined railcars.

In each bogie the two centre axles are driving, and the two end axles carriers. There is one motor driving each bogie, but it is supported on the underframe of the coach and drives the two other axles through a cardan shaft with flexible couplings. The actual drive on all the axles, and the drive in between the two axles is of the worm gear differential type. On the one-hour rating the aggregate h.p. of the four motors is 775 at 1,330 r.p.m., and on the continuous rating the output is 650 h.p. at 1,430 r.p.m. At the one-hour rating the hp. per ton of tare weight is 24.2. The electrical equipment gives an acceleration from rest of about 3.65 ft. per sec. per sec. as a maximum. Multiple-unit control is fitted, so that any number of these triple-car sets can be worked as a train by one man. The maximum permissible speed is 71 m.p.h., but in normal suburban service, working out of St. Lazare, speed will rarely exceed 50 m.p.h. Full application of the brakes enables the train to be stopped from a speed of 50 m.p.h. in 170 yd. Special shoes are provided on each bogie to take the return current to the running rails.

The bodies and framework are of welded all-metal construction, with sheet steel outer panels with interior linings of plywood, faced with imitation leather in a dark green colour. As the car is intended only for use on short-distance services, the seats and interior equipment generally are of a simple character. Just behind the driving cabin at each end is a small baggage compartment, but at rush hours this is used for carrying standing passengers. All the doors on the outside are of the sliding type, and are closed from the driver's cabs by compressed-air motors. There are 136 fixed seats, and 44 folding seats arranged at the entrance vestibules and in the luggage compartments, and, according to the French methods of computation, there is room for 120 standing passengers.

A New Method of Studying the Combustion Process in Boiler Furnaces

By John M. Drabelle, presented before the Iowa State Convention of the National Association of Power Engineers, Marshalltown, Iowa, June 17th, 1938.

Abstracted by Dr. C. A. Robb, M.E.I.C.

Photographing of a boiler furnace fire with colour motion picture film has been made possible through the co-operation of Mr. V. Rayment of the Eastman Kodak Company and the Corning Glass Works. The screens of Aklo glass used transmit most light rays but filter the infra-red or heat rays thus protecting the camera and operator. Other selector filters may be added. Gas stratifications have been observed.

Evidence, that to test the quality of combustion a more comprehensive analysis is required than can be obtained with the conventional apparatus, is provided by publication RI-3379 of the U.S. Bureau of Mines issued in January, 1938. This describes tests conducted in co-operation with the University of Washington on a domestic overfeed stoker burning various coals continuously and intermittently. The flue gas sample was continously withdrawn at a constant rate, as determined by a flow meter, and the results tabulated as follows:—

Constituents of Flue Gas in Per Cent
(From Table V of RI-3379)

Test Number	A	B	C
CO_2	13.8	14	11.8
Oxygen	4.4	5	7.9
CO	0.9	0.3	nil
Hydrogen	0.2	nil	nil
Methane	0.1	nil	nil
Ethylene	0.1	nil	nil

Test B was at a higher rate of combustion than A, and C was at a fairly high rate. Under the conditions of these tests, 0.1 per cent of unsaturated hydrocarbons, considered as ethylene, in the flue gas represents 2.5 per cent of the heating value of the coal. A high smoke density occurred when methane and ethylene were present in the flue gas.

In 1920, Mr. Thomas A. Marsh, then associated with the Combustion Engineering Corporation, and the author, conceived the idea of injecting air over the fire bed in power station boilers, and letters patent were applied for. This was termed "overfired air." A search disclosed a patent granted in 1838 and that the idea was not new. A successful application requires 10 to 15 per cent of the combustion air, at a velocity of 800 to 1,500 ft. per min., which may be provided through a 1 to 1½ in. pipe or nozzle at a pressure of 6 to 8 in. of water, to drive the air blast into the mass of gas coming off the fuel bed, and to create turbulence. When available, preheated air should be used. The effect has been observed in an application of high pressure air to two recently installed boilers at the Boone station of the Iowa Electric Light and Power Company. When the air blast is turned off, the fire becomes smoky yellow and the stack darkens. When the blast is resumed, the fire becomes white and the smoke density is reduced. The same system of air injection, recently applied to three boilers of the Central Fibre Products Co. at Tama, Iowa, has resulted in improved smoke conditions and higher boiler efficiency.

The motion picture film exhibited showed the effect of air injection on an underfeed stoker at the Cedar Rapids Power Station. In this case the air was not properly directed downwards into the flame, but was blowing across the top and the desired results were not produced.

While only a limited number of furnaces have been photographed, further data will probably be available at the next annual meeting of the National Association of Power Engineers.

Marking the Highway Edge

E. J. DuPont de Nemours and Company have issued a bulletin on their new plastic material 'Lucite,' whose optical properties have led to its successful use in reflecting highway markers for outlining the highway edge or curb at night, effectively warning the motorist of road intersections, bends to the left or right and steep grades, without the necessity of installing overhead lights.

In the country the markers are placed 8 ft. from pavement edge or 10 ft. where the shoulder is extra wide; in cities and villages 4 ft. back from the curb face. Uniformity of spacing, location and height is of fundamental importance for effective roadway delineation.

The system has been tried with good results by the Michigan Department of Highways on some seventy miles of U.S. Highway No. 16 (Detroit to Lansing), a highway with extremely heavy traffic. The scheme involved the placing of the reflecting markers on thirty-inch steel standards spaced 100 ft. apart and flanking the road. A break in the line of lights shows as a warning to the motorist; under favourable conditions his car headlights make the markers visible more than a mile ahead. This is made possible by the remarkable reflecting power of the discs, due to the brilliance of the methyl methacrylate resin of which they are made and their effective optical design. The discs are 1⅝ in. dia. and have smooth slightly convex faces, their prismatic backs having accurately moulded facets of a special design developed by J. C. Stimson.

A night-accident analysis of U.S. Highway No. 16, Detroit to Lansing, taken over three months, April to July 1938, shows a reduction of 79 per cent after the installation of this reflector indirect lighting compared with the same period in 1937.

The Michigan Department of Highways states that the average cost for two lines was about $350 per mile installed.

An Investigation into the Causes and Prevention of the Corrosion of Tar Stills

By D. D. Pratt, H. C. K. Ison and R. G. Wood, Great Britain, Chemistry Research Board Special Report 4, January 1938.

Abstracted by A. A. Swinnerton, A.M.E.I.C.

For many years the retorts employed in the carbonization of coal for gas manufacture were of the horizontal type, worked at high temperatures and yielding, as a by-product, a tar somewhat similar to that furnished by coke ovens. In recent years, as is well known, vertical retorts have come into operation, and these yield a tar which is less aromatic than those emanating from horizontal retorts and coke ovens; it contains a higher proportion of resinous and aliphatic constituents and also a higher proportion of tar acids, i.e., of homologues of phenol. These different varieties of tar have an important bearing on the life of the stills employed in their distillation, which are usually made of mild steel. The average life of a 12-ton still, when working entirely on horizontal-retort tar is equivalent to a throughput of 16,000 tons, while throughputs of as much as 30,000 tons have not been uncommon. On the other hand, the corrosive action of a mixture of 75 per cent vertical-retort and 25 per cent horizontal-retort tar is such that the life of the still is reduced by 50 per cent, i.e., the average throughput is only between 7,000 tons and 8,000 tons. It has been calculated that this reduction in the life of the still is equivalent to 5d. per ton of tar distilled, and that the total cost to the tar-distillation industry is of the order of £25,000 annually.

With the object of studying the corrosive properties of coal tars and of finding means to overcome the destructive action on the still of the harmful constituents present, an investigation was put in hand some time ago by Dr. D. D.

Pratt and Messrs. H. C. K. Ison and R. G. Wood, on behalf of the Association of Tar Distillers, at the Chemical Research Laboratory, Teddington. A report of the results of the research has now been published by the Department of Scientific and Industrial Research. This states that an exhaustive examination of a long series of tar fractions has established that, at high temperatures, the resinols, or phenolic resins, are very active in promoting attack, and that in the presence of ammonium chloride this activity is intensified. Whereas coke-oven and horizontal-retort tars are almost devoid of resinols, these components are present in fair quantity in vertical-retort tars. As the resinols are insoluble in petroleum, additions of the latter enable them to be precipitated and removed from the tar, and experimental distillations carried out on the petroleum extract of a corrosive tar have shown that the attack caused by this fraction is much less than that manifested when a so-called non-corrosive tar is distilled. Failing methods such as this, which are based on the preliminary treatment of the tar, the only alternative is to find a constructional material for the still which will withstand the attack of the corrosive constituents of the tar. Efforts made to develop a protective coating for mild steel have proved fruitless, but experiments have shown that a 2.5 per cent nickel-0.6 per cent chromium steel is moderately resistant to the action of the resinols, while the stainless steels tested are quite unattacked. Ternary 80:14:16 nickel-chromium-iron alloys, and 60:40 nickel-copper alloys were also found to be very resistant.

Zinc-Tight Steel Wire

By D. E. Bankart, Electrical News and Engineering, August 1st, 1938.

Abstracted by H. S. Grove, A.M.E.I.C.

The author describes an improved process used for zinc-coating steel wire in a plant recently installed by the Steel Company of Canada at Lachine, Quebec.

The wire, instead of being passed through a tank of molten zinc, as was formerly the practice, is drawn through electrolytic cells, where a coating of zinc from pure zinc anodes is electrically deposited. The thickness of the deposit, which is smooth and uniform, is regulated by the current density and the speed with which the wire moves.

The zinc coating and the wire are so closely united that the wire can be coiled around a rod of its own diameter without flaking taking place—a very much severer test than the wrapping test specified in the Canadian Engineering Standards Specification for Zinc Coated Wire, as revised under No. C3-1937 to cover the maximum of developments in Canadian factories.

This plant is the only one of its kind in Canada and one of four or five similar plants in the whole world.

The Wellington Lake Power Project

By W. P. Dunbar, S.L.S., Canadian Surveyor, July 1938.

Abstracted by J. L. Rannie, M.E.I.C.

This article describes the surveying features of the Wellington Lake hydro-electric power project in Northern Saskatchewan. This development, now under construction by the Consolidated Mining and Smelting Company Limited, has a number of unusual and interesting features. Situated near the company's mining property near Goldfields, Saskatchewan, about fifteen miles north of the easterly end of Lake Athabasca, it is one of the most northerly such projects in the West.

Aeroplanes were used in many of the preliminary investigations; the maps of the whole area were plotted from aerial photographs.

Meteorological observations were commenced in the Goldfields area about two years ago, prior to which the only data were obtained from incomplete records of rain and snowfall and average monthly temperatures at Chipewyan and Fond du Lac, the former 125 miles west of Goldfields. No records were kept of evaporation, nor until lately had any stream flow records been kept for any of the rivers. Thus meteorological and rainfall data were meagre.

In the absence of precise run-off data the areas of the watersheds were first roughly estimated from the air and later calculated from the aerial maps which had just been plotted. Factors of 75 per cent evaporation and 25 per cent run-off were first employed, these being later altered to 68 per cent and 32 per cent from information derived from stream flow measurements and records from similar conditions in Manitoba.

The first surveys made for power purposes were in the fall of 1934 when the power requirements were yet indefinite, and were naturally for the purpose of obtaining general information on the power possibilities, such as a reconnaissance from the air, determining elevations of lakes by use of the plane's altimeter and short traverses in certain sections. The following summer and winter more specific data were secured. By 1936 the situation as regards power needs was clearer and investigation of a power site on Beaverlodge lake only a mile from Goldfields was undertaken. The site had many advantages, but unfortunately the possible power was insufficient for the requirements.

Some 25 miles north the Tazin river watershed and Tazin lake, which discharge west and north to Great Slave lake, seemed attractive as a source of adequate stream flow and considerable water storage, if the water could be diverted towards Lake Athabasca about 433 ft. below Tazin lake. The height of land was close to the south shore of Tazin lake, and the problem was to discover, if possible, an economical diversion of the Tazin lake waters towards Lake Athabasca.

The surveyor's working season in that northern area is short, and speed with reasonable accuracy was essential; the airplane was of the greatest assistance in covering the whole area. The height of land was found to be mostly a plateau except at one point, Taz bay, where a low rock ridge roughly 1,000 ft. across separated the bay from Mud lake whose waters discharged through Charlot river into Lake Athabasca. By excavating at the outlet of Mud lake to lower it 14 ft., raising Tazin lake by a dam at its outlet so its elevation would be higher than Mud lake, and driving a tunnel through the rock ridge between Tazin lake and Mud lake the diversion would be completed.

The final preliminary step was the examination of the river below Mud lake to obtain data on the possibilities of hydro sites, etc. Again the aeroplane was utilized, landing on many small lakes and obtaining their elevations, flying along both sides of the river to observe the fall of the river at different points, the rock formations, soil and water conditions, timber, sand and gravel available for construction and particulars regarding each potential power site.

This diversion was finally selected, and the site for development of power was chosen at Wellington lake.

The present and maximum quantity of water to be diverted is 500 and 1,000 c.f.s. The estimated average head of water available is 70 ft. The estimated initial and maximum horsepower is 3,300 and 6,600. The transmission line from Wellington lake to the Consolidated Mining and Smelting Company's holdings at Goldfields will be about 22 miles long.

It is interesting to note that winter ice conditions which are the bugbear of so many hydro plants in Canada and United States are not serious in these northern areas, as most of the rivers are open and free running even in the coldest of winters.

Seventh International Management Congress, Washington, D.C., September 19th to 23rd, 1938

Papers Presented

An account of this Congress and a list of papers other than the ones printed below were given on pages 474 and 475 of The Engineering Journal, October 1938.

Production:

The Importance of Research and Development in Maintaining Technical Progress—M. W. Smith (U.S.A.).
Basic Factors Governing the Effective Coordination of Manufacture with Other Operating Activities of the Business—A. H. Robinson (U.S.A.).
Purchasing and Profits—Edward T. Gushee (U.S.A.).
Constructive Purchasing Policies—F. Albert Hayes (U.S.A.).
Description of Reorganization of a Works Management —C. P. Turner (Great Britain).
Insurance Management—A Major Phase of Business Administration—Jorh R. Blades (U.S.A.).
The Decentralization of Industry—W. J. Cameron (U.S.A.).
What Savings Have Been Obtained by the Electricity Works of the Municipality of Budapest in the Fields of Technical Operation and Management by the Employment of the Means of Rationalism—Pal Plosz (Hungary).
Rationalization at the Municipal Water Works of Budapest—Ferdinand Liszievicz (Hungary).
Rationalization of the Repair Service of Motor Buses—Alfred Ballo (Hungary).
Maintenance in Air Transportation—S. B. Kauffman (U.S.A.).
Planning the Processes and Equipment for Manufacture and Budgeting for Equipment Replacement—C. E. Bleicher (U.S.A.).
Flow of Work and Non-Continuous Production—Dr. Emanuel Slechta (Czechoslavakia).
Organization for the Control of Manufacture—L. V. Bedell (U.S.A.).
Automatic Luminous Control of Manufacturing Processes and Its Results—Stan. Sliwinski (Poland).
Example of Planning in a Repair Shop—Adam Kucharzewski (Poland).
Les Méthodes de Regulation Appliquées aux Voies Navigables Françaises—L. P. Alvin (France).
The Flow of Work in Non-Continuous Production; Assuring the Flow of Work in Contracting—V. W. van Gogh (Holland).
Modern Quality Control Technique—David Levinger (U.S.A.).
Work Simplification for Promoting Manufacturing Efficiency—Allan H. Mogensen (U.S.A.).
Some Developments in Motion Study Training—A. G. Shaw (Great Britain).
Some Recent Data about the Acquisition of Skill of Apprentices and of Trained Operators—J. F. Cahen (Holland).
Research in Motion and Time Study—Ralph M. Barnes (U.S.A.).
Grading of Labor Occupations—K. O. Schulte (U.S.A.).
The Supervision of Enterprises by Checking Their Estimates of Receipts and Expenditures—Eugene Francis Felsoory (Hungary).
Accounting for the Control of Manufacture—George N. Benoit (U.S.A.).
Objectives of Standard Costs and Their Use in Measuring Performance—Earl A. Green (U.S.A.).
Optimum and the Most Profitable Load—Ignacy Swiecicki (Poland).

Distribution:

Consumer Wants and Product Acceptance—Paul T. Cherington (U.S.A.).
Customer Research for Department Stores—N. Baliol Scott (Great Britain) and R. Robson (Great Britain).
The Merits of Selective Selling—Wroe Alderson (U.S.A.).
Scientific Determination of Regional Sales Potentials—L. D. H. Weld (U.S.A.).
Some Recent Developments of the Problem of Seasonal Variations in Sales and Sales Results—Dr. J. G. Stridiron (Holland).
Fundamentals of Sound Sales Planning—Lawrence B. Whit (U.S.A.).
The Work of the International Chamber of Commerce in the Field of Distribution—The International Chamber of Commerce (France).
Die Arbeiten der Rationalisierung in der Deutschen Absatzwirtschaft 1935-1937—Ein Gemeinschaftlicher Beitrag (Deutschland).
Equalizing the Flow of Goods in Distribution—William H. Ingersoll (U.S.A.).
The Significance of Large Scale Retail Operations in Present Day Distribution of Goods—Prof. Paul H. Nystrom (U.S.A.).
The Agricultural Co-operative Movement in Relation to Consumer Co-operation or Private Trade—A. H. Stensgard (Sweden).
Distribution Cost Statistics and Gross Profit—Dr. F. L. Van Muiswinkel (Holland).
Changes of Operating Expense Ratios at Different Price Levels—Vilem Sada (Czechoslovakia).
Les Limites de la Recherché des Bénéfices—Robert Caussin (Belgique).
Distribution Cost Analysis—Frank M. Surface (U.S.A.).
Pricing Policies and Customer Classification—Williar L. Thorp (U.S.A.).
Educated Consumers—Improved Production—Eleonor Lilliehook (Sweden).
Packaging and Its Effect upon the Standard of Living—Irwin D. Wolf (U.S.A.).
Design as a Constructive Stimulant in Marketing—Walter Derwin Teague (U.S.A.).
Rationalization and Standardization of the Distribution of Goods—Ruben Rausing (Sweden).
Profitable Marketing through Scientifically Planned Advertising—Frank R. Coutant (U.S.A.).
The Role of Control and Measurement in Advertising Management—Prof. Neil H. Borden (U.S.A.).
The Growth and Function of the Advertising Agency—Stanley Resor (U.S.A.) and William G. Palmer (U.S.A.).
Some Features of the Sales-Promoting Activities of the Svenska Sockerfabriks Artiebolaget—Svenska Sockerfabriks Aktiebolaget (Sweden).
The Means and Methods of the Producer to Reach the Consumer—Wilh. Goransson (Sweden).
Modern Methods of Sales Promotion—John Cameron Aspley (U.S.A.).
The Co-ordination of Advertising and Sales Promotion—C. B. Larrabee (U.S.A.).
Scientific Direction of Sales Effort—Clarence Francis (U.S.A.).
Unifying the Efforts of Sales and Engineering Departments in Marketing Industrial Equipment—C. R. Cary (U.S.A.).
Salesmen Training—G. H. Armstrong (U.S.A.).
The Training of Shop Assistants in the Swedish Co-operative Movement—H. Elldin (Sweden).
Salesmen's Compensation and Incentives—Dr. Harry R. Tosdal (U.S.A.).
Expenditure for Distributing Staff in Prosperity and Depression Periods—Dr. Jan Tille (Czechoslovakia).

FIFTY-THIRD

ANNUAL GENERAL MEETING

and

GENERAL PROFESSIONAL MEETING

Under the Distinguished Patronage of

THEIR EXCELLENCIES THE GOVERNOR-GENERAL
AND LADY TWEEDSMUIR

OTTAWA— TUESDAY AND WEDNESDAY FEBRUARY 14 and 15, 1939

PROGRAMME

Tuesday, February 14th—

10.00 a.m.	Opening of Annual Meeting
12.30 p.m.	Luncheon
2.30 p.m.	Continuation of Annual Meeting
4.00 p.m.	Retiring President's Address
7.30 p.m.	Annual Banquet
10.30 p.m.	Dance

Wednesday, February 15th—

10.00 a.m.	Technical Sessions
12.30 p.m.	Luncheon
2.30 p.m.	Technical Sessions
8.00 p.m.	Social Gathering

Ladies will be cordially welcome at all functions. The Meetings will be held in the CHATEAU LAURIER as usual.

Arrangements for the meeting are in the hands of an Ottawa Branch Committee, under the Chairmanship of J. L. RANNIE, M.E.I.C.

ANNUAL BANQUET, Tuesday, February 14th

Guests of honour—Their Excellencies the Governor-General and Lady Tweedsmuir.

Guest speaker—Colonel Willard Chevalier.

Following the banquet there will be dancing.

PAPERS

C. A. McGRATH, Hon.M.E.I.C.
Some Problems Involved in the Expansion of Canada.

D. W. HAYS, M.E.I.C.
Irrigation Developments, Its Possibilities and Limitations.

F. H. PETERS, M.E.I.C.
Mountain Water for the Prairie Grassland.

C. H. ATTWOOD, M.E.I.C.
Soil Water Conservation.

E. S. ARCHIBALD, B.A., D.Sc.
A Livestock Programme in Western Rehabilitation.

G. A. GAHERTY, M.E.I.C.
Rehabilitation Through Water Conservation.

GEORGE SPENCE
Prairie Farm Rehabilitation.

M. W. MAXWELL, M.E.I.C.
American Industry Looks at Canada.

E. V. NEELANDS and J. P. MILLENBACH, MM.C.I.M.M.
Mining Methods at the Canadian Malartic Mine.

(By Courtesy of The Canadian Institute of Mining & Metallurgy)

and others

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."

VOLUME XXI DECEMBER, 1938 No. 12

Once again we approach the joyous season of Christmastide and the New Year—the season when the pulse seems to beat faster, when we remember old friends, when we make plans for the future and give thanks for the past.

The Institute has much for which to be thankful — a record of bridges crossed, of services rendered, of work accomplished, and what is more —the certainty of even more useful work for the future, and the strength with which to accomplish it. Surely this is much for which to be thankful.

The President and the Councillors send to all members, and to all friends of the Institute throughout the world, sincere wishes for a happy Christmas. It is their earnest hope that the coming year will bring peace, happiness and prosperity to them and to all people.

National Voluntary Registration

The Department of National Defence has asked The Institute to assist in a national registration of technically trained men in Canada. Our share of the work is confined to a proper listing of civil, electrical and mechanical engineers, and is to form part of a complete compilation which will include also mining and chemical engineers, chemists, metallurgists, and other technologists. The work is to be carried on by a group known as the personnel sub-committee of the Navy, Army and Air Services Committee, and is made up of one representative from each of the following: The Canadian Institute of Chemistry, the Canadian Institute of Mining and Metallurgy, and The Engineering Institute of Canada, with a chairman and secretary supplied by the Department.

The information is to be gathered on forms prepared by the committee, which are now in the hands of our members. This questionnaire is simple, yet comprehensive. It asks the engineer for no commitments or signature, and places him under no obligation of any kind. There appears to be absolutely no reason why it can not be completed readily, without difficulty or misgivings. The committee asks that it be given preferred consideration, and returned to Headquarters as quickly as possible.

No one will look on an announcement of this kind as good news, and yet no one will think that we can ignore entirely the unhappy trend of events in Europe. The man who stands on his doorstep and sees the water rising to the flood in the river before him, cannot be called foolish if he builds an embankment around his home or if he moves to higher ground for safety. He is simply a provident creature, preparing for a contingency which he foresees as a possibility, and which would bring to him and his family utter disaster if it caught him unprepared. The water may never reach him, but it would be madness for him to ignore the possibility of it.

It is a hopeful sign that the government recognizes now that different men are suited to different tasks, and that an endeavour is being made to find out the qualifications of each person so that he may be fitted to his assignment in case the mad course of events in other countries should reach us here. Probably the task should have been undertaken long ago, but that is no reason why it should not be pushed through now to as rapid and as complete a conclusion as is possible. Council urges all members to answer the questionnaire without delay.

Amendments to the By-laws Proposed by Council

In accordance with Sections 74 and 75 of the By-laws, the Council presents for the consideration of corporate members the following proposals for the amendment of Sections 32 and 35 and for the introduction of a new Section 77.

These proposals will in due course be submitted for discussion at the Annual General Meeting on February 21st, in Ottawa, and will subsequently go out to ballot.

All the proposals now submitted were approved by the Council on November 26th, 1938.

Following each proposal will be found an explanatory note indicating the reasons for Council's action. The proposed changes in wording and figures are underlined.

* * *

Section 32 (As now proposed)

The entrance fees, payable at the time of application for admission to the Institute shall be as follows:

Members	$10.00
Associate Members	$10.00
Juniors	$ 5.00
Affiliates	$10.00

Honorary Members and Students shall be exempt from entrance fees.

Note:—This scale of fees was authorized by resolution at the Annual General Meeting held at London, Ontario, on January 31st, 1938. The proposed change is suggested simply to record the information correctly in the by-laws.

* * *

Section 35 (As now proposed)

The portion of the first annual fee for which a newly elected member shall be liable shall be a proportion of the regular annual fee equivalent to the unexpired portion of the year, calculated from the beginning of the month in which the election takes place.

Note:—This change is desired by Council in order to simplify for all concerned the method of computing the portion of the first annual fee to be paid by new members, and also to put such payments on an absolutely equitable basis. It is expected that the change will be of assistance to the various membership committees.

* * *

Proposed New Section 77

An association which enters into an agreement in accordance with the provisions of By-law 76 shall, when requested by the Association and for the purpose of that by-law, be termed a "Component Association."

Note:—Section 76* of the By-laws, which was approved by a very large majority of corporate members by ballot in February 1938, provides for co-operation between The Institute and any provincial association or corporation of professional engineers.

It has since been found that in one province at least, the conclusion of an agreement for such co-operation would be facilitated if such co-operating associations could be referred to as "component associations" in The Institute by-laws. For this reason the Council recommends the approval of this new section.

*See the Engineering Journal, April 1938, p. 202.

The Fifty-Third Annual General Meeting

Notice is hereby given in accordance with the By-laws, that the Annual General Meeting of The Engineering Institute of Canada for 1939 will begin at Headquarters at eight o'clock p.m. on Thursday, January 26th, 1939, for the transaction of the necessary formal business including the appointment of scrutineers for the Officers' Ballot, and will then be adjourned to reconvene at the Chateau Laurier, Ottawa, Ontario, at ten o'clock a.m. on Tuesday, February 14th, 1939.

L. Austin Wright,
General Secretary

Presidential Activities

Since the 24th of October, the President has visited all the branches of the Institute from Lakehead to Victoria. He was accompanied by the Chairman of the Council Committee on Professional Interests, Mr. Fred Newell, and by the General Secretary. At the branches in Saskatchewan and Alberta, he also had the advantage of the presence of the Chairman of the Institute's Committee on Western Water Problems, Mr. G. A. Gaherty. Details of these branch visits will appear in the news of branches.

At Regina, on the 29th of October, the Headquarters delegation participated in a joint banquet of members of the Institute and of the Association of Professional Engineers of Saskatchewan, at which the formal agreement between the Institute and the Association was duly signed, sealed and delivered. At this banquet also, a brief message from the President of the Association and the President of the Institute was broadcast on an interprovincial hook-up. The significance of this occasion, unique in the history of the engineering profession in Canada, cannot be overemphasized.

On the 30th of October, a very largely attended regional meeting of council was held in Hotel Saskatchewan, Regina, at which the President, the Registrar and the Board of Direction of the Saskatchewan Association were present, by invitation. On the afternoon of the same day, the Presidents of The Institute and the Association with their wives formally received at the Hotel Saskatchewan the Lieutenant-Governor and Mrs. McNab, several ministers of government, the Chief Justice of the Province, leading citizens of the capital city of Saskatchewan and all engineers and their wives attended.

In Winnipeg the President and the members of the party spoke to the third and fourth year engineering students of the University of Manitoba with Student President Sidney E. Smith in the chair. Similar meetings were held at the University of Saskatchewan under the chairmanship of Dean Mackenzie and at the University of British Columbia under the chairmanship of Dean Finlayson. Unfortunately the University of Alberta was closed because of the death of a prominent member of the faculty, and the proposed meeting there had to be cancelled.

At Vancouver, the Headquarters delegation, by invitation, attended the Annual Western General Meeting of the Canadian Institute of Mining and Metallurgy. President Challies was the principal guest speaker at the opening luncheon to the Mining Institute members, when he extolled the contribution made to Canada by the mining and the electrical utility industries. The President also spoke at the Armistice Day luncheon of the Vancouver Rotary Club, when he paid tribute to the International Joint Commission which he termed the best insurance for permanent peace on this continent.

The presentation of the Sir John Kennedy Medal to Past President Col. J. S. Dennis was a very interesting feature of the stay at Victoria. Col. Dennis was in the Hospital but a delegation headed by the President and Mr. C. A. Magrath, Hon.M.E.I.C., visited him there, and under very trying circumstances made the presentation. Col. Dennis was quite feeble but was able to thank Mr. Challies for the honour The Institute was conferring upon him.

By invitation, the Headquarters delegation addressed a round-table conference at Seattle, Washington, on the 12th of November, attended by officers of the Washington section of the Founder Societies.

En route home, the President spoke at Chicago on Tuesday, November 22nd, to the members of the Chicago Engineers Club, and that same evening, in Detroit to the Michigan section of the American Society of Civil Engineers. The following day at noon, he spoke to the Michigan section of the American Institute of Electrical Engineers.

The deep and active interest of the members of the Founder Societies in the status of the engineering profession in Canada greatly surprised and delighted the President.

The Headquarters delegation had the privilege of speaking to over 500 members of the Engineering Society of the University of Toronto at Hart House, on Thursday evening, November 24th. On November 26th, the President presided at the regular November meeting of Council held at Peterborough, which was followed in the evening by the annual banquet of the Peterborough Branch.

1938 Fees—Unpaid

Members who have not already paid their 1938 fees are requested to give this matter urgent consideration. It is of considerable assistance to The Institute to have the fees paid before the end of the year in which they fall due. There is still time to send your cheque.

OBITUARIES

John James Aldred, A.M.E.I.C.

Members of The Institute will learn with regret of the death of John James Aldred, A.M.E.I.C., on October 28th at Twin Pines, West Shefford Mountain, Quebec., He was born at Peckham, Surrey, England, on May 31st, 1872. His engineering experience in Canada began in 1890. He was leveller on the Soulanges Canal, later instrumentman on the Atlantic and Lake Superior Railroad, and then with the Canadian Pacific Railway survey. His railway engineering experience grew as time went on. He took part in the construction of the Rutland Canadian Railroad, the Great Northern Railroad, the Mt. Washington Tunnel, and the Wabash Railroad. Although he engaged in various other engineering enterprises he returned to railway work from 1907-09 when he was field engineer on the National Transcontinental Railway at Dorchester, N.B., and from 1912 to 1913 as inspecting engineer on the same railway at Saint John, N.B.

Some of Mr. Aldred's later activities were outside of the railway field. From 1909 to 1911 he was in charge of transmission line work for Winnipeg Light, Heat and Power Company. From 1911 to 1912 he was superintendent and field engineer of the Mt. Hood Light, Heat and Power Company at Big Sandy Dam, Portland, Oregon. In 1913 he began work on the Welland Ship Canal in which he was engaged for three years. From 1924 to 1927 he was with the Ford Motor Company, Detroit, Michigan. He remained in Michigan until 1931, being located in Saginaw with the Consumers Power Company and the Parks Planning Commission. He returned to Canada and was employed with the Canadian Government in the Department of Northern Development for a year, when he retired from active service.

Mr. Aldred joined the Canadian Society of Civil Engineers in 1907.

Col. John Stoughton Dennis, C.M.G., M.E.I.C.

Many of the senior members of The Institute have been saddened by the announcement of the death of J. S. Dennis, at Victoria on November 26th. Most of his long and active life—he left the east at the age of 16 and died in his 83rd year—was spent in the development of the west. He was in fact an explorer and a leader in the band of pioneers whose efforts prepared that vast area for the stream of settlers who began to flock thither in the eighties and whose activities have made the prairie country what it is today.

The news of his passing will thus have a special and personal meaning to the thousands of people west of the Great Lakes who knew him, appreciated his personal worth and held him in affection and esteem.

John Stoughton Dennis was born at Weston, Ont., on October 22nd, 1856, where he attended Trinity College School, before entering Upper Canada College. He later graduated from the old Military School at Kingston.

In 1872, he first saw the Canadian West, working as assistant to the late H. B. Smith, C.E., in the exploration of Lakes Winnipeg, Manitoba and Winnipegosis and their connecting waters. The following year he was with the late J. Lestock Reed, Dominion Land Surveyor, as head chainman on base line surveys in Northwestern Manitoba, working during the next three years on special surveys under the late Lindsay Russell, Dominion Land Surveyor. After a year of study under the late Bolton McGrath at Aylmer, Quebec, he passed his examinations and received his commissions as Dominion Land Surveyor and Dominion Topographical Surveyor. In 1878 he was appointed to take charge of the surveying party sent out to establish the 4th Meridian in the Northwest Territories.

In 1879, at the age of 23, he joined the service of the Hudson's Bay Company as surveyor and engineer to the Land Department, and during his three years of service with that company, he surveyed and laid out their properties into town lots at Winnipeg, Prince Albert, Edmonton and Laval Portage, now Kenora. In addition to these arduous tasks, he was also in charge of the construction of the company's buildings, also designing and constructing the first sewerage system on their property at Winnipeg, now the southern portion of the city.

Opening his own offices in Winnipeg in 1883, he surveyed and laid out many of the town plots in the West, notably at Brandon, Prince Albert, and part of Regina. During this period he was elected president of the Manitoba Land Surveyors Association. In 1884 he was engaged in surveying and locating mines in the Bow Pass of the Rocky Mountains.

When the Riel Rebellion occurred in 1885, Colonel Dennis was in command of the Dominion Land Surveys Intelligence Corps, which, during the rebellion, was known as Dennis' Scouts. Following Riel's collapse, he joined the staff of the Topographical Surveys of the Department of the Interior, and remained in that service until 1897, when he was appointed Chief Inspector of Surveys. During the latter portion of this period, he was in charge of the administration of the Irrigation Act, with headquarters at Calgary. Here he was responsible for surveying and laying out many of the extensive irrigation systems which were later constructed in southern Alberta.

His history of the Dominion Land Surveys from 1869 to 1889 was published as a portion of the Report of the Department of the Interior in 1891.

In 1896 Colonel Dennis was elected vice-president of the American Association of Irrigation Engineers, and the following year joined the Department of Public Works of the old Northwest Territories Government, with headquarters at Regina, his first position being that of chief engineer. Subsequently he became Chief Commissioner of the Department. During this period he had charge

John Stoughton Dennis, M.E.I.C.

of the design and construction of all public buildings erected by the Government of the territories, the building of all bridges, the operation of ferries, and the supervision of all road improvements.

On January 1st, 1902, he joined the service of the Canadian Pacific Railway Company, first as superintendent and then chief engineer in charge of the construction of the famous C.P.R. irrigation project serving a large tract of land along the main line between Calgary and Medicine Hat. Subsequently he was promoted to manager of the company's Department of Natural Resources. He later became assistant to the second vice-president, then assistant to the President—Lord Shaughnessy—being finally promoted to Chief Commissioner of Colonization and Development, at the head of what is now the Department of Immigration and Colonization of the Canadian Pacific Railway Company. On January 1st, 1930, Colonel Dennis retired from this position, but remained a member of the Advisory Committee which deals with matters affecting the departments of Natural Resources and Immigration and Colonization of the Company. Thus his long experience and his world-wide reputation as a builder of Canada's ever growing structure, were retained to the benefit of both Canada and the Railway Company.

During the war he was appointed representative on the British-Canadian Recruiting Mission in the United States, with the rank of Lieutenant-Colonel, was later promoted to the rank of Colonel, and proceeded to Siberia as Director of Transportation and Intelligence on the General Staff of the Canadian Brigade. During 1918 he acted as Canadian Red Cross Commissioner in Russia, and as Canadian Trade Commissioner in the same territory.

Among the decorations that have been awarded to Colonel Dennis are the Companionship of the Order of St. Michael and St. George, the Northwest Medal, 1885, with clasp, the Great War Medal (with Palm Citation and Mention in Despatches), the Victory Medal, the Cross of Serbia, and the Medal of the Serbian Red Cross.

Colonel Dennis joined The Institute (then the Canadian Society of Civil Engineers) as a Member in 1901, serving on Council in 1906 and in 1911. He was a vice-president in 1907, and was elected President in 1917 just before his service in Serbia. He became a Life Member in 1933.

The last years of his life were spent in well-earned leisure at Victoria, B.C. This year the Council of The Institute, in making the sixth award of the Sir John Kennedy Medal, chose Colonel Dennis as the recipient. His failing health made it evident that the customary personal presentation at an Annual General Meeting would not be possible. President Challies, however, took the medal with him on his recent visit to the West and was fortunately able to place it in the hand of Colonel Dennis at his bedside in hospital at Victoria only a few days before his death.

Those who were present at that simple ceremony were deeply touched by the invalid's evident pleasure and appreciation of the honour that had been conferred upon him. They were happy to think that at the sunset of his life, The Institute's expression of professional esteem and admiration has thus brightened the closing days of this beloved and distinguished Canadian engineer.

Richard L. Latham, M.E.I.C.

We announce with deep regret the death of Richard L. Latham, M.E.I.C., who passed away in the General Hospital, Hamilton, early in the morning of Sunday, November 13th, after a few days' illness.

Mr. Latham was born in Toronto and on Sunday, November 20th, he, with his family, would have observed his 61st birthday.

He graduated from the University of Toronto in Civil Engineering in 1901 and later in the same year joined the Toronto, Hamilton and Buffalo Railway as assistant engineer, under Mr. Fisher. In 1909 he was appointed chief engineer of the same company and held the position until a few days ago.

Under his charge many and varied engineering projects have been carried out successfully; of these the most outstanding are the following: Port Maitland Docks, commenced in 1928; the new engine terminal at Hamilton which was commenced in 1929, and the Hamilton grade separation and new passenger station which were commenced in 1932.

He took an active part in the affairs of the 50th Annual Meeting, which was held in Hamilton in February 1936. He was held in affectionate esteem by his fellow engineers, from coast to coast. His personality was such as to gain the confidence of those over him, in office, and give him and the railway company the untiring loyalty of his engineering staff and all ranks from headquarters away to the end of the farthest siding.

Richard L. Latham, M.E.I.C.

His greatest contribution to engineering was his ability to encourage and give confidence to all those who, in whatever capacity, were connected with the enterprises on which he was engaged.

Mr. Latham joined The Institute in 1906 as an Associate Member, becoming a full Member in 1913.

Othmar Wallace Ross, A.M.E.I.C.

Members of The Institute will regret to learn of the death of Othmar Wallace Ross, A.M.E.I.C., in St. Catharines, Ont., on November 15th, after a prolonged illness. He was born at Burlington Plains, Ont., on January 15th, 1890, and received his B.A.Sc. degree from the University of Toronto in 1912. He obtained his early engineering experience with the city engineer of Brantford. He later joined the Dominion Bridge Company of Montreal where he worked for a time on bridge and structural steel work.

From 1916 to 1918 Mr. Ross served overseas, first as Lieutenant in the C.E.F. and later as Captain in the R.A.F. On returning to Canada he continued work on the Welland Ship Canal. During the time spent on this work he was in charge of the Location and Right of Way Party, assistant to the Ontario Land Surveyor who established the boundaries for the Canal, and later assistant engineer of section one of the Canal work.

Mr. Ross joined the Canadian Society of Civil Engineers as a Student in 1909 and became an Associate Member in 1919 but had been unable for quite some time to take active part in Institute affairs. However, his death will be noted with mourning by his branch and The Institute in general.

PERSONALS

Lieut.-Col. Robert Bickerdike, D.S.O., M.E.I.C., a life member of The Institute and a consulting engineer in Montreal, has been elected president of the Mount Royal Liberal Association.

Floyd K. Beach, M.E.I.C., office engineer for the Petroleum and Natural Gas Division of the Department of Lands and Mines of Alberta, has been moved from Edmonton to Calgary. This move is part of a reorganization following the setting up of a Petroleum and Natural Gas Conservation Board with offices at Calgary. Since the war, he has taken an active interest in militia affairs. Early in 1937 he organized the 9th Army Troops Company, R.C.E. **Capt. R. M. Hardy,** A.M.E.I.C., assistant professor of civil engineering at the University of Alberta, will carry on the unit in his absence.

Charles I. Bacon, S.E.I.C., has been appointed assistant manager of the Stormont Electric Light and Power Company and the Cornwall Street Railway. He is a graduate of the Nova Scotia Technical College, obtaining his B.Sc. degree from there in 1934. Prior to his present appointment he held the position of engineer in charge of the Summerside Municipal Electric Light and Power Plant, Summerside, P.E.I.

Frank L. Grindley, A.M.E.I.C., has recently been appointed hydraulic engineer with the Water Resources Branch of Alberta and will be located in Edmonton.

J. R. Donald, M.E.I.C., Montreal, continues in his position as president of the Donald Inspection Limited, which has changed its name from Donald-Hunt Limited.

Dr. Charles Camsell, C.M.G., LL.D., M.E.I.C., Deputy Minister of the Department of Mines and Resources, was made an honorary fellow of St. John's Anglican College, Winnipeg, at the ceremonies marking the 72nd anniversary of the institution's founding.

J. G. Bradley, Jr.E.I.C., is now with the Demerara Bauxite Company, McKenzie, British Guiana, S.A. He formerly held the position of assistant to the superintendent, Sherwin Williams Company of Canada, Red Mill, Que.

deGaspe Beaubien, M.E.I.C., attended the All-Quebec Safety Conference held in Montreal recently, and was one of the leaders of the open discussion on "The Underlying Causes of Street and Highway Accidents."

M. W. Huggins, Jr.E.I.C., is now lecturer in civil engineering at Queen's University, Kingston, Ont. He was formerly with E. P. Muntz Ltd., Dundas, Ont.

R. H. Pick has been appointed Marconi sales engineer of the Winnipeg office of the Canadian Marconi Company. Mr. Pick has been with this company for thirteen years.

A. Cousineau, A.M.E.I.C., superintendent engineer, Division of Sanitation, Department of Health, Montreal, has been elected vice-chairman of a new organization known as The Conference of Municipal Public Health Engineers which was formed on October 26th during the 1938 sessions of the American Public Health Association, held in Kansas City, Mo.

Y. R. Tassé, S.E.I.C., has recently been transferred to the Quebec office of the Canadian General Electric Company Limited. He has been with the company since 1934 when he entered as a student in the Peterborough plant. The following year he was sent to the Toronto plant where he remained until coming to Montreal in 1937 as sales engineer. Mr. Tasse graduated from the Ecole Polytechnique in 1935 in civil engineering and received the Lieutenant-Governor's medal. He was also awarded the Ernest Marceau Prize by The Institute for his paper on "Le vent pour électrifier nos campagnes."

Meeting of Council

A meeting of the Council of The Institute was held at the Hotel Saskatchewan, Regina, Saskatchewan, on October 30th, 1938, with President J. B. Challies in the chair, and six other members of Council present. By invitation there were also present Messrs. J. W. D. Farrell, I. M. Fraser and J. J. White, President, Vice-President and Registrar respectively of the Association of Professional Engineers of Saskatchewan, W. E. Lovell, R. A. McLellan and S. R. Muirhead, councillors of the Association; five past councillors of The Institute; the chairmen of the Lethbridge, Edmonton and Winnipeg branches; four members of the executive committee of the Saskatchewan Branch, and Mr. G. A. Gaherty, of Montreal, chairman of The Institute Committee on Western Water Problems.

The President having welcomed the President, Registrar and councillors of the Association of Professional Engineers of Saskatchewan, consideration was given to matters arising from the signature on the previous evening of the agreement providing for co-operation between The Institute and the Association.

In regard to the procedure necessary to properly classify in The Institute membership members of the Association who had now become corporate members of The Institute, it was resolved that the executive committee of the branch should be asked to review all such cases and make recommendations to the Council of The Institute as to their classification.

In regard to the provision of the agreement under which the entrance fee of the Association is to be remitted to any corporate member of The Institute resident in the province of Saskatchewan who applies for membership in the Association within twelve months, the President explained that the council of The Institute would endeavour to communicate directly with its members in Saskatchewan who are not now members of the Association, indicating the desirability of their applying immediately for membership in that body.

The Council expressed appreciation of the publicity which had been secured for The Institute and the Association by the Dominion-wide radio broadcast of the proceedings at the recent banquet. The thanks of The Institute were due to Mr. Gordon Pitts, the originator of the idea, and Dr. A. Frigon, the assistant general manager of the Canadian Broadcasting Corporation, whose assistance in the matter had been so valuable.

Professor Spencer reported on the work of his Committee on Membership and Management, and explained that in order to bring the various issues fairly before Council his committee's reports had contained what they believed to be the best methods of bringing about the changes in question, if and when they were decided upon. His committee did not necessarily advocate the changes in question. Professor Spencer was of opinion that all of the issues involved in the changes in the constitution of Council and any changes in classification of Institute members should be thoroughly discussed by all branch executive committees before any action is taken upon his report.

After a long discussion it was the consensus of opinion that there should be no change in the constitution of Council, but that consideration should be given to the establishment of a grade of "Fellow," the change of name of the present class of "Associate Member" to "Member," and revision of the qualifications for the classes of Student and Junior.

After an adjournment for lunch, Mr. Newell, chairman of the Committee on Professional Interests, explained the present status of negotiations for agreements under By-law 76 in the provinces of Nova Scotia, New Brunswick and

Manitoba, in which cases he thought that agreements might be possible in the not too distant future. Mr. Newell further explained the situation in the provinces of Ontario and Quebec, and hoped to report fully at a later date with respect to Alberta and British Columbia.

Mr. Gaherty, the chairman of The Institute Committee on Western Water Problems, reported progress in connection with the symposium of papers on that subject which is being arranged for presentation at the General Professional Meeting in Ottawa on February 22nd. Mr. Gaherty stated that his committee, in arranging for these papers and their discussion, hoped to remove any possible impression that the western water problem was impossible of solution within a reasonable time, a view which he believed was held to a certain extent in the east.

The General Secretary reported progress in regard to the proposed joint meetings with British and American societies in September 1939 in New York during the World's Fair, and also drew attention to the invitation received from the Engineers' Council for Professional Development. They asked The Institute to be represented at the annual meeting of that body which had accordingly been attended by a delegation including the President and the General Secretary. The invitation had been accompanied by a most gratifying offer to make available to The Institute all reports, literature and plans of the E.C.P.D. in order that the welfare of the young engineer might be more effectively sponsored in Canada. The President reported that at the meeting he had willingly accepted this generous offer from the E.C.P.D.

The General Secretary reported that the Department of National Defence at Ottawa had asked The Institute to undertake the registration of all civil, mechanical and electrical engineers in its membership as part of a scheme to catalogue all technically trained men in Canada. The meeting authorized compliance with the request.

Mr. Newell expressed the thanks of the Headquarters delegation to the officers of the Saskatchewan Association and Branch for the warm reception extended to them and to their ladies.

On behalf of the executive committee of the Winnipeg Branch, Mr. Hurst conveyed heartiest congratulations to the Saskatchewan Branch and Association on the signing of the co-operative agreement.

Mr. Farrell, President of the Association, felicitated the President and Council on the manner in which The Institute representatives had participated in the ceremonies incidental to the completion of the agreement. He and Mr. Fraser both expressed their thanks and appreciation of the opportunity to be present at the deliberations of this prairie meeting of Council.

The Council rose at three thirty p.m.

ELECTIONS AND TRANSFERS

At the meeting of Council held on November 26th, 1938, the following elections and transfers were effected:

Members

CARSON, Cecil Edward, B.Sc. (Chem.), (McGill Univ.), gen. supt., Imperial Oil Limited, Sarnia, Ont.

DUBOSE, McNeely, B.E., E.E., (North Carolina State Coll.), gen. supt., Saguenay Power Co. Ltd., Arvida, Que.

WILLIAMS, Charles Gunning, B.A.Sc., (Univ. of Toronto), professor of mining engineering, University of Toronto, Toronto, Ont.

Associate Members

DOBSON, Franklin Alver, B.Sc., (Queen's Univ.), research engr., Canadian Car and Foundry Co. Ltd., Fort William, Ont.

*HEYWOOD, Don W., (Univ. of Alta.), (Milwaukee Sch. of Engrg.), electl. dept. McDougall & Friedman, consltg. engrs., Montreal, Que.

MANN, Arthur Drummond, Lieut., R.C.E., (Grad., R.M.C.), B.A.Sc., (Univ. of Toronto), Works Officer, Military District No. 5, St. Louis Barracks, Quebec, Que.

SPENCE, Howard Clement, B.Sc. (Civil), (Univ. of Man.), secretary, Highway Traffic and Taxicab Office, Municipal and Public Utility Board, Province of Manitoba, Winnipeg, Man.

TAYLOR, Frank Butler, (Liverpool Tech. Sch.), marine supt., Imperial Oil Shipping Company, Montreal, Que.

Juniors

CAWLEY, Hugh Rose, B.Sc. (Mech.), (Univ. of Sask.), asst. locomotive foreman, C.N.R., Melville, Sask.

CONNOR, William Alexander Jr., B.A.Sc., (Univ. of Toronto), asst. to chief engr., Employers' Liability Assurance Corpn. Ltd., Toronto, Ont.

HAMILTON, Harold Percy, B.A.Sc., (Univ. of Toronto), operator, Churchill River Power Company, Island Falls, Sask.

LORIMER, William Clarence, B.Sc. (Mech.), (Univ. of Sask.), operator, Diesel power plant, Canadian Utilities Limited, Kerrobert, Sask.

MANSEAU, Gilbert, B.A.Sc., C.E., (Ecole Polytechnique), engr., B. Trudel & Cie., Montreal, Que.

MONTGOMERY, Mortimer Andrew, B.Sc. (Mech.), (Univ. of Sask.), engr., Canadian Blower & Forge Co. Ltd., Montreal, Que.

Transferred from the class of Associate Member to that of Member

MacKENZIE, Gordon Leslie, B.Sc. (Civil), (Queen's Univ.), office and designing engr., water development, P.F.R.A., Regina, Sask.

WATSON, McClelland Barry, B.A.Sc. (Civil and Mech.), (Univ. of Toronto), consltg. mech. engr., 184 College St., Toronto, Ont.

Transferred from the class of Junior to that of Associate Member

CRUMP, Norris Roy, B.Sc., M.E., (Purdue Univ.), divn. master mechanic, C.P.R., Regina, Sask.

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

VINCENT, Paul Emile Albert, B.A.Sc., C.E., (Ecole Polytechnique), district engr., roads and bridges divn., Colonization Dept., Parliament Bldgs., Quebec, Que.

Transferred from the class of Student to that of Associate Member

COUSINEAU, Louis Philippe, B.A.Sc., C.E., (Ecole Polytechnique), welding supt., Marine Industries Ltd., Sorel, Que.

STEVENSON, Charles Lester, B.Sc. (Civil), (Univ. of N.B.), plant engr., Abrasive Co. of Canada Ltd., Arvida, Que.

THOMAS, James Leslie, B.Sc. (Mech.), (Queen's Univ.), 763 Bloomfield Ave., Outremont, Que.

Transferred from the class of Student to that of Junior

BEIQUE, Henri F., B.Eng. (E.E.), (McGill Univ.), engr., Quebec Power Company, Quebec, Que.

TOY, Edwin Letendu, B.Sc. (Elec.), (Univ. of N.B.), supervisor, test. dept., Can. Gen. Elec. Co. Ltd., Toronto, Ont.

WOOLSEY, John Townley, Lieut., R.C.A., Work Point Barracks, Esquimalt, B.C.

Students Admitted

BOURBONNAIS, Georges Valois, (R.M.C.), Royal Military College, Kingston, Ont.

CAMERON, Curtis Burnette, (Univ. of N.B.), 247 Brunswick Street, Fredericton, N.B.

DEMCOE, John William, (Univ. of Man.), University of Manitoba, Fort Garry, Man.

GRAY, James Lorne, M.Sc., (Univ. of Sask.), 426 Park Street, Peterborough, Ont.

McARTHUR, Donald S., (Univ. of Sask.), 613 Clarence Avenue, Saskatoon, Sask.

MacGOWAN, William Hartley, (McGill Univ.), 6515 Cote St. Luc Road, Montreal, Que.

NATHANSON, Sol, (McGill Univ.), 810 Hartland Avenue, Outremont, Que.

PERRY, George Thomas, (Univ. of Toronto), 69 Strathcona Avenue, Toronto, Ont.

READ, Frederick Cyril, (Univ. of Toronto), 1 Bedford Road, Toronto, Ont.

ROBERT, Andre, B.Sc. (Univ. of Man.), 3611 Hutchison Street, Montreal, Que.

SALVADGE, Charles Harold, B.A.Sc., (Univ. of Toronto), 489 King Street, Peterborough Ont.

STAPLETON, David Outram, B.Eng., (McGill Univ.), 1130 Sherbrooke Street, West, Montreal, Que.

TANNER, William John, (McGill Univ.), 138 Longueuil Street, Longueuil, Que.

*Has passed the Institute's examinations.

WOODFIELD, Raymond Percy, (Univ. of Man.), 303 Gwendoline Street, Winnipeg, Man.

Students at Queen's University, Kingston, Ont.

ASKWITH, Francis Lloyd George, 222 Powell Avenue, Ottawa, Ont.
ASQUITH, A. Reginald, Auburn, Ont.
DENOVAN, John J., P.O. Box 255, Asbestos, Que.
HOBA, Joseph George, Thorold South, Ont.
LOCKEBERG, Rolf Siguro, 542 Wellington Street, Ottawa, Ont.
MASON, Harvey Libby King, 78 Wellington Street, Kingston, Ont.
McGEACHY, Donald D. C., 323 University Avenue, Kingston, Ont.
PHEMISTER, William Ian, 445 Morrison Street, Niagara Falls, Ont.
RIGSBY, David L., 318 University Avenue, Kingston, Ont.
SANDERS, Robert Lewis, 15 Union Street, Kingston, Ont.
SMILEY, Donald C., 124 Hamilton Avenue, Ottawa, Ont.
SHISKO, Nicholas, Ansonville, Ont.

Students at the Ecole Polytechnique, Montreal, Que.

BELANGER, Maurice, 53 St. Catherine Road, Outremont, Que.
BOISCLAIR, Robert, 1320 Demontigny East, Apt. 6, Montreal, Que.
BOULVA, Charles, 824 Cherrier Street, Apt. 10, Montreal, Que.
BOUSQUET, Paul, 1430 St. Denis Street, Montreal, Que.
CHARLAND, Roger, 3416 St. Hubert Street, Montreal, Que.
DOUVILLE, Paul-Emile, 7857 Berri Street, Montreal, Que.
FRECHETTE, Gaston, 5216 Chambord Street, Montreal, Que.
HURTUBISE, Marc, 5290 McKenna Avenue, Outremont, Que.
LAVALLEE, Jean, 1232 St. Denis Street, Apt. 9, Montreal, Que.
LeBEL, Raymond, 4387 Christophe Colomb Street, Montreal, Que.
LEMIEUX, Henri Julien, 759b Champagneur Avenue, Outremont, Que.
LESSARD, Roger, 6214 DeNormanville Street, Montreal, Que.
MARTIN, J. Adolphe, 3492 Berri Street, Montreal, Que.
MORIN, Alphonse, 825 Sherbrooke Street, East, Montreal, Que.
MONTI, Attilio, 60 Jean Talon Street, East, Montreal, Que.
ORTIZ, Thomas, 1011 Sherbrooke Street East, Montreal, Que.
PIETTE, Guillaume, 2024 St. Denis Street, Apt. 5, Montreal, Que.
PROULX, Gilbert, 1430 St. Denis Street, Montreal, Que.
PROVOST, Roger, 4027 Harvard Avenue, N.D.G., Montreal, Que.
QUEVILLON, Olivier, 1820 Bennett Street, Montreal, Que.
RACICOT, Jacques, 3834 St. Denis Street, Montreal, Que.
TETREAULT, Armand, 1322 Sherbrooke Street East, Montreal, Que.
TETREAULT, Jacques, 1322 Sherbrooke Street East, Montreal, Que.
VALIQUETTE, Maurice, 2 Church Street, St. Laurent, Que.
VALIQUETTE, Zephirin, 8 rue Chamfoux, Abord-a-Plouffe, Que.

ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

American Society for Testing Materials: Year Book, August 1938.
Association of Professional Engineers of the Province of British Columbia: Year Book, 1938.
Seventh International Management Congress: Proceedings. Washington, 1938.
New Zealand Institution of Engineers: Proceedings, 1937-38, Vol. 24, pt. 1.
North-East Coast Institution of Engineers and Shipbuilders: Transactions Vol. 54, 1937-38.
Royal Society of Canada: Transactions Vol. 32, Section 5 Biological Sciences. Ottawa, 1938.

Reports, etc.

Alberta Department of Trade and Industry: Annual Report 1937-8.
Canada Bureau of Mines: The Canadian Mineral Industry in 1937; Comparative Pulverized Fuel Boiler Test son British Columbia and Alberta Coals and on Ontario Lignite; Investigations in Ore Dressing and Metallurgy, January to June 1937.
Edison Electric Institute: Electrification of Oil Refineries; Conductor Sags and Tensions for Rural Lines; Suggestions for Specifications for Lag Screws; Test Specifications Automatic Electric Storage Water Heaters; Tree Trimming Practices.
The Institution of Structural Engineers: Report on Steelwork for Buildings, Pt. 1, Loads and Stresses.
National Construction Council and its Constituent Organizations: Brief on the Effects of Municipal Taxation on the Construction Industry in Canada. March 1938.
Royal Commission on Dominion-Provincial Relations: Summary of the Briefs presented to the Royal Commission (Rowell Commission). Canadian Chamber of Commerce, Montreal, 1938.
The Smithsonian Institution: Annual Report 1937.
U.S. Bureau of Mines: Composition of Coal Tar and Light Oil (Bulletin 412); Studies Pertaining to the Catalytic Hydrogenation of Pyrolytic Tars, Cost of Coal-Mine Fatalities and Some Permanent Disabilities in Ohio Jan. 1, 1930 to Dec. 31, 1934 (Technical Papers 587, 589).
University of London: Calendar 1938-39.

Technical Books, etc.

Advanced Mathematics for Engineers. By H. W. Reddick and F. H. Miller. New York, John Wiley and Sons, 1938. 473 pp., diagrs., charts, tables, 9 x 6 in., cloth, $4.00.

Hydraulics for Engineers and Engineering Students. By F. C. Lea. 6th ed. London, Arnold and Co., 1938. 757 pp., diagrs., 6 x 8¾ in., cloth, $6.25.

Concrete Construction By Charles E. Reynolds. London, Concrete Publications Ltd., 1938. 510 pp., illus., diagrs., 6¾ x 9¾ in., cloth, 16s.

Concrete Pipe in American Sewerage Practice. Ed. by M. W. Loving. (American Concrete Pipe Association Bulletin 17). Chicago, The Association, 1938. Illus., diagrs., 6 x 9 in., leather.

Street Cleaning Practice. By the Committee on Street Cleaning. Chicago, American Public Works Association, 1938. 407 pp., illus., 6 x 9 in. cloth, $4.00.

U.S. Bureau of Reclamation Boulder Canyon Project Fina Reports, **Trial Load Method of Analyzing Arch Dams.** Denver, Colorado, 1938. 266 pp., illus., diagrs., tab., 6½ x 9¼ in., cloth, $1.50 (paper $1.00).

U.S. Bureau of Reclamation Boulder Canyon Project Final Reports, **Slab Analogy Experiments.** Denver, Colorado, 1938. 399, pp., illus., diagrs., tab., 6½ x 9¼ in., cloth, $1.50 (paper $1.00).

U.S. Works Progress Administration **Bibliography of Aeronautics**, Pt. 23 Airships. N.Y., W.P.A., 1938. 8½ x 10¾ in., paper.

BOOK REVIEWS

Design and Shop Practice

Kent's Mechanical Engineer's Handbook, Ed. by Robert Thurston Kent, M.E., Sc.D. 11th ed. New York, John Wiley and Sons Inc., 1938. 1,378 pp., 5½ x 8¾ in., Flexible binding, $5.00.

Reviewed by C. A. Robb, D.Eng., M.E.I.C.,
Prof. of Mechanical Engineering, University of Alberta, Edmonton Alta.

Kent's Mechanical Engineer's Handbook, eleventh edition, bearing the title Design and Shop Practice, is in every sense a thoroughly modern compendium of engineering practice. Compiled by competent authorities in their fields and arranged in a manner which provides a quick reference to the practice, the theory and the authority, this edition takes its place as volume III of the Wiley engineering handbook series, just published, and is a worthy companion for the earlier volume II, Power, published in 1936. The division of the handbook into separate volumes has the advantage of providing the mechanical engineer with more complete information than heretofore has been possible and the new plan is more useful and convenient. The handbook is timely in that much of the new material, which it contains, deals with phases of shop practice of recent origin and developments which have tended to modify earlier methods.

Edited and printed in the United States of America, the book deals in the main with American practice. However, the list of periodicals and publications given in the preamble is international in character and since Canadian engineers have largely adopted American standards in this field, the new edition simply amplifies earlier editions which have long been the standard work in this country. The list of collaborators is impressive and includes many leading authorities whose individual publications are familiar to designers.

In certain cases a slight elaboration of the text would assist alert operating engineers in modernizing old equipment. For example, in the mechanical deaerating of water (3-17), when the feedwater in an open heater is brought up to the temperature of the steam above it and high pressure steam is bubbled through the water, the bubbles of steam entrain the air which is liberally vented from the top of the heater and the heat, which would otherwise be wasted, is reclaimed for the heat balance by means of a gleaner condenser as described in fig. 3 of the text. An appreciation of the phenomenon will often make it possible to provide the desirable deaerating service without the necessity of replacing the old heater. The addition of the high pressure jets and the small gleaner condenser is usually all that is required. The text gives the impression that a reduction to .03 c.c. of oxygen per litre of water provides a satisfactory assurance against corrosion in steam power plant equipment. While this standard was quoted by E. R. Fish* in 1930, and seems a fair limit for mechanical deaerating, it has been usual, in recent years, to reduce the oxygen content to zero as shown by the Winkler test. This is accomplished by the addition of sodium sulphite after the mechanical deaerating is completed. This treatment has been described by A. G. Christie† in 1936.

*Trans. Second World Power Conference, Vol. VII, p. 89, Berlin, 1930.
†Mechanical Engineering, Sept. 1936, p. 550.

The above is in marked contrast to the treatment accorded the viscosity index (*13*-53/7). This section alone is worth the price of the book to the purchaser who wishes to guard against careless and improper blending of lubricants.

In view of the importance of molybdenum in controlling creep, especially in steam turbine construction, the scant consideration given is disappointing.

The "Table of Contents," repeated at the beginning of each section, is helpful to the reader by exposing the setting in which the subject matter is discussed. In this connection it is complementary to the general index at the end of the book.

A lack of uniformity in dealing with the references cited is somewhat disconcerting to the reader. In some cases a bibliography is provided at the end of the section which seems a desirable arrangement and avoids the tendency to confusion which arises when many miscellaneous footnotes are placed at the bottom of the page.

A feature of special merit, placed as a sort of conclusion for certain sections, is a list of references under the heading "Information on the state of the art to date (1938) may be obtained from the following articles."

This is a feature which authors of textbooks might adopt with great advantage in view of the statement, too often true, to the effect that textbooks tend to be about ten years behind the practice at the time of their publication. The criticism is probably justified in many cases when new developments are found to work out well in practice but for which a satisfactory theoretical basis for design has not been devised at the time.

Typographical errors seem bound to find a place in so large a work. In this volume the practising engineer is the victim of the proofreader's first observed lapse (p. viii, par. 1).

The book is nicely bound with a durable cover. The paper is good and the sizes of type are well suited to the text.

Trade Literature*

Leipzig Engineering Fair.—The new booklet outlining the various exhibits at the Great Engineering and Building Fair being held in Leipzig, Germany, March 5 to March 13, indicates the wide scope of this division of the historic Leipzig Trade Fairs. At the 1939 Spring show over 3,500 exhibitors from every major industrial country will place their latest engineering developments on display; an attendance of 300,000 buyers and executives from seventy-two different countries is expected.

The Reyrolle Works.—An interesting 36-page booklet, illustrating and describing the switchgear works of A. Reyrolle and Company Ltd. situated at Hebburn-on-Tyne, has been issued by the company. The text deals with the development of the undertaking since its beginning in 1886.

Natural Laws Applied to Production.—Mathews Conveyer Company Ltd., of Port Hope, Ont. have issued a 32-page booklet entitled "Natural Laws Applied to Production" dealing with the continuous flow principle of handling materials.

Small Size Worm Gear Speed Reducers.—Hamilton Gear and Machine Co., 62-100 Van Horne Street, Toronto, have issued No. 106-B of their series of catalogues which deal with their various products. The present catalogue describes and illustrates small size worm gear speed reducers. Thirteen other catalogues constitute the complete set of sections issued to date.

Machine-Operation Recorders.—A modern installation of Bristol's Machine-Operation Recorders is illustrated in a new bulletin recently published by The Bristol Company of Canada Limited, 64 Princess Street, Toronto.

Some of the helpful information for the manufacturer provided for by these instruments is indicated by the following: cutting or running time of the machine . . . delay time . . . idle time . . . set-up or make-ready time . . . quantity and rate of production.

Wood Pipe and Tanks Catalogue.—Canadian Wood Pipe and Tanks Ltd., of Vancouver, B.C. have issue a revised catalogue of data, designs and reference tables for users of their various products. The catalogue is of convenient size, well bound and contains 100 pages with many illustrations.

Reducing Valves, Regulators, etc.—Crude Oil Engine and Engineering Co. Ltd., have been appointed Canadian representatives of the Leslie Company of Lyndhurst, N.J., manufacturers of Leslie Reducing Valves, Temperature Regulators, Turbine and Reciprocating Pump Governors and Pipe Line Strainers. Bulletins regarding these products are being distributed and may be obtained upon request to the company's office, University Tower, Montreal, Que.

Steel Sheet Piling at Toronto Harbour.—An eight page bulletin dealing with "Toronto Harbour and the use of Larssen Piling in its Development," has been issued by Canadian Sheet Piling Co. Ltd., Castle Bldg., Montreal, from whom copies may be obtained.

Air-Operated Cycle Controller.—A new single-cam Cycle Controller that provides for the control of as many as four separate operations is now being built by The Bristol Co. of Canada Ltd., 64 Princess St., Toronto. These instruments are for Process Manufacturing, being extensively used in vulcanizing rubber products and in plastic moulding.

Centrifugal Pumps.—Darling Brothers Limited of Montreal have announced that copies of their latest Bulletin, No. 46-B, covering all types of Horizontal Side Suction Centrifugal Pumps, Class "D," are now available and can be obtained by writing to Darling Brothers Limited, 140 Prince St., Montreal.

The Bulletin comprises a comprehensive list of specifications, performance data and cross-sectional views which graphically illustrate the efficiency of design and operation for the purpose for which each type of pump is required.

*Copies of these publications may be obtained by writing to the companies mentioned.

New and Revised Specifications

American Society of Testing Materials: 1938 Supplement to Book of A.S.T.M. Standards.

Canadian Engineering Standards Association: C22.2-No. 50-1938 Construction and Test of Knife Switches; C22.2-No. 51-1938 Construction and Test of Armoured Cable and Armoured Cord. C22.2-No. 56 Construction and Test of Flexible Steel Conduit.

BOOK NOTES

The following notes on new books appear here through the courtesy of the Engineering Societies Library of New York. As yet, the books are not in The Institute Library, but inquiries will be welcomed at Headquarters, or may be sent direct to the publishers.

Handbook of Petroleum Accounting. By R. W. McKee. New York and London, Harper & Brothers, 1938. 496 pp., diagrs., charts, tables, 10 x 6 in., cloth, $5.00.

Marconi, the Man and his Wireless. By O. E. Dunlap, Jr. Rev. ed. New York, Macmillan Co., 1938. 362 pp., illus., 9 x 6 in., cloth, $3.50.

The life of Marconi is portrayed against the background of his invention—wireless telegraphy. The resulting biography constitutes a history of radio as well. Many historic events are related, together with the ordinary occurrences of a man's life and the developments of a new scientific field. This revised edition contains an account of his death.

Master Builders of Sixty Centuries. By J. A. Miller. New York and London, D. Appleton-Century Co., 1938. 315 pp., illus., charts, 8 x 6 in., cloth, $3.00.

An informal account of certain particularly interesting engineering achievements. Covering the whole span of history, it includes the pyramids, the Great Wall of China, the Roman aqueducts and roads, the Mayan temples, and other works down to modern suspension bridges, dams, canals, etc.

Metal Airplane Structures. By F. E. Loudy. New York, Norman W. Henley Pub. Co., 1938. 455 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $5.00.

A practical treatise on the design and construction of the major component parts of metal airplanes. Discusses the various types, materials of construction, structural elements, welded and riveted joints, stressed skin design, metal wings and beams, fuselage, and hull and float design. Contains tables, diagrams, formulae, and numerous illustrations.

Metallurgy. By C. G. Johnson, R. S. Dean and J. L. Gregg. Chicago, American Technical Society, 1938. 149 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $1.50.

A very concise elementary textbook, in which physical metallurgy is emphasized.

Modern Glass Practice. By S. R. Scholes. Chicago, Industrial Publications, Inc., 1937. 344 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $6.00.

Comprehensive information concerning glass and glass manufacture. Covers composition and chemistry of glasses, raw materials, mixing and melting practice, glassworking and annealing, mechanical and physical properties, colouring, and special types of glass and glassware.

Outlines and Lectures—**Program** for the First **Traffic Engineering Training School,** Aug. 16-28, 1937, conducted by Bureau for Street Traffic Research (formerly located at Harvard University) and Institute of Traffic Engineers. Co-operating organizations: American Public Works Association, Automotive Safety Foundation, American Automobile Association, National Safety Council, and National Conservation Bureau. Publ. by Bureau for Street Traffic Research, now located at Yale University, New Haven, Conn. 224 pp., mimeographed, tables, 12 x 9 in., paper, $1.00.

A compilation of the lectures or lecture outlines as given during the two-weeks' period of the training school. Also appended are professional data concerning the traffic authorities who composed the faculty, lists of students attending, with states and colleges represented, and a bibliography.

Photoelectric Cell Applications. By R. C. Walker and T. M. C. Lance. 3 ed. New York and Chicago, Pitman Publishing Corp., 1938. 336 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $4.00.

Restricted to discussion of the alkali-metal cell (with some reference to the rectifier cell), the circuits and installations used in counting and handling devices, alarms, sound reproduction, phototelegraphy, television and miscellaneous applications are described. Accessory equipment is also considered.

Practical Shell Developing for Steel Shipbuilders. By A. F. Tulin. London, Crosby Lockwood & Son; New York, Simmons-Boardman Publishing Corp., 1938. 153 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $3.00.

A manual for loftsmen, shipfitters, hull draftsmen and others who deal with steel ship construction. The work explains the development and laying-out of the shell of a vessel, considering mainly the points of mold-loft procedure beyond the minor fundamentals which are assumed as familiar.

The **Principles of Motor Fuel Preparation and Application,** Vol. I. By A. W. Nash and D. A. Howes. 2 ed. New York, John Wiley & Sons, 1938. 628 pp., illus., diagrs., charts, tables, 10 x 6 in., cloth, $9.50.

This comprehensive work comprises two volumes, of which Volume I is here considered. It deals fully with the production of motor fuels by distillation, cracking, extraction from natural gas, and hydrogenation. It also contains chapters on the production of benzole and various synthetic fuels, including alcohols, on general storage and distribution, and (in this second edition) pyrolysis and polymerization processes. There is a patent index.

Radio Laboratory Handbook. By M. G. Scroggie. London, Wireless World, Iliffe & Sons, 1938. 384 pp., illus., diagrs., charts, tables, 8 x 5 in., cloth, 8s. 6d.

This handbook has been prepared with special consideration of the needs of amateurs and laboratory workers. Complete information concerning laboratory equipment, necessary instruments and correct operating methods is given. Discussion covers fundamental principles, sources of power and signals, measurements, and certain specialized types of work, such as ultra-high-frequency. A reference chapter contains symbols, abbreviations, formulae, laws, tables and other data.

Railroadman. By C. D. French. New York, Macmillan Co., 1938. 292 pp., illus., 9 x 6 in., cloth, $2.50.

The plain, unvarnished biography of a railroad man who began as a messenger and call-boy at the age of thirteen in 1873, and saw active service until 1930, when he retired at seventy. He served as telegrapher, switchman, brakeman, fireman, engineer, conductor and yardmaster at various periods and on fifteen different railroads west of the Mississippi. His story is an interesting contribution to railroad history.

Rebirth of Monopoly. By W. J. Kemnitzer. New York and London, Harper & Brothers, 1938. 261 pp., charts, diagrs., tables, 9 x 6 in., cloth, $2.50.

The thesis of this book is that monopoly in the petroleum industry of the United States is being reborn and that such rebirth in so large and powerful an industry has great possibilities of danger to the competitive system and the public welfare.

Road Traffic and its Control. (Roadmakers' Library.) By H. A. Tripp. London, Edward Arnold & Co.; New York, Longmans, Green & Co., 1938. 414 pp., diagrs., charts, tables, 9 x 6 in., cloth, $10.00.

This volume presents an unusually comprehensive survey of the traffic problem by the Assistant Commissioner of Police, Scotland Yard, in charge of traffic. Traffic control by law and police, the development of traffic policy, control by construction and mechanical appliances, road transport and road casualties are discussed clearly and in considerable detail, with attention to the problems of legislation, public opinion, psychology and town planning which are involved. Although written for British conditions, the book has much of interest to other countries.

The Rôle of Scientific Societies in the Seventeenth Century. By M. Ornstein. Chicago, University of Chicago Press, 1938. 308 pp., illus., tables, 9 x 6 in., cardboard, $3.00.

An interesting and valuable contribution to the history of science, which calls attention especially to the ways in which scientific development was aided by the scientific societies of the seventeenth century. It also contains valuable accounts of the work of many famous scientists of the period and a description of the scientific work of the universities. There is a bibliography. The new edition retains the text of the original one, but also contains numerous illustrations.

Route Surveys. By H. Rubey. New York, Macmillan Co., 1938. 261 pp., diagrs., charts, tables, 7 x 4 in., lea., $3.75.

A textbook for a course in curves and earthwork intended to treat the problems of route location, curve layout, and the measurement, computation and layout of earthwork, as elements applicable to many forms of engineering work, such as highways, canals, pipe lines, and transmission lines, as well as to railroad construction.

The Science of Production Organization. By E. H. Anderson and G. T. Schwenning. New York, John Wiley & Sons, 1938. 282 pp., 9 x 6 in., cloth, $3.50.

The relation of scientific management to production economics is the subject of this book. The major part is devoted to the physical organization of work through operation study or job analysis and to the various types of organization of workers within small departments, plants, or whole enterprises. The authors also discuss briefly larger aspects of the production problem. There is a large bibliography.

The Silver Magnet. Fifty Years in a Mexican Silver Mine. By G. Shepherd. New York, E. P. Dutton & Co., 1938. 302 pp., illus., 9 x 6 in., cloth, $3.00.

The Soybean Industry. By A. A. Horvath. New York, Chemical Publishing Co., 1938. 221 pp., tables, 9 x 6 in., cloth, $4.00.

This work describes the methods of milling soybeans, the processes of extracting and purifying the oil and the uses of the oil and meal.

Spectrochemical Abstracts, 1933-1937. By F. Twyman. London, Adam Hilger, Ltd., 1938. 52 pp., 10 x 6 in., linen, 3s. 10d.

This bibliography contains abstracts of over two hundred papers on spectrochemical analysis published within the period. The work is in two sections, an alphabetic arrangement by authors and a classed arrangement under substances examined, apparatus and methods.

Steam and Gas Engineering. By T. E. Butterfield, B. H. Jennings and A. W. Luce. 3 ed. New York, D. Van Nostrand Co., 1938. 490 pp., illus., diagrs., charts, tables, 10 x 6 in., cloth, $4.50.

A comprehensive textbook on the subject, covering combustion, fuels and fuel-burning equipment, types of power plants and engines with their mechanical accessories, and refrigeration. Thermodynamical theory is considered as each particular subject is discussed. Practical problems are included.

Structural Aluminum Handbook. Pittsburgh, Pa., Aluminum Company of America, 1938. 211 pp., diagra., tables, 9 x 6 in., lea., $1.25.

This handbook gives the fundamental data concerning the ultimate strength of aluminum-alloy structural members. The characteristics, manufacture and fabrication of structural products are described and the design of structures discussed. The properties of elements of sections for structural shapes are tabulated and specifications, tolerances and commercial sizes given.

Structural Design. By H. Sutherland and H. L. Bowman. New York, John Wiley & Sons, 1938. 402 pp., diagra., charts, tables, plates, 9 x 6 in., cloth, $4.50.

This is a college text covering the fundamentals of the theory and practice of design in steel and timber. The first four chapters and Appendix A contain an amplified résumé of the important considerations met with in the strength of materials course, the remaining chapters apply these fundamentals to common structures, and the remaining appendices provide specifications and design data.

Structure of Steel. By E. N. Simons and E. Gregory, with an introduction by F. C. Lea. New York, Prentice-Hall, 1938. 115 pp., illus., diagrs., charts, tables, 8 x 5 in., cloth, $2.00.

A simple, non-technical explanation of the structure of steel, considering the various combinations of iron with carbon and other alloying constituents, the properties of the various internal structures, with the methods and heat treatments used to produce them, and brief information on corrosion and x-ray examination.

Studies on the Periodicity of Earthquakes. By C. Davison. London, Thomas Murby & Co., 1938. 107 pp., charts, tables, 9 x 6 in., cloth, 13s. 6d.

Dr. Davison has here summarized and thoroughly revised the various articles on the periodicity of earthquakes which he has published during more than forty years. The bearing of these studies upon movements of the earth's crust is discussed.

Technical Progress and Unemployment. Studies and Reports, Series C (Employment and Unemployment) No. 22. By E. Lederer. Geneva, Switz., International Labour Office, 1938. 267 pp., tables, 10 x 7 in., paper, $1.50 [obtainable from U.S. branch, Washington, D.C.].

This study is an analysis of the social and economic effects of technical progress, especially on unemployment and on the formation of capital. The author discusses the various forms of technical progress, the concept of technological unemployment, increasing and diminishing returns, the equilibrium of the labour market, the effects of technical progress on the economic system and the labour and capital market, the elasticity of modern monetary systems, technical improvements and the business cycle, and capital-saving technical improvements.

Television, a Struggle for Power. By F. C. Waldrop and J. Borkin, with an introduction by C. H. Payne. New York, William Morrow & Co., 1938. 299 pp., 9 x 6 in., cloth, $2.75.

Television may be expected to have profound social and political effects, and the question of its control is a matter of great public concern. This book discusses modern developments in communication through movie, radio and television and calls attention to the need for a definite public policy.

Tendances actuelles des techniques de la chaleur. By M. Véron. Paris, Dunod, 1938. 189 pp., illus., diagrs., charts, tables, 8 x 6 in., paper, 48 frs.; bound, 65 frs.

This volume presents a synthesis of present tendencies in heat engineering, based upon a conference held in 1936. The essential notions underlying heating apparatus are reviewed, after which the author describes the practical applications of accelerated convection in boilers and heating furnaces, and discusses the practical consequences of modern work on radiation. A thorough study of present tendencies in boiler design is followed by short accounts of tendencies in furnace and grate construction.

Theory of Mechanical Refrigeration. By N. R. Sparks. New York and London, McGraw-Hill Book Co., 1938. 225 pp., diagrs., charts, tables, 9 x 6 in., cloth, $3.00.

The content of this elementary textbook has been restricted to such material as is necessary for a presentation of the fundamental thermodynamic approach to the subject of refrigeration. The practical data included are only those that will assist in interpreting the text of the book, the aim being to present a general demonstration of the application of fundamentals.

Thermodynamics, Fluid Flow and Heat Transmission. By H. O. Croft. New York and London, McGraw-Hill Book Co., 1938. 312 pp., diagrs., charts, tables, 9 x 6 in., cloth, $3.50.

The purpose of this textbook is to review thermodynamics, introduce dimensional-analysis, fluid-flow and heat-transmission problems, and to combine this material into one continuous study covering fields of engineering knowledge encountered in actual problems. An elementary knowledge of thermodynamics and hydraulics is assumed.

Transformatoren mit Stufenregelung Unter Last. By E. Bölte and R. Küchler. Munich and Berlin, R. Oldenbourg, 1938. 182 pp., illus., diagrs., charts, tables, 10 x 6 in., cloth, 9.60 rm.

This book discusses the theory, construction and use of transformers equipped with tap changers in a comprehensive, practical manner. A brief bibliography is included.

Transformer Engineering. By L. F. Blume, G. Camilli, A. Boyajian and V. M. Montsingar; ed. by L. F. Blume. New York, John Wiley & Sons, 1938. 496 pp., diagrs., charts, tables, 9 x 6 in., cloth, $5.00.

The authors of this volume, who are of the Transformer Department of the General Electric Company, have designed the work to assist engineers in the specification, selection, application and operation of transformers. The treatment emphasizes the essential physics concerned in each problem.

William Tyrrell of Weston. By E. L. Morrison and J. E. Middleton. Toronto and New York, (The) Macmillan Co., 1937. 152 pp., illus., 9 x 6 in., cloth, $3.00.

The story of a young Irishman who went to Canada in the early 19th century and built up a high reputation as an architect and builder, bridge engineer, surveyor, geologist, expert in municipal affairs, magistrate, and gentleman. It provides a picture of the territory around Toronto as it was through the latter half of the last century.

VDI (Verein deutscher Ingenieure) Sonderheft **Flugabwehr.** Berlin, VDI-Verlag, 1938. 51 pp., illus., diagrs., charts, tables, 12 x 8 in., paper, 2.75 rm.

This pamphlet contains nine papers upon various aspects of anti-aircraft defence, reprinted from the Zeitschrift des Vereines Deutscher Ingenieure and the Rundschau Technischer Arbeit. Collectively, they afford a general review of current developments, with emphasis upon the engineering problems involved in the construction and use of defense equipment.

Wireless Servicing Manual. By W. T. Cocking. 4 rev. ed. London, The Wireless World, Iliffe & Sons, Ltd., 1938. 278 pp., illus., diagrs., charts, tables, cloth, 5s. 5d.

This handbook covers the principles and practice of the repair and adjustment of wireless receivers. Methods of fault finding are dealt with in detail, the use of the necessary test apparatus is described, and ganging procedure is fully treated. Specific tables and data are included in appendices. A chapter is devoted to television receivers.

The Modernization of Steam Generating Plants

With the steady increase in electricity consumption—an increase which, so far as the domestic lighting and heating load is concerned, much exceeds that anticipated by many prophets—the problem of expanding the capacity of central supply stations has become one of importance. In most of the older stations, pressures range from 200 lb. to 400 lb. per sq. in., with moderate superheats represented by temperatures varying between 550 deg. and 750 deg. F. More recent plants work at pressures between 650 lb. and 1,850 lb. per sq. in., and steam temperatures in the region of 800 deg. to 900 deg. F. In the case of the newer stations, the problem of increasing capacity is fairly simply solved, and is mainly concerned with the evaporative capacity of new boiler units and the power to be developed by new turbines. With older stations a number of solutions are often possible, from which a choice has to be made.

At a first glance it might, for instance, be thought advisable to build an entirely new plant, designed on modern lines, and to use this for normal load, retaining the old for peak-load service. This plan gives the double advantage of increased capacity coupled with improved thermal efficiency during normal production, and is probably the most common method of attacking the problem. Generally it results, as time goes on, in the gradual replacement of the older plant by modern units. A second solution, and one which is becoming increasingly popular, especially in America, is the super-imposition of high-pressure boiler and turbine equipment on the old plant. In these cases the steam generated by the new high-pressure boiler is taken by the new turbine, exhausted into the original low-pressure main, and is then used with the low-pressure boiler steam in the old turbines. In the latter, the whole is exhausted down to condenser pressure. Obviously this super-imposing, or "topping" as it has come to be termed, not only increases the station capacity, but also adds appreciably to its thermal efficiency, and thus proves very attractive.

The popularity of this method of meeting the situation is largely due to the increased confidence which, it is felt, can now be placed in steam generators working at pressures ranging from 1,000 lb. to 1,850 lb. per sq. in. and delivering steam superheated to temperatures in the neighbourhood of 900 deg. F. It is undoubtedly the fashion at the present time, but though it gives admittedly immediate results of a satisfactory nature, the future presents scope for interesting speculation; for, when the older part of the plant does become obsolescent, as in course of time it must, what will be the correct procedure as regards re-equipment or expansion? Will the newer plant be left, so to speak, high and dry, or will the renewal of the old plant become essential, much on the old lines, in order to preserve the entity of the whole? Sufficient, perhaps, to the day is the evil thereof—so far we have not heard much of the attention paid to this aspect of the matter by those who advocate topping at the present time, though in the effort to "balance dollars and kilowatts" it has doubtless not been altogether overlooked.)—*Engineering.*

Air Raid Precautions and Steel Construction

On September 12, a number of scale models of air-raid shelter construction were exhibited by the British Steelwork Association, Tothill Street, London, S.W.1, at the Hotel Victoria, Northumberland Avenue. The purpose of this exhibition was to demonstrate how the normal every-day products of the steel industry can be applied to the constructional aspects of air raid protection. The models included a block of slum clearance flats showing various alternative constructions for a steel frame building with the roofs and floors reinforced beyond normal requirements, and the strengthening of the basement of an existing multi-storey brick building, using a simple form of construction to take the whole weight of any débris and to give lateral strength. Models of underground shelters were shown in which use was made of experience in colliery arch construction, comprising steel ribs with a covering of corrugated steel sheets, and an "Everyman" shelter consisted of a few standard lengths of galvanized sheet to cover a trench. The models were shown at the Building Exhibition, which opened in London and will afterwards be on loan to A.R.P. organizations and local authorities.—*Engineering.*

General Assembly of the International Union of Geodesy and Geophysics

Following an invitation from the President of the United States, arrangements are being made to hold in the United States the next general assembly of the International Union of Geodesy and Geophysics which will take place in Washington from the 4th to the 15th of September, 1939.

Countries which adhere to the Union, and all other countries or bodies interested in Geodesy and Geophysics, will receive direct from America through diplomatic channels, letters of invitation to attend the Washington Conference.

The various national committees are being asked for recommendations regarding matters which will appear on the agenda.

The objects of the International Union are to promote the study of problems concerned with the figure and physics of the earth; to initiate international co-operation and to provide for their scientific discussion and publication; to facilitate special researches, such as the comparison of instruments used in different countries.

In accordance with the constitution of the Union the Assembly will be attended by delegates from the various national committees and by guests specially invited by the President of the United States on the recommendation of the national committees.

The chairman of the National Committee of Canada is Noel J. Ogilvie, Director, Geodetic Service of Canada, Ottawa, and the secretary Ernest A. Hodgson, Seismologist, Dominion Observatory, Ottawa.

BRANCH NEWS

Border Cities Branch

J. F. Bridge, A.M.E.I.C., Secretary-Treasurer.

The second meeting of the season was held in the Prince Edward hotel, Friday, October 21st, 1938. About thirty were present at the dinner to welcome the speaker, Mr. Jesse McBride, Vice-President of Palmer-Bee Company Detroit. The following is an abstract of his address on:

Conveyor Economics

The conveyor business has grown from practically nothing in the last few decades to a forty million dollar sales volume in 1937.

The materials handled by conveyors are mainly bulk materials, such as coal, grain, cement, sand, gravel, etc., or unit materials, such as cars, radios, washers, stones, etc. Conveyors also find wide application in the processing of materials, as in connection with heat treating and annealing, washing and drying, plating, etc. Conveyors used for the handling of materials are usually either belt conveyors, chain conveyors, screw conveyors or skip hoists.

Belt conveyors either flat or troughed are used for conveying bulk or unit materials long distances. As much as 1,500 tons of coal per hour has been transported four miles by this type of conveyor.

The chain conveyor can be used on greater inclines; it has greater strength but is slower than the belt type. There exists an 8,000 ft. conveyor of this type used in transporting various auto parts.

The screw conveyor, usually employed in handling grain and coal, uses more power but takes less space than the other types.

The advantages of conveyors in factory production methods are: Floor space is saved, as much as 1/10 to ¼ by using the conveyors as transportation systems. Work is often done directly on conveyors.

Conveyors are used as pacemakers. They cause increased production per man, point out weak men not suited for that particular task. As a means of transportation they insure speed, more volume, lack of damage, less handling. They tend to transfer the control of production from workmen to management, create a neat and orderly factory, and reduce losses due to rejections. Better products are turned out, human effort and strength is conserved.

At the completion of his interesting paper, Mr. McBride showed slides of all types of conveyors and answered the many questions that were asked.

It was moved by T. H. Jenkins, A.M.E.I.C., that Mr. McBride be given a hearty vote of thanks. All present agreed.

Calgary Branch

B. W. Snyder, A.M.E.I.C., Secretary-Treasurer.
J. S. Neil, A.M.E.I.C., Branch News Editor.

Our annual golf tournament was held at Strathmore, under ideal weather conditions and with approximately 50 members, wives and friends present, on September 10th, 1938. The Strathmore course was in excellent condition and more than half of those present played the royal and ancient game.

Non-golfers were conducted over the C.P.R. supply farm and irrigation headquarters gardens and orchards, by T. Schulte, A.M.E.I.C. This tour proved most interesting and was greatly enjoyed.

Tea was served on the spacious lawn at the residence of Mr. and Mrs. G. H. Patrick, with Mrs. E. W. Bowness and Mrs. G. P. F. Boese officiating at the table.

A most pleasant afternoon was concluded by a short address by the Branch chairman, E. W. Bowness, M.E.I.C., who thanked Mr. and Mrs. Patrick and Mr. and Mrs. G. P. F. Boese and all those responsible for the tournament, the tea party and the trip over the C.P.R. headquarters.

A general meeting of the branch was held on Friday, October 7th, 1938. This meeting took the form of a dinner entertainment provided through the kindness of the Canadian Western Natural Gas, Light, Heat and Power Company Limited. Dinner was served at 6.30 p.m., with 54 members and 4 guests in attendance.

During the course of the dinner, E. W. Bowness, M.E.I.C., having to leave early, turned the chair over to S. G. Coultis, M.E.I.C., but before doing so he urged the members to make themselves acquainted with the new and younger members of the Branch, as this was one of the primary reasons behind this informal gathering. Mr. Bowness also announced the impending visit of Dean C. J. MacKenzie, M.E.I.C., of the University of Saskatchewan on November 18th.

Mr. Coultis thanked Mr. Bowness on behalf of those present.

At the conclusion of the dinner, the guests were welcomed by Mr. Coultis and new members were introduced by the secretary.

After a short address by G. A. Gaherty, M.E.I.C., of the Calgary Power Company, and a short intermission, all present were entertained by the Gas Company's orchestra comprised of Messrs. Ted Forsey (at the piano), Banks, McDougall and Brailey; Mr. Stan James with his piano accordion; Mr. Brailey with his marimbaphone; Miss Fay Thoms and Miss Maisie Foster with songs and tap dances. G. H. Patrick, A.M.E.I.C., also contributed to the entertainment by singing a couple of his rousing songs, which were much appreciated.

A vote of thanks to the Gas Company, Mr. Bowness and his staff was unanimously carried.

The meeting adjourned with one and all of the opinion that this was the best yet.

A branch general meeting was held on October 20th in the Palliser Hotel with about 50 present. This meeting was turned over to our secretary, Mr. Snyder, who delivered an interesting paper entitled "The Operation of Calgary's Natural Gas System."

Calgary Branch Dinner for the President and Party.

Calgary Branch Executive Committee Luncheon with President and Party.

On November 3rd, 1938, we had the pleasure of a visit from Dr. J. B. Challies, L. Austin Wright, A.M.E.I.C. and Fred Newell, M.E.I.C., president, secretary and council member of The Institute respectively.

A dinner was arranged to which were invited all members of the E.I.C., the Canadian Institute of Mining and Metallurgy and the Association of Professional Engineers of Alberta, and their ladies. The city of Calgary was represented by Deputy Mayor, Frank R. Freeze.

A most enjoyable dinner was served at the Renfrew Club, at the conclusion of which an address was given by Dr. Challies, followed by short addresses by G. A. Gaherty, M.E.I.C., of the Calgary Power Company, Mr. Newell and Mr. Wright. Greetings on behalf of the city of Calgary were extended by Mr. Freeze in the absence of Mayor "Andy" Davidson.

E. W. Bowness, M.E.I.C., local chairman of the E.I.C., presided in his own inimitable way. Col. Steele of the C.I.M.M. made a few short remarks and welcomed the party to the C.I.M.M. Western Annual General Meeting to be held at Victoria, B.C., in the near future.

Those present were greatly pleased with the speeches and a most enjoyable and instructive evening came to a close with the singing of the National Anthem.

At noon of the same day, a splendid luncheon meeting was held with the Branch executive at the Ranchman Club, at which the affairs of the engineer, The Institute and the Branch were thoroughly discussed.

Edmonton Branch

F. A. Brownie, A.M.E.I.C., Secretary-Treasurer.
J. W. Porteous, Jr.E.I.C., Branch News Editor.

Special meetings of the Edmonton Branch were held on Tuesday, November 1st, 1938, to meet and hear members of President J. B. Challies' party from Montreal.

Dr. Challies, Councillor Newell, G. A. Gaherty, M.E.I.C., and L. A. Wright, A.M.E.I.C., spoke at a noon luncheon and executive meeting dealing particularly with business matters.

During the day the ladies of the party were entertained at a noon luncheon and an afternoon tea at the home of Mrs. R. S. L. Wilson.

In the evening a formal mixed dinner was held, to which members of the Association of Professional Engineers of Alberta and of the Canadian Institute of Mining and Metallurgy were invited. Major General A. G. L. McNaughton, M.E.I.C., President of the National Research Council, Mrs. McNaughton, President and Mrs. W. A. R. Kerr of the University of Alberta, and L. A. Thorssen, S.E.I.C., President of the Engineering Students Society of the University, were special guests. The meeting was in charge of Branch Chairman W. E. Cornish, A.M.E.I.C.

At the instigation of Mr. Wright, Mr. Challies presented the Plummer Medal to Mrs. E. Stansfield in recognition of her husband's paper, "The Burning of Low Rank Alberta Coals." The Engineering Institute Prize was presented to Mr. L. Thorssen.

The toast to the profession was ably proposed and answered by A. W. Haddow, A.M.E.I.C., and Mr. Challies respectively.

The toast to the ladies which was wittily proposed by Mr. Wright, was responded to with equal wit by Mrs. E. Stansfield. During the evening several short speeches were given by some of the visitors and entertainment in the form of songs was provided by Mr. E. F. McGarvey accompanied by Mr. R. R. Couper.

Altogether it was very pleasant to meet Dr. Challies, Mr. Newell, and Mr. Wright and to renew acquaintance with Mr. Gaherty.

Edmonton Branch Dinner During President's Visit.

Halifax Branch

R. R. Murray, A.M.E.I.C., Secretary-Treasurer.
A. D. Nickerson, A.M.E.I.C., Branch News Editor.

The first meeting of the winter season was held at the Halifax hotel on October 20th, 1938. Mr. R. D. McKay, Sanitary Engineer, Department of Public Health, spoke on the proposed new world calendar which is being sponsored by the World Calendar Association of New York City.

Mr. McKay spoke briefly on the history of the calendar pointing out the early difficulties in devising one that would keep exactly in step with the seasons over a long period of time. Our present calendar—which is the Roman calendar with one modification—is out of step by one day in 20,000 years.

The proposed new calendar will contain 12 months, each with 26 working days. The calendar will repeat itself each year, thus eliminating one important disadvantage of the present calendar. January will have 31 days beginning on Sunday. February will have 30 days beginning on Wednesday. March will have 30 days beginning on Friday. April will have 31 days beginning on Sunday. Each quarter of the year is thus a repetition of the previous quarter. It is proposed that the 365th day in the year be an extra Saturday to be known as Year End Day. On leap years an extra Saturday would be inserted at the end of June. All holidays would be adjusted to come on Mondays in the new calendar.

Church bodies universally have approved of the new calendar; they are particularly interested since it will lead to the establishment of a fixed date for the celebration of Easter. The League of Nations have approved the new calendar and have submitted it to all governments for proposed adoption, in 1940.

It is felt in some circles that the advantages of the new calendar are slight, and that the effort of changing to it is not justified.

Hamilton Branch

A. R. Hannaford, A.M.E.I.C., Secretary-Treasurer.
W. E. Brown, Jr.E.I.C., Branch News Editor.

The regular monthly meeting of the Hamilton Branch was held on November 15th, 1938, in the lecture theatre at McMaster University, the subject being "The Story of Dynamite" and "Power in Industry" by Mr. G. C. Grubb.

In opening the meeting the Chairman, W. J. W. Reid, M.E.I.C., said that as during the afternoon many of the members had attended the funeral of R. L. Latham, he would ask R. K. Palmer, M.E.I.C., to say a few words about our departed member and friend. We quote Mr. Palmer:

"I am surprised to find myself addressing you tonight but, because we have today performed the last service we can render to one of our most esteemed members, I have been asked to say just a few words to you in appreciation, more because Dick Latham and I have known one another, and been friends, since the early years of the century and have been next door neighbours for the past twenty years, rather than because I can do it in as fitting terms as can many of his other friends.

"Richard L. Latham, born in Toronto, a graduate of Toronto University, 1901 in Civil Engineering, came to Hamilton very shortly after his graduation and joined the engineering staff of the then young Toronto, Hamilton and Buffalo Railway, under Mr. Fisher who was then chief engineer. A few years thereafter he became chief engineer and has held that position with distinction down the years to the present time.

"Now, there is no question that Dick Latham was technically competent in all those things that pertain to day in and day out railway engineering which is evidenced by the fact that the Toronto, Hamilton and Buffalo Railway has been kept in a state of efficiency since its beginning. But there is more than that.

"Dick Latham has held the respect of every member of his staff and I personally know that he has always had their esteem and co-operation in all the railway's undertakings. He has likewise had that same esteem and co-operation from the heads of all the other departments. And more than that. He has had the esteem of those engineers who are in charge of the engineering departments of the other Canadian and American railways, as is evidenced by the presence here today of J. M. R. Fairbairn, M.E.I.C., Chief Engineer of the Canadian Pacific Railway; W. A. Duff, M.E.I.C., Engineer of Roads and Bridges, Canadian National Railways; S. B. Clement, M.E.I.C., Chief Engineer, Temiskaming and Northern Ontario Railway; D. G. Kilburn, M.E.I.C., Division Engineer, Board of Railway Commissioners, Ottawa; J. R. W. Ambrose, M.E.I.C., Superintendent, Toronto Terminals, and Mr. Neubert, Chief Engineer, New York Central System.

"He held the confidence and trust of those men who are ultimately and finally responsible to their stockholders for the successful operation of their railway.

"In his dealings with the City and the Province and with the many contractors, he always worked for his company as every engineer should do but, so far as I am aware, there never has been any feeling but one of confidence and fairness in all the broad aspects of such dealings.

"Gentlemen, we have lost a good friend, a good neighbour, and finally, a good engineer, and one who has been a credit to our profession."

At the close of his remarks Mr. Palmer asked the assembly to rise for a few moments silence and reflection.

The speaker of the evening Mr. Grubb, Manager of the Explosives Division of the Canadian Industries Limited was introduced by J. R. Dunbar.

Mr. Grubb's lecture was divided into the following sections,

1. Brief history of the development of explosives.
2. General description of a modern explosives plant.
3. Raw materials used in manufacture.
4. Brief description of manufacture.
5. Importance of explosives to our present civilization.

The speaker prefaced his talk with this important definition. An explosive reaction is the rapid transformation of a material into other more stable substances, largely or entirely gaseous; such reaction always produces intense heat. It is the rapid expansion of the gases so formed into a volume very much larger than that occupied by the original substance which accomplishes the useful work which is intended.

Black blasting powder is the oldest of all explosives and while the Chinese are often given credit for the invention, the most authentic records indicate that the monk, Roger Bacon, invented it about 1252. For 300 years it was put to no useful purpose but in 1613 it was used for mining in Saxony and towards the end of the century for road building in Switzerland.

The most important modern explosive is one with a nitroglycerine base.

Nitroglycerine, the most powerful explosive known, was discovered by Sobrero at Turin in Italy in 1846. He made little use of it but Alfred Nobel, the father of high explosives, was a Swedish engineer who in 1860 started to carry on most of his work in Scotland. In 1870 he made the epoch making discovery of dynamite; this was followed by his discovery, by reason of necessity through the danger entailed by carrying the liquid, of gelatin as a solidifier or base.

Nobel is perhaps better known as the donor of prizes for the advancement of literature, science and peace.

Approximately 90 per cent of all high explosives in the world are of the dynamite or gelatin class. In Canada about 70 per cent of the high explosives used are of the gelatin class. This explosive is suitable for use in gaseous places and dusty mines.

The most common explosive for military purposes is trinitrotoluene (TNT) and cordite. These explosives are normally unsuitable for industrial use.

The arrangement of an explosive plant requires from 500 acres to 1,000 acres of ground so that danger zones may be given much space. Such a plant will contain an extensive power house also many conveniences for workers with a complete village of from 50 to 100 houses, also a school and church and all modern city conveniences.

Of the raw material nitrate of soda is now largely made synthetically from atmospheric nitrogen. This artificial production is one of the greatest triumphs of chemical engineering.

The speaker dealt with the use of glycerine, nitric acid and sulphuric acid in the work of the manufacture of explosives.

It will interest all to know that the degree of civilization and prosperity of a country can be closely measured by its relative per capita consumption of explosives for useful purposes, a few of which follow; fishing industry, breaking ice so that sealing and whaling ships may reach their hunting grounds; lumber industry, blowing out stumps, breaking up log jams, breaking up ice jams; excavating, mining, etc. Probably the largest blast on record was made recently at Flin Flon, Manitoba, where 280,000 lb. of explosives were set off in one huge blast to shatter 500,000 tons of ore for the Hudson Bay Mining and Smelting Company, Limited.

The lecture was followed by two moving picture reels: "The Manufacture of Explosive" and "Power in Industry."

Owing to inclement driving weather the meeting for this instructive meeting was attended by only 48 members, and E. G. MacKay, A.M.E.I.C. in moving a vote of thanks to Mr. Grubb regretted this detail.

At the close of the meeting members adjourned for the usual social half hour and coffee and sandwiches.

Lakehead Branch

H. Os, A.M.E.I.C., Secretary-Treasurer.

The President and party arrived at Port Arthur on October 25th, 1938, at 10.20 p.m. Members of the local branch and their ladies met the train to welcome the visitors to the Lakehead Branch and escorted them to the Prince Arthur hotel.

After registering at the hotel, Dr. and Mrs. J. B. Challies, Mr. and Mrs. Newell, and L. Austin Wright, together with members of the local branch and their wives, motored to Fort William where they were entertained at the home of Mr. and Mrs. G. R. Duncan.

An informal luncheon, with Dr. J. B. Challies and Mr. F. Newell and L. Austin Wright as guests, was held at the Royal Edward hotel, Fort William, at 1.00 p.m., October 26th. Present were the members of the Executive committee and prominent members of the local branch. The object of this meeting was to enable local members to meet the visiting officers of The Institute to discuss Institute affairs.

Dr. Challies spoke on consolidation. The speaker contended that the contemplated consolidation of The Engineering Institute with the Professional Associations came before the membership at large was ready for this change and that this issue was voted down in practically every province. He stated, however, that the Consolidation Committee's work had not been in vain. He spoke of the great step forward in the general approval by the membership of by-law 76 giving wide power to enter into close co-operation with the Provincial Associations.

The speaker also discussed the proposed reduction of council and voiced his conviction that this change would not be beneficial.

Mr. F. Newell, Councillor of The Institute, discussed means and methods whereby a closer co-operation between The Engineering Institute and other engineering organizations could be realized.

The different grades of membership were clarified by L. Austin Wright, A.M.E.I.C., General Secretary.

Mr. Wright also gave a very interesting talk on a meeting held last summer at New York as a joint meeting of the Engineering Council of Professional Development.

Other speakers were Messrs. J. Antonisen, M.E.I.C., P. E. Doncaster, M.E.I.C., and G. R. Duncan, S.E.I.C.

E. L. Goodall, A.M.E.I.C., chairman of the local branch, presided at the meeting.

A Dinner Meeting of the Lakehead Branch, at which the President and Party were present

Engineers and their wives attended a dinner meeting of the Lakehead Branch in the Prince Arthur hotel on October 26th. Eighty-eight persons sat around the tables.

A feature of the evening was the introduction of Miss E. M. G. MacGill, A.M.E.I.C., a member of the engineering staff of the Canadian Car and Foundry Co. aeroplane plant in Fort William. Miss MacGill, who is a member of the Lakehead Branch, is the only woman member of The Institute in Canada.

President J. B. Challies, in the principal address of the evening, paid tribute to an old friend, Hon. C. D. Howe, Hon.M.E.I.C., Minister of Transport, as "one of our great engineers, rendering outstanding service to the country." He also commended Dr. Thomas Hogg, M.E.I.C., chairman of the Hydro-Electric Power Commission of Ontario, as an engineer doing great public service.

"Fifty years ago the few outstanding engineers in Canada were self-made men, with no colleges in Canada to give them training. Last year 3,500 students graduated in various branches of engineering from 11 Canadian colleges," Dr. Challies said.

Councillor Fred Newell, M.E.I.C., spoke on the movement for co-operation between the engineering associations, which would reach one of its climaxes in Regina on Saturday with the signing of an agreement between The Institute and the Saskatchewan body.

L. A. Wright, A.M.E.I.C., General Secretary, outlined advantages of membership in the organization.

Mr. Newell was introduced by H. G. O'Leary, and Dr. Challies was introduced by R. J. Askin, district councillor for The Institute. A vote of thanks was tendered by G. R. Duncan and J. M. Fleming. E. L. Goodall, chairman of the branch, presided.

Joint Luncheon of the Lethbridge Branch of The Engineering Institute of Canada and the Association of Professional Engineers of Alberta. Left to right: C. S. Clendening, A.M.E.I.C., G. H. Thompson, A.M.E.I.C., C. S. Donaldson, A.M.E.I.C., F. G. Cross, M.E.I.C., J. Haimes, A.M.E.I.C., C. M. Moore, A.M.E.I.C., J. B. Burke, D. W. Hays, M.E.I.C., N. H. Bradley, A.M.E.I.C., G. A. Gaherty, M.E.I.C., R. Livingstone, M.E.I.C., J. T. Watson, A.M.E.I.C., C. E. MacKinnon, A.M.E.I.C., W. L. McKenzie, A.M.E.I.C., Dr. J. B. Challies, M.E.I.C., R. F. P. Bowman, A.M.E.I.C., Fred Newell, M.E.I.C., A. J. Branch, A.M.E.I.C., G. F. Hilliard, E. A. Lawrence, S.E.I.C., P. M. Sauder, M.E.I.C., L. A. Wright, A.M.E.I.C., G. S. Brown, A.M.E.I.C., H. W. Rowley, A.M.E.I.C., R. S. Lawrence, A.M.E.I.C., J. M. Campbell, A.M.E.I.C.

Lethbridge Branch

E. S. Lawrence, S.E.I.C., Secretary-Treasurer.

The members of the Lethbridge Branch of The Engineering Institute of Canada and the Association of Professional Engineers of Alberta met at a luncheon on Thursday, November 3rd, 1938, under the chairmanship of R. F. P. Bowman, A.M.E.I.C., with Dr. J. B. Challies, M.E.I.C., the President of The Engineering Institute of Canada; L. Austin Wright, A.M.E.I.C., the General Secretary, and Fred Newell, M.E.I.C., Councillor for the Montreal Branch, present as guests. About thirty members representing electrical, mining, municipal, irrigation, highway and railway engineers attended the meeting.

P. M. Sauder, M.E.I.C., introduced President Challies.

Dr. Challies outlined the efforts which The Engineering Institute of Canada, the Dominion-wide organization, is now making to more closely co-ordinate the work of the various associations of provincial engineers with a view to establishing more uniform standards for admission to the engineering profession and to facilitate the exchange of technical information amongst its members.

An agreement to facilitate this objective, between the Association of Professional Engineers of Saskatchewan and The Engineering Institute, was consummated during the visit of Dr. Challies and party at Regina last week, and the details for a similar arrangement suitable for conditions existing in Alberta were discussed at meetings held at Edmonton, Calgary and Lethbridge.

Dr. Challies introduced Mr. Wright and Mr. Newell. Mr. Wright spoke briefly about The Engineering Journal and secretarial work at Headquarters. Mr. Newell then gave a clear picture of the feelings in the various Provinces across Canada with regard to co-ordinating The Engineering Institute of Canada and the Provincial Professional Associations.

J. T. Watson, A.M.E.I.C., introduced G. A. Gaherty, M.E.I.C., of Montreal, president of the Calgary Power Company, who spoke briefly regarding the annual meeting of The Institute to be held in Ottawa next year.

A hearty vote of thanks was tendered Dr. Challies and the members of his party for their excellent addresses by J. M. Campbell, A.M.E.I.C., who assured them of the full support of the Lethbridge Branch in their efforts to bring about a better understanding between the E.I.C. and the Provincial Professional Association.

Immediately following this meeting the Executive committee of the Lethbridge Branch met with Dr. Challies and his party regarding matters of increased rebates to smaller branches, The Engineering Journal and more intimate matters dealing with co-ordinating the two engineering bodies, particularly the formation of a Provincial Division in Alberta for the purpose of uniting the three Alberta branches as a unit for negotiating with the Association of Professional Engineers of Alberta.

Those present at this executive meeting were: President J. B. Challies, M.E.I.C., L. Austin Wright, A.M.E.I.C., Fred Newell, M.E.I.C., G. A. Gaherty, M.E.I.C., R. F. P. Bowman, A.M.E.I.C., Chairman, J. T. Watson, A.M.E.I.C., Vice-chairman, and Councillor, E. A. Lawrence, S.E.I.C., Secretary-Treasurer, J. M. Campbell, A.M.E.I.C., Past-Chairman, G. S. Brown, A.M.E.I.C., Past-Councillor, C. S. Donaldson, A.M.E.I.C., P. M. Sauder, M.E.I.C., W. L. McKenzie, A.M.E.I.C.

London Branch

D. S. Scrymgeour A.M.E.I.C., Secretary-Treasurer.
Jno. R. Rostron, A.M.E.I.C., Branch News Editor.

The regular monthly meeting was held on October 26th, 1938, and formed a joint meeting with the Military Engineers Association in the Richmond Street Armouries by kind permission of Lt.-Col. W. M. Veitch, A.M.E.I.C.

By courtesy of the Bethlehem Steel Corporation, sound pictures were exhibited under the direction of Mr. C. G. Lamb, representative of the Corporation.

Our Branch chairman, A. O. Wolff, has been promoted to the position of Assistant District Engineer of the C.P.R. and is now located at Toronto. In his unavoidable absence the chair was taken by H. F. Bennett, M.E.I.C., who opened the meeting by introducing Mr. Lamb.

The first film shown was entitled the "Production of Structural Steel." Views were given of the Corporation's extensive plant in Pennsylvania and every stage of the manufacture of steel was shown from the arrival and unloading of the iron ore, coal, etc. to the rolling of the structural steel shapes. The cranes used in the unloading of the materials from the ships' hold are of a unique pattern. The operators are located in steel cages immediately over the grab buckets and travel with their load. The lowering and raising is done by the steel jibs of the cranes and the operators steel cages are kept vertical—no wire hoisting ropes appear to be used, the cranes travel bodily on steel rails and deposit their load exactly where required.

The blast furnaces were shown in operation and the method of handling the skips, containing tons of molten metal, by massive machinery; the pouring into the ingot moulds and finally the conversion of the ingots at the rolling mills to the form of I-beams, angles, etc. and steel rods. The ease and precision with which the machinery handles, conveys and deposits the heavy and dangerous loads is simply marvellous.

The second film was entitled the "Golden Gate Bridge, San Francisco." This showed the erection of the steelwork from the tops of the foundations to the completion of the bridge. The first operation shown was the grinding by machinery of the tops of the foundations to a perfectly level and even surface.

The construction and erection of the towers was then shown. These towers are 746 ft. high (roughly only about 150 ft. less than the Eiffel Tower at Paris) and of steel honeycomb "built-up" sections. The sections were hoisted into position by steel cranes fixed on each successive top section, the steelworkers being raised and lowered in steel cages. After the fixing of the saddles at the top, the spinning and erection of the steel wire cables was shown. These (by Roeblings) were built up of 3/16 in. wire and were compacted to 36½ in. dia. and bound around their circumference by steel wire. Some idea of the gigantic strength of the two cables may be formed when it is realized that they have to carry, in addition to their own weight, the dead and live load of the road structure over a span of 4,200 ft.—practically four-fifths of a mile.

The erection of the wire suspenders (cradled) and the floor system was begun at each end and carried forward to the centre. The cross floor beams, carrying stiffening trusses and stringers, were hung from the suspenders and the concrete deck was laid over this system. The film showed up the marvellous agility and nerve of the steelworkers who seemed just as much at home up in the air traversing, swinging loads, etc., as on the ground.

The photographer who took these "close up" views must have been something of a steeple-jack to accomplish it.

The films, considering the difficult positions from which they were taken, were beautifully clear.

A hearty vote of thanks was moved by H. A. McKay, A.M.E.I.C., and seconded by W. G. Ure, A.M.E.I.C., to the Bethlehem Steel Corporation for the exhibition, and unanimously carried.

Sixty members, military engineers and guests were present.

Niagara Peninsula Branch

G. E. Griffiths, A.M.E.I.C., Secretary-Treasurer.
J. G. Welsh, S.E.I.C., Branch News Editor.

On November 18th, 1938, the members of the Niagara Peninsula Branch of the E.I.C. spent an exceedingly interesting afternoon and evening in the study of aircraft construction and development.

In the afternoon the members visited the plant of the Fleet Aircraft Co. at Fort Erie, Ontario. There the construction of aeroplanes, from light training ships to four ton gross weight freighters, was observed. Every stage in their transition from the stock room to the finished product was in evidence. Keen interest was taken in the structural framework. The planes were practically entirely of metal, all main members being tubular. The lighter structural members were of an aluminum alloy which, when heated to 920 deg. F., became quite soft and pliable. In that form the flat bars or sheets could be moulded to whatever shape or section that was required. On quenching in air, the metal regained its original structural strength and rigidity. It was worthy of note that welding was used on all main connections and whenever possible on the remaining structure. As yet, no satisfactory method of welding the light aluminum alloy was available.

With the sections moulded and cut to length, all assemblies were made in jigs which held each member rigidly until assembly section was completed. The steel workers present, noted that the members to be riveted were held together, drilled, and riveted, rather than completely prefabricated.

The radial motors, with the single throw counterbalanced crankshaft, and master connecting rod to the hub of which the remaining rods were pin-connected, proved very puzzling, especially in view of the excellent balance attained when the principle necessitates a slightly different stroke on the radial cylinders.

In the evening an excellent dinner was enjoyed at the Mather Arms hotel, Fort Erie. Wing Commander D. G. Joy, District Inspector of Civil Aviation, Department of Transport, spoke briefly of the Trans-Canada Airways, and of his trip to Vancouver and back, just completed that morning on a regular test schedule of the T.C.A. Mr. Joy spoke of the dangers encountered in this service, but also of the many precautions taken. In view of the numerous newspaper accounts of accidents to aircraft it was very interesting to hear that from actual statistics the chance of an accident is one in 8,000,000 miles of travel.

The speaker of the evening was Mr. Richard Young, Chief Designing Engineer of the Fleet Aircraft Company. In light of the fact that his company is just starting production on a new freighter designed especially for Canadian conditions, he was admirably fitted to talk on the subject "Steps in the Design of a Bush Transport Aeroplane." Many questions were brought up for discussion following this address.

A. J. Grant, M.E.I.C., dean of the Niagara District engineers, expressed the appreciation of the members of the branch to the Fleet Aircraft Company for their courtesy of the afternoon, to Mr. Joy for his attendance and talk, and to Mr. Young for his excellent paper and resultant discussion.

Ottawa Branch

R. K. Odell, A.M.E.I.C., Secretary-Treasurer.

STEEL—MAN'S SERVANT

A technicolour sound film, "Steel—Man's Servant," prepared by the United States Steel Products Company, was shown at an evening meeting on November 17th at the Canadian Government Motion Picture Bureau before a capacity audience. This film showed the process of iron and steel making from the mining of the ore to the production of the many kinds of steel required for modern commercial purposes.

W. F. M. Bryce, A.M.E.I.C., Chairman of the Ottawa Branch, presided at the meeting.

Peterborough Branch

A. L. Malby, Jr.E.I.C., Secretary-Treasurer.
J. L. McKeever, Jr.E.I.C., Branch News Editor.

At the regular meeting of the Branch held on October 27th, 1938, the speaker was Mr. J. W. McFarlane, of the Eastman Kodak Company, Rochester, N.Y., and his subject "Colour Photography." As this is a subject of wide interest, and as Mr. McFarlane wished to reach as large an audience as possible, the meeting was held jointly with the Foreman's Association of the Canadian General Electric Company, and was held in the Collegiate Auditorium, the public being invited to attend.

Mr. McFarlane started his talk by telling something of the nature of light, and then went on to illustrate by means of coloured gelatine filters in three separate projectors, how the three colour process of colour printing is effected. He then showed how the same effect could be achieved in photography by a subtractive process by coating the film with three separate emulsions sensitive to blue, green and red light respectively. These emulsion layers are selectively sensitized. Instead of lumping all colours together as an ordinary single emulsion film does, each of the Kodachrome film emulsions picks out a particular colour band and records only that. If some hue of the subject is a combination of colours, the emulsion will divide up that hue into its elements, each emulsion layer recording its proper part of the colour combination. After processing, the finished positive is placed in a projector and light is passed through these separate images, they re-combine into the original colours.

A large and appreciative audience listened to Mr. McFarlane's explanation of the Kodachrome colour process, and viewed the many slides and reels of colour film which were shown in illustration.

At the regular meeting of the Branch held on November 10th, the speaker was Mr. A. C. T. Sheppard, D.L.S., of the Bureau of Geology and Topography, Department of Mines and Resources, Ottawa, and his subject,

Canada's Contribution to Aerial Photographic Mapping

Mr. Sheppard has been engaged on topographical mapping for the Department of Mines, later the Department of Mines and Resources, since 1910, and has had a great deal to do with the development of photographic mapping, hence he was in a position to give an authoritative talk on the subject.

Aerial mapping in Canada began shortly after the war, when use was made of open cockpit military flying boats. The oblique method of photography was used, and the camera was not automatic, but directed and controlled by the operator. The results were encouraging, but difficulty was experienced in registering the prints with the ground maps and large overlaps had to be used to make up for the deficiencies of the camera.

Since that time, much progress has been made. The mapping is now part of the duty of the R.C.A.F. under the Department of National Defence, and the planes used are cabin types equipped with either floats or skis, depending upon the season. Both oblique and vertical mapping are used, depending upon the nature of the country to be mapped, but control of the camera is now automatic. Many different types of cameras were tried, but at the present time the Fairchild F.3 with 4 in. aperture and focal length of about 8 in. is used as standard. Each plane is equipped with three of these cameras set so that the three pictures overlap by about forty per cent. Lately, infra-red film has been used with greatly increased clearness of picture.

A library of aerial photographic prints is maintained in Ottawa, of which use can be made by the public. 50,000 prints (9 in. by 9 in.) have been added this year, and over 100,000 have been used or loaned in the same period. To date approximately 770,000 square miles of Canada has been covered by aerial photographic mapping, and more territory is being added each year.

At the conclusion of his talk on mapping, Mr. Sheppard showed a film of a trip by air and water from Edmonton to Cameron Bay, which film proved of great interest to and was much appreciated by his audience.

The attendance was 35.

Saskatchewan Branch

J. J. White, M.E.I.C., Secretary-Treasurer.

The regular October meeting of the Saskatchewan Branch of The Engineering Institute of Canada was cancelled in order to co-operate with the Association of Professional Engineers of Saskatchewan, which organization held its semi-annual meeting for all engineers in Saskatchewan.

This meeting, held at the Hotel Saskatchewan, Regina, on October 29th, was of a rather significant nature since it was set aside for the signing of the co-operative agreement entered into by the Saskatchewan Branch of The Engineering Institute of Canada and the Association of Professional Engineers of Saskatchewan. The purposes of this agreement are to build up a common membership within the Province, endeavour to reduce fees, simplify the collection of these fees and have a common executive for the management of engineering affairs.

It was further rather significant because it afforded an opportunity of a visit from Headquarters in the persons of Dr. J. B. Challies, President of The Institute, F. Newell, Councillor of The Institute, L. Austin Wright, General Secretary of The Institute and G. A. Gaherty, Chairman of The Institute's Committee on Western Water Problems.

The meeting took the form of a dinner at which 106 engineers were present. The chairman was J. W. D. Farrell, M.E.I.C., President of The Association of Professional Engineers of Saskatchewan. Seated at the head table with Mr. Farrell were L. A. Wright, A.M.E.I.C., L. A. Thornton, M.E.I.C., Geo. Spence, H. S. Carpenter, M.E.I.C., Dr. J. B. Challies, M.E.I.C., F. Newell, M.E.I.C., I. M. Fraser, A.M.E.I.C., G. A. Gaherty, M.E.I.C., D. A. R. McCannell, M.E.I.C., R. A. Spencer, A.M.E.I.C., and H. R. Mackenzie, M.E.I.C.

After dinner the guests of the evening were introduced by executive members of the organizations present, and Mr. Spencer, Councillor for Saskatchewan, spoke on the problems which had confronted the engineering organizations and the steps which had been taken leading up to the agreement which was to be signed later in the evening.

The presiding officer then called on the speaker of the evening, Dr. Challies, who outlined conditions within The Institute generally. He was particularly glad to have the opportunity of visiting all the Western Branches of The Institute and discussing with them their own peculiar problems. He conveyed greetings from Headquarters to all members of The Institute and extended a very warm welcome to all who would become members automatically with the signing of the agreement. Dealing with matters of policy he emphasized his objections to an increase in the quorum of Council, suggesting that such an increase would delay the business of Council at a time when Council should have more freedom in being able to act with dispatch in the almost national desire for closer co-operative relations with the Provincial Professional Associations. He felt that The Institute was on the threshold of a new era, in which the policy of closer co-operation with all engineering bodies would become effective and more particularly so with the Professional Associations.

Following the President's address, the co-operative agreement between the two organizations was signed by Dr. J. B. Challies and

Banquet to Celebrate Signing of Co-operative Agreement between The Engineering Institute of Canada and the Professional Engineers of Saskatchewan, Regina, October 29th, 1938.

Seated at Head Table: J. J. White, M.E.I.C., L. A. Wright, A.M.E.I.C., L. A. Thornton, M.E.I.C., George Spence, H. S. Carpenter, M.E.I.C., Dr. J. B. Challies, M.E.I.C., J. W. D. Farrell, M.E.I.C., F. Newell, M.E.I.C., I. M. Fraser, A.M.E.I.C., G. A. Gaherty, M.E.I.C., D. A. R. McCannel, M.E.I.C., R. A. Spencer, A.M.E.I.C., H. R. MacKenzie, A.M.E.I.C.

L. Austin Wright for The Institute, witnessed by H. S. Carpenter and F. Newell and signed by J. W. D. Farrell and J. J. White for the Professional Association, witnessed by I. M. Fraser and W. E. Lovell. Immediately following, Dr. Challies presented Mr. Farrell with a solid gold fountain pen, the one used by the parties who executed the co-operative document, as a memento of the occasion.

An Institute Committee in Montreal, of which Gordon McL. Pitts was the chairman, feeling that this historic event in the annals of the engineering profession in Canada should be put on the air, had succeeded in arranging to have part of this programme broadcast from coast to coast over the Canadian Broadcasting Corporation national network.

After a brief introduction by Mr. Farrell, the following message was delivered by the President of The Institute and was heard by a nation-wide audience.:—

"Tonight in Regina two great engineering bodies gather to celebrate a special occasion—an occasion that permits them to render a better and broader service to their fellow men. In the Province of Saskatchewan from today there will be a common membership between the provincial association and The Engineering Institute. This will guarantee that the resident members of the national body will gain the privileges and will assume the responsibilities that go with the right to practise as a professional engineer in the Province. Reciprocally, the members of the Association will obtain the advantage of participating in all the social and technical activities of a national body which enjoys great prestige not only on both sides of the international boundary, but abroad as well.

When the average citizen thinks of an engineer and his work, he thinks of those things which he can see—great bridges like the Lion's Gate Bridge which is nearing completion at Vancouver—the Borden Bridge over the Saskatchewan River just west of Saskatoon—the International Blue Water Highway Bridge that joins Canada to the United States, at Sarnia and Port Huron. He thinks of great buildings like this hotel and the massive grain elevators that are so essential to this great West. He thinks of the oil fields with all their machinery and the great wealth which they are pouring forth.

And yet the greatest accomplishments of engineers are not readily available to the eye of the average citizen. When you flip on the switch that floods your room with useful light, you do not think of all the engineering that lies back of that small piece of hardware on your wall. You are not aware of a power site, that is perhaps a hundred or more miles away; of the structure that impounds that water, of the flumes that direct it, of the powerful turbines and the magical generators that transform water power into electricity, and of the great buildings that house them; of the transmission lines or even of the wiring within your own building, and yet they constitute an engineering triumph.

When you turn on the tap that gives you continuously a flow of water that is inexhaustible, you do not think of intakes, pumping stations, filtration plants, water treatment and water control. To you it is just a modern convenience, and yet it is an engineering triumph.

Similarly with your telephone. When you put the receiver to your ear, you are not aware of all the years of patient intelligent effort that lie back of it, the great cable systems, the machinery that with superhuman intelligence carries your spoken word to your friends or the corner grocer. To you it is just a telephone—practically a gadget—and yet it too is an engineering triumph.

And so it is with this agreement which we have signed tonight. The average citizen will never be aware of its existence, will not know of the years of patient effort on the part of many people, of the trials and disappointments that accompanied its development or of its significance to the engineers in other parts of Canada. And yet there it is, a completed document which in its own quiet way makes it possible for the engineers of this province to give to his fellow man a greater and a better service. *It too is an engineering triumph.*

It seems only natural that this forward step should be made first of all in the West. So many great things have been done for the first time, out here, that we have been accustomed to seeing pioneering in many things come from this section of our great Dominion. In spite of much privation and years of disappointment, their spirit still survives. We people of the East salute you and we give great thanks that we are permitted to participate with you in this brilliant future that lies before us all.

As a feature of this celebration, it is my privilege to announce the decision of the Council of The Engineering Institute to honour two eminent elder engineer statesmen whose careers had much to do with the development of the Prairie Provinces. Since its inception fifty-one years ago The Engineering Institute has awarded only forty-three honorary memberships. Sixteen of these recipients are now living, of whom the most distinguished is His Excellency the present much beloved and greatly respected Governor-General of Canada. It is, therefore, appropriate that at its Annual General Meeting in Ottawa next February, Lord Tweedsmuir will, on behalf of the Council, hand a Certificate of Honorary Membership in The Engineering Institute of Canada to Chas. A. Magrath, M.E.I.C. This honour is in recognition of Mr. Magrath's services to this country—

As a pioneer Dominion Land Surveyor all over the Prairie Provinces;

As an early mayor of Lethbridge, Alberta;

As a member, first of the Territorial Legislature, and then of the Territorial Government, being Minister in the administration of Sir Frederick Haultain;

As a representative of the Province of Alberta in the Parliament of Canada;

As a member, and, for many years, the Chairman of the Canadian Section of the International Joint Commission;

As a chairman for six years of the Hydro-Electric Power Commission for Ontario;

As a member of a British Royal Commission which aided in solving the economic problems of the ancient and Royal Colony of Newfoundland; and

Finally, for being one of the outstanding senior engineer statesmen of the Dominion.

I am also privileged to announce that in the City of Victoria, one week from tonight, it is expected that His Honour The Lieutenant-Governor of British Columbia, will, on behalf of the Council of the Institute, present to Col. John Stoughton Dennis, M.E.I.C., the Sir John Kennedy Gold Medal. This is an award greatly prized among engineers, and one rarely conferred. It was established to commemorate the life of a distinguished pioneer member of the Engineering Profession of Canada, John Kennedy, whose engineering career in the development of the Harbour of Montreal was suitably recognized when our late lamented Beloved Sovereign George the Fifth conferred upon him a Knighthood in Nineteen Hundred and Sixteen. Only six Sir John Kennedy Gold Medals have been awarded. They are as follows:

To the late Past President, Col. R. W. Leonard, St. Catharines, for his contributions to mining and as a generous founder of the Royal Institute of International Affairs.

To Past President Dr. George Herrick Duggan, Montreal, as one of the leading bridge builders of this continent.

To the late Past President, John G. Sullivan, Winnipeg, for his connection with the Panama Canal and as a pioneer railway builder.

To Past President Alex. J. Grant, Ottawa, as the builder of the Welland Canal.

To the late Past President, Dr. Robt. Alexander Ross, for his leadership in the electrical utility industry of Canada.

To Dr. Andrew Harkness, Toronto, for his prominence in the field of structural and architectural engineering.

The seventh Sir John Kennedy Gold Medal now goes to Col. J. S. Dennis, a Companion of the Distinguished Order of St. Michael and St. George, for distinguished service to his country,

as an explorer of the western plains;

as a pioneer surveyor of the prairies;

as a Commissioner of Public Works, in Regina;

as a promoter of irrigation in Alberta;

as a colonizer for a great railway system;

as a life-long soldier with distinguished service in the Riel Rebellion and during the Great War;

and

as a distinguished and senior Past President of The Engineering Institute of Canada.

It is an interesting fact that when Col. Dennis came West in eighteen hundred and seventy-seven, sixty-one years ago, to start his first exploratory survey of the prairies, he brought with him as assistant, Mr. Chas. Magrath. Their relations, professional and personal, have been very close ever since.

Both recipients of these premier honours of The Engineering Institute of Canada are now living in retirement in Victoria, that haven of rest for so many professional men who have lived a long life of useful service. It will be a happy circumstance that will permit Mr. Chas. A. Magrath to see the professional career of his first chief so fittingly recognized by the award, through His Majesty's representative, of the Sir John Kennedy Gold Medal. In honouring these two great public benefactors, these two courtly gentlemen, these two outstanding leaders for so many years of a great profession, The Engineering Institute of Canada is honouring itself.

Finally, to those members of the engineering profession within sound of my voice who cannot be present at the engineers' banquet at Regina tonight to see the completion of this progressive agreement between the Institute and the Association of Professional

Engineers of Saskatchewan, I have this brief message—*The engineering profession in every province of the Dominion was never more alert to the opportunity for rendering public service, and was never better prepared to serve the public, than it is today.*"

Following the broadcast the meeting was addressed by Mr. Newell and Mr. Wright, both of whom contributed to the success of the evening by very timely remarks.

During the banquet a party of ladies, 60 in number, enjoyed a dinner bridge and listened to the broadcast in the Spanish Room of the Hotel Saskatchewan. Souvenirs in the form of silver teaspoons were presented to Mrs. Challies and Mrs. Newell during the evening. In addition to these visiting ladies, out of town guests were Mrs. R. A. Spencer, Mr. I. M. Fraser, Saskatoon, Mrs. Jonsson, Prince Albert, and Mrs. E. C. S. Carpenter, Melville.

This function was a very delightful affair and much appreciated by all the ladies present.

The following day a Reception was held in the Blue Room of the Hotel Saskatchewan under the auspices of The Engineering Institute of Canada and The Association of Professional Engineers of Saskatchewan. Receiving the guests, of which 180 signed the register, were Dr. J. B. Challies and Mrs. Challies, Mr. J. W. D. Farrell and Mrs. Farrell and Mr. H. S. Carpenter and Mrs. Carpenter. Officiating at the tea urns, serving and generally attending to the pleasure of the guests were the wives of the officers of the local organizations. An interesting feature of the tea was a display of the illuminated addresses presented to the Institute on the occasion of its semicentennial anniversary in 1937.

Our thanks are hereby extended to the President and his party on coming to Regina, helping us generally in our deliberations and assisting in creating a new feeling of esprit de corps within our ranks.

VISIT OF HEADQUARTERS DELEGATION TO SASKATOON

Saskatoon engineers were glad to welcome the delegation on Monday, October 31st. A visit to the Engineering College in the morning, a luncheon at noon, and a public address by the President in the afternoon provided a busy day.

At the Engineering College, the delegation addressed an audience of over one hundred students of the two senior years. Most of the faculty were also present. Dean Mackenzie, M.E.I.C., as chairman, introduced the speakers. President Challies emphasized the value of contacts, and in humorous vein illustrated his remarks by examples from his own experience. The student group appreciated to the full the opportunity given them of hearing from the President. Mr. Gaherty, Mr. Wright and Dean Mackenzie, infected by the note of levity introduced by the President, recalled some highly amusing personal experiences in such far-flung localities as the citadel at Halifax, the shell holes of Passchendaele, the South American Republics, and the Falls of Montmorency. Their remarks drew enthusiastic applause. Mr. Newell was more serious. He prefaced his address by stating that, as he felt that he could not compete in humour with the preceding speakers, he would confine himself to such advice to the young engineers as he could draw from his own experiences. In this he was a tremendous success. One member of the faculty afterward expressed general

Some of the Saskatoon Engineers who attended the Luncheon held during the President's Visit there. Left to right, 1st row: A. R. Greig, M.E.I.C., J. B. Mawdsley, A. M. Macgillivray, A.M.E.I.C., C. J. Mackenzie, M.E.I.C., R. D. Overholt, W. G. Worcester, M.E.I.C., A. B. Olsen, B. Chappel. Second row: J. E. Underwood, F. H. Edmunds, V. Howie, E. Chan, I. M. Fraser, A.M.E.I.C., Third row: R. A. Spencer, M.E.I.C., E. H. Phillips, A.M.E.I.C., F. Young, A.M.E.I.C., C. Hay, C. R. Forsberg, S.E.I.C., H. C. Bear, T. J. Boyle, L. M. Howe. Fourth row: W. M. Courtenay, G. D. Archibald, H. McI. Weir, R. J. Baker, N. B. Hutcheon, J. Jonsson, W. G. Dyer, A.M.E.I.C.

opinion when he said that this was one of the finest addresses of its type that he had ever heard. The suggestion was seriously made that the Institute should ask Mr. Newell to make a "talkie" of his address so that it might be sent to all the engineering schools in Canada.

At noon the delegation members were the luncheon guests of about fifty of the practising engineers of the city and vicinity. Mayor Pinder, M.P.P., extended a welcome to the party on behalf of the city and each of the delegates spoke briefly. It was intended that these addresses should inform those who had been unable to make the Regina trip and others, who up to the present had not been particularly interested, of the present situation as regards engineering organizations in Canada.

At the afternoon session, President Challies addressed an audience composed of over 250 University students, engineers and guests from the city. His subject was "The Great Lakes to Ocean Waterway." Such addresses as this one of the President make clear to the public that engineers are becoming actively interested in political and economic, as well as technical, phases of our national problems, and this reacts in many ways to the benefit of the profession. Local publicity given this address (as also to the whole visit of the delegation) was excellent. The meeting was held in the Chemistry Theatre of the University with Professor I. M. Fraser as chairman. A pleasing preliminary was the presentation by Mr. Challies of the certificate accompanying the third year E.I.C. prize to Mr. J. L. deStein.

In the meantime the ladies of the party were being entertained at tea at the home of Mrs. C. J. Mackenzie. Among the guests were the wives of all the engineers of the city.

At 5.30 we were sorry to see the group depart for Edmonton. Thinking back, we probably worked them too hard, especially after their extremely arduous activities in Regina. In fact, we were vastly relieved to find that there were no hospital cases as a result.

Finally, we have to note that it is very seldom indeed that we in Saskatoon have visits from a President of The Institute. In view of the great value attending these presidential visits, and also the visits of the others of the delegation who have just been with us, we suggest that an effort be made to find some means by which similar groups may visit us more often in the future.

Sault Ste. Marie Branch

N. C. Cowie, Jr.E.I.C., Secretary-Treasurer.

The Sault Ste. Marie Branch of The Engineering Institute of Canada held a general meeting at the Windsor hotel, Sault Ste. Marie, Ont. on Friday, November 18th, 1938.

Following an enjoyable dinner served to twenty-nine members and guests, the Chairman of the Branch, J. S. Macleod, A.M.E.I.C., called the meeting to order.

In announcing that John L. Lang, M.E.I.C., would introduce the General Secretary of the Institute, Mr. Macleod said that he was very glad Mr. Wright had found it possible to visit us on his way home from his trip to the western branches.

Mr. Lang, introducing Mr. Wright to the meeting mentioned that the Branch had been looking forward to Mr. Wright's visit and would be much interested in his talk which would deal with his trip to the Western Branches, and general Institute affairs.

Mr. Wright expressed his pleasure on visiting the Sault Branch and that his remarks would be a kind of "shop talk" on the subjects Mr. Lang had mentioned. The high light of his western trip had been the dinner meeting in Regina on October 29th, at which the agreement between the Association of Professional Engineers of Saskatchewan and the Engineering Institute of Canada had been completed. He expressed the hope that with this as a beginning The Institute would serve as a common bond for all Canadian engineers, and that further agreements would be arranged in the other Provinces. The possibilities, of an early agreement in two of the other provinces were very good, he said. In this regard he pointed out the superiority of the state of affairs in the profession in Canada as compared to that in the United States, where the large number of divisions into specialized branches of the profession made co-operative agreements much harder to work out.

The advantages of membership in The Engineering Institute were described by Mr. Wright. Respect of the engineer for himself and his profession, the employment service, the library service and the privilege of obtaining subscriptions to our own journal and to those of the societies in United States, the opportunities of engineers to express themselves at Branch meetings and the fraternalism among engineers being among the subjects mentioned by the speaker.

Several questions were answered by Mr. Wright for individual members in the discussion that followed his address. Following this discussion A. E. Pickering, M.E.I.C., tendered Mr. Wright the thanks of the meeting. This motion, which was seconded by C. W. Holman, A.M.E.I.C., was warmly approved.

Toronto Branch

J. J. Spence, A.M.E.I.C., Secretary-Treasurer.
D. D. Whitson, A.M.E.I.C., Branch News Editor.

The Branch held its opening meeting of the season at Hart House on October 13th, 1938, assembling to hear an address by Col. E. J. C. Schmidlin, M.C., R.C.E., Director of Engineering Services, Department of National Defence, Ottawa. His subject was:

TECHNICAL ASPECTS OF ATTACK AND DEFENCE IN MODERN WARFARE

Col. Schmidlin was of the opinion that if war broke out tomorrow it would be fought along lines similar to the Great War except for minor differences due to minor improvements in guns, shells, rifles, and explosives and transportation. "Attack" involved the delivery in enemy territory of destructive material in the form of explosives or gas at points designated, in the shortest possible time, with the best possible aim, and in the desired quantity; whereas "defence" consisted of efforts to defeat all the aims of the attackers by using counter attacks, or by passively awaiting the attackers in forts or trenches. The best example of passive defence preparations was France's Maginot line, or Germany's Siegfried line. In the speaker's view the infantry were still the backbone of military operations, and the dire results of gas and bombs in Ethiopia, Spain, and China were very largely due to lack of defence; he stressed the fact that last minute preparations for defence were very likely to prove ineffective against modern forms of attack.

In the field of transportation many specialized vehicles had been developed, particularly for cross-country work, but commercial types of motor vehicles were favoured wherever possible. Cross-country transportation was possible only in certain type of terrain, under fairly good conditions when there had not been too much rainfall. Tanks had been developed that weighed 15 tons and could go 35 m.p.h. on broken ground, but in the speaker's opinion these vehicles were still extremely vulnerable and could be easily stopped with the right kind of defensive preparations; due to the jolting, uneven progress of a tank, it was extremely difficult to make hits with its guns, and if the tank stopped, it usually became easy prey for anti-tank guns which fired two-pound shells or steel clad bullets. Tanks, crawler type trucks, and tractors now used articulated rubber endless belts as a means of propulsion instead of the old type steel belts. Despite the advances in cross-country vehicles, travel by this procedure is so difficult and uncertain that the modern tendency is to build more and more military roads such as have been constructed across Germany in recent years.

Turning to aircraft, the speaker noted the greatly increased speed, range, and bomb-carrying capacity of the recent models, but felt that the bogey of mass aerial bombardment of cities was not so fearsome as it seemed. The attacking planes would be met by anti-aircraft defences which would cause them to fly at great heights for safety. In this connection, Col. Schmidlin pointed out that a bomber flying 250 m.p.h. at an altitude of 20,000 ft. must release its bombs approximately 1¾ miles before reaching the desired target in order to register a direct hit. The difficulty would be further increased if the bomber had to alter its speed and direction due to anti-aircraft fire from the defence artillery or defending planes.

Col. Schmidlin described the French Maginot Line as a tremendous engineering work, extending for 200 miles, built at a cost of $400,000,000 without its armaments, and capable of accommodating 200,000 men in its underground labyrinth which is about 40 feet below the surface of the ground. Its series of fortified areas are studded with large numbers of massive concrete toadstools, containing weapons ranging from machine guns up to 6 in. howitzers, all interconnected with deep dugouts below, completely equipped with supplies, living quarters, communication systems, etc.

In Canada, the speaker said we had the beginnings of a coast-defence system centered around points such as Vancouver, Esquimault, and Halifax.

Anti-aircraft defence was described as being particularly expensive, with three rings of guns around the large cities at fairly close spacing in each ring, and with the rings a few miles apart. About two searchlights are required for each gun installation with candlepower running into the millions. Fast defending planes must also be used to harass the attacking planes; the general idea of anti-aircraft defence is to keep the enemy high and disturbed, thus lessening the chances of direct hits on his part.

Col. C. S. L. Hertzberg, M.E.I.C., moved a vote of thanks to Col. Schmidlin, and those present retired to the Great Hall for refreshments, an innovation for Toronto Branch meetings.

C. E. Sisson, M.E.I.C., Branch chairman, conducted the meeting and announced that the Toronto Branch had joined the Affiliated Engineering Societies of Toronto and that this organization would hold joint meetings at stated times.

Dr. A. E. Berry, M.E.I.C., in charge of papers, outlined a very attractive programme for the coming season.

The meeting of the Toronto Branch held on November 3rd was very well attended. C. E. Sisson, M.E.I.C., occupied the chair, and A. U. Sanderson, A.M.E.I.C., last year's chairman, moved that the Branch congratulate Dr. J. B. Challies on receiving the degree of Doctor of Engineering. This motion met with unanimous approval.

B. K. Read of Canadian Industries Limited presented a very interesting address on the "Production of Synthetic Rubber," a synopsis of which follows.

The Production of Synthetic Rubber

Outstanding, and in some cases spectacular, achievements in science and industry are casually accepted as commonplace today. Synthetic rubber certainly falls in this category—it is a highly specialized development.

Synthetic rubber, like other important discoveries of recent times, goes back a good many years. Bouchardat in 1875 isolated isoprene as the mother substance of rubber. Tilden in 1884 synthesized isoprene from turpentine. Fritz Hoffman laid the foundation for the partially successful manufacture of synthetic rubber in Germany during the 1914 war. 2,300 tons were produced. After the war there was a lull in activity, but in 1925 the price of crude rubber rose. The chemists in the major industrial countries got busy and at least eight commercial types of synthetic rubber-like materials were the result.

There is usually a wasteful lag between the announcement and the reduction to practice of technological achievements. Ten years ago this lag was in all countries. Today this is not so.

We are being reminded—unpleasantly perhaps—that certain nations of the world (the totalitarian group) are demonstrating a rising energy level. It is predicted that sooner or later we shall feel the economic impact of these more energetic countries. We may perhaps frighten ourselves into a rekindled spirit of enterprise by contemplating this threat to our security.

The lag period in utilizing the benefits of modern technological achievements seems a carry-over of habit of thought from the handicraft days. It is going by the board in the energetic countries and needs to be dispensed with elsewhere as well.

A suggested solution to the problem is for technical men to accept their share of the responsibility for public education and enlightenment.

New developments raise living standards and increase employment, and the public must be made to see this side of the picture. Since 1928 DuPont has brought out twelve new groups of products that employ today 18,000 men and represent a plant investment of about $175,000,000.

DuPont announced neoprene in 1931—built a plant with about 10 tons monthly capacity, and began supplying to the rubber industry. The product was very much like the present material—not quite as good but almost. In eight years the production has grown to ten or fifteen times this quantity.

In Germany a different type was chosen, but progress, despite a late start, has been much more rapid—German production has been estimated at about 25 million pounds annually.

Their first synthetic rubber factory in Russia was built in 1931, and was reported to be supplying 75 per cent of current rubber needs. The annual output is said to be 140 million pounds. Japan and Italy have projected plants for synthetic rubber manufacturing—so did Czechoslovakia. To date England and France have shown no announced intention of entering the field.

The raw materials for neoprene manufacture are (1) coal, from which is obtained carbide and acetylene, (2) salt, yielding hydrogen chloride and water, all plentiful and cheap. The modern carbide furnace is the last word in electrical perfection—in size the only limits are the electrodes and the electrical equipment to operate the furnace.

Acetylene generated from carbide has been known since 1836. Father Niewlands, late of Notre Dame, was the first to discover how to polymerize acetylene. From his research DuPont chemists created neoprene.

Commercial neoprene is a substance resembling rubber—it can be easily processed on modern rubber machinery and needs no new installation of equipment or new technique.

The superior properties of neoprene constitute its claim to distinction. It is more resistant to sunlight, heat, most oils, fats, etc., high voltage discharge, decidedly less inflammable, and with a much longer vital life compared to rubber. The x-ray examination of neoprene shows a physical structure very similar to the natural product.

These superior properties may be converted to economic advantage in an increasing number of ways. The petroleum industry alone stands to benefit by many millions of dollars annually by the growing use of neoprene finished products of proven value.

In conclusion, attention may be called to the fact that when the charges against any one successful product are added up, the sum is a huge loss, which may take years to cancel out. Millions of dollars have been expended since 1875 on synthetic rubber, but the public at large will benefit by the progress in the long run.

There was an attendance of 125 at the meeting of the Branch on November 17th at Hart House. Tracy D. LeMay, Commissioner of City Planning of the City of Toronto, addressed the meeting on the subject of "Regulation of Traffic in a City." C. E. Sisson, M.E.I.C., was in the chair.

Vancouver Branch

T. V. Berry, A.M.E.I.C., Secretary-Treasurer.
J. B. Barclay, A.M.E.I.C., Branch News Editor.

Visit of Dr. J. B. Challies and Official Party

The Vancouver Branch were honoured by a four day visit from Dr. J. B. Challies, President of The Institute; Mr. Fred Newell, Chairman of The Institute Committee on Professional Interest, and Mr. L. Austin Wright, recently appointed General Secretary of The Institute.

This four day visit coincided with the annual meeting of the B.C. division of the Canadian Institute of Mining and Metallurgy and several functions of a joint nature were enjoyed by members of both Institutes.

Meeting of the Vancouver Branch Addressed by the President.

Among those present were: Front row: James Robertson, M.E.I.C., J. D. Galloway, G. S. Eldridge, J. Alexander Walker, M.E.I.C., L. Austin Wright, A.M.E.I.C., Lt.-Col. J. P. MacKenzie, M.E.I.C., Fred Newell, M.E.I.C., Dr. J. B. Challies, M.E.I.C., R. R. Hedley, A. E. Foreman, M.E.I.C., F. W. Anderson, Frank Lee. Second row: W. G. Swan, M.E.I.C., Group Captain Johnson, A.M.E.I.C., Col. Keen. Back row, standing: T. V. Berry, A.M.E.I.C., P. H. Buchan, M.E.I.C. Back row, sitting: Prof. A. Peebles, A.M.E.I.C., Charles Brakenridge, M.E.I.C., Dr. E. A. Cleveland, M.E.I.C., Dr. Victor Dolmage, M.E.I.C.

Joint Public Meeting, Tuesday, November 8th

Perhaps the highlight of the visit was the public meeting held in the Aztec Ballroom of the Hotel Georgia on Tuesday evening, November 8th. To this meeting had been invited the Council and members of the B.C. Association of Professional Engineers, the B.C. division of the Canadian Institute of Mining and Metallurgy, the Architectural Institute of B.C., the Vancouver Section of the American Institute of Electrical Engineers and the Building and Construction Industries Exchange, to hear Dr. Challies speak on "The Status of the Engineer." About one hundred and thirty-five attended.

Dr. Challies outlined the great progress made by the engineering profession in Canada since Confederation and told of the high esteem in which Canadian engineers are held both abroad and at home. He felt that the growing desire of engineers to enter public life was good for the country and good for the engineering profession.

Mr. Fred Newell next spoke, confining his remarks to the recent co-operative agreement signed by The Engineering Institute of Canada and the Association of Professional Engineers of Saskatchewan and outlining plans for further agreements of a similar nature with other Canadian provinces in the near future.

Following a short address by Mr. Wright, the meeting was given over to a spirited discussion on Institute-Association relations as they affected British Columbia.

Refreshments were then served and an opportunity given for members and friends to meet Dr. Challies and the official party.

Joint Luncheon

Vancouver Board of Trade (Engineering Bureau) and Canadian Institute of Mining and Metallurgy, held a joint luncheon on Wednesday, November 9th, 1938.

The address was given by Dr. Challies. The Engineering Bureau of the Vancouver Board of Trade were hosts to the visiting delegates of the Mining Convention and to members of The Engineering Institute and the B.C. professional association at a luncheon in the Vancouver hotel on Wednesday, November 9th. At the head table with Dr. Challies were prominent men in the mining industry in Western Canada, and the Ministers of Mines from three Western Provinces.

Dr. Challies in an interesting address dealt with the great progress, present and future of the power industry in Canada. It was the expressed opinion of a well known Canadian economist that in spite of the late depression, increased corporation taxes and increased labour costs, the two great Canadian industries, that of mining and hydro power production, had been the greatest steadying influences on the Canadian economy during a very difficult period.

In Canada we are very fortunate as regards power for industrial and domestic purposes. Great Britain depends entirely on coal for its source of power and in the United States only about 25 per cent of its power comes from hydro developments. In striking contrast with these two great industrial countries, hydro-electric developments in Canada supply about 98 per cent of the total power concerned. It is interesting to note that our per capita hydro power development is larger in Canada than any other country, and in no other country is the technique of hydro development more advanced.

* * *

Perhaps one of the most interesting functions held during the visit of Dr. Challies was the meeting with the engineering students in the Faculty of Applied Science at the University on Thursday midday, November 10th.

About fifteen members of the Vancouver Branch with the President visited the University where approximately one hundred and fifty engineering students listened to interesting and instructive addresses by Dr. Challies, Mr. Newell and Mr. Wright. An interesting incident on this occasion was the presentation by the President to A. L. Sutton of The Engineering Institute of Canada award for the year 1938. The Institute members later enjoyed luncheon as the guests of J. N. Finlayson, M.E.I.C., Dean of the Faculty of Applied Science and head of the Department of Civil Engineering.

The official party were kept very busy during their stay. Besides functions reported above, they were the guests of the Vancouver Branch executive on Tuesday, November 8th, at an informal dinner, on which occasion Institute affairs were discussed.

At noon on Tuesday, Dr. Challies was the guest speaker at the Rotary Club, choosing as his address "Insurance for Peace."

The University of Toronto School of Science graduates entertained on Thursday at a cocktail party at the Jericho Golf Club, and on Armistice Day a luncheon under the auspices of the Association of Professional Engineers of B.C. was addressed by Mr. Wright.

Later in the day, the official party were guests at the annual convention dinner of the Canadian Institute of Mining and Metallurgy.

Neither were the visiting ladies neglected. On Tuesday, Mrs. Challies and Mrs. Newell were guests at a luncheon at the Jericho Golf Club and on Thursday about forty wives of members entertained them at a reception in the Georgia Club.

The Vancouver Branch members enjoyed every minute of the time that the visitors were in Vancouver, and feel that the inspiration gathered from the social contacts and discussions of Institute matters with these gentlemen will do much to cement relations between the East and the West and further the interests of Canadian engineers wherever they may be.

Victoria Branch

Kenneth Reid, Jr.E.I.C., Secretary-Treasurer.

It was with a great deal of pleasure that the Victoria Branch of The Institute had the privilege of entertaining President Challies and his party on the occasion of their tour of the Western Branches on November 5th and 6th, last. The President was accompanied on his visit to Victoria by Mrs. Challies; Councillor Fred Newell and Mrs. Newell; Mrs. W. G. Swan of Vancouver; J. Robertson, M.E.I.C., of the Dominion Bridge Company, Vancouver, and L. Austin Wright, A.M.E.I.C., General Secretary of The Institute.

Great honour was conferred on two members of the Victoria Branch now living in retirement here for their contributions to the engineering profession in Canada, namely Col. J. S. Dennis, M.E.I.C.,* and C. A. Magrath, M.E.I.C., the former being awarded the Sir John Kennedy Gold Medal, and the latter by the announcement of his election to Honorary Membership in The Institute. Due to the very grave condition of his health it was considered inadvisable to have Col. Dennis go to Ottawa next February to receive this award and arrangements were made to have the medal brought West by the President on this occasion for presentation here. Unfortunately Col. Dennis was too ill to attend any of the functions held in Victoria and presentation of the medal was made by President Challies to Col. Dennis at his bedside in hospital. The very touching nature of the simple ceremony to such a great and distinguished engineer did not fail to impress all who were privileged to be present.

The Victoria Branch held a luncheon at the Empress hotel on Saturday noon for the President and other Institute members of the party which was attended by the executive committee and other members of the Branch, and was followed by an informal discussion of Institute affairs.

*Col. Dennis, since deceased.

While the luncheon was in progress the visiting ladies were the guests of Mrs. Magrath at luncheon in her home on St. Charles Street and enjoyed a delightful afternoon in her charming company.

On Saturday evening the Branch was host to the distinguished visitors at a formal reception and dinner at the Empress hotel to which the ladies, and members of the Professional Association and other kindred engineering bodies and their families were invited, about fifty persons being present. It was deeply regretted that due to a previous engagement His Honour the Lieutenant-Governor of the Province was unable to be present. The honours of the evening went to Mr. Magrath when his election to Honorary Membership in The Institute was announced by the President. In a simple but dignified and touching address Mr. Magrath expressed his sincere appreciation of the honour conferred upon him. The toast to the profession by J. N. Anderson, A.M.E.I.C., addresses by Dr. Challies, Mr. Newell, Mr. Wright, K. Moodie, M.E.I.C. chairman of the Branch, and Mr. Freeland of the Professional Association gave the finishing touches to what proved to be a most enjoyable evening.

On Sunday afternoon the visiting party was entertained by drives to points of interest in and around Victoria, including the famous Butchart gardens at Brentwood. Following the drives the visitors, together with the members of the Victoria executive and their families, gathered for afternoon tea around the huge fireplace in the rotunda of the Empress hotel and spent a most pleasant social hour together before bidding adieu to one of the most pleasing and distinguished delegations from Headquarters to be entertained in Victoria for many years.

Victoria Branch Holds Dinner for Visitors.

Winnipeg Branch

J. Hoogstraten, A.M.E.I.C., Secretary-Treasurer.

At the regular joint meeting held on October 13th, 1938, H. L. Briggs, A.M.E.I.C., operating engineer of the Winnipeg Hydro-Electric System, gave an interesting address on

Keeping the Lines Alive

Total prime mover capacity connected to the circuits of the City of Winnipeg Hydro-Electric System is 170,000 hp. The load is supplied over two widely separated transmission lines interconnected at both ends, there being a total of 496 circuit miles of 66 kv. lines. Tables summarizing six years of experience, 1932 to 1937, in operating these lines showed lightning to be the largest single cause of trouble. In the same period there have been three total interruptions of power. The procedure whereby operating staffs restore service after a shutdown was described, as were several innovations which are expected to expedite and assure restoration of power in the event of serious trouble in the future. Fault detector relays recently added are expected to further improve continuity of service.

With reference to regulating the system load, 50,000 hp. in off peak electric boiler load is controlled in a manner which results in raising the daily system load factor from 60 per cent to 90 per cent. The flexible procedure whereby the generating stations are maintained at their safe full load, and the hydraulic turbines in their most efficient operating range, was dealt with in considerable detail.

Visit of Delegation from Headquarters

On October 27th and 28th, the Winnipeg Branch was host to President and Mrs. J. B. Challies, Mr. and Mrs. F. Newell and Mr. L. A. Wright. On October 27th, members of the visiting delegation were introduced at a mixed luncheon at the Fort Garry hotel. In the afternoon, the delegation met with the Committee on Consolidation, including members of the Provincial Professional Association, and later with members of the executive committee and other senior members of the Branch.

Winnipeg Luncheon Meeting.

L. A. Wright, A.M.E.I.C., J. J. White, M.E.I.C., A. J. Taunton, M.E.I.C., Mrs. Newell, A. E. Macdonald, M.E.I.C., Mrs. Challies, W. D. Hurst, A.M.E.I.C., Mrs. Taunton, President Challies, Mrs. Hurst, Mr. Burke Gaffney, Mrs. Macdonald, F. Newell, M.E.I.C., J. Hoogstraten, A.M.E.I.C.

At 6.30, the visitors were entertained at dinner, which was attended by members of the executive committee, past chairmen and councillors of the Branch, and the ladies.

At the regular joint meeting in the evening, Mr. Wright spoke on "Reasons for Belonging to The Institute," and Mr. Newell spoke briefly on the progress made in co-operation with the Provincial Associations.

Mr. Aaron Gusen, student in engineering at the University of Manitoba, and winner of The Engineering Institute of Canada Prize, was presented by President Challies with the Certificate of Award.

President Challies, in a short address, traced the history of The Institute and the Provincial Associations of the last fifty years, and pointed with pride to the progress made by the profession.

On October 28th, President Challies addressed a luncheon meeting of the Empire Club on "The Great Lakes to Ocean Waterways," and in the afternoon, members of the visiting delegation addressed the students in engineering at the University of Manitoba.

MEETINGS

American Society of Civil Engineers—Annual Meeting, January 18th-21st, 1939, New York, N.Y.

American Society of Heating and Ventilating Engineers—Annual Meeting, January 23rd to 26th, 1939, William Penn Hotel, Pittsburgh, Pa.

American Water Works Association, Canadian Section—Annual Meeting, April 12th-14th, 1939, at the Royal York Hotel, Toronto. Secretary, Dr. A. E. Berry, Parliament Buildings, Toronto, Ont.

Canadian Construction Association—January 10th-12th, at Winnipeg, Man.

Canadian Pulp and Paper Association—Annual General Meeting, January 25th-26th, 1939, at the Mount Royal Hotel, Montreal.

Ontario Good Roads Association—Annual Meeting, February 22nd and 23rd, 1939, in Toronto. Secretary T. J. Mahony, Court House, Hamilton, Ont.

The Engineering Institute of Canada—Annual General and Professional Meeting, February 14th-15th, 1939, at Ottawa.

Montreal Branch—Smoker at the Windsor Hotel on Thursday, February 2nd, 1939.

Twelfth National Asphalt Conference—February 20th to 24th, 1939, Biltmore Hotel, Los Angeles, Calif.

Additional information about any of these functions may be secured from the General Secretary.

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.

Notices appearing in the Situations Wanted column will be discontinued after three insertions, and will be re-inserted after a lapse of one month, upon request.

All correspondence should be addressed to

The Employment Service Bureau, The Engineering Institute of Canada
2050 Mansfield Street, Montreal

Situations Vacant

COMMISSIONED OFFICERS, ROYAL CANADIAN SIGNALS

At the present time there are two vacancies in the Royal Canadian Corps of Signals for commissioned officers and they anticipate having three or four more between now and the spring. These vacancies are available to graduates of Royal Military College and also to graduates in Electrical Engineering of a recognized university where military training forms part of the curriculum. Copies of the application forms and pamphlets which outline the qualifications necessary for appointment to a commission, may be obtained from the District Signal Officer at any of the headquarters of Military Districts, or from The Institute.

GRADUATE ENGINEER, with ten to fifteen years experience. With particular knowledge of cost estimating of hydro-electric power plants, transmission systems and substations. A knowledge of French and English is an essential requirement. Location Montreal. Apply to Box No. 1816-V.

ELECTRICAL ENGINEER, capable of making inventory in the field. Must be familiar with Overhead and Underground distribution systems. Must be able to make neat records of equipment. Apply to Box No. 1817-V.

ELECTRICAL ENGINEER, capable of making inventory in the field of Power Houses and Substations. Must be familiar with Power House and Substation operation. Must be able to make neat records of equipment. Apply to Box No. 1818-V.

SENIOR ENGINEER, required for radio development work on transmitters and receivers. Must be engineering graduate. and preferably have some experience in radio. Applicants should state salary expected and when their services would be available. Apply to Box No. 1819-V.

JUNIOR ENGINEER required for radio development work. Must be engineering graduate. Applicant should state salary expected and when services would be available. Apply to Box No. 1820-V.

Situations Wanted

ENGINEER, A.M.E.I.C., Combustion specialist heat balance. Steam, Mechanical. Refrigeration. Office routine. Correspondence. Plant layout. Apply to Box No. 5-W.

ELECTRICAL ENGINEER, Jr.E.I.C., B.Sc.; age 31; at present employed, desires change in location. Experience includes; three summers experience in power conduit construction; two years in telephone engineering; four years experience in radio, both development engineering and production; two and one half years in a paper mill on electrical maintenance, with a short time in the cost accounting and draughting departments. Would be interested primarily in electrical maintenance. Apply to Box 12-W.

PAPER MILL ENGINEER A.M.E.I.C., Married, Ten years experience in the design, construction, maintenance and costs of pulp and paper mills is seeking a permanent position. Available on short notice. Apply to Box No. 150-W.

SALES ENGINEER REPRESENTATIVE. Mechanical graduate with fifteen years experience in Eastern Canada in sales and service of mechanical equipment; full details upon request to Box No. 161-W.

ENGINEER-DRAUGHTSMAN, experienced in design of machines for widely varied purposes and arrangement of motor drives. Accustomed to layout of small mill buildings, steel and timber. Good references. Present location Montreal. Apply to Box No. 329-W.

Situations Wanted

CIVIL ENGINEER, M.A.Sc., A.M.E.I.C. eight years survey and municipal engineering experience, and three years draughting, detailing steel, concrete, and timber structures. Apply to Box No. 467-W.

CIVIL ENGINEER, B.Sc. (McGill '20), A.M.E.I.C. Married. Twelve years experience in pulp and paper mill design, and six years general construction. Available immediately. Location immaterial. Apply to Box No. 547-W.

ELECTRICAL ENGINEER, B.Sc. '28. Two years student apprenticeship at Can. Westinghouse Co., including test and electrical machine design. Also about two years experience in operating dept. of large electrical power organization. Available on short notice. Apply to Box No. 660-W.

CIVIL ENGINEER, B.A.Sc. (Toronto '27), age 34, married. Five years railway and construction work as building inspector and instrumentman. Level engineer and on construction of a long timber flume for a pulp and paper mill. Field engineer for a sulphite company, in charge of the following mill buildings, acid, digester, blow pit, barker room, chip storage and acid towers. Available immediately. Apply to Box No. 714-W

ELECTRICAL ENGINEER, B.Sc. '31 (U.N.B.), Jr.E.I.C. Age 30 years. Single. Experience in electrical wiring, construction of concrete wharves, inspection of piling, rip rap, concrete reinforcing, forms, and dredging. Also junior engineer. Available at once. Apply to Box No. 722-W.

CIVIL ENGINEER, B.Sc., M.Sc., P.P.E.; Lieut. C.E., R.O. Sixteen years municipal, highway and construction. Five years overseas. Married. Read, write and talk French. Will go anywhere. Apply to Box No. 737-W.

ELECTRICAL ENGINEER, B.Sc. '31. Jr.E.I.C. Age 31. Experience includes: eight months on installation of power and lighting equipment; three years as supervisor of an electrical and service dept.; seven months testing power and radio equipment; one year as inspector on electrical equipment and control. At present employed. Available on one month's notice. Location immaterial. Apply to Box No. 740-W.

CIVIL ENGINEER, A.M.E.I.C. Experienced in general construction, buildings, gravel and asphalt roads. Acting in charge P.W.D. West Africa. Chief field engineer refinery construction. Survey Angola Rly. West Africa. General Office work. Apply to Box No. 765-W.

ELECTRICAL ENGINEER AND GEOPHYSICIST. Age 41. 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. Experience 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.

TECHNICALLY TRAINED EXECUTIVE. General experience administrative, organization and management in business and industrial fields, including; business, plant, property and estate management; plant maintenance, modernization, production and personnel; economic studies, company reorganizations and amalgamations, valuations; railroad, highway, hydro, pulp, newsprint, housing, industrial surveys, investigations and construction; B.Sc. degree in engineering, age 49, married, Canadian. Apply to Box No. 1175-W.

CHEMICAL ENGINEER, grad. McGill '34, experienced in meter repairs, control work; and also chemical laboratory experience. Apply to Box No. 1222-W.

Situations Wanted

ELECTRICAL ENGINEER, B.Sc. '31. Age 35. Experience in oil field work and railways construction survey. Two years on installation and maintenance of mine equipment, and two years industrial plant engineering on design and layout of equipment. Available immediately. Will go anywhere. Apply to Box No. 1249-W.

MECHANICAL ENGINEER, B.Eng (McGill). Age 25. Experience includes—one year marine engineering, Diesel and steam; over two years general engineering work in paper mills including draughting, building and equipment layouts, power plant work, mill maintenance planning and costing. Seeking permanent position to acquire thorough knowledge of operation and maintenance. Available immediately. Apply to Box No. 1272-W.

FIELD ENGINEER AND DRAUGHTSMAN, A.M.E.I.C. Age 36. Married. Fifteen years experience in civil engineering, general draughting and instrument work. Experience covers office and layout work on construction of sewers, water mains, gas mains, (6" to 30" dia.) and transmission line structures; topographic and stadia surveys. Draughting covers general civil, reinforced concrete and steel design, mechanical detailing and arrangements, and mapping. Present location Montreal, but willing to locate anywhere. Available at once Apply to Box No. 1326-W.

CIVIL AND ELECTRICAL ENGINEER, Jr.E.I.C. (Univ. of Man.). Married. Age 25. Good draughtsman. Four months draughting, one year instrumentman on highway location and construction, inspection and miscellaneous surveying and estimating. Six months as field engineer on pulp and paper mill construction. Prefer electrical or structural design. Available at once. Apply to Box No. 1633-W.

CIVIL ENGINEER, B.Sc. in C.E. '34. S.E.I.C. Age 27. Five years experience, including harbour construction, highway paving, one and a half years paper mill construction, instrument work, draughting, estimating, interested in design. Available on short notice. Apply to Box No. 1737-W.

CHEMICAL ENGINEER, graduate, Toronto '31. Seven years experience in paper mill, meter maintenance, control work and chemical laboratory. Speaking French and English. Location immaterial. Available at once. Apply to Box No. 1768-W.

CIVIL ENGINEER, B.A.Sc., Jr.E.I.C. (Toronto '35). Age 24. Experience in structural design, construction and surveying, including one year in South America. Details on request. Apply to Box No. 1784-W.

ELECTRICAL ENGINEER, Jr.E.I.C. B.Sc. Age 25. At present employed, but desiring change of location. Three years maintenance and test work, toll and automatic telephone equipment; two years sales engineering, telephone and electrical equipment. Prefer to remain in telephone field, but would be interested in any opportunities in electical engineering. Apply to Box No. 1817-W.

CIVIL ENGINEER, B.E., Jr.E.I.C., 28 years of age. Married. Desires position with reliable construction firm. Intends to make construction life work. Over five years experience on permanent highway construction, inspection, estimates and instrument work. Available on short notice. Apply to Box No. 1820-W.

ELECTRICAL ENGINEER, B.A.Sc. '33. Age 27. Married. Jr.E.I.C. One year's experience in power plant operation and over three years experience in hydroelectric development and construction. Expert draughtsman and instrumentman, including experience in steam gauging, and reinforced concrete design and construction. Available at once. Apply to Box No. 1829-W.

CIVIL ENGINEER, B.A.Sc. (Toronto '35), Jr.E.I.C. Age 26. Experience in highway layout and construction, concrete bridge construction, draughting, office work, and surveying. Further details on request. Good references. Available immediately. Location immaterial. Apply to Box 1832-W.

ELECTRICAL ENGINEER, B.Sc. (Manitoba '36), S.E.I.C. Practical and theoretical experience in radio. Have done experimental work. At present doing radio service work. Available at once. Apply to Box No. 1833-W.

CIVIL ENGINEER, B.Sc. '37, S.E.I.C. Age 22. At present employed, desires position with construction firm. Experience includes field instructing of transit and chain survey crews, draughting for geologist, instrument work and general supervision on highway construction work, purchasing in papermill. Available on few weeks' notice. References and details on request. Willing to locate anywhere that offers required class of work. Apply to Box No. 1840-V.

Preliminary Notice

of Applications for Admission and for Transfer

November 25th, 1938.

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 1939.

L. Austin Wright, General 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

BALL—ELMER LANGDON, of 113 South Park St., Halifax, N.S., Born at Botwood, Nfld., March 24th, 1916; Educ., B.Eng. (Civil), N.S. Tech. Coll., 1938; 1935-36-37 (summers), Geodetic Survey of Nfld.; July 1938 to date, junior engr., Engineering Service Company, Halifax, N.S.
References: I. P. MacNab, W. P. Copp, S. Ball, W. M. Dennis, J. R. Kaye, P. A. Lovett.

BIRD—WILLIAM HENRY STEPHENSON, of 338 So. Marks St., Fort William, Ont., Born at Fort William, April 18th, 1910; Educ., Bach. Aero. Engrg., Univ. of Minn., 1935; Dec. 1935 to June 1936, aeronautical design, layout, dfting., etc., and June '36 to July 1937, chief dftsman., J. D. Akerman and H. W. Barlow Co., Minneapolis, Minn.; July '37 to Dec. '37, project engr., Porterfield Aircraft and Engineering Corpn., Kansas City; Dec. '37 to Sept. '38, group leader i/c landing gear, hydraulic system, wings, tail surfaces, etc., and at present, chief dftsman., Canadian Car and Foundry Company, aviation divn., Fort William, Ont.
References: D. Boyd, G. R. Duncan, P. E. Doncaster, G. O'Leary, K. A. Dunphy.

BIRD—WILLIAM LISTER, of 338 So. Marks St., Fort William, Ont., Born at Bracebridge, Ont., April 5th, 1878; Educ., Grad., Can. Gen. Elec. students elect'l. course, Peterborough, 1895-97; Life Member, A.I.E.E.; 1897-99, switchboard operator, 1899-1903, asst. supt., 1903-06, supt., Lachine Rapids plant; 1920-21, gen. mgr. and treas., Fort William Paper Co., during constrn. and first year's operation; 1906 to date, with the Kaministiquia Power Co. Ltd., as gen. supt., manager, director, and at present, vice-president and general manager (and engineer), in responsible and executive charge of all constrn., mtce. and operation of company's plant extensions up to 35,000 h.p. (Past-President, Canadian Electrical Association.)
References: R. S. Kelsch, J. C. Smith, G. R. Duncan, G. O'Leary, P. E. Doncaster.

CARRIERE—JEAN P., of 995 Maitland Ave., London, Ont., Born at Hull, Que., Nov. 15th, 1907; Educ., Private tuition. R.P.E. of Quebec by Exam.; 1923-24, instr'man., 1924-27, asst. engr., City of Hull; 1927-28, asst. engr., E. B. Eddy Co., Hull, Que.; With the Dept. of Public Works of Canada as follows: 1928-34, dftsman., Ottawa and Rimouski, 1934-36, junior engr., and 1936-38, asst. engr., Rimouski, and at present, asst. engr., London, Ont.
References: K. M. Cameron, R. de B. Corriveau, H. F. Bennett, B. Grandmont, A. R. Decary, J. E. St. Laurent, R. F. Legget.

GERMAN—HORACE HENRY, of 190 Stanstead Ave., Town of Mount Royal, Que., Born at Bere Alston, Devon, England, May 15th, 1888; Educ., 1908-12 (1 year) Royal College of Science, (3 years) Royal Naval College, Greenwich; (National Scholar, Martel Scholar (1 award), Admiralty Scholar); 1902-08, shipwright ap'tice, incl. 1 year in drawing office and 1 year "lining off" H.M.S. "Temeraire;" 1912-14, asst. chief., scientific dept., Vickers Ltd., Barrow, England; With Canadian Vickers Ltd. as follows: 1914-16, chief of design, 1916-18, naval architect, 1918-22, asst. gen. mgr., 1922-28, mgr., marine and aviation; 1928 to date, consltg. naval architect, Lambert and German, now Lambert, German & Milne, Montreal, Que.
References: R. Ramsay, F. S. B. Heward, J. L. Busfield, C. K. McLeod, G. J. Desbarats, W. T. Reid, R. E. Heartz, R. C. Flitton.

HULL—ARTHUR HARVEY, of 12 Crang Ave., Toronto 10, Ont., Born at Cayuga, Ont., Feb. 6th, 1886; Educ., B.A.Sc., Univ. of Toronto, 1906; 1905 (summer), machine shop work, Smart Turner Co., Hamilton, Ont.; 1906-09, engr. ap'tice course, Canadian Westinghouse Co., Hamilton; 1909-11, elect'l. dftsman., and 1911-13, engr.—field inspection, test and supervising of station dfting., Smith Kerry & Chace, Toronto; 1913-20, engr., (asst.) field inspection tests, design, specifications and contracts on elect'l. stations and equipment, 1920-38, engr.-in-charge, station section, elect'l. engrg. dept., and at present, acting elect'l. engr., Hydro-Electric Power Commission of Ontario, Toronto, Ont.
References: T. H. Hogg, E. T. J. Brandon, C. E. Sisson, O. Holden, W. P. Dobson, D. Forgan.

INGLIS—WILLIAM LEISHMAN, of 552 Boundary Road, Vancouver, B.C., Born at Glasgow, Scotland, Dec. 23rd, 1912; Educ., B.A.Sc. (Civil), Univ. of B.C., 1934; 1934-35, dftsman., B.C. Electric Rly. Co.; 1935-37, estimating, detailing and field work, Western Bridge Co.; 1937-38, asst. engr., Sir Alexander Gibb & Partners, consltg. engrs., London, England, on design and constrn. of Treforest Trading Estate; asst. res. engr., British Air Ministry, at Carlisle and Chawbury on aerodrome constrn.; at present, struct'l. steel detailer, Western Bridge Company, Vancouver, B.C.
References: J. P. Mackenzie, P. H. Buchan, C. W. Deans, E. C. Luke, A. Peebles, W. H. Powell, H. B. Muckleston.

KAY—WILLIAM, of Riverbend, Que., Born at Bury, Lancs., England, Oct. 26th, 1902; Educ., 1916-21, Bury Municipal Tech. School; Passed Union of Lancashire and Cheshire Institute Exams. to 5th year mech. engrg.; 1916-23, ap'ticeship, dfting. office, fitting and outside erection with C. Walmsley Atlas Iron Works, Bury, Lancs.; Transferred to C. Walmsley Can. Works, Longueuil, Que., 1923-24, erecting shop, 1924-27, outside erection supervisor, 1927-28, production manager; 1928-30, outside erection supervisor, Dominion Engineering Works Ltd.; 1930 to date, mech. dept., and at present, master mechanic, Price Bros. & Co. Ltd., Riverbend, Que.
References: S. J. Fisher, G. F. Layne, G. H. Kirby, A. Cunningham, J. G. Notman.

LEMIEUX—CHARLES, of 198 Holland Ave., Quebec, Que., Born at Henryville, Que., Sept. 23rd, 1898; Educ., 1919-21, two years, app. science, McGill Univ. Diploma in Chemistry, Univ. of Nancy, France, 1923; 1930-32, surveying, testing materials, City of Montreal; 1932-33, chief chemist, Lasalle Petroleum Refineries, Champlain Oil Ltd.; 1933-37, erection supt., Amherst Oil Ltd.; 1937-38, assayer and chief chemist, General Petroleum Refineries Ltd.; at present, managing director, Les Petroles de Quebec Inc. (chemist of newly formed company), Quebec, Que.
References: R. Dupuis, L. G. Trudeau, P. Methe, F. J. Leduc, C. E. Hogarth.

MORRISON—FREDERIC CHARLES, of New Waterford, C.B., N.S., Born at New Waterford, May 19th, 1910; Educ., B.Eng. (Elec.), N.S. Tech. Coll., 1936; 1931-32 (summers), P. Pilot Officer, R.C.A.F.; 1933 (summer), mechanic, Dominion Coal Co.; 1935 (summer), Dept. of Highways, Sydney, N.S.; June 1936 to date, lubrication engr., Dominion Steel and Coal Corporation, Sydney, N.S.
References: W. S. Wilson, A. P. Theuerkauf, J. A. MacLeod, S. C. Mifflen, W. P. Copp.

MORRISON—ROBERT LAURANCE, of 2017 Daniel St., Trail, B.C., Born at Kelowna, B.C., Dec. 18th, 1905; Educ., B.A.Sc., Univ. of B.C., 1929; Summers—1924, rodman, C.P.R., 1925 transitman and dftsman., Cariboo Highway Surveys, 1926, recorder and transitman, Dominion Topog'l. Surveys; 1927, transitman i/c sub-parties, and 1928, topog'r. i/c sub-parties, Dominion Topog'l. Surveys; 1929-30, testman, 1930-31, i/c industrial control testing dept., 1931-32, production engrg., responsible for production of small motors, meters and industrial control equipment, Can. Gen. Elec. Co. Ltd., Peterborough, Ont.; 1935 to date, mech'l. designer, special-

izing in plant layout, Consolidated Mining and Smelting Co. of Canada Ltd., Trail, B.C.
References: H. A. Moore, H. Vickers, A. E. Wright, A. C. Ridgers, S. C. Montgomery, G. H. Bancroft, A. L. Atwood.

MUTCHLER—JAMES IRVING, of Regina, Sask., Born at Milwaukee, Wis., Feb. 8th, 1905; Educ., B.Sc. (Agric.), Univ. of Sask., 1925; 1922-24 (summers), chainman and rodman, C.N.R.; 1925-26, instructor, farm motors and mach., Univ. of Sask.; 1928-29, instr'man. and topogr., and 1929, res. engr., constrn. dept., C.N.R.; 1930-35, field and office engr., Beauharnois Construction Co.; 1936-38, district engr., and April 1938 to date, senior survey engr., P.F.R.A., Dom. Dept. of Agriculture, i/c surveys, design, and office administration of water development and irrigation projects under the above Act.
References: B. Russell, M. V. Sauer, L. H. Burpee, J. P. Chaplean, E. K. Phillips, C. H. Pigot.

PROUDFOOT—W. BRADLEY, of 4710 Decarie Blvd., Montreal, Que., Born at Russell, Ont., Sept. 11th, 1911; 1928-35, line constrn., elect'l. power house mtce., power costing, etc., H.E.P.C. of Ontario; 1935-37, design and erection of elect'l. control apparatus for Canadian Controllers Ltd., Toronto; at present, engr., Railway and Power Engineering Corpn. Ltd., Montreal, Que.
References: K. O. Whyte, G. Kearney, R. A. Yapp.

RUSSELL—EARL ALBERT, of 111 Ranleigh Ave., Toronto, Ont., Born at Fort William, Ont., Sept. 1st, 1915; Educ., B.A.Sc., Univ. of Toronto, 1938; 1936-37 (summers), dftsman; 1938 (2 mos.), dftsman. and designer, Harkness & Hertzberg, Toronto; 1938 (3 mos.), dftsman. and i/c calculations on location survey party; at present, demonstrator, dept. of surveying, University of Toronto, Toronto, Ont.
References: J. J. Spence, J. R. Cockburn, C. R. Young, W. S. Wilson, C. S. L. Hertzberg, A. H. Harkness.

SPENCER—BRIAN ROFF, Lieut.-Commdr. (E), R.C.N., of Halifax, N.S., Born at Alberni, B.C., Jan. 8th, 1907; Educ., 1925-29, Royal Naval Engineering College, Devonport, England. 1922-24, Univ. of B.C.; 1929-30, junior engr. on engine room staff, H.M.S. "Emperor of India"; 1930-31, junior engr., H.M.S. "Valiant"; 1931-33, asst. to chief engr., H.M.C.S. "Saguenay"; 1933-34, asst. to director of naval engrg., Dept. of National Defence, Ottawa, Ont.; 1934-36, engineer officer, H.M.C.S. "Champlain"; 1936 to date, engineer officer, H.M.C.S. "Saguenay."
References: A. D. M. Curry, G. L. Stephens, A. C. M. Davy, H. S. Johnston, J. L. Busfield.

TAYLOR—THOMAS FRANKLIN, of 46 Garfield Avenue, London, Ont., Born at Watford, Ont., Dec. 24th, 1910; Educ., B.A.Sc., Univ. of Toronto, 1934; 1930 and 1932 (summers), Wells Motors, and Richards Wilcox Canadian Co., London, Ont.; 1935-37, demonstrator, engrg. drawing, Univ. of Toronto; 1937 to date, dftsman., Richards Wilcox Canadian Co., London, Ont.
References: J. J. Spence, M. B. Watson, E. A. Allcut, D. S. Scrymgeour, J. R. Cockburn.

TAYLOR—WILLARD DAVIDSON, of 6187 Terrebonne Blvd., Montreal, Que., Born at Ottawa, Ont., Dec. 18th, 1902; Educ., B.Sc. (E.E.), McGill Univ., 1927; 1922-23-24 (summers), Dominion Bridge Company, Ottawa; 1925 (June-Dec.), student training course, Wagner Elec. Corpn., St. Louis, Mo., 1926, with above firm in automotive starting, lighting and ignition dept., designing above equipment; 1927-32, with the C.N.R., as electrician, electrical inspector, and finally as asst. elect'l. engr., central region. Work incl. design and supervision of installn. of elect'l. and mech. equipment as used on rlys., incl. transmission lines, transformer structures, foundry and locomotive shop elect'l. equipment; 1932 to date, with the Railway and Power Engineering Corpn. Ltd., sales and design, incl. supervision of erection of industrial furnaces, elect'l. control apparatus, pyrometer equipment, and deep well pump equipment, at present, engr. in charge, Montreal office, technical sales, design and erection supervision.
References: K. O. Whyte, G. Kearney, C. V. Christie.

YOUNG—LOYOLA CURRIE, of 365 Morris St. Ext., Halifax, N.S., Born at Sydney, N.S., Dec. 26th, 1903; Educ., B.Sc., N.S. Tech. Coll., 1930; Summers—1920-24, electrn's helper, 1924-25, electrn.; 1925-26, electrn., pulp mill, Corner Brook, Nfld.; 1926-27 and 1928-29, elect'l. dftsman. and asst. to elect'l. supt., Dominion Iron & Steel Co., Sydney; 1930-35, student engr., N.S. Light & Power Co. Ltd., Halifax; 1935-36, acting gen. supt., Demerara Electric Co., Georgetown, British Guiana, S.A.; 1936 to date, elect'l. engr., light and power dept., N.S. Light & Power Co. Ltd., Halifax, N.S.
References: J. R. Kaye, J. J. Sears, J. B. Hayes, P. A. Lovett, R. R. Murray.

FOR TRANSFER FROM THE CLASS OF ASSOCIATE MEMBER TO THAT OF MEMBER

BABCOCK—HAROLD AUSTIN, of Toronto, Ont., Born at Oshawa, Ont., July 8th, 1895; Educ., B.A.Sc., Univ. of Toronto, 1917; R.P.E. of Ont.; 1917-18, Dominion Bridge Company, Toronto; 1918-20, H.E.P.C. of Ontario; 1920-28, designing office, James, Proctor & Redfern, Toronto; 1928 to date, partner, Margison & Babcock, consltg. engrs., Toronto. Responsible for design and supervision of many industrial bldgs. in various parts of the province, and retained by several municipalities in an engrg. capacity. (*A.M. 1922.*)
References: C. R. Young, A. R. Robertson.

DUNSMORE—ROBERT LIONEL, of Imperoyal, N.S., Born at Seaforth, Ont., Sept. 2nd, 1893; Educ., B.Sc. (Civil), Queen's Univ., 1915; 1912, recorder, Geodetic precise levelling party; 1913-14, asst. engr., Federal Dept. Public Works, Harbours development, Fort William; 1915-19, overseas, Major, C.E.F.; 1919, asst. to city engr., Sarnia, Ont.; With the Imperial Oil Limited as follows: 1919-22, engr., Sarnia, Ont., 1922-24, engr. i/c constrn., Calgary Refinery, 1924-25, asst. supt., Calgary Refinery; 1925-29, supt., and 1929-30, gen. supt., Talara (Peru) Refinery, International Petroleum Company; 1930 to date, supt., Halifax Refinery, Imperial Oil Limited. (*A.M. 1924.*)
References: T. Montgomery, J. J. Hanna, I. P. MacNab, H. S. Johnston, C. H. Wright.

PITTS—GORDON MacLEOD, of 900 Sherbrooke St. West, Montreal, Que., Born at Fredericton, N.B., March 10th, 1886; Educ., B.Sc., 1908, M.Sc., 1909, B.Arch., 1916, McGill Univ.; 1906-07, engr. on constrn., C.P.R.; 1907-08, senior dftsman., Transcontinental Rly.; 1909-12, constrn. engr., P. Lyall & Sons; 1912-14, engr. for Protestant School Commn.; 1914-16, engr. with Edward and W. S. Maxwell; 1916-19, asst. to John A. Pearson, Parliament Bldgs., Ottawa; 1919 to date, partner, Maxwell & Pitts, Architects, Montreal, Que. (*St. 1908, A.M. 1914.*)
References: J. B. Challies, R. E. Jamieson, R. J. Durley, B. R. Perry, F. S. Keith, H. O. Keay.

WILSON—HARRY ALTON, of Leslie Apts., 6 Griffith St., Welland, Ont., Born at Glenora, Ont., April 17th, 1890; Educ., Grad., S.P.S., Univ. of Toronto, 1911; 1907-13, during vacations and for two years after graduation, machine shops, designing, field erection, etc.; 1913-14, tool designer, Cadillac Motor Car Co.; 1914-15, Montreal Editor, Canadian Machinery and Manufacturing News; 1915-18, gen. supt., munition plant, J. C. Wilson & Co., and 1918-20, chief engr., J. C. Wilson Mfg. Co. Ltd.; 1920-21, new equipment engr., North East Electric Co.; 1921-23, sales engrg. and gen. work; 1923, sales engr., and 1923-35, chief engr., Canadian Fairbanks Morse Co. Ltd., Montreal; work included recommendation of Diesel engines, marine and stationary; electric motors, generators and alternators; pumps of all types, etc.; designing municipal water and pumping plants, steam power plants, hydro-electric plants; improvements to steam and water power plants, industrial plants, municipal plants, etc.; 1935-38, resident Canadian engineer, for Aurora Pump Co., Aurora, Ill., Labour Co. Inc., Elkhart, Ind., Micro-Westco Inc., Davenport, Iowa, Kisco Boiler and Engrg. Co., St. Louis, Mo.; at present, in charge of engrg. sales and development, Canada Foundries & Forgings Ltd., Welland, Ont. (*A.M. 1922.*)
References: J. A. McCrory, F. S. Keith, M. S. Macgillivray, F. A. Combe, D. F. Grahame, F. V. Dowd, N. E. D. Sheppard.

FOR TRANSFER FROM THE CLASS OF JUNIOR

DUCHASTEL de MONTROUGE—LEON ALEXANDRE, of 4582 Oxford Ave., Montreal, Que., Born at Westmount, July 22nd, 1905; Educ., B.A.Sc., C.E., Ecole Polytechnique, Montreal, 1927; R.P.E. of Que.; 1922-26 (summers), with the Quebec Streams Commn., Quebec Highway Dept., Welland Ship Canal; With the Shawinigan Water & Power Company as follows: 1929-31, study of upper St. Maurice River and prelim. layout of hydro-electric plants; 1931-33, design of concrete for Rapide Blanc development; 1933-35, various work incl. cost survey of all the company's power houses; 1935 to date, power sales divn., commercial and distribution dept., at present, power sales engr., asst. to power sales mgr. (*St. 1925, Jr. 1933.*)
References: O. O. Lefebvre, A. Frigon, J. A. McCrory, A. L. Patterson, J. B. Challies, P. S. Gregory, J. C. Smith, A. Duperron.

REGAN—FRANCIS EDWARD, of 45 Niagara St., Toronto, Ont., Born at Darwen, Lancs., England, Nov. 3rd, 1905; Educ., Associate of Royal Technical College, Salford, 1924; City and Guilds of London Institute, First Class Diploma in Elec. Engrg. (Final), 1927; 1924-27, college ap'tice, Lancashire Dynamo and Motor Co., Trafford Park, England; 1927-32, sales engr., Montreal, and 1932-33, asst. manager, Toronto office, Lancashire Dynamo and Crypto of Canada; 1933-34, sales engr., Toronto and Montreal, and 1934 to date, Ontario Manager, Bepco Canada Limited, Toronto, Ont. (*Jr. 1930.*)
References: J. L. Busfield, C. K. McLeod, R. A. Yapp, D. M. Fraser, J. A. Reid, G. Moes, F. A. Becker, K. O. Whyte, A. C. Blue.

TIMLECK—CURTIS JAMES, of 574 Gertrude Ave., Winnipeg, Man., Born at Pittston, Ont., June 16th, 1903; Educ., B.A.Sc., Univ. of B.C., 1926; 1924-25 (summers), Britannia Mining Co. Ltd., Britannia Beach, B.C.; 1926-27, shop work, Phillipsburg and Easton plants, 1927-28, service engr., New York and Syracuse, Ingersoll Rand Co.; With the Canadian Ingersoll Rand Co. Ltd. as follows: 1928-29, sales and service, Rouyn; 1929-34, i/c contract service dept., Montreal; 1934, sales engr., Nelson, B.C., and 1934 to date, sales engr., Winnipeg, Man. (*St. 1923, Jr. 1931.*)
References: W. Walkden, H. B. Brehaut, E. Winslow-Spragge, T. C. Main, W. H. Powell.

YEOMANS—RICHARD HENRY, of Montreal, Que., Born at Buffalo, N.Y., Sept. 17th, 1905; Educ., B.Sc., McGill Univ., 1930; 1922-38, work in various depts. in factory, also in inspection engrg. dept., equipment dept., and apparatus engrg. dept., at present, asst. dial apparatus engr., Northern Electric Co. Ltd., Montreal. (*St. 1928, Jr. 1933.*)
References: N. L. Dann, H. J. Vennes, A. J. Lawrence, W. H. Jarand, H. Miller.

FOR TRANSFER FROM THE CLASS OF STUDENT

HART—HERBERT TRENCH, of Kingston, Jamaica. Born at St. Andrew, Jamaica, Jan. 18th, 1910; Educ., B.Eng. (Elec.), McGill Univ., 1932; Summers—1927, factory work, Power Equipment Co., Hendon, England; 1929, pole line constrn., Bell Telephone Company; 1930, Jamaica Public Service Co. Ltd.; 1931, electrn. helper, Beauharnois Constrn. Co.; 1932 to date, asst. manager, i/c buildings and equipment, Jamaica Theatres Ltd., Kingston, Jamaica. (*St. 1930.*)
References: E. Brown, C. V. Christie, R. DeL. French, C. M. McKergow, A. R. Roberts.

Consumers of Canada

Through the kindness of Consumers' Research, Inc., sample copies of that body's publication "Consumers' Digest" are being furnished to The Institute library and will be placed on the reading room table at Headquarters. This body, which has for years been active in the United States, is planning to extend its operations to Canada, for which purpose a similar organization, Consumers of Canada, Inc., has been formed. A Federal Charter has been secured and the objectives of the new body, like those of Consumers' Research are:—

1. To provide its subscribers with accurate, scientific, complete and unbiased information about the everyday commodities which they buy, giving comparisons by brand-name and price so that intelligent selections may be easily made.
2. To expose deceits, frauds and hazards wherever they may occur.
3. To develop a widespread consumer-consciousness which will be strong enough eventually to effect much-needed reforms in business and government.

The Canadian organization, like that in the United States, will be supported entirely by subscriptions to its publication, a monthly magazine informing its subscribers as to the results of tests of household appliances, examinations of fuels, foods, materials, and equipment etc., offered for sale to and used by the public.

Among examples of the information recently furnished by the American organization may be cited the results of tests on nine brands of mayonnaise as to odour, consistency, taste, fat content and character of the oil used as a base. In another article information is given which is of great value to a householder contemplating the installation of an oil burner for domestic heating, emphasis being laid on the technical characteristics of the various makes. A third article gives data as to the relative appreciation by the public which has been accorded to a long list of motion pictures which are now being shown, this rating being based upon an analysis of the reviews published in current papers and periodicals.

It will thus be seen that the information service available will be of wide scope, and if intelligently used, will furnish much-needed guidance and protection.